PART I

MACROECONOMIC FRAMEWORK FOR RISK MANAGEMENT IN THE MARKET OF FINANCIAL SERVICES

Chapter 1.

RISK TREATMENT IN SOLVENCY II AND BASEL III CONCEPTS[1]

The increased number of risks in the current terms of globalization, internationalization, financial deregulation and integration, as well as complex macroeconomic environment, impose the necessity for new measures of capital adequacy of financial institutions. Global economic crisis that emerged in 2007/08 has made the issue of redefining risk treatment in solvency evaluation of insurance companies and banks even more important. During the last decades the process of establishing a risk-based regulatory framework for financial institutions was intensified in the form of Solvency II concept in insurance sector, and Basel II/III standards in banking sector.

The subject of this chapter is a comparative analysis of Solvency II and Basel III concepts, in terms of capital adequacy requirements and treatment of risk. The aim of the research is to identify similarities and differences of two regimes, in order to determine their advantages and disadvantages. In the light of consolidation in financial sector, Flamée & Windels (2009) emphasize the importance of comparing regulatory frameworks for various financial institutions. In order to ensure the level playing field for all participants, convergence of regulatory approaches should be enhanced. Discrepancies between regulatory regimes enable arbitrage opportunities for financial conglomerates, through investments in entities with lower capital requirements thereby endangering the stability of financial system[2]

While papers that compare different solvency regimens of insurance companies are abundant in the literature[3] comparisons of Solvency II and Basel II/III are

[1] The authors gratefully acknowledge the financial support of the Ministry of Education, Science and Technology of the Republic of Serbia, Grant No 179005.

[2] Mälkönen, V. (2004). Capital adequacy regulation and financial conglomerates. *Bank of Finland Discussion Papers,* 10(2004), p. 20.

[3] See, for example: Cummins, J.D., Harrington, S., Niehaus, G. (1993). An Economic Overview of Risk-Based Capital Requirements for the Property-Liability Insurance Industry. *Journal of Insurance Regulation,* 11(4), pp. 427-447; Eling, M., Holzmüller, I. (2008). An Overview and Comparison of Risk-Based Capital Standards. *Working Papers on Risk Management and Insurance,* No. 57, St. Gallen: Institute of Insurance Economics, University of St. Gallen; von Bomhard, N. (2010). The Advantages of a

rare. Comparison conducted by Gatzert & Wesker (2011) is based on different characteristics of banks and insurance companies, which impose different objectives of their regulation. In the focus of the analysis of Al-Darwish et al. (2011) are expected consequences of simultaneous application of two regulatory frameworks, with special emphasis on capital costs and possible sources of arbitrage. Laas & Siegel (2015), on the other hand, analyse the consistency of two concepts in the domain of measuring market and credit risk, while Thibeault & Wambeke (2014) are interested in the implications of these concepts on investment decisions of insurers and banks. The contribution of our research compared to previous efforts resides in the comparison of two frameworks by applying a unique approach, which is focused on treatment of risk as an essential feature of these concepts, but at the same time our approach is not limited to individual risks but it takes into account all risks that threaten banks and insurance companies.

1. BASIC ELEMENTS OF SOLVENCY II CONCEPT

The regulatory framework for determining the solvency of insurance companies in the European Union (EU) was formally established with directives adopted in 1973 for non-life and in 1979 for life insurance. In meantime, new risks emerged and previously identified risks were intensified and significant progress was achieved in the field of risk measurement and management. During the last two decades, the insurance sector is exposed to volatility pressures of financial markets and increasingly frequent catastrophic events.[4] The present environment of insurance companies is characterized by complex insurance products and investment strategies as well as business expansion into new markets and activities. This modified environment imposes a challenge for supervisory authorities.[5] The inconsistency in application of the existing solvency regime, its non-compliance with international accounting and financial reporting standards, as well as the failure to recognize the growing role of

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Global Solvency Standard. *Geneva Papers on Risk and Insurance - Issues and Practice,* 35(1), pp. 79-91.

[4] Linder, U., Ronkainen, V. (2004). Solvency II - Towards a new insurance supervisory system in the EU. *Scandinavian Actuarial Journal*, 2004(6), p. 463.

[5] Kočović, M., Mitrašević, M. (2011). Savremeni problemi i trend u regulaciji solventnosti. In: *Nadzor i kontrola poslovanja osiguravajućih kompanija,* Kočović, J. (ed.), Belgrade: Faculty of Economics, Publishing Center, pp. 488-489.

insurance groups and financial conglomerates[6] are increasingly taking the role of limiting factors for further development of insurance industry.

In quite different environment for insurance companies, there is a need to develop a fundamentally different methodology for determining their solvency that departs from the outdated model based on fixed coefficient. While the revisions of Solvency 0 regime have resulted in the implementation of Solvency I concept, at the beginning of the XXI century the process of building a completely new, risk-based approach for evaluation of insurer's solvency was initiated resulting in Solvency II concept. In December 2009 Solvency II Directive[7] was adopted. After multiple delays, the implementation of this concept in EU started on 1st January 2016.

The aim of Solvency II concept is not related to *a priori* increase in the overall level of capital in insurance sector, but to the establishment of high standards of risk management, ensuring better protection of interests of policyholders.[8] In accordance with this main objective, additional objectives are related to increasing the level of competition, transparency and flexibility of insurers' business, establishing trust in insurance institutions, stability and integrity of insurance sector, and the whole financial sector in the EU, as well as the harmonization of control of various financial institutions.[9]

Following Basel standards, Solvency II concept combines three pillars in its structure (see Figure 1). The first pillar incorporates quantitative requirements in terms of formation and disposal of technical reserves, the required and available capital of insurance companies and their investment activities. The second pillar is devoted to qualitative standards of risk management in insurance, to principles of internal control and to interaction with supervisory authorities. An important element of risk management system is insurer's Own Risk and Solvency Assessment (ORSA), that takes into account specific risk

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[6] Trainar, P. (2006). The Challenge of Solvency Reform for European Insurers. *Geneva Papers on Risk and Insurance - Issues and Practice,* 31(1), pp. 170-171.

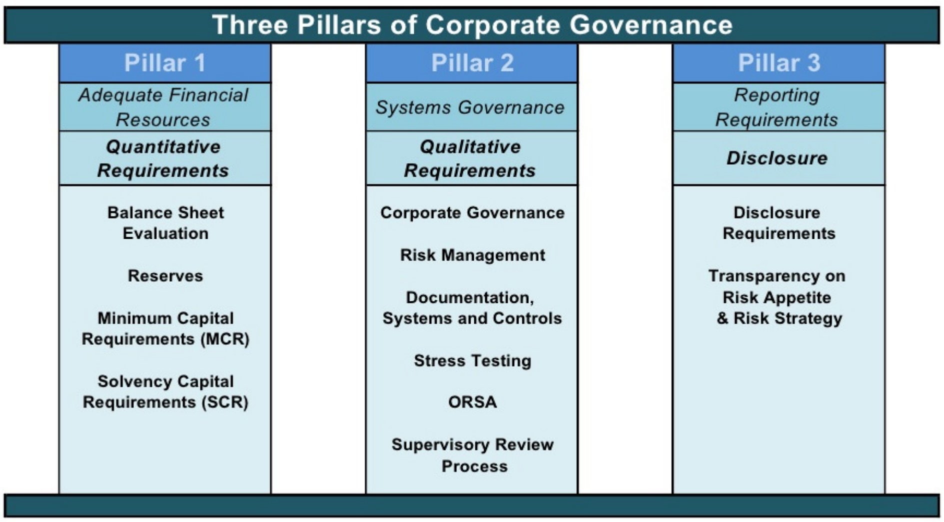
[7] EC (2009). Directive 2009/138/EC of the European Parliament and of the Council of 25 November 2009 on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II). *Official Journal of the European Communities,* 2009/138/EC.

[8] Jovović, M. (2015). Merenje rizika pri utvrđivanju solventnosti neživotnih osiguravača. *Doctoral thesis.* Belgrade: Faculty of Economics, University of Belgrade, p. 238.

[9] Steffen, T. (2008). Solvency II and the Work of CEIOPS. *Geneva Papers on Risk and Insurance - Issues and Practice,* 33(1), p. 61.

profile, risk tolerance and business strategy of insurer, perceives on a regular basis actual capital needs and compliance with the required capital as well as the needs for technical reserves and provides this information to regulatory authority.[10] The aim of the third pillar is to provide policyholders, investors, rating agencies and other interested parties a reliable and complete image of risks to which insurance company is exposed trough requirements regarding disclosure of information. The establishment of minimal reporting standards strengthens market discipline and transparency.

Figure 1. Three pilars of Solvency II concept



Source: Mazars (2010). Solvency II Update - Current Position & Key Milestones. Presentation July 2010. Dublin: Mazars Actuaries and Consultants, p. 5.

1.1. Capital adequacy of insurance companies

The solvency assessment of financial institutions is defined as the ratio of available and required capital. Solvency II concept distinguishes two levels of capital requirements. The minimum capital requirement (MCR) is the level of capital at which each additional business operation of insurer exposes policyholders to unacceptably high level of risk and triggers the ultimate intervention of supervisory authority. Its calculation, as a linear function of a set of variables (including technical reserves, written premiums and capital at risk), is defined uniformly for all companies and the use of internal models is not allowed. The value of MCR may not be less than 25%, or higher than 45% of the calculated solvency capital requirement.[11] The lowest allowed absolute

[10] EC (2009), *op. cit.,* article 45.

[11] EU Commission (2010). *QIS5 Technical Specifications.* Brussels: European Commission, p. 287.

amount of MCR is determined by the type of insurance operations that company is undertaking.[12] Solvency capital requirement (SCR) is an additional capital over the best estimate of technical reserves that is needed to absorb unexpected insurer's losses. As a target level of capital, SCR reflects the risk profile of insurer and guarantees its solvency. At the defined level of confidence and in one-year time horizon, this capital requirement should cover market, credit, insurance risks, operational risks as well as the risk of intangible assets.

In defining available, as opposed to required capital, insurer's net assets are classified and ranked in tiers according to their availability to absorb potential losses. Total eligible funds are divided into basic own funds, as dominantly balance sheet positions (including the excess of assets over liabilities and subordinated liabilities) and auxiliary own funds that include off-balance sheet positions.[13] Own-funds items of the highest quality, such as paid up and common equity and retained earnings are classified as Tier 1 capital. Tier 2 includes medium quality basic own-funds (e.g. called up ordinary share capital, a call for payment of other equity instruments with the priority use to cover losses) and auxiliary funds (e.g. other paid-in capital instruments including preference shares and subordinated mutual members accounts). Finally, Tier 3 consists of basic and auxiliary funds of low quality that do not absorb losses neither on a going-concern basis nor in the case of winding-up.[14]

The minimum capital requirement can be covered only by basic funds from Tiers 1 and 2 (where at least 80% of MCR must be covered by Tier 1 items). Of the total funds used to cover SCR, at least one half must belong to Tier 1, while the share of Tier 3 items must not exceed 15% of SCR. Also, total share of funds from Tier 2 and 3 in SCR coverage must be less than 50%.[15] In addition to these limits, the ratio of Tier 1 items to insurer's own funds must be at least one third, and the share of Tier 3 items must be less than one-third.[16]

2. BASIC ELEMENTS OF BASEL III STANDARDS

Problems in the functioning of financial systems during the global economic crisis of 2007/08 have revealed multiple weaknesses of Basel II standard that

[12] See more in: EC (2009), *op. cit.,* article 129. and 300.

[13] See more in: EC (2009), *op. cit.,* article 88-96.

[14] EU Commission (2010), *op. cit.,* pp. 295-304.

[15] EIOPA (2014). Technical Specifications for the Preparatory Phase (Part I). *EIOPA-14/209.* Frankfurt: European Insurance and Occupational Pensions Authority, p. 348.

[16] EC (2009), *op. cit.,* article 98.

have motivated its revision. The first amendments were implemented in 2009 by adopting a set of documents related to market risks and securitization (the documents were labeled Basel 2.5).[17] However, fundamental reform of standards, in terms of capital adequacy ratio (i.e. Basel III standards) and the introduction of liquidity requirements for banks were initially documented in 2010. The final revised version of Basel III standard was published in 2011[18], while the text of the revised document related to the liquidity ratio was published in 2013.[19] Parallel changes in the regulatory framework for banking sector in the European Union were implemented, by adopting directives enabling the implementation of Basel III in the Member States.[20] Gradual implementation of Basel III standard in the EU started on 1st January 2013, with transitional period until 2019, when it will be fully implemented.

The objective of the new Basel standard is to increase the stability of the global banking system by strengthening the resilience of banks on financial and economic stresses, as a prerequisite for long-term economic growth. The structure of three pillars is maintained and significantly improved compared to previous Basel II standard. The most significant changes in the first pillar are related to the improvement of capital's quality, increased capital requirements, the use of stress tests in modeling market and credit risk, and the introduction of leverage ratio as an additional indicator of bank's performance that is not based on the level of riskiness of assets (see Table 1).

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[17] See more in: BIS (2009a). *Enhacements to the Basel II framework.* Basel: Bank for International Settlements, Basel Committee on Banking Supervision; BIS (2009b). *Guidelines for computing capital for incremental risk in the trading book.* Basel: Bank for International Settlements, Basel Committee on Banking Supervision; BIS (2009c). *Revisions to the Basel II market risk framework.* Basel: Bank for International Settlements, Basel Committee on Banking Supervision.

[18] BIS (2011). *Basel III: A global regulatory framework for more resilient banks and banking systems.* Basel: Bank for International Settlements, Basel Committee on Banking Supervision.

[19] BIS (2013). *The Liquidity Coverage Ratio and liquidity risk monitoring tools.* Basel: Bank for International Settlements, Basel Committee on Banking Supervision.

[20] EU (2013a). Directive 2013/36/EU of the European Parliament and of the Council of 26 June 2013 on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms, amending Directive 2002/87/EC and repealing Directives 2006/48/EC and 2006/49/EC. *Official Journal of the European Union,* 2013/36/EU; EU (2013b). Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms and amending Regulation (EU) No 648/2012. *Official Journal of the European Union,* No. 575/2013.

Table 1. Three pillars of Basel III standard

Capital				
Pillar 1			Pillar 2	Pillar 3
Capital	**Risk coverage**	**Leverage ratio**	**Risk management and supervision**	**Market discipline**
1. Quality and level of capital - focus on common equity; - increase of capital requirements; **2. Allowed capital loss absorption in the case of bank`s non-viability** **3. Introduction of capital conservation buffer** **4. Introduction of countercyclical buffer**	**1. Securitisations** - stronger capital treatment of compex securitisations **2. Trading book** - significantly higher capital for operations with derivatives; - stress testing for modeling market risks; **3. Credit risk** - stronger framework for measuring and managing counterparty credit risk; **4. Bank exposures to central counterparties**	Introduction of leverage ratio, that includes off-balance sheet risks, as protection from further exposure of a bank to risks;	Additional requirements defined including: - off-balance sheet risks; -securitisation risks; - management of risk concentration; - greater incentives for banks to optimise return for a given level of risk in the long term; - stress testing; - sound valuation practices; - accounting standards for financial instruments, etc.	Revised disclosure requirements including: - requirements related to securitisation and to off-balance sheet exposures; - more detailed disclosures concerning the components of regulatory capital; - comprehensive explanation for calculating bank's capital ratios.

Liquidity
Global liquidity standards
1. Liquidity coverage ratio - banks must have sufficient amount of high-quality liquid assets to withstand a 30-day stress scenario specified by regulatory authority; **2. Net stable funding ratio** - ensures matching of sources and assets in long run, by covering whole bank's balance sheet; **3. Principles for Liquidity Risk Management and Supervision** - revision of practice of liquidity risk management in banks based on lessons learned from the global financial crisis; **4. Supervisory monitoring** - set of indicators for assistance to regulatory authorities aiming to identify and analyse liquidity risk trends at banks individual and system level.

Source: Bank for International Settlements (available at http://www.bis.org/bcbs/basel3.htm)

In order to improve the risk management of banks and to strengthen market discipline, the second and the third pillar are supplemented by additional requirements. Finally, for the first time minimal indicators and standards for managing banks' liquidity risk and its supervision were introduced. Through a combination of micro- and macro-prudential reforms, Basel III recognizes risks not only at the level of individual banks, but also the level of the entire banking system.[21]

2.1. Capital adequacy of banks

Banks' capital adequacy ratio (coefficient) is defined as the ratio of available capital and bank's risk-weighted assets (RWA). More precisely, the denominator of this ratio corresponds to the sum of credit risk-weighted assets and capital requirements for market and operational risks (multiplied by the reciprocal value of the prescribed minimum capital ratio):[22]

$$\frac{capital}{sum\ of\ credit\ risk\text{-}weighted\ \ assets + 12.5(CR\ market\ risk + CR\ operational\ risk)} \geq 8\% \quad (1)$$

where CR is calculated capital requirement. In the area of capital adequacy of banks, Basel III, compared with Basel II, brings changes that are both of quantitative and qualitative nature in the form of:[23]

- stricter criteria for the classification of bank's instruments into Tier 1 and Tier 2 capital;
- suppression of Tier 3 capital as a coverage for market risks;
- increase of capital requirements;
- the introduction of new categories of capital: capital conservation buffer and countercyclical buffer.

Total regulatory capital under Basel III consists of Tier 1 Capital (going concern capital) and Tier 2 Capital (gone concern capital). The structure of Tier 1 includes Common Equity Tier 1 (instead of the previous concept of Core capital) and the Additional Tier 1 Capital.[24] Common Equity capital is acquired

[21] Walter, S. (2011). Basel III: Stronger Banks and a More Resilient Financial System. *Conference on Basel III, April 2011,* Financial Stability Institute, p. 3.

[22] Gatzert, N., Wesker, H. (2011). A Comparative Assessment of Basel II/III and Solvency II. *Geneva Papers on Risk and Insurance - Issues and Practice,* 37(3), p. 555.

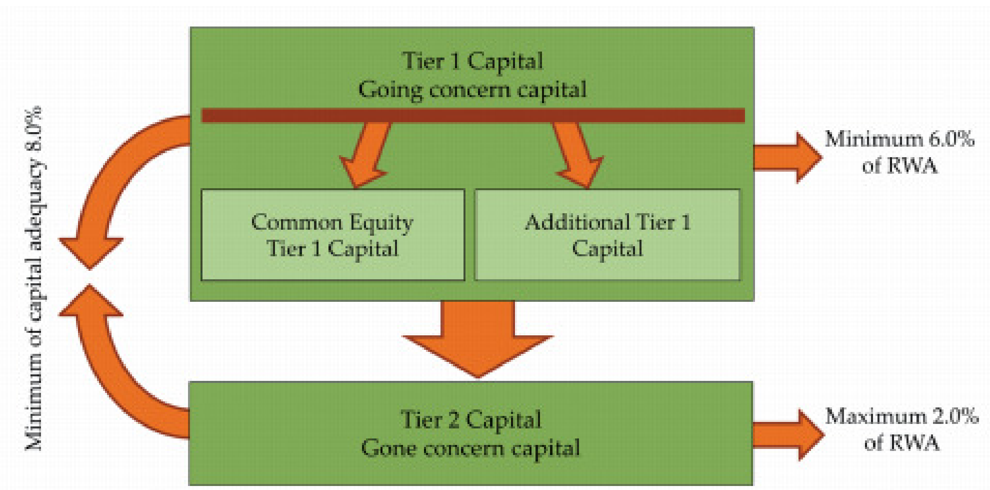
[23] Zelenović, V., Vunjak, N. (2014). Adekvatnost kapitala bankarskog sektora Srbije. *Anali Ekonomkog fakulteta u Subotici,* 50(31/2014), p. 9.

[24] BIS (2011), *op. cit.,* p. 12.

primarily from the issuance of common shares and retained earnings of banks. Since this is the most preferred form of capital for covering losses, its participation in risk-weighted assets must be at least 4.5% (which is greater than the previous participation of core capital of 2.0%). Additional Tier 1 Capital refers to the instruments issued by banks that must meet certain criteria (such as non-cumulative preference shares and premiums based on issued ordinary shares that are grouped into Common Equity Capital). Total Tier 1 Capital must participate in the RWA with at least 6.0% at any time[25] (previously that level was set at 4.0%).

Tier 2 Capital consists of instruments issued by banks, that fulfill the criteria for classification in this category and are not included in Tier 1 Capital, share premium based on their issue, certain provisions for loan losses, and regulatory adjustments in the calculation of this capital category. Its participation in risk-weighted assets may not exceed 2.0%.[26]

Figure 2. Structure of banks` regulatory capital according to Basel III standards



Source: Matić, V. (2011). Bazel III - izmenjeni koncept kapitala. Bankarstvo, 7-8 (2011), p. 175.

Even though the capital ratio is maintained at a level of 8.0%, with the introduction of new capital categories, bank's capital adequacy requirements were effectively increased. Capital conservation buffer of 2.5% of risk-weighted assets has the role to absorb losses during financial and economic crises.

[25] *Ibid.*

[26] BIS (2011), *op. cit.*, p. 12.

Countercyclical buffer, that is not obligatory,[27] has the role to satisfy the objectives of macro-prudential protection of the banking sector from losses in periods of excessive credit growth. In addition, Basel III prescribes specific level of capital for systemically important banks in order to prevent their bankruptcy.

3. COMPARATIVE ANALYSIS OF SOLVENCY II AND BASEL III CONCEPTS

Since the substantial differences between the two concepts are in the domain of the first pillar, a comparative analysis in this chapter was carried out primarily in terms of capital adequacy requirements and risk treatment in these concepts. In the objective of comprehensive analysis, four relevant criteria of comparison were identified: 1) the quality of available capital; 2) the approach of capital requirement calculation, 3) covered risk categories and 4) measurement of risk and their interdependencies.

3.1. The quality of available capital

The common characteristic of Solvency II and Basel III concepts is the classification of own funds according to their availability for covering losses. However, there are differences both in terms of the criterion for the classification of specific instruments in different tiers of capital, and in terms of the relative shares of these tiers in total capital.

In contrast to banks, for covering capital requirements of insurers, instruments of lower quality may be used (such as deferred tax assets), as well as certain off-balance sheet items (see Table 2). Therefore, the definition of capital in Basel III is stricter than in Solvency II concept. In addition, the high quality capital has a relatively higher weight in Basel III in the capital structure. As previously mentioned, of the total capital ratio (8.0%), over 50% is related to Common Equity Capital (ratio of 4.5%), and 75% to Tier 1 Capital (ratio of 6%). The lower limit of the share of Tier 1 Capital in covering SCR of insurer is 50%.

[27] National regulators are enabled to introduce the requirement for this capital catagory in the range between 0-2.5% of risk-weighted assets depending on circumstances of bank's operations.

Table 2. Comparative view of capital in Solvency II and Basel III concepts

	Solvency II	Basel III
Tier 1	Instruments of relatively similar characteristics	
Tier 2	- Called upon but unpaid instruments are included; - Instruments original maturity of at least 10 years; - Suspension of payment in the event of non-compliance with the SCR.	- Instruments must be paid in; - Instruments original maturity of at least 5 years; - No mandatory suspension of payment in the event of non-compliance with the capital ratios.
Tier 3	Includes e.g. intangible assets and deferred tax assets	Phased out.
Auxiliary own funds	Includes items such as unpaid share capital, etters of credit or guarantees, etc.	Not included in capital.

Source: Thibeault, A., Wambeke, M. (2014). Regulatory impact on banks` and insurers` investments. The role of insurers financing the economy, Ghent: Vlerick Business School, Vlerick Centre for Financial Services, p. 47.

The inconsistency of the criteria for the recognition of certain instruments influences the relative cost of capital within two regulatory regimes.[28] It is natural at each level that there exist instruments that are specific to insurance companies but not for banks. This is the case, for example, with expected profit, that is calculated in future premiums on the basis of valid insurance contracts or calls for payment of contributions by members of mutual and mutual-type undertakings. However, the recognition of intangible assets in Solvency II, but not in Basel III, is not explainable by differences in business models of these financial institutions. Such provisions put banks in a relatively unfavorable position, and open the possibility for regulatory arbitrage.

3.2. The approach of capital requirement calculation

Considering regulatory approaches for solvency evaluation of financial institutions at global level, we can distinguish between static and dynamic models. Static models include fixed coefficient and risk-based capital models while dynamic models include theoretical risk and ruin approaches and scenario-based approaches.[29] Static models assess the financial position of a

[28] Al-Darwish, A., Hafeman, M., Impavido, G., Kemp, M., O`Malley, P. (2011). Possible Unintended Consequences of Basel III and Solvency II. *IMF Working paper,* WP/11/187, Washington D.C.: International Monetary Fund, p. 32.

[29] IAIS (2000). *On Solvency, Solvency Assessments and Actuarial Issues*. Basel: International Association of Insurance Supervisors, p. 18.

company at a given point in time, by applying predefined risk factors on individual items in the balance sheet and income statement that are assumed to be highly correlated with the degree of risk exposure. According to dynamic models, the required capital is based on projections of financial situation in the future, on the basis of cash flows that will be generated by balance sheet positions in the chosen time horizon. Due to the strictly prescribed values of risk factors and specified categories onto which these factors apply, static models are based on strict rules. Theoretical risk and ruin approaches, on the other hand, are entirely principle-based. Financial institution is expected to formulate its own opinion about the necessary amount of capital to cover risks based on internal models that respect the generally established principles. Finally, scenario-based approaches are characterized by the combined use of rules and principles.

The required capital according to both concepts, Solvency II and Basel III, can be calculated by using a single standard approach or internally developed model. The standard approach in Basel III framework is strictly rule-based, due to the fact that calculation of capital requirements uses a static risk-based capital model.[30] Depending on the risk category, the standard formula for the calculation of solvency capital requirement in Solvency II concept, on the other hand, results from the combination of a fixed coefficient model and scenario-based approach. Factor-based approach is applied to premium and reserve risk (for non-life and health insurance), credit risks that cannot be diversified, the risk of intangible assets and operational risks, while for all remaining risks the scenario approach is used. Therefore, in comparison with Basel III, dynamic component is more pronounced in Solvency II concept, because it introduces principles and scenario analysis in the standard approach of evaluating insurer‘s solvency.

3.3. Covered risk categories

The appropriate model for determination of capital adequacy should recognize the important risk categories, as well as the ways in which these risks threaten each individual entity, as key determinants of its risk profile. Since the risks facing insurance companies and banks are not identical, there are differences in the risk categories covered by Solvency II and Basel III concepts.

In an effort to cover all risks that threaten to jeopardize the solvency of insurers, Solvency II concept contains several risk modules, including: market, credit and operational risks, risks of life, non-life and health insurance and risk of

[30] Gatzert, Wesker, *op. cit.,* p. 552.

intangible assets that are further sorted into sub-modules (see Table 3). Risk classification in Basel III is less jagged. In addition to market, credit and operational risks, it takes into account liquidity risk. Through the introduction of countercyclical buffer and additional capital requirement for systemically important banks it implicitly recognizes systemic risk in the banking sector.

Table 3. Comparative view of risks in Solvency II and Basel III concepts

	Solvency II			**Basel III**	
Market risks	✓		- interest rate risk - equity risk - property risk - spread risk - currency risk - concentration risk	✓	- price risk - currency risk - commodity risk
Credit risk	✓			✓	
Insurance risks	✓	Life insurance	- mortality risk - longevity risk - disability risk - lapse risk - expense risk - revision risk - katastrofalni rizici	✗	
		Non-life insurance	- rizik premije - rizik rezervi - rizik opcija - catastrophe risk		
		Health insurance	- similar to life insurance techniques - similar to non-life insurance techniques - catastrophe risk		
Liquidity risk	✗			✓	
Operational risks	✓			✓	
Systemic risks	✗			✓	

Source: Prepared according to EIOPA (2014), op. cit., pp. 132-288.; BIS (2006). International Convergence of Capital Measurement and Capital Standards. A Revised Framework. Comprehensive Version. Basel: Bank for International Settlements, Basel Committee on Banking Supervision, pp. 19-203. and BIS (2011), op. cit., pp. 7-8.

Thus, Basel III deals with risks that affect asset side of bank`s balance sheet. The focus of Solvency II, on the other hand, is not just on the assets risks, but also onto risks arising from the liabilities of insurers, i.e. insurance (underwriting) risks. By promoting "total balance sheet" approach, this concept is more risk-sensitive and provides a more complete image of institution`s risk profile compared to Basel standards.

Variations in the structure of covered risk categories can be explained by fundamental differences in the purpose and functioning of these institutions, reflected in their risk profiles. Transformation of risk is typical for both types of institutions. As financial intermediaries that transform deposits into loans, banks perform horizontal transformation of risk between assets and liabilities. Insurers, on the other hand, seek to ensure the leveling of risk between policyholders (in space) and in time. Therefore, the transformation of risk that they perform is vertical, i.e. on the liabilities side[31], resulting in a relatively greater importance of risks associated with obligations and especially insurance risks that are specific only to insurers.

Many risks are common to both types of financial institutions, such as market risks (including the risk of decline of the market value of investments due to adverse market movements, interest rate risk, currency risk, concentration risk, etc.) and operational risks. At the same time, there are some common risks that affect insurance companies and banks in different ways and their relative importance varies. Credit risk arising from approved loans and securities that are held in the investment portfolio of a bank to maturity, is the inherent feature of the banking business model. Insurers, on the other hand, are exposed to credit risk primarily in relations with reinsurers. Therefore, the nature of this risk is different, as well as the ways for measuring credit risk in these two concepts.

Average duration of bank assets (that mainly consist of long-term loans) is relatively higher than the average duration of its obligations (composed mainly of liquid deposits).[32] Unlike deposits that can be withdrawn in short term, loans can not be immediately converted into liquid assets. In order to overcome liquidity needs, banks rely on short-term loans in the interbank market that may "dry up" in a liquidity crisis which implies high sensitivity of banks to liquidity risk. On the other hand, due to the fact that premature cancelation of insurance policies involves certain penalties, or is not possible at all, insurers are relatively less exposed to liquidity risk. In addition, insurance premiums are

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[31] Schubert, T. (2004). Solvency II = Basel II + X. *PROGRES,* No. 40, Zurich: The International Association for the Study of Insurance Economics (The Geneva Association), p. 2.

[32] Insurance Europe (2014). *Why insurers differ from banks.* Brussels: Insurance Europe, p. 26.

predictable and, in many types of insurance, they represent long-term source of funding, as opposed to short-term and unstable borrowings in the interbank market. Consequently, Basel III provides special attention to liquidity risk, while the same risk is not covered by the standard formula for calculation of solvency capital requirement in Solvency II concept.

Finally, due to the complex interconnections with other segments of financial system (through financial intermediation, participation in the interbank market, relations with the central bank and securitization operations), banks, unlike insurers, are exposed to high systemic risk. Their bankruptcy triggers a domino effect that can severely shrink the level of economic activity.[33] The larger the bank, the higher the level of this risk. In contrast, the larger the insurance company, the more stable its portfolio is. Recognizing the danger of cyclical transmission of bank's losses in the economy, Basel III introduces capital requirements that take into account the systemic risk while these requirements don't exist in Solvency II concept.

3.4. Measurement of risks and their interdependencies

As a measure of risk exposure, Solvency II and Basel III concepts use value at risk (VaR). However, the adopted levels of confidence are different. Solvency capital requirement corresponds to the maximum possible loss of insurance company's net assets at the level of statistical reliability of 99.5%, for a period of one year. In the context of Basel standards, on the other hand, capital requirements should cover unexpected losses stemming from the realization of market risks with 99% probability, while the confidence level increases to 99.9% in the case of credit and operational risk.[34] Previous facts imply substantially different treatment of risk in the two concepts. Solvency II concept takes a holistic, integrated approach where all risks are measured in the consistent manner in order to ensure the solvency of insurance company. Basel standards, on the other hand, evaluate risks in isolation, according to individual parameters for each of them.

Another difference resides is the treatment of independence between different risks in two concepts. In general, capital requirements can be calculated at the level of certain types of risks, risk categories, lines of business of financial

[33] De Bandt, O., Hartmann, P. (2000). Systemic Risk: A Survey. *European Central Bank Working Paper,* No. 35, p. 18.

[34] BIS (2009c), *op. cit.,* p. 2.; BIS (2005). *An Explanatory Note on the Basel II IRB Risk Weight Function.* Basel: Bank for International Settlements, Basel Committee on Banking Supervision, p. 11. and BIS (2006), *op. cit.,* p. 148.

institution, and also at the level of entities of which it consists. Solvency assessment involves aggregation of obtained amounts in order to determine the required capital at the level of the whole institution. In the aggregation of calculated amounts of capital at each higher level, it is necessary to take into account the interaction of risks, or the effects of their diversification and concentration. The risks must be managed in their totality, because risks that are negatively (positively) correlated with each other reduce (increase) total level of risk facing the insurer.

Aggregation of capital requirements within different risk modules (and sub-modules) in Solvency II concept is realized on the basis of the square root formula, taking into account the effects of diversification of risk through a pre-defined correlation matrix.[35] Basic solvency capital requirement (BSCR) is obtained by using the following equation:[36]

$$BSCR = \sqrt{\sum_i \sum_j \rho_{i,j} \cdot SCR_i \cdot SCR_j} + SCR_{intangible}, \tag{2}$$

where:

$\rho_{i,j}$ - correlation coefficients between the risk categories whose values are predefined,

SCR_i - calculated solvency capital requirements for risk category i (including market, insurance and credit risks),

$SCR_{intangibles}$ - calculated solvency capital requirement for risks of intangible assets, if these assets are considered as integral elements of insurer`s eligible own funds.

Thus, Solvency II concept takes into account the effects of diversification between different risk categories, as well as within them. Therefore, the total capital requirement is lower than the sum of individual capital requirements. The exceptions are operational risks and risk of intangible assets that are supposed to be perfectly positively correlated with other risk categories, and as such are not subject of the square root part of the formula that takes into account diversification effect.

Basel III concept, on the other hand, only takes into account the effects of diversification within risk categories, but not between them. Total risk weighted assets and, consequently, capital coefficient, is obtained as a simple sum of

[35] See more in: EC (2009), *op. cit.,* Annex IV.

[36] EIOPA (2014), *op. cit.,* p. 126.

capital requirements for the three risk categories (according to equation (1)). This approach corresponds to the unrealistic assumption of perfect positive correlation of these risk categories. Consequently, Solvency II concept generates greater incentives for risk diversification in insurance companies, by reducing the overall level of risk exposure and therefore lower capital requirement than the level required by Basel III for banks.

Also, Basel III does not only ignore the effects of diversification, but also the effects of risk concentration in the calculation of capital requirements. The concentration risk is treated only qualitatively in the second pillar. In Solvency II concept, on the other hand, the capital requirement for risk concentration is calculated explicitly as a sub-module in the module of market risks (see Table 3) and it directly increases SCR of insurance companies. By analogy with insurance companies, banks are exposed to the risk of concentration not only for loans, but also for investments. It is therefore difficult to justify the lack of regulator's interest for adequately modeling this component of risk to protect bank's solvency.

Table 4. Similarities and differences with respect to capital adequacy and risk treatment in Solvency II and Basel III

Criterion	Solvency II	Basel III
1) Quality of capital	- Three tiers of capital; - More flexible definition of capital; - The possibility for including off- balance sheet items; - Lower required ratio of high quality capital in SCR coverage.	- Two tiers of capital; - More strict definition of capital; - The impossibility for including off- balance sheet items; - Higher required ratio of high quality capital in RWA coverage.
2) The approach of capital requirement calculation	- Two levels of required capital (MCR and SCR); - Standard approach or internal model; - Combination of static model of fixed coefficient and dynamic scenario approach; - Based on rules and principles.	- One level of required capital (capital ratio); - Standard approach or internal model; - Static risk based capital model; - Based on rules.

3) Covered risk categories	- Risks on assets and liabilities side of balance sheet (market, credit, insurance risks) and operational risks; - Emphasis on insurance risks (including catastrophic risks); - More jagged risk classification.	- Risks on assets side of balance sheet (market, credit, liquidity risk) and operational risks; - Emphasis on liquidity and systemic risk.
4) Measurement of risks and their interdependences	- VaR as the measure of risk; - The same level of confidence for all risks; - Holistic approach to risks at the level of an insurance company as a whole; - Taking into consideration the effects of risk diversification between and within risk categories; - Quantitative and qualitative treatment of concentration risk.	- VaR as the measure of risk; - Different levels of confidence for different risks; - Isolated modeling of risks that endanger banks; - Taking in consideration the effects of risk diversification within risk categories but not between them; - Only qualitative treatment of concentration risk.

Source: According to previously cited sources in the text and authors' conclusions.

In this chapter we identified similarities and differences with respect to capital adequacy and risk treatment in Solvency II and Basel III using four criteria: quality of capital, the approach of capital requirement calculation, covered risk categories and measurement of risks and their interdependences (see Table 4). The analysis shows that the coverage of risks in Solvency II and Basel III concepts is relatively adapted to specific business models of insurance companies and banks. Due to difference in their purpose and functioning of these institutions, they are not equally exposed to same risks and this fact was identified by the regulator. However, due to different approaches for measuring risk, it is possible that capital requirements for similar risks are different.[37] This leaves the possibility for arbitrage and transfer of products and risks in the lines of business where insurers and banks are direct competitors. Variations in the definition of available capital also put these institutions in unequal position. Hence, there is a scope for further harmonization of the two regulatory frameworks, in order to mitigate deviations between them that cannot be explained by fundamental differences between the two sectors.

[37] Al-Darwish *et al., op. cit.,* p. 41.

Chapter 2.

RISKS FOR THE MACROECONOMIC ENVIRONMENT IN SERBIA

We live in the times of deep changes. Global risks manifest themselves in new and unexpected ways, and their consequences affect economies, institutions and people. The range of risks expands under the influence of technological and environmental changes, as well as socioeconomic factors. Tensions between countries negatively affect business activities, unsolved crises result in a large number of refugees all over the world; terrorist attacks result in the loss of human lives and negatively affect economies; droughts and floods are a reality in many parts of the world; risks of infectious diseases entail economic and human costs, the advancement of technology and fast digitalization („the fourth industrial revolution“) represent a fertile ground for cyber crime and benefit long-term unemployment and underemployment.[38]

Global risks go beyond national borders. The effects of natural and cyber disasters, as well as man-made ones, resemble a cascade („the grasshopper effect“) and spread over wide areas. The world is faced with a serious task of preventing or mitigating the negative effect of catastrophic events in an ever more complex global environment, which is constantly changing and developing. Increasing the resilience on the national and global level is an imperative in these modern times and is nowadays receiving more and more attention. Global risks can be successfully managed only if there is a common understanding of their meaning and interdependence, as well as expressed readiness from all interested parties to engage in the dialogue and action.

1. RANKING RISKS IN THE MODERN WORLD, WITH A SPECIAL EMPHASIS ON ECONOMIC RISKS

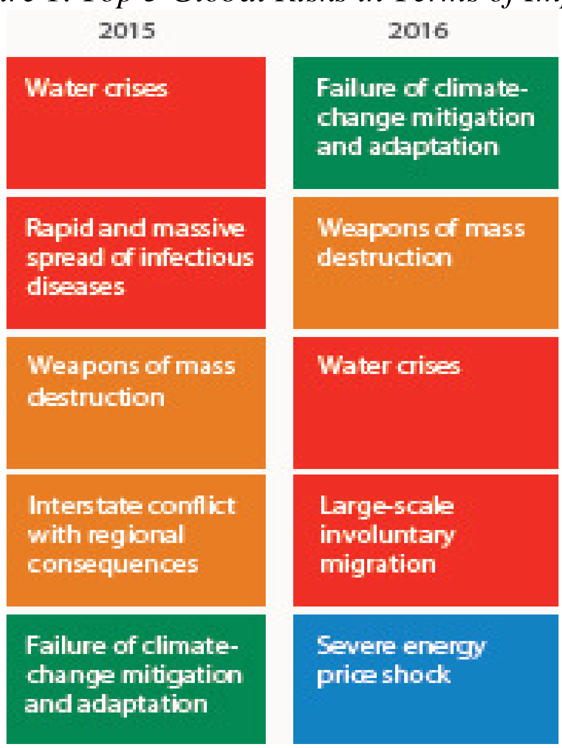
Based on the Global Risks Perception Survey by the World Economic Forum, global risks for the year 2016 were assessed according to their likelihood and impact, on the scale from 1 to 7 (where 1 indicates risk which is unlikely to happen or make an impact, whereas 7 denotes a risk which is very likely to happen and generate a massive and devastating effect). A total of 29 risks was

[38] See: World Economic Forum (2016). *The Global Risks Report 2016.*Geneva: World Economic Forum, pp. 6-9.

considered, classified into five groups: economic, ecological, geopolitical, social and technological.

Economic risks were the most prominent ones in the period between 2007 and 2014 for the strength of their impact, but they were replaced in 2015 by the water supply crisis, which belong to the group of social risks. It is noteable that economic risks, according to the mentioned criterium, are not even in the top five list, although they make a comeback into the fifth place in 2016, in the form of a sharp shock connected to energy prices. The first place is now occupied by the failure of climate change mitigation and adaptation.

Figure 1. Top 5 Global Risks in Terms of Impact



Source: World Economic Forum (2016). The Global Risks Report 2016.Geneva: World Economic Forum, p. 11.

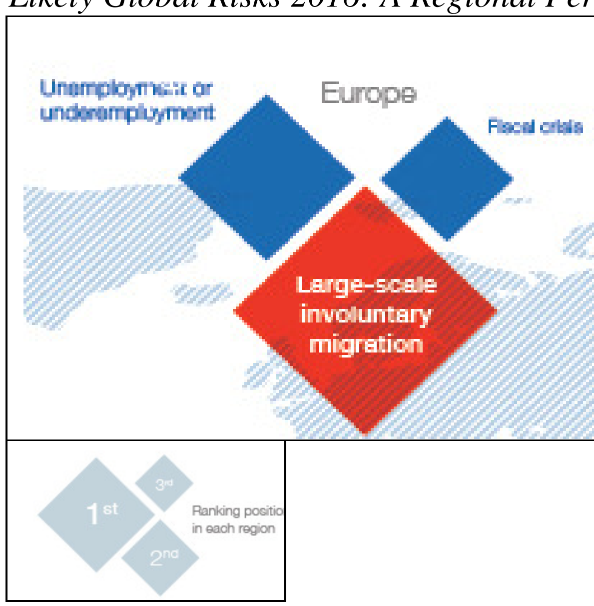
When it comes to risks classified according to the likelihood of their realization, economic risk of high structural unemployment or underemployment occupies the fifth place in 2015, as shown in Figure 2, whereas as many as three risks in the top five have a geopolitical character. The leading position in 2016 is occupied by the social risk – mass involuntary migration, whereas economic risks are not so highly ranked anymore. However, ecological risks take the lead and occupy second, third and fifth place.

Figure 2. Top 5 Global Risks in Terms of Likelihood

Source: World Economic Forum (2016). The Global Risks Report 2016.Geneva: World Economic Forum, p. 11.

Global Risks Perception Survey also identifies three risks which are most likely to appear in a certain region. In Europe these are: mass involuntary migration (social risk) and unemployment or underemployment, as well as fiscal crisis (which are both classified as economic risks).

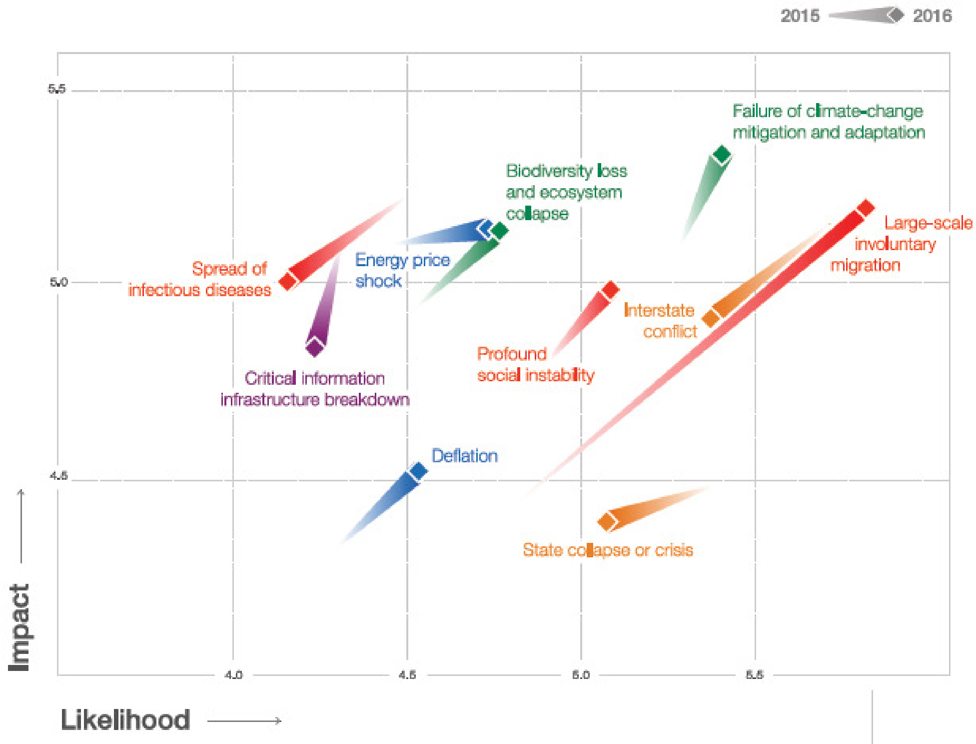
Figure 3. The Most Likely Global Risks 2016: A Regional Perspective – Europe



Source: World Economic Forum (2016). The Global Risks Report 2016.Geneva: World Economic Forum.

Figure 4 shows the risks that exhibit the biggest growth and fall in the perception of likelihood and impact. Among them, the most prominent is the mass involuntary migration, which grew sharply in 2016. Among the risks which gained prominence in both dimensions is also the deep social instability, which is closely connected with other risks. It should be emphasized that economic risks such as unemployment and underemployment, as well as fiscal crises, have increased in the last two years, when assessed by their likelihood and impact, but not enough to place them among the top ten risks that bring about the biggest change.

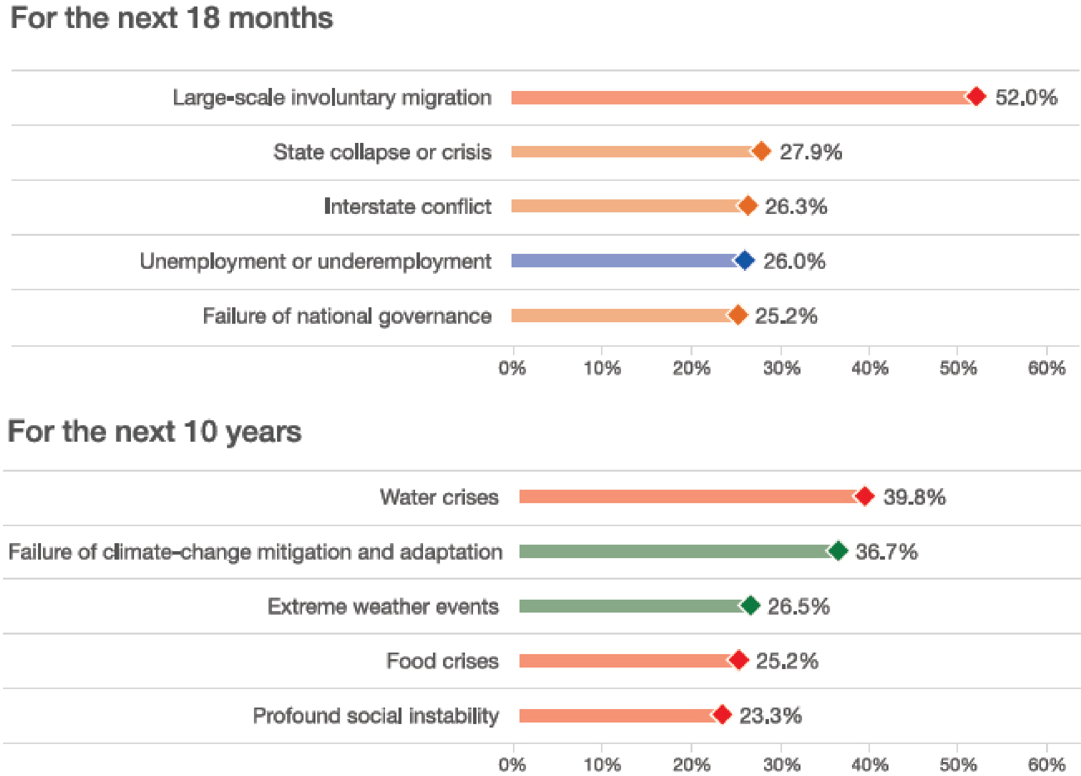
Figure 4. The Changing Global Risks Landscape 2015–2016: The 10 Most Changing Global Risks



Source: World Economic Forum (2016). The Global Risks Report 2016.Geneva: World Economic Forum, p.12.

Risk perception also differs according to the observed time horizon. In the short term, as Figure 5 shows, one of the five leading risks is an economic one (unemployment or underemployment), whereas in the long term the leading positions are taken by social and ecological risks.

Figure 5. The Top Five Global Risks of Highest Concern for the Next 18 Months and 10 Years



Source: World Economic Forum (2016). The Global Risks Report 2016.Geneva: World Economic Forum, p. 12.

Note: Survey respondents were asked to select up to five risks of highest concern for each time frame. The percentage indicates the share of respondents who selected the specific global risk among five risks of the highest concern for each time frame.

The abovementioned report of World Economic Forum aims to develop awareness of the importance of not only short, but also long term consideration of global risks, as well as timely response to them.

Assessing the current economic situation in the world and prospects for the future, the World Bank has noted in its recently published report that global economic prospects are „muted“, and the risks of growth slowdown significant. Economic concerns arise because of possible global impact of Chinese economy, which is going through transition process towards the new phase of economic development, the so called „new normal“, based on spending and services; continued fall of commodity prices, especially oil, with significant redistributive effects on sectors and regions; related slowdown of investments and trade, as well as reduced capital inflow into developing countries and emerging markets. There are also numerous non-economic factors, including geopolitical tensions which negatively impact the economic growth. A drop in GDP in three particularly affected countries – Ukraine, Libya and Yemen – reduced global GDP growth by about 0.1 percentage points in 2014-2015[39] Eurozone is plagued by persistently low inflation and its interaction with outstanding debts. Political challenges connected with an enormous inflow of refugees and asylum seekers do not abate. Unexpected twists in the Greek crisis could negatively impact the investments and growth in this part of the world.

Having in mind the close interdependence of national economies, any country can be the „weak link". Therefore it is very important to strengthen the resistance to risks in all the countries in the world, including Serbia.

2. CHARACTERISTICS OF MACROECONOMIC ENVIRONMENT IN SERBIA

We will observe macroeconomic environment in Serbia from two aspects: institutional and developmental. For the former, the focus is on the development of market economy, and the latter, on the quality of achieved development results.

2.1. Market reforms progress

Measuring and assessing performances of a country in the process of transitioning towards market economy is not an easy task, but it is of vital importance for the national government as a landmark in the implementation of systemic reforms and the narrowing of a transitional gap. One of the first attempts in this area was the introduction of EBRD indicators in 1994 – a set of indicators used for the purpose of tracking the transition progress on the level of individual countries. The abovementioned indicators have changed through time – in the beginning there were nine of them, but after 2010 that number has fallen to six (privatization of large enterprises, privatization of small enterprises, managing and restructuring enterprises, price liberalization, trade and foreign exchange system, competition policies). That same year, new sector transition indicators were introduced, which are focused towards the future and assess the remaining transitional gap in the market structure, and the quality of institutions and policies supporting the market in four key sectors: corporate, energy, infrastructure and finance.

[39] International Monetary Fund (2016). *World Economic Outlook: 2016:Too Slow for Too Long*.Washington, D.C.: International Monetary Fund, p. 1.

Since 2015, EBRD no longer uses traditional transition indicators measuring liberalization, privatization and reforms at the level of enterprises. However, it continued with different ways of registering changes in the domain of political competition, where the degree to which many countries, including Serbia, lag behind is significant. Still, relying on the data on six traditional transition indicators for 2014, we will consider the relative position of Serbia when it comes to the development of market economy in comparison to new EU members, as well as candidates and potential candidates for the membership in this regional organization. It should be mentioned that after 2010 the values of traditional EBRD indicators in Serbia have not changed, which points to the stagnation in reforms, also visible in other transition countries.

Table 1. Value of EBRD traditional transition indicators in selected countries, 2014

	EU members	EU candidates	*Serbia*	Potential EU candidates
Privatization of large enterprises	3.7	3.4	2.7	3.3
Privatization of small enterprises	4.2	3.8	3.7	3.5
Managing and restructuring enterprises	3.2	2.5	2.3	2.2
Price liberalization	4.2	4.1	4.0	4.2
Trade and foreign exchange system	4.2	4.2	4.0	4.2
Competition policies	3.2	2.6	2.3	2.3
Average value	3.8	3.4	3.2	3.3

Source: Comprised from data of the EBRD (2014), p 123.
Note: Values of indicators range from 1 to a maximum of 4.3, which corresponds to the standards of functional market economy.

Judging by the data from Table 1, Serbia lags the most behind the European Union average when it comes to the privatization of large enterprises, managing and restructuring enterprises and competition policies. There is also a noticeable lagging behind the average of EU candidates, while being one of them, and in certain segments it even lags behind the potential EU candidates' average.

Table 2 shows sector transitional indicators for Serbia from 2010 to 2014. During the observed time only isolated changes of certain sector indicators were recorded, and their value did not exceed 3 in any of the cases, which means that none of the sectors has entered the advanced stage of transition. Two out of four positive developments were registered in 2012, in sustainable energy sector and financing micro, small and medium enterprises. It should be noted that in transition countries, viewed as a whole, the number of deteriorations (12) of values of sector transitional indicators in 2014 surpassed the number of improvements (9) for the first time, because some countries veered from the market principles.

Table 2. Values of EBRD sector transition indicators for Serbia, 2010-2014.

		2010	011	2012	2013	2014
Corporate sector	Agribusiness	2.7	2.7	2.7	2.7	2.7
	Industry	2.7	2.7	2.7	2.7	2.7
	Real estate	2.7	2.7	2.7	2.7	2.7
	ICT	3.0	3.0	3.0	3.0	3.0
Energy sector	Natural resources	2.0	2.0	2.0	2.0	2.0
	Sustainable energy	2.0	2.0	2.3↑	2.3	2.3
	Electrical energy	2.3	2.3	2.3	2.3	2.3
Infrastructural sector	Water	2.0	2.3↑	2.3	2.3	2.3
	Public transport	2.7	2.7	2.7	2.7	2.7
	Roads	2.7	2.7	2.7	2.7	2.7
	Railway	3.0	3.0	3.0	3.0	3.0
Financial sector	**Banking**	**2.7**	**2.7**	**2.7**	**2.7**	**2.7**
	Insurance and other financial services	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**
	MSME financing	2.7	2.7	3.0↑	3.0	3.0
	Private capital	1.7	1.7	1.7	1.7	2.0↑
	Capital markets	2.7	2.7	2.7	2.7	2.7

Source: EBRD, London*, Transition Report, Various years.*
Note: MSME – micro, small and medium enterprises; Values of indicators range from 1 to a maximum of 4.3, which corresponds to the standards of functional market economy.

From 2015 EBRD is focused on sector transitional indicators, for which the methodology of measuring will likely soon significantly change. Precisely because of that, values of these indicators in the observed year are kept on the same level as in the previous year (2014), but the sectors within individual countries, that recorded changes which could lead to positive or negative developments in transitional scores in the future are marked. An important innovation was made when two new indicators of sustainabilty were introduced, which reflect the priorities of EBRD within the *Sustainable Resource Initiative*, introduced in 2013. The existing sustainable energy indicator was supplemented with two new indicators measuring the efficiency of water resource and material use. These indicators are measured separately and are used to assess to what extent structures and institutions of observed countries promote re-using and recycling natural resources.

Out of 15 observed sector indicators in Serbia, positive expectations are present in three cases, i.e. in the sectors of electricity, roads and railway. Otherwise, the total number of positive expectations in all 35 observed countries stood at 30 and it exceeded the number of negative ones (only 8), which represents a big shift compared to the previuos year. The highest number of positive expectations was registered in the area of infrastructure, which was confirmed in the case of our country.[40]

Sustainable resource use of lies at the heart of successful transition. It proved that the values of three chosen indicators from this domain were on average low and mostly range between 1 and 2.33, with the exception of Central Europe and the Baltic states, where the lowest value is 2.67.[41] It points to the large gaps in relations to the standards of developed market economies. There are evident market failures in all segments of sustainable energy use, which means that adopting the appropriate legislation would be the main driver of changes for the better. The values of three observed indicators in Serbia – sustainable energy, efficiency of water resource use and the efficiency of material use, are 2.33, 2.00 and 2.33 respectively, whereas in 2015 there were positive expectations when it comes to sustainable energy.[42] The situation is similar in other EU candidate countries, as well as potential candidate countries.

The question of the quality mark of business environment in Serbia deserves special attention. It is well known that thriving private sector with new companies entering the market, wand the creation of jobs and new products contributes to the prosperity of economy and society. The state has an important task to create such a regulatory framework which facilitates interaction on the market and protects important public interests, without unnecessary obstruction of the private sector. Serbia is relatively badly ranked according to the quality of business environment, but its position is improving. In the World Bank report *Doing Business 2016,* our country was placed 59th out of 189 countries, which is an improvement of nine places compared to the previous report, after the methodological changes which took place in the meantime are taken into

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[40] EBRD (2015). *Transition Report 2015-2016: Rebalancing Finance.* London: European Bank for Recostruction and Development, p. 90.

[41] *Ibid,* p. 93.

[42] *Ibid*, p. 95.

account. The area with the most problems is the tax collection, where Serbia was ranked the 143rd. The second problem is the process of obtaining building permits, where we are ranked 139th.[43]

Table 3. Serbia: ranking on the Doing business list, 2015-2016.

Topics	2015	2016	Change in Rank (+ improvement/ - deterioration)
Dealing with Construction Permits	178	139	+39
Paying Taxes	165	143	+22
Protecting Minority Investors	81	81	No change
Enforcing Contracts	73	73	No change
Trading Across Borders	23	23	No change
Registering Property	72	73	-1
Resolving Insolvency	49	50	-1
Getting Electricity	61	63	-2
Starting a Business	62	65	-3
Getting Credit	52	59	-7

Source: http://www.doingbusiness.org/

Although *Doing Business* covers some important dimensions of regulatory environment, this report does not measure a whole range of factors, policies and institutions that impact the quality of business environment of a country or its national competitiveness. Therefore it should be complemented with other sources of information. Despite of its positive regulatory development, Serbia is still ranked 94th out of 140 countries in the World Economic Forum's *Global Competitiveness Report 2015-2016*.[44] This place that Serbia occupies reflects low business sophistication, market inefficiency, weak institutions and unstable macroeconomic environment.

2.2. Achieved development results

From 2010 to 2015, gross domestic product (GDP) of Serbia has recorded levels between 3,067.2 billion dinars (29,766.3 million euros) in 2010 and 3,973.0 billion dinars (32,907.7 million euros, see Table 4). On average, in this

[43] World Bank (2016). *Doing Business 2016 - Measuring regulatory quality and Efficiency.* Washington, DC: World Bank, p. 231.

[44] Schwab, K. (ed.) (2015). *Global Competitiveness Report 2015-2016.* Geneva: World Economic Forum, p. 7.

time period GDP *per capita* was 4,530 million euros. Annual GDP values indicate that growth rates after 2010 had alternately positive and negative sign, i.e. that year-on-year growth and the decline in economic activity interchanged. Also, quarterly dynamics of GDP shows that in Serbia, after the recession which appeared immediately after the onset of the global crisis (which started at the end of 2008), there were two more waves of recession – in 2011 and 2014[45].

Annual GDP growth rates show that the real value of this macroeconomic aggregate was lower in 2012 in comparison to 2011, as well as in 2014 in comparison to 2013 (see Table 4 and Graph 1).

Table 4. Serbia: selected macroeconomic indicators, 2010-2015

	2010	2011	2012	2013	2014	2015
Gross domestic product (in billions of dinars)	3,067.2	3,407.6	3,582.6	3,876.4	3,908.5	3,973.0
Gross domestic product (in millions of euros)	29,766.3	33,423.8	31,683.1	34,262.9	33,318.6	32,907.7
Gross domestic product *per capita* (in euros)	4,082.0	4,619.0	4,400.0	4,781.0	4,672.0	4,626.0
Gross domestic product (real growth, y-o-y, in %)	0.6	1.4	-1.0	2.6	-1.8	0.7
Consolidated fiscal balance (in % of GDP)	-4.6	-4.8	-6.8	-5.5	-6.6	-3.7
Public debt (in % of GDP)	41.9	44.4	56.1	59.4	70.4	75.6
Foreign debt (in millions of euros)	23,508.7	24,123.5	25,645.3	25,644.3	25,679.4	26,357.8
Foreign debt (in % of GDP)	79.0	72.2	80.9	74.8	77.1	80.1
Current account (in millions of euros)	-2,036.7	-3,656.0	-3,671.4	-2,098.3	-1,984.7	-1,590.3
Current account (in % of GDP)	-6.8	-10.9	-11.6	-6.1	-6.0	-4.8
Balance of goods and services (in millions of euros)	-4,729.0	-5,341.5	-5,522.9	-3,845.3	-3,645.4	-3,280.8
Balance of goods and services (in % of GDP)	-15.9	-16.0	-17.4	-11.2	-10.9	-10.0
Imports of goods (in millions of euros)	11,575.0	13,613.7	14,010.8	14,673.7	14,751.7	15,350.4
Exports of goods (in millions of euros)	6,855.9	8,118.1	8,376.4	10,515.0	10,641.0	11,344.3
Foreign direct investment (in millions of euros)	1,133.4	3,319.6	752.8	1,298.1	1,236.3	1,800.2
Foreign direct investment (in % of GDP)	3.8	9.9	2.4	3.8	3.7	5.5
Personal transfers (in millions of euros)	2,880.0	2,579.6	2,459.6	2,701.1	2,442.3	2,671.1
Workers' remittances (in millions of euros)	2,382.7	2,064.7	1,934.6	2,159.9	1,863.0	2,077.4
Consumer price index (y-o-y growth, in %)	10.3	7.0	12.2	2.2	1.7	1.5
Real exchange rate dinar/euro (index, average 2005=100)	88.0	80.4	85.3	80.2	81.8	83.2
Nominal exchange rate dinar/euro	103.0	102.0	113.1	113.1	117.3	120.7

Source: NBS, FREN (QM43) and the Ministry of finance (Public Finance Bulletin 137).

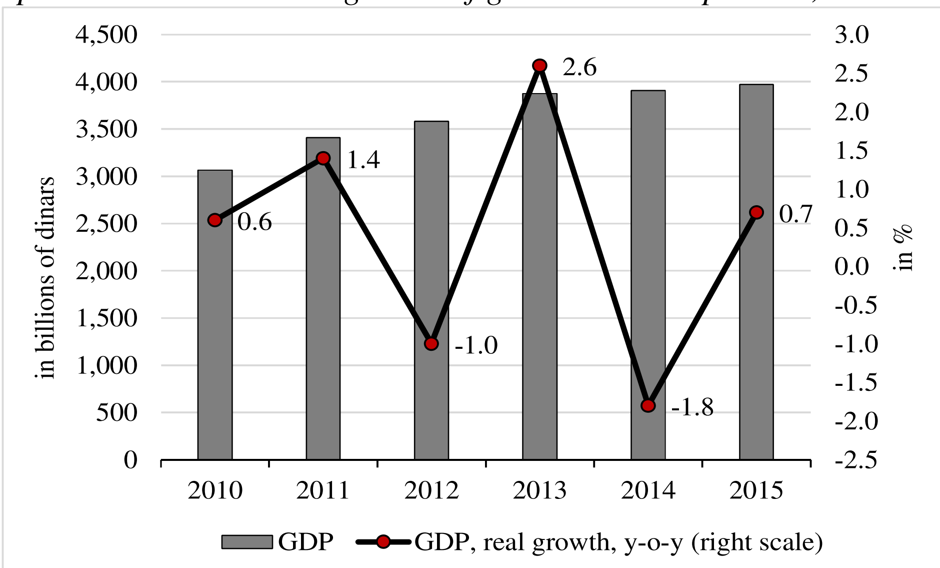
The value of GDP in 2012 was 1.0% lower than the previous year. In the first half of that year, economic activity was negatively affected by, on the one hand, the weather (very cold winter), and on the other the growth of GDP was influenced by the increase of consumption in the pre-election period. Then, in the second half of the year, there was a decline in activity due to drought, but also a positive influence from the launch of production of FIAT cars[46]. In 2012

[45] Arsić, M., Ranđelović, S., Brčerević, D. (2015). Economic policies and medium-term economic prospects of Serbia. In *Economic policies of Serbia in 2015*, Živković, B., Cerović, B. (eds.), Serbian Scientific Society of Economists with the Academy of Economic Sciences, p. 9.

[46] FREN, *QM*31, p. 11.

the drought caused a significant drop in agricultural production – of 20 percent year-on-year (if that effect was excluded, economic activity in 2012 would have actually remained on the same level as in 2011[47]). The dominant reason for year-on-year decline in the value of GDP in 2014 of 1.8% were the floods in May, which particularly negatively affected mining and the electricity production.

Graph 1. Serbia: level and growth of gross domestic product, 2010-2015.



Source: Author's presentation based on the data from the Ministry of finance (Public Finance Bulletin 137).

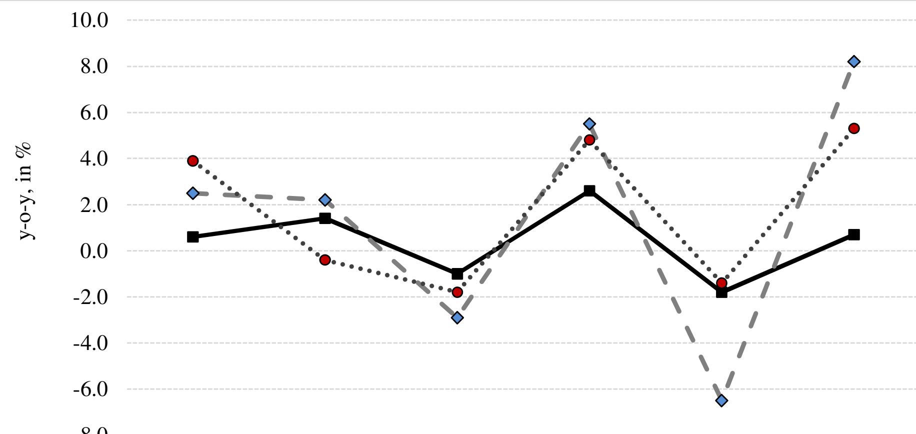
Graph 2 shows the growth rates of GDP, industrial production, and within it the manufacturing industry. It is noticeable that industrial production recorded a significant decline in 2012. Year-on-year decline of industrial production was especially pronounced in 2014, primarily due to the negative effect of floods. In 2015 GDP growth was accompanied by the recovery of industrial production – of as much as 8.2% above the level from 2014, whereas the manufacturing industry recorded the growth of 5.3% in comparison to the production level from 2014.

GDP growth was recorded in 2015, even though it was anticipated at the start of that year that it would fall, in line with the then current circumstances and the start of fiscal consolidation. Year-on-year growth of economic activity in 2015 was 0.7% (Table 4 and Graph 1). On one side, recorded recovery in 2015 can be positively assessed from two standpoints: one being that it was recorded along with a big decline of fiscal deficit, the other that it was based on investment and

[47] FREN, *QM*31, p. 11.

export growth. On the other side, the growth rate in 2015 was significantly below the desired rate which would ensure Serbia coming closer to GDP growth rates of more developed European countries.

Graph 2. Serbia: growth rates of gross domestic product, industrial production and manufacturing industry, 2010-2015.



	2010	2011	2012	2013	2014	2015
GDP	0.6	1.4	-1.0	2.6	-1.8	0.7
Industrial production	2.5	2.2	-2.9	5.5	-6.5	8.2
Manufacturing industry	3.9	-0.4	-1.8	4.8	-1.4	5.3

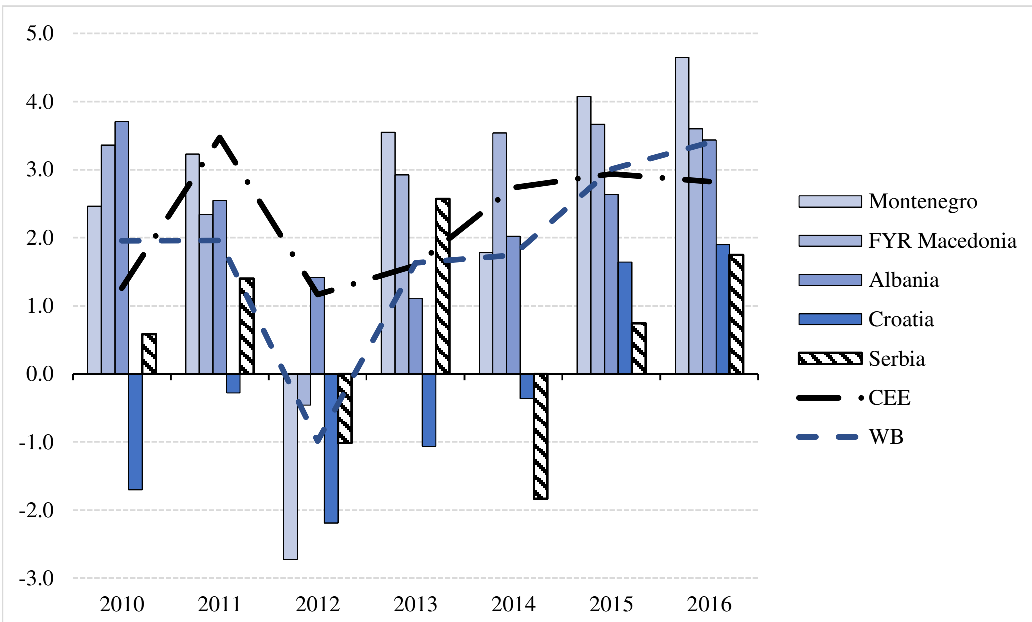
Source: Author's presentation based on FREN data (QM43).

Additional conclusions about Serbia's economic growth dynamics up to 2010 can be drawn from comparing annual GDP growth rates of Serbia to the rates recorded by individual neighbouring countries belonging to the Western Balkans group (WB: Montenegro, FYR Macedonia, Albania and Croatia), as well as averaged values of GDP growth rates of WB and the more developed countries of Central and Eastern Europe (CEE[48]: Romania, Estonia, Latvia, Lithuania, the Czech Republic, Hungary, Slovenia, Slovakia and Poland). Based on the data presented in Graph 3, it is evident that Croatia, for the most part of the observed period (in 2010, 2011, 2012 and 2013), is the country with the relatively „worst" result among the singled out countries when it comes to economic activity trends. Serbia recorded the same result in 2014 and 2015, which will, according to IMF estimates, be repeated in 2016 as well (Graph 3). More precisely, Serbia recorded a relatively bigger GDP decline in 2014 and more modest economic growth in 2015 (and probably in 2016) than other WB countries.

[48] Countries that became European Union members in 2004 (excluding Cyprus and Malta) and 2007.

During the observed time period, Serbia recorded GDP growth rate higher than the average of other WB countries in only one year (2013, see Graph 3), when it even exceeded the average growth rate of CEE countries. Therefore, although Serbia achieved recovery in 2015, which is expected to continue in 2016, it can be described as comparatively modest – because Serbia's GDP growth rate is lower than the one of comparable countries, and especially the one of the developed countries, whose GDP levels Serbia strives to ach

Graph 3. Gross domestic product growth rate in Serbia and other Central and Eastern European countries



Source: Author's presentation based on IMF data.

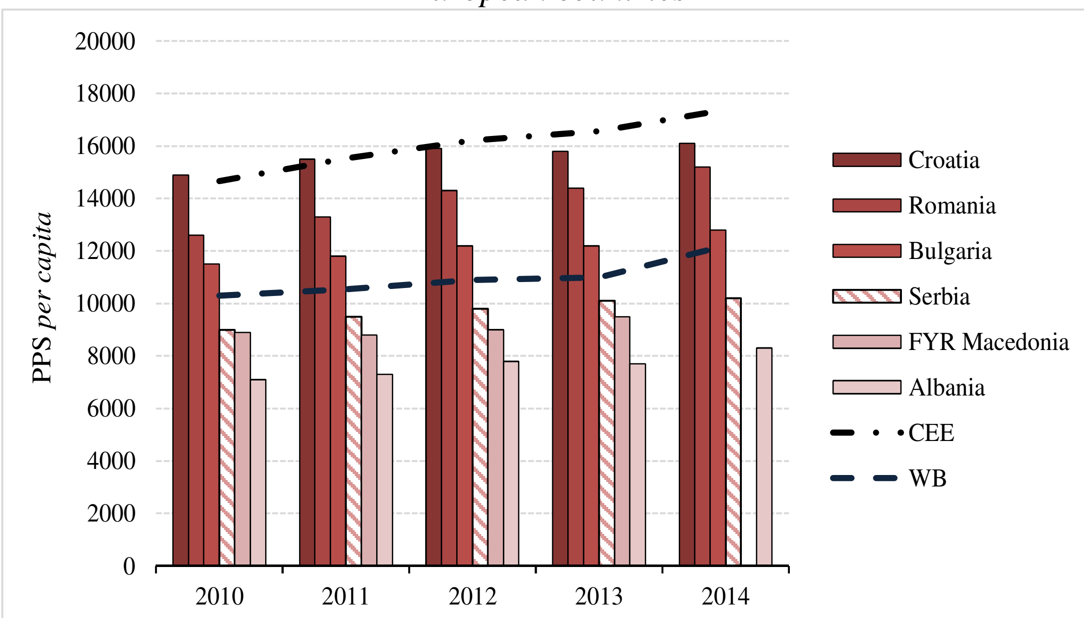
Note: 1) CEE represents the average of annual GDP growth rates of Bulgaria, Romania, Estonia, Latvia, Lithuania,the Czech Republic, Hungary, Slovenia, Slovakia and Poland, WB represents the average of annual GDP growth rates of Albania, Croatia, Montenegro and FYR Macedonia, 2) IMF's estimation for Albania for the period 2013-2016, for Bulgaria, Croatia, Macedonia and Montenegro for 2015 and 2016, for other countries for 2016.

If we observe the level of GDP (GDP according to the Purchasing Power Standard, abbr. PPS[49]), Serbia exceeds the values of GDP in FYR Macedonia

[49] Purchasing Power Standard (PPS) is used in order to eliminate the impact of differences in prices between countries on the calculation of values of macroeconomic aggregates. It is an artificial currency, created under the assumption that one PPS can buy the same amount of goods and services in each country. See. http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Purchasing_power_ standard_(PPS).

and Albania, but falls significantly behind the levels recorded by Croatia, Bulgaria and Romania[50] (Graph 4). As these data show, Serbia's GDP level is below the average of WB countries and well below the average of CEE countries. This indicates that Serbia has room for improvement, and in order for the convergence with the income level of more advanced countries to take place, growth rate in Serbia should be above the rate of these countries.

Graph 4. Gross domestic product of Serbia and other Central and Eastern European countries



Source: Author's presentation based on EUROSTAT data.

Note: CEE represents the average of annual GDP growth rates of Bulgaria, Romania, Estonia, Latvia, Lithuania,the Czech Republic, Hungary, Slovenia, Slovakia and Poland, WB represents the average of annual GDP growth rates of Albania, Croatia, Montenegro and FYR Macedonia, 2) data for FYR Macedonia are not available for 2014, so the average for WB countries for 2014 was calculated without this country.

Somewhat better results were achieved in the area of labour market in 2015, compared to 2014. According to the latest, revised data from the Statistical Office of the Republic of Serbia (SORS) (Labour Force Survey, LFS), the employment is slightly increasing, whereas unemployment and informal employment are decreasing (Table 5). Thus the employment rate in Serbia in 2015 is on the level of 42.2%, while unemployment rate is 17.9%.

[50] Data for Montenegro are not available in the used EUROSTAT database.

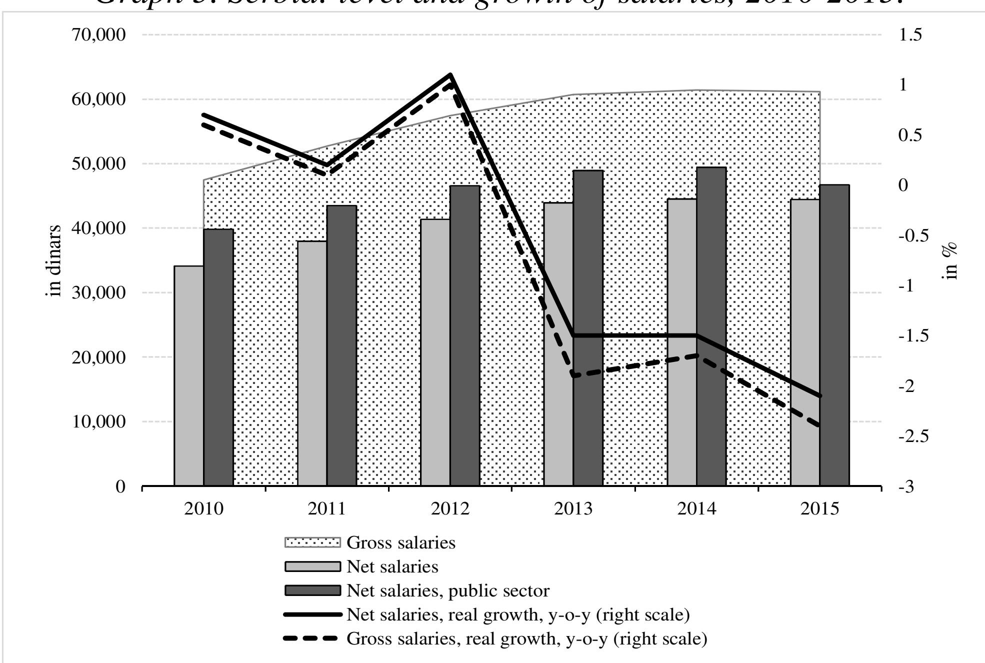
Table 5. Serbia: labour market indicators, 2014-2015.

	2014	2015
Activity rate	51.8	51.4
Unemployment rate	19.4	17.9
Employment rate	41.7	42.2
Informal employment rate	21.2	19.5

Source: SORS.

Salary trends are shown in Graph 5, where the „columns" show the levels of average monthly gross salaries, net salaries and public sector salaries. The lines on the graph show year-on-year changes in the levels of gross and net salaries. According to the data in the graph, during the observed period there was a decline in the real value of salaries in three consecutive years: 2013, 2014 and 2015.

Graph 5. Serbia: level and growth of salaries, 2010-2015.



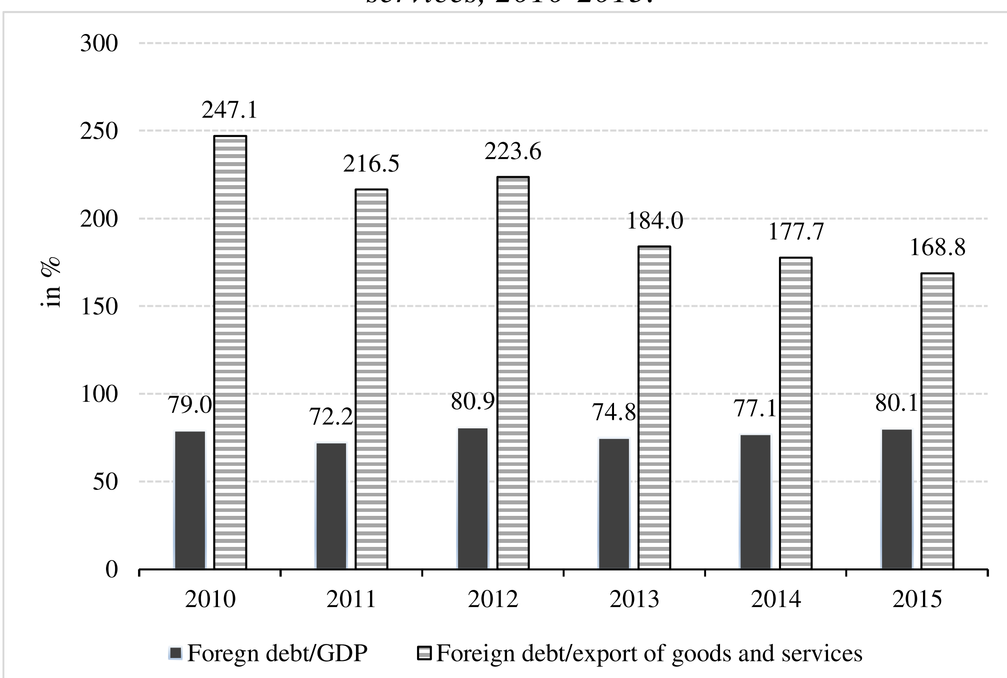
Source: Author's presentation based on the data from the Ministry of finance (Public Finance Bulletin 137).

Inflation in Serbia has for the past two years been kept below the National Bank of Serbia's target (defined as a range of 4%±1.5 percentage points). At the end of 2015, the inflation, measured by the consumer price index, amounted to 1.5%, year on year (Table 4). At the start of 2016, the inflation stays below the lower limit of the target range, at the end of March it is 0.6%, and the return within the target range is expected only at the end of 2016 or the beginning of

2017[51]. During 2014, the reason for the relatively low inflation rate was recession and the decline of domestic demand, as well as low global energy and food prices. The inflation in 2015 was largely affected by external factors, and was therefore low in neighbouring countries as well – which is partly reflected on its level in Serbia. Low inflation rate in 2015 is primarily the consequence of a very sharp decline in oil prices on the global market, but also of low global prices of agricultural produce, metals etc[52], which reached their long-term minimums in 2015.

Between 2010 and 2015, dinar recorded a nominal depreciation and in 2015 the nominal exchange rate was 120.7 dinars/euro (average for the period), i.e. 121.63 at the end of December 2015 and 123.5 at the end of February of 2016[53]. On the other hand, real appreciation of the dinar against the euro was recorded from 2010 (Table 4), which we consider to be a negative fact from the viewpoint of foreign trade imbalance.

Graph 6. Serbia: ratio of foreign debt to GDP and to export of goods and services, 2010-2015.



Source: Author's presentation based on the data from NBS and the Ministry of finance.

[51] http://www.nbs.rs/internet/cirilica/scripts/showContent.html?id=9543&konverzija=no.

[52] For details see NBS (*Inflation report*), as well as FREN (*QM*, part: Prices and the exchange rate).

[53] http://www.nbs.rs/static/nbs_site/gen/latinica/90/statisticki/sb_02_16.pdf, p. 96.

At the end of 2015, Serbian foreign debt was 26.36 billion euros, i.e. 80.1% of GDP (Graph 6). When it comes to the export of goods and services, a significant decline of the observed share was recorded, but primarily thanks to the growth of the denominator (a significant increase of the export of goods and services in the previous period). After 2010 the total foreign debt grew by 2.85 billion euros, i.e. by 1.1 pp of GDP. Growth of the long-term debt in this period was 4.31 billion euros, which is the consequence of a significant growth of the external debt of the public sector (which grew by 6.2 billion euros) and the deleveraging of the economy (deleveraging by 1.89 billion euros).[54]

Serbia's public debt increased from 41.9% of GDP in 2010 to 75.6% of GDP in 2015. (Table 4). In order for the growth of public debt to be stopped, it is necessary to continue with the fiscal consolidation. The first goals were already achieved and in 2015 a significant decrease of fiscal deficit of 2.9 percentage points of GDP was recorded (from 6.6% to 3.7% of GDP), i.e. by 109 billion dinars (from 268 to 149 billion dinars). The deficit decrease was even bigger than planned in 2015, due to the reduction of public sector salaries and pensions, as well as intensive measures to combat the grey economy, collection of non-tax revenues and increasing excise taxes[55].

The current account deficit in Serbia was 1.59 billion euros, i.e. 4.8% of GDP in 2015, which is below the level of the previous years of the observed period (2010-2015). The decrease of this deficit was largely the consequence of the fall of foreign trade deficit (Graph 7). The thing that influenced the decrease of the external imbalance in 2015 was limiting domestic demand growth as a result of fiscal consolidation, but also particularly favourable ratios of goods exchange. In 2015 there was a significant net capital inflow, primarily due to the inflow of FDI, but the fact that 2016 is election year can result in lower FDI.

Table 6. Serbia: share of remittances in export, import of goods and services and in foreign trade deficit, 2014.

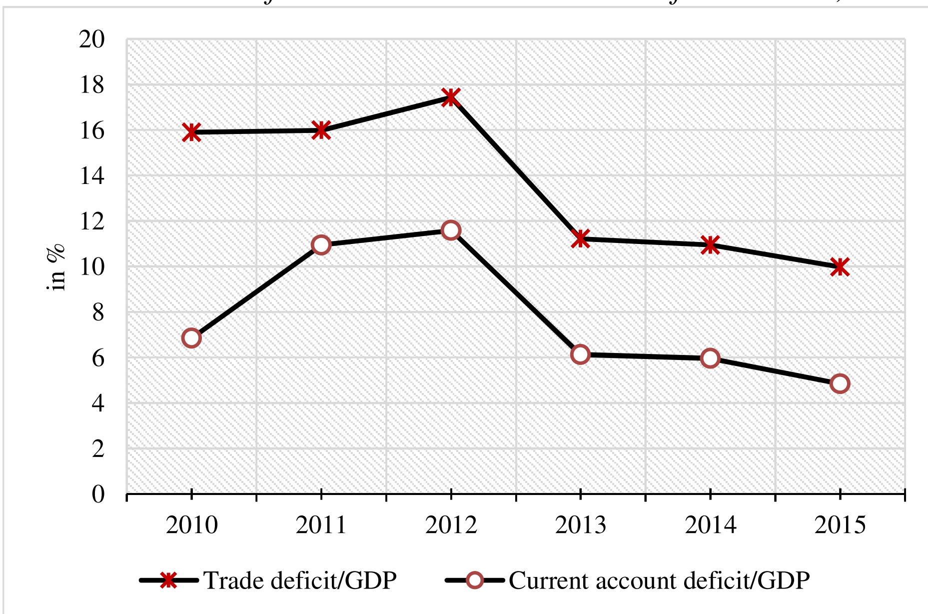
	2014
	u %
Remittances/import of goods and services	17.7
Remittances/export of goods and services	22.9
Remittances/foreign trade deficit	79.0

Source: Gligorić, M., Janković, I. Highlight 1. Improvement Possibilities of Remittances' Economic Potential in Serbia. QM43, FREN, p. 49 and p. 50.

[54] Calculated on the basis of statistics data from the NBS.

[55] *QM*43, p. 34.

Graph 7. Serbia: share of current account and trade deficit in GDP, 2010-2015.



Source: Author's presentation based on the data from NBS and the Ministry of finance.

Table 7. Serbia: indicators of poverty and inequality, 2013-2015.

	2013	2014	2015
At-risk-of-poverty rate, %	24.5	25.4	25.4
S80/S20 income quintile share ratio	8.6	9.8	9.0
Gini coefficient	38.0	38.6	38.2

Source: SILC, SORS.

The Survey on Income and Living Conditions (SILC) was conducted in Serbia three years in a row and its results are shown in Table 7. According to these data, the poverty risk rate in Serbia was 24.5% in 2013, 25.4% in 2014 and 2015. In means that one out of four citizens of Serbia is poor or there is a risk he will become poor, i.e. his income is under the so-called at-risk-of-poverty threshold[56]. Also, Table 7 contains data on quintile ratio of the richest 20% to the poorest 20% of the population. These data suggest that the population with the lowest equivalised income in Serbia disposes of less than a tenth of disposable income of the population with the highest equivalised income[57]. Gini coefficient grew from 38.0 in 2013 to 38.6 in 2014, and then in 2015 it slighty

[56] At-risk-of-poverty threshold is a relative poverty line – and is set to 60% of median national equivalised income.

[57] Equivalised income is a total disposable income of a household, evenly distributed among household members, in accordance with OECD equivalence scale. See SORS press release number 084 (PD10), http://www.silk.stat.rs/Documents/PD10_084_engl_2015.pdf

fell to 38.2, which indicates an initial growth and then a certain drop of economic inequality during the observed years.

3. SYNTHETIC ASSESSMENT OF MACROECONOMIC ENVIRONMENT IN SERBIA AND THE RISKS ACCOMPANYING IT

The previous analysis showed that Serbia was lagging behind in market reforms and that in many areas there were medium or large gaps with the standards of developed market economies. EBRD divides transition reforms into three phases: the first (market-enabling) consists of reforms relating to the privatization of small enterprises, market liberalization, trade and exchange rate system; the second (market-deepening) includes the privatization of large enterprises and strengthening of the financial institutions, while the third (market-sustaining) presents fundamental reforms in enterprise management and restructuring, development of institutions for competition protection and promotion and a more pronounced commercial approach to providing infrastructure services.[58] The presentation of traditional (horizontal) and sector transition indicators, which is included in the chapter, points to the conclusion that Serbia made the most progress in the implementation of the first phase of reforms and that the agenda is still open and considerable when it comes to the second and, especially, the third phase which is, as it turns out, the hardest to implement, but also has the biggest impact on achieving economic growth.

Our economy should be brought up to par with the standards of a functional market economy in the near future by adopting and implementing adequate systemic laws, in order to create attractive business environment, supportive of the sustainable economic growth and development.

Freedom concerning the concept and implementation of reforms in Serbia is, without doubt, narrowed down and in this regard we are not much different from other countries of similar economic strength, pursuing European integrations. Although we are being presented with various conditions by certain countries and international institutions, it is important for the government to remain a pivot in shaping and implementing changes and the relentless keeper of vital national interests. In order to decrease the risk of the collapse of reforms, voluntarism of government and international conditioning, there should be a comprehensive, designed and agreed package of long-term

[58] EBRD (2007). *Transition Report*. London: European Bank for Recostruction and Development, p. 8.

social changes, which is at present lacking. Documents such as Fiscal strategy are short-sighted and have a sectoral character and therefore cannot serve as a substitute for the comprehensive reform strategy.

After seven years of stagnation and some results achieved in reducing macroeconomic imbalances, the question of creating dynamic and sustainable economic growth and development, which was pushed aside for a while, must again become the focus of attention. Current problems should be solved looking ahead into the future and with a clear path leading to it. Some see the growth rate of 0.7% achieved in 2015 as a great success and the start of sustainable GDP growth. Others think it is a barely noticeable growth, not worth the attention. The fact is that the aforementioned growth rate, achieved by a country of this level of development and after the decline in GDP caused by catastrophic floods, can be described as very modest, or almost insignificant. However, there are healthy elements in the foundations of this growth, which gives it a certain specific weight and importance, but it is still too early to call it a sustainable growth. In the years to come, Serbia can expect to achieve somewhat higher, but, for the conditions we live in, almost symbolic growth rates of 1.8% in 2016, 2.2% in 2017 and 3.5% in 2018.[59] Those growth rates could be positively evaluated if they rest on secure foundations and represent a shift towards healthy economic expansion and sustainable economic development.

When it comes to the development pattern, abundant global liquidity up until the onset of the crisis created an illusion that fast economic growth is possible even without reforms. It fueled economic expansion based on the consumption and import, which resulted in a certain improvement in the living standards of the population, but was not sustainable and did not contribute to the increase in employment. Therefore, in the near future, Serbian economy should switch to investments and export as new and potentially powerful sources of growth. This is affirmed by the findings of the Commission on Growth and Development, which say that the path to dynamic and sustainable economic growth, which Serbia requires too, leads across: quick export growth, preservation of macroeconomic stability, high savings and investment rate relying primarily on domestic sources, market allocation of resources, as well as dedicated, credible and competent government.[60]

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[59] Government of the Republic of Serbia (2015). *Fiscal strategy for 2016 with forecasts for 2017 and 2018,* Belgrade: Government of the Republic of Serbia, p. 12.

[60] Commission on Growth and Development (2008). *The Growth Report - Strategies for Sustained Growth and Inclusive Development,* Washington, D.C.: The International Bank for Reconstruction and Development / The World Bank, p. 22-28.

Gross fixed investment rate, which was between 20% and 25% in the years prior to the crisis, when the economic growth was relatively dynamic, is now considerably below 20% (17% in 2014 and somewhat higher in 2015), which is insufficient having in mind the experience of other Central and Eastern European countries. It seems that ad hoc state intervention with an aim of attracting investments and giving employment incentives is not the right path for their more permanent revival. Along with efforts to strenghten macroeconomic stability and improve the investment environment through further fiscal consolidation, it is also necessary to strategically direct domestic and foreign investments primarily into the real sector, which would enable the increase of exports.

It is evident that, at the time when readiness for change is expressed and when we see the first signs of economic recovery, there is no officially accepted strategy for the economic development of Serbia fin the upcoming period, and the sustainable growth, which is formally accepted as a global development paradigm for the next 15 year period, is barely even mentioned. Regardless of the fact that the confidence in development strategies was betrayed in our country, Serbia needs strategic development benchmarks. Admittedly, our commitment to join EU also entails an obligation to accept Europe 2020 strategy, which advocates for smart, sustainable and inclusive development.[61] It appears to be a good, but only a general (and thus insufficient) plaform for our economic future.

According to the assessments from Harvard economists, which are also supported by the findings of the World Bank, Serbia is too poor for its production potentials. Accordingly, our country is advised to work most on the development of its industrial production (primarily machine and automotive industry, but also chemical industry in a broader sense, as well as to try to be more competitive on the export market.[62]) More competitive economies are, it was proven, more resistant to risks and more capable of adjusting to the ever changing environment.[63]

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[61] EC (2010). *Europe 2020 - A Strategy for smart, sustainable and inclusive growth.,* Brussels: Communication from the European Commission, COM(2010) 2020 final, p. 8.

[62] See: Hausmann, R. et al. (2013). *The Atlas of Economic Complexity - Mapping Paths to Prosperity.* Harvard University: Center for International Development; World Bank (2012). Republic of Serbia: The Road to Prosperity: Productivity and Exports, Vol. II, Main Report. Washington, DC: World Bank.

[63] Schwab, K. (ed.) (2015). *Global Competitiveness Report 2015-2016.* Geneva: World Economic Forum, p. xiii.

Ambitious reindustrialization was for a while a very current topic in our scientific, professional and political communities, which made sense because during the previous development some serious disproportions in the structure of Serbian economy became evident, along with the neglect of the real sector. (especially the industry). Discussions on this subject have now, however, subsided, giving way to fiscal consolidation, though those are two related subjects which not only do not exclude, but support each other. Industry revitalization, which was seriously set back by the privatization process in Serbia, should without any doubt remain at the forefront of the minds of creators of our development strategies and policies. Also, emphasis should be placed on the modern production based on research and development and sensitive to the needs of environment. We should also mention the importance of implementing a responsible industrial policy, which facilitates structural changes through «smart», targeted interventions.

Macroeconomic environment in Serbia is exposed to the influence of numerous risks, both from inside and outside. External risks have lately intensified, which especially affects small and open economies such as ours. It became very difficult to predict not only the intensity, but the course of change in the global environment. External risks are associated with the recovery of global and European economies and, based on that, on the increase of foreign demand and foreign capital inflows, the movements of import prices and the prices of food and petroleum products. A risk of the deterioration of geopolitical situation should also be added here, with all its adverse effects on financial, foreign trade and energy areas. This imposes the duty to carefully monitor changes in the world and to take adequate measures in accordance with the assessment of their influence on Serbian economy. The resistance of domestic economy to the international risks is positively affected by the improvement in the area of public finances and of business and investment environment, as well as the reduction of external imbalances.

Internal risks refer to implementing reforms in the real sector (reforms improving the business environment, reforms of the labour market, reforms in the area of transport and energy infrastructure, reforms of the export and investment support system, etc.) and the public sector (reforms in the area of employment and the salary system in the state sector, reforms of the largest public and state-owned enterprises, health system reforms, public financial management reforms, etc.). The lack of investments and comprehensive structural measures would negatively affect the key macroeconomic indicators of the country. Whether the needed reforms will be implemented or not depends largely on the political support to their implementation. It seems that in Serbia there is still a political will for change, which is, to a large extent, brought about by the difficult economic situation in the country.

The risk of social instability in Serbia is very high and it should be paid special attention to. Cumulation of social discontent, at a time when the implementation of politically very sensitive measures (such as the ones concerning wages, pensions and public sector layoffs) is not accompanied by broader social consensus achieved through a social dialogue, can jeopardize further reform implementation. In order to reduce social pressures, caused by the anticipated increase of unemployment due to the rationalization in the public sector and the completion of restructuring state-controlled enterprises, it is necessary to increase employment in the private sector, which requires that adequate conditions be created first. Respecting the principles of fairness in the implementation of changes is one of the things that would blunt the blade of social discontent. Restrictions in public spending should be accompanied by the efforts to increase the public revenue. Grey economy hides great reserves of budgetary funds. We should add to this the revenues lost due to the taxes not being paid, as well as enormous assets acquired through criminal activity, which could be confiscated if it turns out to be impossible to trace quite significant funds of dubious origin, deposited in foreign banks. The implementation of these measures would also reduce the risk of so called illegal trade, which includes illegal financial flows, tax evasion, organized crime etc.

There are also risks of failures in managing the country, relating to the areas such as the rule of law, corruption, political deadlock.[64] Serbia should pay special attention to the building of institutions - economic, legal and political, which represent one of the fundamental drivers of economic growth. Good institutions encourage people to work, save, innovate and engage in entrepreneurship, whereas the bad ones encourage corruption and enrichment without any effect on the growth and employment.

Institutional improvements are also very important for their role in making human capital the key determinant of growth in a knowledge-based economy. High quality of institutional environment makes it easier to keep and attract high-quality staff who will be the bearers of innovation and the application of modern achievements in the economy, which will stimulate economic growth. This would at the same time enable adequate compensation to highly qualified staff, which encourages talented individuals to educate themselves. In an unregulated institutional enviroment, the position of an individual in the society

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[64] World Economic Forum (2016). *The Global Risks Report 2016.* Geneva: World Economic Forum, p. 86.

does not depend on his/her true qualities and engaging in socially productive activities is less attractive than acquiring various benefits and the corruption. The consequence of that is less interest in education, the best people leaving the country to work abroad and the economic and social collapse. World Economic Forum's data for 2015 show that Serbia is ranked the last among 140 countries in terms of the capacity to retain talents, which is extremely worrying.[65] At the same time, Serbia was placed 50th in the Human Capital Index (HCI) out of a total of 124 countries, below all EU member countries. The EU country closest to Serbia on the list was Bulgaria, which was placed 42nd, and when it comes to the region, Macedonia and Albania occupied 53rd and 66th spot respectively, while Bosnia and Herzegovina and Montenegro were not included in the analysis.[66] It is interesting that, within the aforementioned composite index, Serbia is placed high (38th in the world) when it comes to the economic complexity indicator, derived from the study by R. Hausmann et al., measuring production knowledge and skills embodied in export goods, which is compatible with previous assessments of the development potentials of real sector in Serbia.

Risks are also linked with the movement of individual macroeconomic indicators - from the economic growth and fiscal performance to the inflation and unemployment. Due to the seriousness of problems in the domain of public finance, fiscal risks are paid special attention to in Serbia, which is also evident in the Fiscal strategy.[67] Experts are particularly worried when it comes to the rationalization of the number of employees in the general government sector (where the focus should be on the disposing of incompetent party cadres), which should have been faster, and premature lifting of salary and pension freeze in the public sector (which could be compensated with a more efficient fight against the grey economy and tax evasion through the introduction of necessary systemic measures and adequate tax administration reform). There is also a danger of new budget costs for covering the losses of public and state-owned enterprises due to their bad business performance. It will also be very challenging to complete the privatization process in due time (by mid-2016).[68]

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[65] Schwab, K. (ed.) (2015). *Global Competitiveness Report 2015-2016.* Geneva: World Economic Forum, p. 315.

[66] World Economic Forum (2015). *The Human Capital Report.* Geneva: World Economic Forum.

[67] See: Government of the Republic of Serbia (2015). *Fiscal strategy for 2016 with projections for 2017 and 2018.* Belgrade: Government of the Republic of Serbia, pp. 41-43.

[68] See: Petrović, P., Brčerević, D., Minić, S. (2016). *Economic recovery, employment and fiscal consolidation: lessons from 2015 and prospects for 2016 and 2017,* Belgrade: Fiscal Council, p. 6.

Serbia is at a turning point when it comes to reforms and development, after a transition stalemate and several years of economic stagnation. It remains to be seen whether our country will find the strength in the coming period to complete the ongoing market reforms and to transform the initial results in the fiscal area into more permanent fiscal stability, which would support the dynamic and long-term, sustainable economic growth in conditions of numerous external and internal risks and challenges.

Chapter 3.

RISK MANAGEMENT IN FINANCIAL SERVICES MARKET

In liberalized and deregulatory environment, it is impossible to give a full guarantee for an enterprise's business solvency. All institutions having business activities in financial market, need to pay attention to risks which can endanger their financial stability. In other words, assessment and control of potential risks are necessary in order to maintain solvency and business stability.

The basic aim of risk management is to ensure efficient business activities of an enterprise after the realization of risk, i.e. to maintain business solvency and liquidity after the occurrence of loss caused by given risks. The management of every financial institution must continually identify, assess, i.e. quantify and classify risks they face and thereafter define necessary risk control and security measures, all of this in order to provide efficient management. Traditional risk management method includes the management of separate risks an enterprise is exposed to. Modern business circumstances, identified by new business environment as a result of globalization, deregulation and technological innovations, as well as the presence of new, complex risks, have forced the companies to apply integrated risk management concept as a special corporate management technique.

Enterprise risk management - ERM is a management concept with an aim to minimize the impact of risk on capital and income of the enterprise, as well as to provide a more efficient risk capital allocation capital. This model can be used by all companies regardless of their business activity. ERM can also be defined as an integrated process including identification, analysis and monitoring of potential risks through formal organizational structure of the company and quantitative approach which enables the achievement of strategic objectives.

Risk management assessment rules and procedures have significant similarities, but also vary among institutions present in financial market, banks and insurance companies in the first place, but also other specialized institutions whose primary business activity is related to securities. Risk management is aimed at providing independent assessment and business risk control, i.e. the development of quantitative risk measures, also including operational risks which are difficult for measuring, all this in order to maintain solvency and liquidity. In the control of primary, but also wider secondary business risks, the dominant role in strategic risk management belongs to hedging techniques, as well as capital and reserves maintenance techniques.

Due to the fact that loans make a significant part of bank assets, credit risk is dominant in banking business. Depending on the scope of other activities (interbank business, securities business, derivatives business etc.), banks may also be exposed to market risk, including foreign currency risk and other risks in connection with securities. It is also important to control interest rate risk and liquidity risk as there is a possibility of non-compliance between the maturity dates for assets and obligations. Banks are certainly exposed to operational risks as well.

Based on the criterion of risk impact on insurer's solvency, risks can be classified as technical risks (liability risks), investment risks (assets risks) and other risks (non-technical risks). Technical risks refer to the obligations of insurance companies and vary depending on insurance portfolio. They are directly or indirectly connected with technical, i.e. actuarial basis for premium and reserves calculations. Investment risks may include various risks, among which most dominant is interest rate risk, as well as market risk and liquidity risk. Other, non-technical risks include operational and legal risks.

In addition to intermediary institutions, specialized financial institutions also exist in financial market (clearing houses, broker and dealer companies etc.), trading securities and doing other business related to securities. The risks these companies are exposed to are different from those dominant for banks and insurance companies. For specialized financial institutions, the largest parts of assets are receivables secured by securities. These institutions request collateral and monitor the exposure to risk depending on the collateral. Specialized financial institutions are active participants in derivatives market, where market and credit risks exist. Since these companies are active in the business such as property management, securities trade, investment banking, i.e. various advisory and research activities, operational risk management is of great importance for specialized financial institutions.

1. RISK MANAGEMENT

Risk management has a direct impact on solvency, economic security and total financial stability of an enterprise and, thereby, financial institutions. The purpose of risk management is the decrease of uncertainty extent which may be a threat to successful business, prediction of changed business circumstances and timely reaction to them.

Risk management process itself must contain at least these phases:

- Risk determination or identification,
- Risk assessment and measurement,
- Risk-handling (approach to risk, i.e. choice of management technique),
- Monitoring, i.e. risk management process control and reporting.

The person in charge of risk management must be aware of all risks to which their company is exposed. Risk recognition is very complex. Risk identification is an initial management phase. Besides potential risks determination and documenting, it also includes risks causality determination, as well as their mutual impact. Most commonly used risk identification methods are: joint workshops, interviews, statistics, financial reports, etc.

After risk identification, it is necessary to carry out risk measurement, i.e. the assessment of damage occurrence probability and intensity, i.e. risk impact[69]. Thereafter, risks are ranked, priorities are determined and information important for decision making are given regarding the risks the enterprise should be focused on. The figure 1 gives risk matrix with risk probability and intensity, so that the total exposure to risk can be determined. Total exposure to risk is obtained as a multiplication equivalent of probability and impact points and it may be low (marks 1 and 2), average (marks 3 and 4) and high (marks 6 and 9).

Figure 1. Risk matrix

Probability	High	3	3		6		9	
	Average	2	2		4		6	
	Low	1	1		2		3	
			Low	1	Moderate	2	Serious	3
			Impact					

Source: Ministry of Sea, Transport and Infrastructure (2011). Risk Management Strategy, Zagreb: Ministry of Sea, Transport and Infrastructure of the Republic of Croatia, p. 5.

[69] Impact is the assessment of consequences or a result of certain outcome if the risk is realized.

Table 1. Risk Matrix Results

Result					
1		2		3	
Probability Assessment	Impact Assessment	Probability Assessment	Impact Assessment	Probability Assessment	Influence Assessment
low	**rather low**	**average**	**moderate**	**high**	**serious**
Event occurrence is unlikely.	In case of risk occurrence, planned activities remain undisturbed or they are slightly disturbed, so there is no need for additional resources.	The event may occur. Risk occurrence probability is based on evidence or knowledge regarding similar situations which occurred in the past.	In case of risk occurrence, activities are significantly disturbed, with possible necessity to use additional resources so as to ensure further achievement of goals.	The occurrence of event is expected in most cases. The probability of risk occurrence is based on clear and frequent evidence related to situations which occurred in the past.	In case of risk occurrence, activities are significantly disturbed and significant additional resources are necessary in order to achieve the goals.

Table 1and Figure 1 show us how the risks should be classified (insignificant, significant and catastrophic risks), i.e. what the exposure of a company to risk is like. Blue colour indicates low risks (insignificant risks which should be accepted), yellow colour is for average risks (significant risks which should be solved and decreased), while high risks are marked with red colour (so-called catastrophic risks). For example, a natural disaster is a risk with low occurrence probability, but of a great impact, i.e. damage intensity, so it is regarded as a high risk, or a high priority event.

Having analyzed the risk matrix, the four possible answers to risk are as follows:

- To accept and tolerate risk - the management estimates that the observed risk level can be and must be accepted because the cost of risk reduction would be higher than potential damage. Or, better, no additional actions are taken in order to decrease the risk.
- To decrease (mitigate) risk - actions are taken in order to decrease risk probability and/or its impact. Some of the measures are, for example: the change of legislation and simplification of operational procedures.
- To transfer the risk - actions for risk probability and impact decrease are taken, such as risk transfer or partial risk distribution. The risk can be transferred by contract on the third party able to control it, or on the person who will bear the risk at the lowest cost (insurance companies, concessionaires, bankers and others through contracts and financial agreements).
- To avoid risk - actions are taken in order to stop or modify existing activities. In extreme cases, replacement or giving up certain activity can be the only way to avoid risk.

Therefore, the choice of risk management technique can include the approach to risk through physical control, which can be realized though avoiding, prevention and risk reduction, as well as an approach through financial control which includes taking the whole risk, transfer of risk surplus or internal risk reduction. Maximum probable damage[70] which can be a consequence of risk is the crucial factor determining which risks should be focused on. Risk control is a management phase carried out due to the possibility of error occurrence during damage frequency and intensity determination, i.e. the choice of an adequate technique. Also, in this phase of risk management, the investigations of techniques' adequacy are carried out for the risks identified in the past. Bearing in mind that business circumstances change, a “risk manager” must

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[70] MPD indicates the damage which can occur taking into account all circumstances, i.e. causes related to the risk taken with insurance.

reassess the selected techniques, as every change can represent a new risk or it can lead to the change in the size of existing risks. Enterprise risk management is also monitored by existence and functioning estimation of its components during a period of time, which is achieved by constant monitoring, evaluation or their combination. In order to monitor the risk efficiently, it is necessary to establish an adequate reporting system which would indicate the efficiency of risk management and control, i.e. which would inform the management when new risks are identified or when existing risks are not controlled adequately or they grow.

Risk assessment and control are complex processes which should not be limited by legal procedures. A state or independent regulatory organ (for example in insurance or banking) cannot approach the risk as precisely as banks and insurance companies because they cannot possess precise information regarding the nature of each risk taken by the institution, neither can they possess information on mutual relations or impact of all taken risks on their activity.[71]

Therefore, the aim of enterprise risk management is the minimization of risk impact on enterprise's capital and income, as well as efficient allocation of risk capital. ERM can be defined as strategy which harmonizes the company's business activity with risk factors in order to achieve the most important aims. Risk management method through ERM provides more precise predictability of potential losses and, therefore, less exposure to losses compared to companies which apply traditional approach to risk management. Therefore, this concept allows the risks which were traditionally unacceptable for an institution to be represented in a services portfolio. The reason of new risks introduction is intensive competition in financial market, new requirements from services users and the wish to realize the profit. More accurately, in global market, financial institutions are requested to widen their offer and accept new, more complex risks.[72]

2. RISK MANAGEMENT TECHNIQUES SIGNIFICANT FOR BUSINESS ACTIVITY OF FINANCIAL INSTITUTIONS

There are a number of techniques (instruments) of risk management used by intermediary and specialized financial institutions. These techniques include the

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[71] Risk management in Insurance, *27th International Congress of Actuaries*, Cancun, Mexico, 2002.

[72] Kessler, D. (2001). Anticipating and Managing Risks at the 21st Century. *The Geneva Papers on Risk and Insurance,* 26(1), p. 7.

development of certain corporate policies and procedures relating to the use of quantitative methods of risk measurement, product and service price determination based on risks, establishment of risk limits, active risk management through diversification and hedging techniques, as well as provision of adequate reserves and capital level for absorption of potential losses. The application of the above listed instruments depends on the nature of financial services and risks themselves and largely on the nature of relevant supervisory regime. Therefore, the management of every company implements reliable risk management policies and procedures related to identification and measurement of risk, detailed structure of limits and guidelines for risk taking as well as internal control and management of informational systems in order to report and monitor the risks.

Most risks can be identified, but not measured easily. Regardless of the type of the risk which is attempted to be measured (market, credit, operational, etc.), it must be observed through three key dimensions: loss occurrence probability; loss size (damage impact and intensity) and exposure extent. Probability and size of loss are uncertain categories which must be observed from statistical aspect (data analysis). Joint aspect of financial institutions risk measurement is analysis of various scenarios in order to define accurate profile of an institution's sensitivity to risk. When the risks are identified and quantified, company's management defines the policies and procedures for their limitation and control. For example, they define instruments in which the company can invest its free resources, the standards for debtor's credit worthiness, risk transfer contracts (insurance policy, forward contracts, etc.) etc.

Risk diversification, distribution and transfer techniques are used by all institutions doing business in financial market. Risk diversification is carried out for a number of various positions from the aspect of risk characteristics, in order to mitigate total potential loss for each position. Institutions in financial market use various techniques of risk mitigation. Banks and specialized financial institutions decrease risk using collaterals most frequently. Insurance companies do it through implementation of franchise into insurance contract, for example. Financial institutions also transfer and distribute their risks. Insurance companies mostly realize risk distribution through contracts on reinsurance, while banks do it through securitization of loans, while specialized financial institutions and also banks, carry out hedging transactions through derivatives. Due to the capacity of capital market and the characteristics of options, futures and swaps, forward contracts can ensure efficient protection from risks which cannot be transferred by contract onto the insurer, such as, for example, interest rate change risk, currency risk, default risk, liquidity risk, etc. Insurance companies also appear as financial derivatives users (futures, options, swap arrangements) and as dealers, although most frequently banks act as dealers, as well as the companies trading securities. Financial institutions are big users of financial derivatives because in the basis of their use we can see the maximization of company's value, cost reduction and often tax reasons.[73]

Reserves and capital level maintenance is also an important technique of financial institutions' protection from potential losses. Banks must maintain their reserves in order to cover credit losses. Specialized financial institutions trading securities and doing other business with securities mainly do not form reserves for loss coverage, except in special circumstances when, for example, they are requested to reserve potential liability due to a possible negative court decision, i.e. because of the court process itself. Most often, these companies use the mechanism of daily adjustment -"marking to market"[74], as a tool for the elimination of expected losses. Technical reserves are especially important for insurers as they represent future obligation toward policy holders, i.e. they are funds which would be paid to insurance users in future. Technical reserves can be used for payment of potential unforeseen losses (risk equalisation reserves). Finally, it is important to emphasize that all companies must maintain their capital on an adequate level. Capital is an indicator of business solvency and institutions use it to protect themselves from losses which cannot be covered by other resources.

The most important risks which are analysed and controlled by financial institutions, with a significant impact on the solvency and liquidity of their business activity are: credit risk, market risk, liquidity risk, interest rate risk, technical risk and operational risk.

2.1. Credit risk

Credit risk refers to potential loss due to counterparty's failure to perform their obligation based on loan or securities (for example bonds), as well as to a

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[73] Kenneth, B., Skipper, H. (2000). *Life & Health Insurance*, 13th Ed., New Jersey: Prentice Hall, p. 893.

[74] Marking-to-market mechanism for contracts. For example, a clearing house automatically calculates and transfers from account to account losses and gains because of minimum funds participants must have on their accounts (maintenance margin). These amounts are usually between 75 and 80% of initial margins. If they drop below this limit, the clearing house requests from the client to pay additional funds and ensure the minimum level. If margin level is below maintenance margin longer than one day, investor's futures position is automatically closed as it is regarded they have no intention to fulfill the contractual obligation.

situation when a guarantor (endorser) or the counterparty in a derivative contract will not perform their contractual obligation. This kind of risk is present in all sectors of financial market, but it is the most significant for banks. Credit risk can be identified in all activities where the success depends on partner party, issuer or borrower. For a bank, credit risk occurs every time when the payment of its funds is prolonged, i.e. when the funds are engaged, invested or in some other way exposed to risk through contractual arrangements.

In the situation of debtor's credit worthiness decrease, there is also a decrease in the price of debtor's shares, but also an increase of their debt if the loan was contracted based on variable interest rate. Credit risk management includes successful assessment of expected loss which is covered by bank from its operational reserves. In modern business circumstances, credit risk does not refer only to the failure in regular debt payment within contractual dates, but it can also occur in the following situations:[75]

- The debtor has stopped performing their contractual obligations even after three months since the debt was due for payment
- The debtor has violated one or more contract clauses
- The debtor is unable to continue paying the debt because their assets market value has dropped below the value of their debt. If the market value of debtor's assets drops below the market value of their obligation, it means that present expectations regarding future cash flows are that the debt cannot be paid.

Therefore, besides credit risk analysis through loan activities, it is also necessary to analyze it in the situation when securities are possessed as well. If securities issuer's credit worthiness deteriorates, it is a potential loss for the bank as the owner of the subject securities.

There are various credit risk reduction techniques. Primarily, rational decision making is necessary in the field of crediting, i.e. credit risk assessment based on a rating system and credit limit system must be carried out for every borrower. The borrowers with better rating have higher credit limits. Limits are also introduced for certain industry sectors, geographic regions and specific products. These limits provide an adequate diversification of bank's credit activities. However, it is important for the bank to carry out risk diversification onto all borrowers in order to reduce potential loss, approving loans with different maturity dates to borrowers with different economic strength and solvency.

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[75] Ćirović, M. (2006). *Bankarstvo*. Belgrade: European Centar for Peace and Development, p. 348.

For the loans approved in their portfolios, banks have developed a system of loan classification as aid in credit risk measuring and monitoring. More accurately, banks develop systematic internal models for credit risk quantification, using portfolio approach to credit risk management, in order to measure “default” probability (probability of failure to pay), as well as the exposure to potential losses due to the risk of default in timely obligations payment. Based on the obtained information, the amount of economic capital necessary for all the activities including credit risk is estimated.

Banks must provide guarantees (collaterals) for fulfilment of contractual clauses. For credit risk decrease, besides collaterals, banks also use credit derivatives. Credit risks mitigation techniques applied by banks for their market activities are very similar to those applied by specialized financial institutions, which largely rely on collaterals. Specialized financial institutions are exposed to credit risk through various activities, such as conclusion of forward contracts, repo transactions, approvals of margin loans to clients[76], transactions including derivatives in OTC market, etc. Specialized financial institutions, like banks, also carry out an important client analysis in order to define the exposure to credit risk. They build internal systems for the assessment of client’s credit worthiness, i.e. for credit rating determination. These companies also decrease credit risk by adjustment of collateral requests on a daily basis (for secure transactions), while for the insecure ones, the risk is most frequently decreased by collateral request increase.

Insurance companies also manage credit risk, present in property portfolio where bonds are dominant, as well as in reinsurance contracts. Life insurance companies may insure their mortgage property (for example, mortgage bonds), which also requires a high level expertise in credit risk management. Investment policy of insurance companies in Europe is limited by special rulebooks brought by insurance supervision institutions, clearly prescribing in what types of assets free financial funds may be invested and in which amount, which certainly limits their exposure to credit risk. Insurance companies must also pay attention to their reinsurance contracts as contractual obligations unfulfilled by reinsurer are a certain loss for the insurer. For this reason, insurance companies should diversify risk surplus placement into reinsurance. Diversification can be realized through conclusion of several contracts with different reinsurers, as well as through provision of additional protection for reinsurance credit risk, for example, collateral or letter of credit.

[76] A specialized loan the broker approves to the client for securities trade. The loan is collateralized by securities owned by the client.

2.2. Market risk and liquidity risk

Exposure to market risk refers to potential losses which are the result of changes in value (price) of assets. The value of assets can change due to instability of market factors, such as interest rate, currency rate and the price of shares and goods. Liquidity risk refers to potential loss an institution may face due to failure to perform due obligations. Liquidity risk is a result of failure to recognize or react to market factors changes affecting the speed of assets liquidation at minimum value loss, as well as due to inability to manage unforeseen financing resources decrease.

Together with liquidity risk, market risk is important for all financial system institutions in order to achieve financial yield through adequate management and face acceptable market losses.

Banks, insurance companies and specialized financial institutions use various statistical models in order to measure the impact of different market factors on price and value of their assets. The most important model is VaR (Value at Risk), aimed at measuring the level of capital a company needs to provide so as to maintain its solvency, i.e. the magnitude of expected loss (total risk size) during given time, based on damage distribution probability and specific level of trust. VaR can measure absolute risk of assets and/or liabilities portfolio, or active risk regarding the difference between portfolio and its benchmark.
This risk measure may sum up several risk factors, such as interest rate risk, currency risk, but also capital risk. VaR may also be used as ex ante or ex post measure of risk or it can be based on market and/or historical data. In other words, VaR can be a parametric or a historical risk measure.

For insurance companies, a more applicable risk measure is TailVaR (*tail value at risk*), which represents expected, i.e. average loss value if there is a break through of capital threshold calculated using VaR measure. $TVaR_{1\%}$ is a much more restrictive measure because compared to VaR, it indicates possible additional loss if capital threshold is broken through, i.e. when the value of loss is higher than expected[77].

Most VaR models start from statistical analyses which estimate past prices volatility based on which risks or future price changes are assessed. Practically, VaR models enable quantification of market risks and are useful for limitation and monitoring of market risks. Along with VaR models, companies also use

[77] Denuit, M., Dhaene, J., Goovaerts, M., Kaas, R. (2005). *Actuarial Theory for Dependent Risks*. New Jersey: John Wiley & Sons, p. 72.

auxiliary instruments, such as stress tests and scenario analyses. Stress tests measure potential negative impact of various market changes on a company's portfolio value, i.e. identify company's exposure to market risk. Scenario analyses focus on potential impact of certain market events on portfolio value, while problematic past events are often used as potential scenarios.

Liquidity risk for a bank occurs due to maturity mismatch between the structure of assets and liabilities. The incompliance between balance positions occurs due to an unexpected growth of portfolio securities prices, as well as due to changes in capital purchase conditions and investment policy execution. Applying ALM (asset liability management) concept most frequently, a bank should provide financing for its short-term assets through short-term resources, while total long-term placements and a part of short-term placements must be covered through long-term resources. Only these financing rules lead to continuous liquidity maintenance of the business bank.

Borrowed funds are dominant in the structure of insurance companies' liabilities, i.e. reserves as future liabilities towards policy holders. For this reason, it is very important how the insurance company is going to estimate their reserves and how they are going to place them later in the financial market. Reserves assessment depends on the experience and data available to insurance companies, while resources placement is determined by the quality and maturity of liabilities. Security of liabilities regulation towards policy holders and maximization of investment yield at an acceptable level of risk are basic principles of financial business activity for insurance companies. The coordination of assets and liability maturity is the basic risk for insurance companies while doing their business in financial markets. Although mathematical reserve is long-term and, therefore, placements are long-term as well, there can always be an unpredicted situation when the company is forced to cash their financial property urgently, which can lead to certain property loss. In many countries, insurance companies are obliged to limit liquidity risk and market risk pursuant to, for example, Rulebook on Depositing and Investment of Free Funds, i.e. they are obliged to provide limits regarding ratio and property type they can have in their portfolio.

2.3. Interest rate risk

Interest rate risk is defined as a possibility of future interest rate change, which would cause unforeseen economic loss. These losses result in a lower interest rate margin, lower assets value or both simultaneously. Therefore, interest rate risk is exposure of a company to potential loss due to unfavourable trend of interest rate and it is a part of market risk. Banks and life insurance companies are exposed to this risk in the first place.

For a bank, interest rate risk occurs with the increase of market interest rates, which can lead to uneven change in interest rate on bank's placements and obligations. Interest rates on obligations the bank needs to pay adjust to placement interest rates changes faster, which results in the decrease of bank's profit. Interest rate risk for bank also occurs when the bank has a credit contract concluded based on variable interest rate. If a bank possesses securities in its assets (for example bonds), interest rate risk occurs with the increase of market interest rate because in this case the value of the bond decreases.

Interest rate risk is a primary risk controlled by ALM technique. Bank's exposure to interest rate risk is particularly present due to offensive business strategy, as well as due to incompliance between maturity of the loan and changes in interest rates. With an offensive business strategy, a bank tends to anticipate interest rate trend changes, while the defensive approach is aimed at minimization of exposure to risk through risk coverage by certain market transactions. Interest rate risk can be controlled directly or indirectly.

Direct interest rate risk control includes control of a balance position value change, for example through securitization. Higher share of securities in property structure compared to approved loans, improves banks' balance structure, i.e. it establishes a satisfying relation between yield, expenses and risks when there is a high indebtedness of the bank. Indirect interest rate control can be carried out through hedging, i.e. protection of assets and liabilities based on use of financial derivatives (options and futures) under conditions of interest rates changes. Monitoring of interest rates changes is carried out using interest rates sensitivity analysis. When interest rates grow, ALM technique tends to increase the assets sensitive to interest rate compared to liabilities sensitive to interest rate. In this way, it is possible to calculate resources maturity incompliance, i.e. determine an acceptable level of interest rate risk compared to bank's capital as a basis for the coverage of risks the bank is facing.

Insurance companies' business activity in financial markets includes free reserves investment. Free reserves investment process must be coordinated with the structure and maturity of insurance based liabilities. ALM model is aimed at construction of an optimum investment portfolio for insurance companies. Immunization strategy is an ALM technique applied by life insurance companies. Investment portfolio immunization technique measures the duration and convexity of insurance companies' assets and liabilities. It indicates the necessity of interest rate risk control. Life insurance companies are exposed to interest rate risk, primarily due to long-term products with guaranteed interest rate which are offered to policy holders. For this reason, interest rate risk is often equated with technical risk in insurance because the amount of future premium depends on guaranteed interest rate and therefore the amount of technical reserves placed on financial market and their increase at market interest rate also depend on it. Technical reserves funds must be accumulated on the level of expected obligations coverage, which can be called into question by the change in market interest rate. As a response to this type of risk, insurance industry has developed life insurance products with variable yield rates (products with profit), as well as united-linked products where interest rate risk and expected yields are transferred on the policy holder. Insurance companies, due to the purpose of their business activity and the function of technical reserves, must manage and control the sensitivity of investment portfolio to interest rate changes.

Banks also apply hedging techniques (through derivatives and structure products[78]), which can also be applied on interest rate management.

Non-life insurance companies have developed a special management technique (dynamic financial analysis), which is implemented in order to control a wide range of risks and all transactions, i.e. all business lines.

In order to include other types of exposure to risk besides the exposure to interest rate risk, financial managers have created new sensitivity measures. Among the new ones, spread duration is a measure mostly used for corporate bonds in order to determine price sensitivity or market value of the bond due to a wide range of changes[79]. Investment managers often use *option-adjusted duration* or *effective duration* to indicate the necessity of explicit observation of cash flows generated through positions which substantially depend on interest rates flows. Cash flow dependency on interest rate trends is primarily observed for securities with options included, such as *callable bonds*[80], options, *floating rate notes*[81] and residential mortgages with pre-paid commission. If future cash flows change in the situation when rates grow and then decrease, from the

[78] Structured products are also called hybrid products. Besides a basic instrument (such as, for example, a bond), they also combine derivatives (such as options).

[79] Society of Actuaries (2003). *Professional Actuarial Specialty Guide Asset-Liability Management.* Schaumburg: Society of Actuaries.

[80] Bonds which can include payments before maturity date.

[81] Securities with variable interest rates issued by the borrower, i.e. debtor in *Eurobond* market, as a market independent from securities market, developed in 1960's, where securities are issued in € by governments or ultinational companies.

situation when interest rates decrease and then grow, securities are defined as „*path dependent*" (securities with dependent interest rates paths).

Key Rate Duration or *Partial Duration* is a much more advanced concept applied on securities with variable interest rate. By this risk measure, the sensitivity of securities or portfolio is determined, when there is a change of yield for an exactly determined maturity, with an assumption that all other interest rates (all other maturities) are constant. Partial duration measures the sensitivity of a financial instrument or portfolio to the changes in shape of yield curve[82]. Therefore, partial duration determines the sensitivity of cash flow to interest rate change, but only in one part of yield curve, which means that for every point on the curve duration can be determined, i.e. there is a vector of interest rates duration describing every maturity on yield curve. Total change of bond or portfolio value can be determined by simple duration measure only if we assume that all interest rates are changed for the same amount of basic points, i.e. for the same percentage. Interest rate trends are constructed in a way that interest rates duration sum corresponds with effective duration of instruments with fixed interest rate. Duration of key interest rate is calculated mostly for complex securities such as structured products

2.4. Other risks

Technical risks affect insurance companies' obligations and differ depending on insurance portfolio. These risks are directly or indirectly connected with technical, i.e. actuarial base used for premium and reserves calculation. The impact of realized technical risks can be seen in the fact that insurance company would not be able to fully respond to all its guaranteed obligations using the money funds collected from the policy holders, due to the claims frequency, claim amount and management expenses being much higher than expected.

When it comes to technical risks, it is necessary to differentiate current and special technical risks.

Current technical risks include the following risk types:

• tariff insufficiency risk or wrong tariff calculation risk referring to potential loss due to insufficient premiums for total insurance costs coverage;
• deviation risk, i.e. risk which appears due to bad assessment of claim frequency trend, mortality, interest rates, inflation and other similar factors which are included in premium calculation;

[82] Ho, S.T. (1992). Key Rate Durations: Measures of Interest Rate Risks. *Journal of Fixed Income*, 2(2), pp. 29-44.

• error risk which depends on the quality of tariff calculation and increases parallel with the lack of knowledge regarding expectations, i.e. assessments connected with insurance risks;
• reserves assessment risk which can lead to insufficient technical reserves for regulation of future insurer's obligations;
• reinsurance risk, related to potential loss due to insufficient reinsurance coverage or insurer's inability to regulate a part of their obligations;
• operational risk of expenses, which is realized when current or future expenses largely exceed the assessment used for tariff calculation;
• catastrophe risk, connected with catastrophic losses caused by a single hazardous event (earthquake, for example).

Special technical risks include a risk which can lead to a rapid or excessive growth of claim or aggravation of insurance costs, as well as the liquidation risk indicating insufficiency of insurance company's funds for regulation of all obligations in the situation of discontinuity of main or total insurance transactions.

Through regulations of supervisory institutions, insurance companies are protected against technical risks which can endanger their ability to regulate contractual obligations. These rules regulate technical reserves, reinsurance agreements, as well as actuarial calculations.

Operational risks are present in business activities of all institutions and insurance companies. When insurance companies are observed, all the risks can be divided into technical, investment and non-technical risks. Non-technical risks can be observed through three following risk types:

• management risk, referring to incompetent company management, i.e. activities which are caused by company management with a certain intention. For example, management risk exists if paid premiums are underestimated so that the company takes a certain position in the market;
• business risk connected with changes in economic and social environment, as well as with changes in business portfolio and business cycle of the company;
• legal risk, referring to unexpected legal changes in the field of services offered by the institution.

Operational risk refers to the possibility of negative effects occurrence related to financial result and capital of the bank as a consequence of employees' fault, inadequate internal procedures and processes, inadequate management of information and other systems, as well as due to unpredictable external events. This definition includes legal risk, but excludes strategic risk and reputation risk[83]. The definition was taken from the document Basel II[84] in which it is practically, precisely and comprehensively given, being applicable in all companies. Legal risk represents a possibility of loss occurrence due to penalties and sanctions which are the result of legal disputes based on the lack of fulfilment of contractual and legal obligations and penalties declared by a regulatory body.

According to the definition of operational risk, there are four basic causes of operational risk event occurrence[85]:

- people (employees),
- processes,
- systems and
- external events

Regarding employees, there are losses caused by one or more employees (for example, illegal acts such as frauds, unauthorized actions like power abuse, lawsuits against employees, etc.). The process category includes losses caused by unintentional errors in employees' work, negligence or inadequate business practice. When it comes to systems, this category includes losses as the consequence of mistakes or faulty software, hardware, technological systems, etc. The external events include losses which are the consequence of events caused by factors independent from the institution (natural disasters, changes in political and economic circumstances, legislation, public activities, etc.)

Operational risk management is a complex process, beginning from standard phases of risk identification (by risky events mapping, forming loss data bases), measurements of exposure to risks, reporting, monitoring and control. For the assessment of exposure to these risks, institutions can use various tools. Some of them are: internal and external data bases (on risks and losses); self-assessment technique; indicators of risk and effects measuring potential losses due to operational events before they occur; analysis scenario and other methods.

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[83] Reputation risk refers to loss occurrence possibility due to a negative impact on company's positioning on the market. Strategic risk refers to loss occurence possibility due to the long-term development component in the management team of the bank.

[84] BIS (2004). *Basel II: International Convergence of Capital Measurement and Capital Standards. A Revised Framework.* Basel: Bank for International Settlements, Basel Committee on Banking Supervision.

[85] Mishkin, S.F. (2006). *Monetarna ekonomija, bankarstvo i finansijska tržišta*. Belgrade: Data Status, str. 14.

Chapter 4.

RISK MANAGEMENT IN BOSNIA AND HERZEGOVINA FINANCIAL MARKET

In general, the risk management process has a single goal, i.e. to ensure the uninterrupted business for an insurance company by decreasing the insurer's risk exposure. There are a lot of risk management techniques but the basic difference among them is in the risk that is to be managed.

In discussing risk management, it is typically believed that risk management is treated as a discipline which has insurance as one of its methods. This chapter does not discuss insurance as a method of risk management; rather, risks are viewed as realistic categories that can occur within the insurance industry and have a major negative impact on some industry segments. The phrase ‘risk management’ can be used in several activities, but this chapter is focused on the insurance industry.

It is a well-known fact that risk management is inevitability. A country's credit rating is one of the general indicators of risk synthetic measurement and assessment. In mid March 2016, the international rating agency Standard and Poor’s (S&P) confirmed the 'B' credit rating for Bosnia and Herzegovina with stable prospects. The rationale states that S&P expects Bosnia and Herzegovina to continue receiving the international financial support, which will back up the government finances and release pressures on balance of payment.

Department of financial stability of the Central Bank of Bosnia and Herzegovina publishes the annual Report on Financial Stability. It presents: (a) trends and risks from international environment, (b) trends and potential risks in Bosnia and Herzegovina, (c) households, (d) enterprises, (e) financial intermediaries, (f) financial infrastructure, and (g) statistical appendix.

The main risks for financial stability in the B&H macroeconomic environment are: fiscal weaknesses (which are reflected in the budgetary deficit and increase in public debt), a complex public sector, an increase in the current account deficit, slow economic recovery and poor domestic demand. The budgetary deficit from previous years and slowness in implementing the necessary structural reforms resulted in an increased debt of Bosnia and Herzegovina with international financial institutions, and due to absence of previously agreed tranches with the International Monetary Fund on the basis of stand-by arrangement, increase of government sectors' debt with commercial banks and in the domestic financial market. According to rating agencies' assessments, the sovereign rating of Bosnia and Herzegovina is still in the zone of speculative credit standing, with a high credit risk. Unfavorable trends in the balance of payment due to the current account conditions are continuing in a years-long sequence.

Trends and risks from international environment have had a significant effect on trends and risks in Bosnia and Herzegovina, which are correlated in several ways, and have multiplied in a few directions in the sectors of households, enterprises, financial intermediaries, etc. The character and purpose of the chapter lead to focusing attention only to the segment of risk management in the financial market of Bosnia and Herzegovina through insurance industry institutions, particularly insurance companies.

1. RISK MANAGEMENT CONCEPT

Risk management (RM) is defined as a way to reliably define and take over a risk with the aim of optimizing the insuring technical and financial stability of an insurance company.[86] The insuring stability primarily implies the properly quantified basic insuring risks. The technical stability pertains to the use of high-quality and reliable techniques, methods and models of assessing the insurer’s basic technical elements, first technical reserves and then insurer’s other technical categories (solvency margins, guarantee fund …). The financial stability is also an extremely important category in discussing risk management. The financial stability pertains to the suitability of reserves, character of assets, and term, quantitative and qualitative alignment of insurer’s assets with its obligations.

One of the ways to manage risks in the insurance industry is the reinsurance technique, which requires that the risk surplus over the amount of the insurer’s deductible be transferred to reinsurance, and that the premium be paid for it. In general, the risk management system implies processes of risk identification, its control, risk reduction and financing. Different writings include different names for the four processes of risk management, although the essence is mostly the same.

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[86] Andrijašević, S., Račić-Žlibar, T. (1997). *Rječnik osiguranja.* Zagreb: Masmedia, p. 384.

Risk identification is the first step in the risk management process and implies research into whether the insurer is exposed to risks. There is a series of methods for identifying the insurer's risk, but it should be noted that they pertain to the research into the insurer's past and current business, and to the assessment of the technical bases of the product offered by the insurer. The second part of the process is described as risk control. Risk control implies obtaining more information on the risk in terms of its intensity and frequency. In life insurance it pertains to the frequency of the occurrence of insured events and the level of insured amounts and share in the gain that the insured pays. Risk reduction, i.e. the reduction of risk exposure is, naturally, the next measure that insurers can take. Risk reduction implies the positive results of the method used in the previous segments of risk management process (risk identification and control). The insurer is bound to finance losses sustained due to possible damage.

In 2007, some of the reasons for a different approach to risk management were identified. Actually, the emphasis was placed on the regulator's role, on the increase in private ownership share, internationalization, globalization, escalation of risk and insolvency. The initial approach, whose elements have been listed, implied the identification of individual risks, their management and their further treatment. However, in the turbulent business environment risks are increasing and time resources no longer allow the exclusively individual approach to risks. This led to the formation of phrase 'enterprise risk management' (ERM).

Four steps were identified in the context of the new approach: modeling, interaction between assets and liabilities in the company, model simulations and testing and the dynamic financial analysis.

The first step implies creation of appropriate pre-requisites, selection of suitable assumptions for forming a tariff of products that will be offered by the insurer. The first papers in this area, by Henry William Manly, with the appropriate comparative analysis date from 1868.[87] As early as then it was recognized that valuation of the insurer's liabilities is extremely important. The valuation was performed in two parts: the first consisted in determining the insurer's financial strength and then reserve resources were studied; this assessment was followed by recording possible surplus of resources available for use. Due to the limited

[87] For more details see: Manly, H.W. (1868). A Comparison of the Values of Policies as found by means of the various Tables of Mortality and the different Methods of Valuation in use among Actuaries. *Journal of the Institute of Actuaries and Assurance Magazine,* 14(4), pp. 249-305.

resources in the observed period, the created models were exclusively of static character. Actually, modeling whose basis is the change of the defined environment conditions in order to create assumptions on the future behavior in new circumstances was based on different actions. The model assumptions could not be changed because the computer support for scenarios and their analysis was not available. More recent understandings of the insurer's liabilities (or more accurately, their technical reserves) indicate that liabilities should be treated in a different way. Since the insurer's assets were treated as a dynamic category, and having in mind the fact that the insurer's assets and liabilities are inevitably connected, it was deduced that the insuring company's liabilities should also be treated as a dynamic category. Using the previous static models, which included fixed assumptions, a simple data output (unambiguous result) was obtained. In the dynamic analysis variable can change, both on the assets and liabilities side of the insurer's balance sheet, and the result no longer has such a simple form. The result points to the need for further studies into the insurer's assets and liabilities, and the need for their integral management. At present, life insurance models are still of deterministic character, based on scenarios. They rely upon computing data obtained from the insurer's liabilities. Their future lies in software solutions that are gradually developed.

In discussing mutual links between insurer's assets and liabilities (in broader sense) in more detail, it should be noted that the focus of risk management used to be on one side of the balance sheet – that of liabilities. Assets were wrongly neglected. Besides, the concept of simultaneous risk management on both sides of the balance sheet was completely unknown. New economic situations and happenings in the world showed that there are phenomena that affect both assets and liabilities, and that in such a context it is necessary to manage both sides of the balance sheet. In general, such a problem can be treated in three ways: by testing cash flows, immunization and aligning cash flows.

The fundamental idea in testing cash flows is the Actuarial standard of practice (ASOP) number 7 of 2011. According to ASOP 7, the assessment of cash flows is related to the assessment of the adequacy of reserves, capital, product development, investment strategy, financial projections and other financial and technical insurance elements. According to the same source, cash flow testing is a form of cash flow analysis that involves projections and comparison of the timing and amount of cash flows resulting from economic and other assumptions.[88]There may be many reasons which may initiate the need for cash flow testing. Besides, the level of analysis can differ. The text below will present the most frequent situations that may point to the need for conducting the cash flow testing:

- If a credit risk, i.e. asset risk (the two terms – asset risk and credit risk are often used as synonyms in actuary literature) is identified at the insurer, the cash flow analysis is recommended. This risk reflects the situation where there is a realistic threat that the amount of inflow and outflow that affect the insurer's assets or the time period of their occurrence will deviate from the expected or assumed levels (reasons for deviation are not a result of a change in return-on-investment rate);
- If the insurer has, in their portfolio, liabilities that have cash flows far into the future (which is the case in a large number of life insurance contracts), the analysis is a matter of actuarial estimate, but is recommendable;
- If the insurer has a new line of business (a new set of insurance products they offer), or products whose rise in the market is significant, the insurer's actuary should consider a need for a detailed cash flow analysis;
- All insurer's contracts that grant options to policyholders and where there is a possibility of antiselection are bound to analyze cash flows.

After the assessment of whether there is the need to conduct the analysis, it is necessary to determine its level. The level of analysis directly depends on the type of asset the insurer has at their disposal, type and character of policy (i.e. the product offered), and type and character of policy-based obligations. Besides, it is necessary to consider the intensity of realized risks (which is in direct relationship with mortality tables in life insurance).

Since the analysis also assumes the projections of insurer's cash flows, it is also necessary to assess the insurer's asset characteristics and investment strategy. Insurer's assets vary - primarily in terms of the degree of sensitivity to external influences. In this context, actuaries primarily have to consider the degree of insurer's asset sensitivity to economic factors (interest rates, inflation rates or other relevant market factors). Naturally, any limitations on the ability to use insurer's assets have a negative impact on the projections of future flows that are part of the analysis. If the quality of assets is questionable or if the assets are related to high cost of its conversion from a less liquid form to another, more

[88] ASB (2002). Analysis of Life, Health, or Property/Casualty Insurer Cash Flows. *Actuarial Standard of Practice No. 7,* Washington, DC: Actuarial Standards Board, p. 2. (the version revised in May 2011).

liquid form, and the actuary does not take into account such specifics when making projections, the projections will not be good. Investment strategy is directly associated with the insurer‘s decisions on the sale of assets prior to maturity, asset segmentation in support of some parts of technical reserves, strategy of investment of future cash flows, decisions that define ways of covering future negative flows (if applicable), use of derivative financial instruments, or other factors that can have a material impact on the insurer’s investment strategy (or the possibility of its implementation).

Besides assets and investment strategy, it makes sense to also take into account the cash flows that can result from policy. In this case, when analyzing cash flows the actuary should keep in mind the risk of insolvency of individual parties to the policy, character and composition of expense loading, previous experiences with insured cases, the effects of external factors (if policies are subject to them – inflation rate, reference interest rate or something else), effects of changes in the frequency of payment or amount of premium or other factors estimated to have a direct, material effect on the cash flow.

Immunization is another form of distinctive interaction between assets and liabilities. Guarantees offered by life insurance policies are directly related to the strategy of investing the insurer’s assets and the return it achieves. When such a relationship is established, it has been determined that there is no model which can accurately defined the amount of return and on this basis create the distribution of guarantees by underwritten policies. Instead, there must be a given relationship between the insurer’s assets and the offered guarantees. All the bonuses and other policy benefits must be covered with asset of certain characteristics or other surpluses. The first papers that recognized this strategy were published in the 1950s. More accurately, in 1952, Frank Redington wrote about the principles of valuations in life insurance and immunization (it was also the first use of the term). The idea presented by Redington[89] was the protection of portfolio from effects of interest rate change by using Macaulay durations (the concept named after Frederick Macaulay, pertaining to the weighted average time to maturity). The ‘Macaulay duration’ concept was introduced in 1938, when it was a direct measure of bond price volatility, and could also be viewed as the average time to maturity (years to maturity are weighted with the present value of corresponding cash flows). It was believed that the time discrepancy between assets and liabilities can have direct effects on values. Actually, if insurer’s assets are of a longer-term character compared

[89] Redington, F.M. (1952). Review of the principles of life-office valuations. *Journal of Institute of Actuaries,* Vol. 78, pp. 286-340.

to liabilities, a decrease in interest rates can have a negative impact on value. The opposite is also true.[90]

Cash flow alignment is the third form of interaction between assets and liabilities. The greatest challenge of this strategy is to find the cheapest portfolio of securities with fixed yield, so that the accumulated net cash flows are positive over the entire selected time period.

Simulation and model testing is the third step in the risk management process. The simulation process is typically used in managing the insurer's assets and liabilities. The aim of the process is to that detect as many risk as possible that the insurer is faced with, the interaction of assets and liabilities and diversification results. In the early days of the method application, simulation models were typically of deterministic character. The values of variables in models were determined in advance. At present, the models are of stochastic character and variable are selected from the assumed distributions of probabilities. It certainly does not mean that deterministic models are no longer in use; they are now primarily used not for simulating situations but rather for the interpretation of results obtained by stochastic simulation.

The dynamic financial analysis is the last, fourth step in the risk management process. Such an analysis studies all risks that can be quantified and their effect on business. Dynamic analyzing offers financial results that are projected according to a series of relevant scenarios. This way shows all the variations in the result, which can be due to a change in some of the internal or external input parameters. The dynamic analysis originates from the first forms of asset and liability management. The first forms in life insurance included the dynamic solvency testing and dynamic capital adequacy testing. In the early 1990s, US and Canadian regulators estimated that dynamic models can yield the best valuations of insurer's solvency, and the basic principles of dynamic modelling became an integral part of regulators' documents.

2. ENTERPRISE RISK MANAGEMENT CONCEPT

Enterprise Risk Management (ERM) is a phrase coined as a result of intention to start treating the concept of risk holistically. This system succeeded the individual approach to risks, which had been the only one used for a long time. ERM is an approach which includes different although coherent processes in

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[90] Haynes, A.T., Kirton, R.J. (1952). The financial structure of a life office. *Transactions of the Faculty of Actuaries,* Vol. 21, pp. 141-197.

the risk identification, estimation, planning, organization and control. This pertains to the processes of measuring, estimating and reducing the effect of risk within the company.

A part of ERM includes the estimate of the insurer's solvency. In the early 1990s, the risk-based assessment system was applied. This system received different manifestations across countries. For the European Union countries, it is an integral system of solvency assessment (integral in terms of covering all risks) and is named Solvency II. There are several definitions of the ERM, but the most comprehensive one is the definition by the International Association of Insurance Supervisors (IAIS), according to which ERM involves the self-assessment of all reasonably foreseeable and relevant material risks that an insurer faces and their interrelationships.[91]

The typical risk management involves monitoring individual risks, without taking into account their interrelationships. In contrast, the ERM approach monitors risks integrally, with a special focus on their interrelationships. Viewed in this way, ERM is a permanent process rather than a periodical risk review. Such a process should be integral part of an insurer's strategic goals. The ERM process starts from the top of the pyramid (company) and should be accompanied by local institutions and rules, as well as by international regulatory bodies, rating agencies and other interested organizations (in the insurance context, they may include professional associations such as International Association of Actuaries of International Association of Insurance Supervisors).

ERM Institute International (ERMII), Casualty Actuarial Society (CAS) and Society of Actuaries (SOA), as professional associations, produced a joint definition of the ERM processes for property insurance and liability insurance. We will not elaborate on details of these types of insurance but it should be concluded that the basic five principles, which were defined for these groups of insurance, also apply to life insurance. ERM is defined as a discipline which studies the risk dynamics in the company(interaction of internal and external players), quality and quantity of effects and interactions, with the final aim of improving a company's performance and resiliency. The first principle pertains to the details of risk dynamics, which is presented as the continuous state of affairs. Thus, the interaction among internal and external players is a natural phenomenon. Since there are both local and macro interactions at various levels

[91] IAIS (2007). *Guidance Paper on Enterprise Risk Management for Capital Adequacy and Solvency Purposes,* Fort Lauderdale: International Association of Insurance Supervisors, p. 5.

in a company, the second principle requires that it is necessary to understand all parts of the whole for the image to be accurate. The third principle points to the fact that (market and internal) valuationsare activities that can have the greatest impact on interactions in the company. In this context, a large part of ERM is devoted to the market valuation and the impact of this value on an insurer's assets and liabilities. Besides, it is believed that the internal modelling considerably affects the behavior within the insurer. The fourth principle points to the importance of the proper construction of the risk measurement model. The models should properly reflect the insurer's risk profile (which directly correlates to its portfolio), insurer's capital requirements and other relevant metrics. The last, fifth principle points to the importance of interaction between individual stakeholders internal to the insurer. According to these principles, it can easily be deduced that ERM in an insurance company is treated as a central process, extremely sensitive to all happenings within the company, and in its close and broader environment.

The present importance of the ERM system and its effect is considerably supported by the fact that in rating insurance companies, Standard & Poor's rating agency takes into account five areas: risk management culture, risk control, new risk management, risk and economic capital models, and strategic risk management.[92]

In 2007, IAIS published the first documents that provided guidelines for the ERM process in assessing capital adequacy and insurer's solvency. The documents were innovated in October 2008.[93] The focus of ERM is on the activities that an insurer has to undertake to manage risks that the company is exposed to. The essence of the approach is that risk management should be continuous. The document confirms treatment of ERM as a discipline and separate function that has a very important position in an insurer's everyday business practice. This document (standard) was preceded by documents with basic principles of solvency assessment but based on a smaller number of risks. Besides, the risk management process previously involved risk identification but no adequate methods were developed for high-quality risk measurement and management. Furthermore, the concept of calculating the adequate capital necessary for covering recorded risk was neither recognized nor applied. At present, the ERM process is conceived in such a way that allows insurers

[92] Sandström, A. (2011). *Handbook of Solvency for Actuaries and Risk Managers: Theory and Practice*. Boca Raton: Chapman & Hall/CRC, p. 44.

[93] IAIS (2007), *op. cit.,* pp. 7-16.; IAIS (2008). *Guidance Paper on Enterprise Risk Management for Capital Adequacy and Solvency Purposes.* Budapest: International Association of Insurance Supervisors, pp. 6-18.

increasingly use internally developed methods and sophisticated risk metrics to manage the identified risks properly and timely, and transform the probability of their realization into the amount of capital necessary for covering the potential risk realization. Such an approach involves an integral approach to both sides of balance sheet – both assets (which used to be ignored) and liabilities. This is the reason why the insurer's asset-liability management activity began to be treated as an integral part of ERM process. Thus, decisions in the context of risk management are now made with insurer's asset and liability timing and structure in mind.

The standard defines eight ERM principles (i.e. 19 requirements which are sublimed in the principles), as described below:

Principle 1 – ERM process management framework

- ERM framework should be established as part of the overall management structure. The framework should correspond to the nature of an insurer's business and to risks faced by the business. The created risk management process framework should describe the company's business culture and address all reasonably foreseeable risks faced by an insurer which could have direct material consequences on business and which should be integral part of the created risk management policy. The establishment and operation of ERM framework should be part of the business process at an insurer's top management level. Since the risk management framework should be adequate for managing both the company capital and its solvency, the framework should understandably provide for the formation of adequate reserves in the case that risk quantification has not been properly performed, or that the frequencies and intensities of risk realization are beyond the scope of expected values.

The ERM process should be supported by both insurer and supervisor. The insurer's basic business, risk-taking, cannot be adequately carried out if the ERM system does not reflect the true profile of the taken risks and company as a whole. It primarily pertains to the character of risks taken, their duration (or more accurately, the duration of coverage), intensity and frequency. Besides, a supervisor should insist that each insurer has clearly defined policies and procedures of risk identification, analysis, measurement and management. These measures can be fully or only in principle defined by supervisor (and it has a direct effect on the way of creating an insurer's policies). When these operational elements of an insurer's business policy are clearly defined, probability of capital adequacy and insurer's insolvency decreases.

Principle 2 – Risk management policy

- An insurer should have a developed risk management policy which clearly describes the way in which the insurer manages any relevant component of individual risks (both strategically and operationally). Besides, the risk management policy should describe the linkage between an insurer's reserves, capital requirements, economic capital and processes and methods for monitoring risks. It should be noted that, among other things, the risk management policy is strongly determined by risks that the insurer has agreed to cover. In this respect, a special attention is paid to the type of risk, its characteristics related to the period for which the risk is taken, damage intensity, damage frequency, as well as to the maximum possible damage (in non-life insurance). In life insurance, the interest rate used by the insurer in risk quantification also plays an extremely important role.

Integral parts of the policy also include the principles of risk control and reduction that an insurer should develop, as well as basic policies of reinsurance, reserve investment and asset-liability management

Principle 3 – Risk tolerance (retention) statement

- An insurer should create and maintain policies and rules on risk tolerance. Constituent part of these documents should include both qualitative and quantitative limitations of all relevant risk segments. The risk tolerance policy should be based on the insurer's general business strategy and should be actively applied during the management process.

Considerations of risk tolerance should also take into account the reinsurance policy implemented by the insurer. The re-insurance coverage chosen by an insurer primarily depends on the risk that the insurer agreed to cover (risk quality, risk quantity, policy duration and the amount of insurer's excess).

Principle 4 – Risk responsiveness

- Risk management system in an insurance company should be responsive to risks, i.e. to a change in one of the vital risk representations. In case of a change in the profile of risk that the insurer has agreed to cover (in the context of a considerable change in the duration of policy, intensity or frequency of the insured case realization), the outlined risk management policy should be designed in a way that allows timely and adequate response to the change.

A change in the profile of risks in an insurer's portfolio will result in a change in the whole insurer's risk portfolio. Such a change can be due to a series of internal and external factors. The most frequent causes in business practice include: creation of new lines of business, change in investment strategy and change of legal regulations.

Principle 5 – Own Risk and Solvency Assessment – ORSA

- An insurance company must necessarily perform periodical self-assessments of risk and solvency (ORSA) to provide the board and senior management with the information on the adequacy of its risk management system and on the current and future (more or less probable) company solvency. ORSA implies the analysis of all reasonably foreseeable risks, including the basic risk covered by the offered product (in life insurance, it is endowment risk or death risk), credit risk, market risk, operational risk or liquidity risk.

The ERM created framework serves as a support to the insurer for such an analysis. ORSA is a sine qua non for any insurer regardless of the type of risk in their portfolio or some other technical and/or financial determinants. ORSA analysis results should be stored in the insurance company, but they have to be accompanied with an adequate action plan in order to establish and support the ERM framework. ORSA should be performed periodically, according to the previously established schedule; in this way it will realistically reflect the insurer's ability to meet its obligations (to various stakeholders). If an insurer's risk portfolio unexpectedly changes, it is necessary to perform a new ORSA analysis in order to maintain the risk management system.

Principle 6 – Economic and regulatory capital

- As part of its ORSA, an insurer must determine the overall financial resources it needs to manage its regular business. Above all, it implies the insurer's ability to absorb some risks itself, as well as limitations and requirements set by supervisor. An insurer's activities in the risk management system should primarily be based on the understanding of the insurer's available economic capital, regulatory capital and other financial resources (other elements of the insurer's assets and liabilities).

When performing the self-assessment, an insurer must permanently keep in mind the amount of capital it currently has at its disposal, the required amount of capital (by regulator or legal regulations) and the amount of capital and reserves that will ensure the insurer's solvency. Besides, the insurer should consider future estimates in the context of business processes, i.e. perform the

ORSA analysis in line with future business plans (possible new products, new markets, acquisitions, new product lines, new regulations …) The exclusive maintenance of the needed capital on insurer's accounts are not necessarily the best way of capital management. Insurers should also consider capital management and risk management in parallel. Rules on the necessary capital are typically constituent part of any national economy. These rules are explicitly stated in laws and other regulations, but principles are outlined in framework documents (in case of the EU countries it is the Solvency Directive II). These rules should be fitted into the ORSA analysis and thus adequately reflect the true conditions in the company. If an insurer assesses that legally required ways of calculating technical values pertaining to capital requirements and solvency assessment are not sufficiently detailed and adequate, the insurer can develop internal assessment models. Internal models involve the use of extremely sophisticated techniques and assessment methods that should result in the assessment model developed in line with technical, actuarial and mathematical elements in the company.

Principle 7 –Business continuity analysis

- An integral part of ORSA analysis is the analysis of an insurer's ability to continue its business, analysis of the adequacy of risk management system necessary for the long-term successful business and assessment of capital requirements. This analysis includes qualitative and quantitative elements in a medium and long term, as well as projections of insurer's financial position and assessment of probability that the insurer will fulfill all the future capital requirements.

In this analysis, the crucial significance is attached to the determination of distinction between the assessment of current capital requirements and projections and scenario analyses for the estimate of insurer's future financial conditions, which should have a high quality for risk management and solvency maintenance. The continuity analysis is typically performed for longer time periods, of three to five years. Using the analysis, an insurer can momentarily establish a better relationship between the currently available capital and future business projections. When future business ideas are analytically individually treated in detail, it is possible to detect future capital needs.

Principle 8 –Role of supervision in risk management

- The supervisor is bound to oversee risk management processes and financial situation in an insurance company. If the supervisor deems it necessary, measures can be required for strengthening the effect of risk management system, and implicitly also strengthen the solvency assessments and capital management processes.

ERM framework in an insurance company and the risk management process are of great significance for insurer's solvency assessment and the assessment of capital management quality. It is the reason why supervisors should also assess the adequacy of ERM system (and its parts) framework and process. If an insurer uses internal models of assessing individual technical values in an insurance company, a high-quality continuous cooperation between an insurer and supervisor is necessary (actually, no internal model must be used as an addition to or replacement for the one prescribed by rules without the national supervisor's approval). If the supervision detects deficiencies in the applied model, it is bound to prohibit its use. Since supervision continuously monitors an insurer's business, in developed systems it is certainly a stimulus for insurer's to intensify a high-quality use of risk management models at all levels. If the supervisor is not satisfied with risk management processes and practice in a company, they have the possibility to take penalty measures. The type of penalty measures directly depends on the cause of detected irregularities.

Thus, the basic mission of creating the ERM framework in an insurance company boils down to creating pre-requisites for conducting a holistic risk management process at the level of insurance company. It primarily implies the creation of environment for managing an entire range of risks, from risks insured through contracts signed with insured persons and insurance underwriters, through liquidity and solvency risks, all the way to risk of choosing an adequate investment strategy. Thus, in general, theory has identified four basic categories of goals whose implementation should be spurred by ERM: strategic goals, operational goals, reporting system and alignment with regulations.[94]

Strategic goals pertain to carrying out an insurance company's basic mission – providing security, at various levels, to persons who signed an insurance contract (policy). Operational goals are defined at a lower level than the former. Operational goals are mostly related to the business technique itself, and as such are the most interesting for this chapter. The implementation on operational goals is ensured by creating the optimum portfolio of offered insurance products, adequate premiums, technical reserves, reinsurance policies and investment. In the same time, the reporting system should be transparent (which is integral part and directive of the EU), i.e. all activities should be conducted in line with positive legal regulations.

[94] CAS (2003). *Overview of Enterprise Risk Management.* Arlington: Casualty Actuarial Society, Enterprise Risk Management Committee, p. 8.

Besides the described contributions to defining ERM, one should certainly mention the role of the International Actuarial Association (IAA) which, in the period 2007-20009 published a series of instructions for treating ERM processes and analytical parts and functions of the activity.

The European project, Solvency II, is an ERM process. One of its basic characteristics is the internal system of risk management and ORSA, which has a dominant role.

3. BASIS FOR RISK MANAGEMENT IN THE FINANCIAL MARKET OF BOSNIA AND HERZEGOVINA

The previous sections of the chapter paid a particular attention to theoretical elaborations of (1) Risk management concept and (2) Enterprise risk management concept. The Report on financial stability of the Central Bank of Bosnia and Herzegovina says that the insurance market is the most developed segment of non-banking sector (compared to: leasing companies, microcredit organizations, investment funds). In the overall value of financial intermediaries' assets in 2014, insurance and reinsurance companies' share was 5.2% (investment funds 3.0%, microcredit organizations 2.5%, leasing companies 2.0%, banks 87.3%). Compared to neighboring countries, and particularly to developed countries, the structure of this market is still insufficiently developed. It is also proved by a low share of premium in the total GDP of Bosnia and Herzegovina, of only 2%. The insufficiently developed awareness and knowledge among population and managers about the significance of insurance, a low level of available income among most people and almost chronic insolvency in the real economy sector, and a lack of budgetary resources are main, though not the only reasons for a poor reach of risk insurance, both in life and non-life insurance. It is clearly confirmed by some statistical indicators presented in the following tables.

Table 1. Insurance companies in B&H on 31.12.2015

Entity	Non-life	Life	Composite	Reinsurance
Federation Bosnia and Herzegovina	5		7	**1**
Republic of Srpska	7		3	
Brčko District	2			
TOTAL B&H	**14**		**10**	**1**

Table 2. Performance of insurance in FB&H

in Euros

Federation Bosnia and Herzegovina	2014	2015	Index
Non-life	155,189,042	163,639,298	**105.45**
Life	44,722,857	47,543,713	**106.31**
Total	**199,911,899**	**211,183,011**	**105.64**

Table 3. Performance of insurance in RS

in Euros

Republic of Srpska	2014	2015	Index
Non-life	73,678	77,809	**105.67**
Life	13,816	15,618	**113.04**
Total	**87,494**	**93,427**	**106.78**

Table 4. Performance of insurance in B&H

in Euros

Bosnia and Herzegovina	2014	2015	Index
Non-life	228,866,944	241,448,249	**105.50**
Life	58,538,906	63,161,638	**107.90**
Total	**287,405,850**	**304,609,887**	**105.99**

Table 5. Comparison to the region, 2014

Country	Life insurance mil EUR	Non-life insurance mil EUR	Total mil EUR
Slovenia	535.36	1,402.19	**1,937.56**
Croatia	344.28	772.99	**1,117.27**
Serbia	132.32	441.47	**573.79**
Bosnia and Herzegovina	58.54	228.82	**287.36**
Macedonia	14.45	109.64	**124.09**
Montenegro	**12.56**	**59.85**	**72.41**

The presented data clearly show part of the quantitative basis for risk management in the financial market of Bosnia and Herzegovina. A significant part related to the observed topic pertains to systemic risks present in Bosnia and Herzegovina, region and the world, as well as in operational risks in the overall complexity of insurance companies' business and the insurance industry in general.

Risk management in the financial market of Bosnia and Herzegovina is of essential significance, both for its further development and its survival as a sovereign country.

Chapter 5.

RISK MANAGEMENT PROCESS IN BANKS

Although major part of our life is beyond our control, and even our understanding, a lot can be done to control and manage risk and uncertainty. People manage risk on a daily basis, often subconsciously, as part of their struggle for survival, when avoiding natural hazards, for example; or consciously, when applying what they have learned, when, for example, going to a medical check up or, for example, when fastening their seat belt in the car, as bound by regulations. However, managing risk, as a broadly accepted economic and social activity implies a formalized process. In that sense, risk management is a recent phenomenon whose origins are related to the post World War II period. There is no general consensus on the beginning of the development of risk management, but most of the authorities in this field agree that risk management did not start before 1950s. Prior to 1960s, for most organizations, risk management was quite narrow in its scope, and usually a part time activity. Like with other disciplines, there were disciplines that preceded Risk Management too. The most important of these is insurance. Many see 1964 as a milestone in the development of risk management, which is when the famous periodical the *Journal of Insurance* changed its name to the *Journal of Risk and Insurance.*[95]

Initially, the development of risk management was prompted by the realization that some risks could not be insured, the fact that the existing insurance plans did not suit all organizations and that some activities of an organization might affect the level of risk. However, since 2008, with the onset of the global economic crisis, the main factors contributing to the development of risk management have been the increasingly strong and comprehensive regulatory requirements in various fields, especially in the field of finance. In some fields, such as primarily in banking and insurance, the regulatory wave has had a global reach (e.g. the Basel Accords or the Solvency Program). In addition, the development of regulatory requirements for risk management has also been contributed to by a number of other national regulations and requirements of regulatory bodies, or the requirements of professional and other investors.

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[95] Williams, C.A. Jr., Smith, M.L., Young, R.C. (1995). *Risk Mangement and Insurance*. New York: Mc Graw Hill.

1. APPROACHES TO AND VARIOUS GENERAL METHODOLOGIES FOR RISK MANAGEMENT

What characterises the latest approaches to risk management most are a holistic approach and understanding that risk management is associated with the creation of value.[96] Risk management is seen as a general integrative function, direct responsibility of top management of the organization (the Supervisory Board and top management), which permeates the entire organization and all its activities and functions. So far, more than 80 risk management frameworks have been developed, some of the most famous among them being:[97]

- COSO ERM Integrated Risk Management framework developed by Committee of Sponsoring Organizations of the Treadway Commission;
- ISO 31000:2009 Risk Management – Principles and guidelines;
- AS/NSZ 4360:2004 Joint Australian/New Zealand Standards for Risk Management;
- FERMA Risk Management standards (Federation of European Risk Management Associations); and
- CoCo (Criteria of Control) - Canadian Institute for Chartered Accountants.

According to the COSO methodology, one of the most widely accepted methodologies for risk management, risk management is:[98]

- a process that takes place within the entity;
- influenced by people at all levels of the organizational structure;
- applicable in strategic terms;
- applied throughout the organization, at all levels and in all organizational units;
- designed to enable identification of the events, which, in case they realise, affect the entity; and
- a tool that provides reasonable assurance to the management and the board of the company in achieving their goals.

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[96] The integration of Enterprise Risk Management - ERM and the concept of Value Based Management - VBM resulted in Value-Based Enterprise Risk Management. See: Segal, S. (2011). *Corporate Value of Enterprise Risk Managementnt - The Next Step in Business Management*, New Jersey: John Wiley, pp. 61-110.

[97] Vuksanović, I. (2015). Uticaj upravljanja rizikom na vrednost preduzeća u elektro-energetskom sektoru. *Doctoral thesis.* Belgrade: Faculty of Economics, University of Belgrade.

[98] COSO (2004). *Enterprise Risk Management Framework - Integrated Framework: Executive Summary*, New York: Committee of Sponsoring Organizations of the Treadway Commission, p. 4.

According to the COSO methodology, risk management consists of eight interrelated, components or, observed as a timeline, of eight phases, which must be consistent with the management process of the enterprise.

The first component or phase is to create an internal environment conducive to risk management, which involves determining the risk appetite, the organization's approach to risks it is exposed to in its operations, and the risk management philosophy, determining the way in which the attitude towards risk is transferred to the employees, the values system in the organization, its environmental values, and the like.

As the organization's objectives must be defined before the management identifies events that may affect their achievement, the second component of Risk Management is setting goals. Risk management ensures that the set goals are in line with the organization's mission and risk appetite.

The third phase identifies internal and external events that affect the achievement of the objectives of the organization. In accordance with modern understanding of risk management, an organization manages not only the risks with adverse outcomes (loss, damage, injury, reduced values and the like) or pure risks, but also the risks that enable profit making or speculative risks. Thus, the events that are identified must be divided into risks and opportunities.

The fourth phase is risk assessment. The goal of this phase is to determine the level of risk, so that the management may focus on the most significant risks and create a basis for responding to risks. Risk assessment is a complex activity that involves: defining criteria for risk assessment, risk assessment, assessment of interaction of risks and prioritization of risks.[99] The criteria for risk assessment are likelihood of the risk being realised and the impact of events on the organization, but they may also include vulnerability of the organization and speed of realisation or manifestation of the risk impacts. Risk assessment represents allocation of certain value for each type of risk in accordance with the defined criteria. In doing so, risks are assessed from the viewpoint of their inherent properties, as well as their residual impact (after responses to risks). Usually, risk assessment is carried out in two phases; first by means of qualitative, and then quantitative risk assessment.

Since risks do not occur independently, organizations should be managing connected risks. Therefore, risk assessment includes an assessment of

[99] Curtis, P., Carey, M. (2012). *Risk assessment in Practice*, New York: Committee of Sponsoring Organizations of the Treadway Commission, Deloitte & Touche, p. 2.

interaction between risks. In an effort to apply integrative, holistic approaches to risk management, organizations use techniques such as: risks interaction matrix, bow tie diagram and aggregate probability distribution. The last activity in the context of risk assessment is to determine the priorities in the process of risk management. Setting priorities in the process of risk management is done by comparing the level of identified risks with a predetermined, target risk levels and risk tolerance. Risk is assessed not only from the standpoint of its financial consequences and likelihood of realisation, but also from the standpoint of subjective criteria, such as, for example, the impact on health and safety, the impact on reputation, vulnerability of the organization, the speed of realisation, and the like.

The fifth stage, the organization responds to risks by applying some of the risk control or risk financing techniques. In line with the risk appetite and risk tolerance, as well as with the characteristics of risks, management determines whether the risks will be controlled by avoiding it, mitigating or reducing, or financed by being retained or transferred primarily to insurance companies or other organizations (by means of agreement, hedging transactions, futures, etc.).

The sixth phase involves determining policies and establishing procedures, which enable control of risk management process and ensure effectiveness of the response to the risks in the risk management processes.

The aim of the seventh phase (information and communication) is to identify relevant information, to collect, process and communicate such information in the form and timeframes that enable employees to perform their jobs in accordance with the risk appetite and risk tolerance.

The eighth phase of risk management is monitoring. Monitoring involves monitoring of risk management and, if necessary, modifying the process with changes in risks the organization is exposed to, or in line with changes in risk profile of the organization. Monitoring can be performed as part of regular management activities or as a separate activity.

2. RISK MANAGEMENT SPECIFIC FOR THE BANKING SECTOR

Like other financial institutions, banks are exposed to and faced with a multitude of market and non-market risks on a daily basis. Risk exposure is increased in the environment of prominent changes in the global environment and in the banking business. The global economic crisis, which escalated in

2008, exposed weaknesses of the former regulation of the banking business, embodied in the Basel II Accord. A new regulatory framework, Basel III, came in response to the observed flaws of the banking system, which should offer solutions for more efficient risk management and, inter alia, emphasise liquidity risk, which was not included in the Basel Committee standards. The main competitive advantage of a bank is manifested precisely in its capacity for adequate risk management. Banks should not avoid risks, but rather manage them efficiently. In literature, banking risk is defined as the probability of loss caused by occurrence of uncertain events in banks.[100] Successful management of banking risks is beneficial to both the shareholders and the creditors alike, as well as the supervisory authorities. Regulatory authorities are particularly motivated to promote a policy of successful risk management in banks since the role of the banking system is crucial for economic growth and stability of financial markets. The implementation of Basel III standards should prevent the development of potential new financial crises, such as the aforementioned one, or at least minimize their negative effects. The development of the risk management systems has happened under the influence of market forces on the one hand and changes in banking regulations on the other. Banks and other financial institutions have contributed to the emergence of many innovations in risk measurement and risk management, while financial regulators have contributed to the expansion and implementation of good practices with other financial market participants.

The risk management process is defined as identification, assessment and definition of priority risks followed by coordinated, rational use of resources for their mitigation, monitoring, and control of the likelihood of realisation and/or the impact of adverse events.[101]

The process of risk management in banks primarily involves identifying and analysing all risks the bank is exposed to, both the realised ones and, and the potential ones. These analyses are used as basis for forming the internal database of basic indicators of risk and losses. Pursuant to the Decision on Risk Management by Banks[102] each bank in Serbia is obliged to adopt and implement specific procedures for identifying risks, in order to ensure timely and comprehensive identification of risks and facilitate analysis of the causes leading to the realisation of risks. The second phase of risk management in

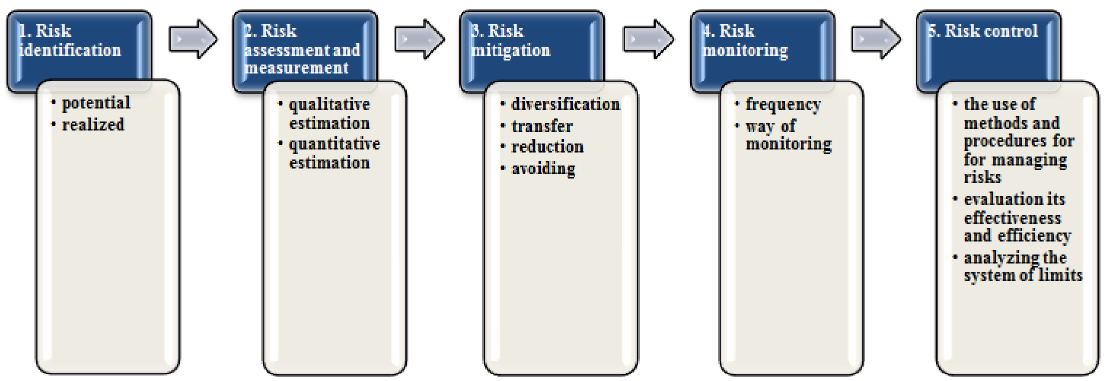
[100] Vasiljević, B. (1990). *Rizici u bankarskom poslovanju*. Belgrade: Fokus, p. 7.

[101] Hubbard, D. (2009).*The Failure of Risk Management: Why It's Broken and How to Fix it*, New Jersey: John Wiley & Sons, Inc, p. 10.

[102] Decision on Risk Management by Banks. *Official Gazette of RS,* No. 45/2011, 94/2011, 119/2012, 123/2012, 23/2013, 43/2013, 92/2013, 33/2015 and 61/2015.

banks consists of assessment, or risk measurement and, accordingly, the application of quantitative and qualitative methods for timely detection of changes within the risk portfolio and also the emergence of new risks. Risk measurement is essentially a measurement of the volume of potential losses that may arise from the banking business. Given that the interaction of different risks may result in a greater or lower exposure of the bank, risks should not be viewed separately. In accordance with the risk profile of the bank and its risk appetite, the bank takes the necessary actions to mitigate risks. This primarily refers to the diversification, transfer, mitigation and/or avoidance of risk. The risk management process includes defining appropriate risk limits and their control within the established system of limits. As shown in Figure 1, the last phase of risk management is risk control. Risk control includes a set of methods for elimination, mitigation or acceptance of business risk and it is ideally widely present in all stages of the process.

Figure 1. Risk management processes in banks



Source: Prepared in line with the Decision on Risk Management by Banks. Official Gazette of RS, No. 45/2011, 94/2011, 119/2012, 123/2012, 23/2013, 43/2013, 92/2013, 33/2015 and 61/2015.

There are different classifications of risk that a bank takes in its operations and that are reflected on the level of yield and safety of its operations. One of the globally accepted classifications is shown in Figure 2.

Financial risks can be manifested as fundamental and speculative. Basic risks include liquidity risk, credit risk and solvency risk, while speculative risks include interest rate, currency and price risks. All financial risks are intertwined and their impacts can increase the overall exposure of banks to potential losses. Operational risks are related to the overall organizational structure of the bank and the efficiency of its information technology. Business risks are related to the business environment of the bank, while risk of events includes all forms of external risks such as political risk, force majeure or banking crises.

Figure 2. Scope of risk in banks

Source: Greuning, H.V., Brajović Bratanović S. (2006). Analiza i upravljanje bankovnim rizicima. Zagreb: MATE, p. 4.

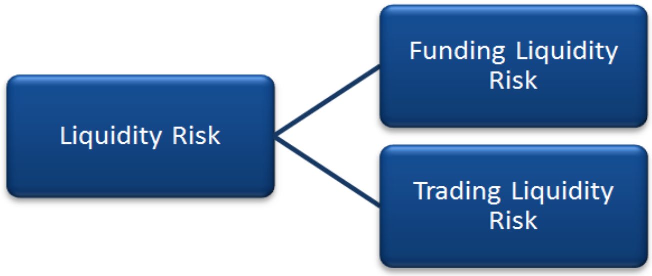
According to the classification applied by the National Bank of Serbia, banks should pay special attention to the following risks: 1) liquidity risk; 2) credit risk (residual risk, dilution risk, the risk of settlement/disbursement, and counterparty risk); 3) interest rate risk; 4) foreign exchange risk and other market risks; 5) concentration risk (this particularly involves risks of exposure to a single entity or a group of related entities); 6) investment risks; 7) country risk; 8) operational risk, including legal risk; 9) compliance risk; 10) strategic risk and other risks.

From the perspective of the analysis and assessment of financial performance of banks, the most important risks are financial risks, whose dominance is a key limiting factor in realizing high levels of profitability, liquidity and capital adequacy.

2.1. Liquidity risk

Liquidity of a bank can be defined as the ability to secure the necessary cash funds, primarily in the form of high quality liquid assets. In addition, these funds should be provided in a timely manner and under favourable conditions, i.e. at an acceptable cost, whether it be for the purpose of asset growth or coverage of overdue obligations. It is accepted that a bank has an adequate level of liquidity when it is able to obtain the necessary resources (by increasing liabilities, securitization or sale of assets) without delay and at reasonable prices.[103] Liquidity risk can be viewed through two dimensions – as funding liquidity risk and trading liquidity risk.

Figure 3. Dimensions of liquidity risk



Source: Crouhy, M., Galai, D., Mark, R. (2001). Risk Management. New York: McGraw-Hill, p. 38.

Liquidity risk of sources of funding is the risk of aggravation of financial results and the bank's capital due to its inability to cover due liabilities caused by withdrawal of the existing sources of funding, or its inability to find new sources of funding. Market liquidity risk includes the possibility that disruptions in the financial markets prevent smooth conversion of assets into liquid assets.

Despite the fact that liquidity risk is of one of the greatest risks a bank may face and that it is the core of confidence in the banking system, it was not specifically treated in Basel Accords prior to the development of the concept of Basel III. Having learned from the consequences of the global economic crisis in 2008, the Basel Committee has offered a solution for the reduction of systemic risks faced by financial institutions, through the strengthening of regulations in the field of liquidity.[104] The international framework for liquidity risk exposure measurement, standards and monitoring of this risk, has developed two minimum standards: Liquidity Coverage Ratio - LCR and Net Stable Funding Ratio - NSFR.

LCR is designed with the aim to ensure that banks maintain an adequate level of free, high quality liquid assets, which can be quickly converted into cash (high quality liquid assets – HQLA) at any time. Checks whether the funds are sufficient to cover all obligations maturing in the next 30 days are performed based on the stress test of liquidity, modelling a scenario of negative market

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[103] Greuning, H.V., Brajović Bratanović S. (2006). *Analiza i upravljanje bankovnim rizicima.* Zagreb: MATE, p. 168.

[104] BIS (2010). *Basel III: International framework for liquidity risk measurement, standards and monitoring*. Basel: Bank for International Settlements, Basel Committee on Banking Supervision.

trends, i.e. high pressure on the liquidity of banks. LCR is calculated as the ratio between high quality liquid assets of the bank to total liabilities maturing in the next 30 days:

$$\frac{High\ quality\ liquid\ assetss}{Total\ \ net\ cash\ outflows\ over\ the\ next\ 30\ calendar\ days} \geq 100\%$$

This means that, according to this new standard, the amount of high quality liquid assets that the bank holds should be equal to minimum 100% of the value of total liabilities maturing in the next 30 days. This ratio is focused on the daily liquidity management for the purpose of an adequate response to the unexpected cash outflows. High quality liquid assets are divided into two groups:[105] Level 1 assets and Level 2 assets. Level 1 liquid assets should constitute at least 60% of the total HQLA and include cash, reserves with the central bank, securities issued or guaranteed by central banking institutions, states and other organizations, provided that their risk score determined in line with Basel III standards is 0%. There is no upper limit to which these assets can be included in the formula for calculating the ratio of coverage of liquidity, while Level 2 liquid assets may comprise a maximum of 40% of the total HQLA. These include corporate bonds rated at least AA-, securities issued by governments, central banks and other organizations with the risk score of up to 20%, in line with the standards of Basel III. In EU countries, Basel III will be implemented through the new regulatory package, which entered into force on 1 January 2014.[106] Sudden implementation of the LCR standard could jeopardize lending activities of financial institutions and damage the real economy, because of the possibility of orientation towards liquid forms of assets. In this regard, the implementation of standards is carried out in several phases, as shown in Figure 4.

Figure 4. Timeline for the implementation of LRC standards in Europe

	2015	2016	2017	2018	2019
Liquidity Coverage Ratio	60%	70%	80%	90%	100%

Source: BIS (2013). The Liquidity Coverage Ratio and liquidity risk monitoring tools. Basel: Bank for International Settlements, Basel Committee on Banking Supervision.

[105] *Ibid,* p. 7.

[106] As published in the *Official Journal of the European Union*: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=OJ:L:2013:176:TOC. Previous directive, Capital Requirement Directive III (CRD III) was superseded by the Capital Requirement Directive IV (CRD IV) and Capital Requirement Regulation (CRR), which are jointly referred to as CRD IV package.

It is important to note that the CRD IV sets a deadline for the European credit institutions that is one year shorter than that in Basel III, so that full implementation (LCR 100%) should be ready by 2018. Once these provisions are fully adopted, certain deviations are envisaged so that banks will not have to maintain the level of LCR> 100% at all times. In emergency situations, economic turbulences and "stress" in the financial market, banks will be able to use liquid assets and lower LCR below the level of 100% in the short term. In this case, they are obliged to immediately inform financial regulators, and to present a plan to raise the LCR to the level of 100%.

Another indicator of liquidity introduced in Basel III is the net stable funding ratio (NSFR). This long-term coefficient has been introduced to ensure stable coverage of activities on the asset side of the balance sheets of banks and other credit institutions in the medium and long term. The NSFR is used to define the items that require stable sources of funding and positions that are considered as available stable sources of funding, as well as the relationship between them. This indicator is obtained by the ratio between the available amount of resources for stable funding and the required amount of resources for stable funding and should be greater than 100:

$$\frac{\textit{Available amount of stable funding}}{\textit{Required amount of stable funding}} > 100\%$$

Unlike the LCR ratio, which has become the minimum standard of liquidity as of 1 January, 2015, implementation of the NSFR ratio is expected as of January 1, 2018. The ratio has been formulated with the aim to limit excessive short-term financing in turbulent periods, and to encourage more efficient assessment of liquidity risk in balance sheet and off-balance sheet activities.[107]

In late 2013, the National Bank of Serbia introduced the "Strategy for Implementation of Basel III Standards”[108] with set deadlines for project implementation and achieving full compliance with the said regulations. This strategy was used as the basis for conducting the analysis of compliance of the regulatory framework with these standards, and, among other things, it was concluded that the existing regulations in the field of liquidity in the Republic of Serbia were largely different from the regulations of the European Union

[107] See: BIS (2014). *Basel III: the net stable funding ratio*. Basel: Bank for International Settlements, Basel Committee on Banking Supervision.

[108] National Bank of Serbia (2013). *Strategija za uvođenje standarda Bazel III u Srbiji.* Belgrade: National Bank of Serbia. Available at: http://www.nbs.rs/export/sites/default/internet/latinica/55/55_2/bazel_3/Strategija_BazelIII.pdf.

aiming at the implementation of Basel III. The introduction of minimum standards of liquidity envisaged in the concept of Basel III should help to strengthen the resilience of the system to uncertain events, thus to preserve the balance of the entire banking system.

2.2. Credit risk

Since one of the basic functions of banking institutions is lending to households and businesses, credit risk is by nature immanent to their operations. There is simply no such thing as a risk free loan. Whether it is a situation where a bank approves a loan to a client or is issuing a letter of credit, guarantee or some form of credit instruments on his behalf, credit risk is inevitably present. If a loan can be defined as a time limited monetary claim, then credit risk is the likelihood that this liability will not be realized.[109]Credit risk is the risk that approved funds will not be collected, partially collected, i.e. not collected according to the agreed dynamics. Credit risk counterpart is market risk - the possibility of changes in the value of investments under the influence of market factors such as interest rates, price of the product and the volume of savings. Market risk has existed for as long as market itself.[110]

Credit risk can be defined as the risk of failure of the borrower to repay the approved loan or the interest accrued.[111] Deferred debt collection or ultimately complete failure of collection can result in serious disruption of liquidity and cash flows of the bank, in the short term, as well as solvency in the long term. There are two categories of factors that determine the quality of the loan portfolio of the bank: the exogenous or external factors (e.g. the economy, force majour, central bank policy, fiscal policy, etc.) and endogenous or internal factors (e.g. management philosophy and management discretion of the company). This general framework of modelling credit risk can be represented as a direct function:

credit risk = f(endogenous factors, exogenous factors)[112]

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[109] Caouette, J.B., Altman, E.I., Narayanan, P., Nimmo, R. (2008). *Managing Credit Risk. The Great Challenge for the Global Financial Markets*. Hoboken, New Jersey: John Wiley & Sons, Inc., p. 17.

[110] *Ibid,* p.17.

[111] Đukić, Đ., Bjelica, V., Ristić, Ž. (2003). *Bankarstvo.* Belgrade: Faculty of Economics University of Belgrade, p. 186.

[112] Sinkley, F.J., Jr. (1999). *Commercial Bank Financial Management in the Financial Services Industry.* New York: MacMillan Publishing Company, pp. 492-494.

A bank can only exercise a minor impact on external factors, while internal factors can be controlled, thereby reducing credit risk. Measurement and management of credit risk is based on an estimate of creditworthiness of the borrower at the time of loan approval and during the entire period of exposure to credit risk. Also, assessments are made of their timeliness in meeting their obligations to the credit institution and other creditors, as well as the quality of the collateral. Credit worthiness assessment of the borrower includes quantitative and qualitative assessment. Quantitative assessment is based on financial reports available and business indicators, while qualitative assessment is based on previous professional experience with the borrower, previous knowledge of the borrower and their purchasing power. The data thus obtained are included in the model estimates, the result of which should show the probability of default by the borrower, usually over a period of one year.

In line with regulatory requirements, credit institutions need to determine capital requirements for credit risk. In this regard, the banking sector has developed a set of methodologies for the assessment of probability of default of the borrower (PD) based on the aforementioned quantitative and qualitative indicators. With the prior approval of the regulatory authorities, when determining capital requirements for credit risk, banks may choose a standardized approach or the internal ratings based approach (IRB).

A standardized approach to credit risk is considered to be the simplest one and is intended for banks that prefer a simple system of capital adequacy. Its methodology has been formulated using the portfolio approach, so that banks, depending on their type, allocate respective risk weights to their exposures, based on external credit rating. For example, if a company has a credit rating of AAA to AA-, the risk weight of 20% is applied; a company with a credit rating of A+ to A- attracts the weighting of 50%, while exposures related to companies with a credit rating below BB- are weighted with a risk weight of 150%. If a borrower has no credit rating, it is assigned a risk weight of 100%.[113] The quality of this type of credit risk assessment is determined by the reliability of the external rating agencies. In this regard, the Basel Committee introduced the process of identifying the rating agencies by national supervisors, in order to ensure objectivity, independence, adequacy of resources, transparency and credibility. In Serbia, adequacy of credit ratings, awarded by rating agencies for

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[113] BIS (2015). *Second consultative document. Standards. Revision to the Standardised Approach for credit risk.* Bank for International Settlements. Basel: Bank for International Settlements, Basel Committee on Banking Supervision.

the purpose of calculating capital requirements for credit risk, according to the standardized approach, is confirmed by the National Bank of Serbia.[114]

Another approach to credit risk management established by the Basel Committee is the internal rating based approach. It is believed that this approach provides a more precise and better quality assessment of credit risk because the bank has the ability to independently assess creditworthiness of each borrower. The reform program, which includes Basel III is also relevant for efficient risk coverage including capital requirements to cover credit risk of the counterparty. Internal ratings include probability of loss due to default risk assessment and are based on an analysis of relevant quantitative and qualitative data. Calculating capital requirements for credit risk includes the following key input parameters: the borrower's Probability of Default with the credit institution within one year (PD), the amount of Loss Given Default (LGD), the Exposure at Default (EAD) of the credit institution at time of default. In addition to these key factors, remaining Maturity (M) of exposures is also taken into account. Expected loss (EL) is calculated using the formula below:

$$EL = PD * LGD * EAD$$

The lower the *PD, EL, EAD, LGD* and remaining maturity, the lower the capital risk requirement. Practice has shown that, out of the parameters for managing credit risk, most banks can independently calculate PD only. For this reason, the Basel Committee offers two variants of the IRB approach, the foundation and the advanced approaches. Within the foundation IRB approach, all the parameters, except for PD, are calculated by the regulatory authority, while with the advanced IRB approach, all the parameters for calculating the expected loss are determined by the bank independently. However, if a bank is to asses all credit risk components by using its own methodology, it first must meet the prescribed eligibility criteria for the advanced IRB approach. Compared with the standardized approach, the IRB approach is quite complex and is reserved exclusively for the banks that have technologically advanced software, highly qualified staff and high-quality customer bases.

Compliance Analysis of the regulatory framework of the Republic of Serbia with the regulations of the European Union, in terms of credit risk management in banks, has shown that there are no major differences in the parts of the regulations pertaining to credit risk capital requirements. Credit risk capital requirements, according to Decision on Capital Adequacy of Banks by the

[114] In line with the Decision on Capital Adequacy of Banks. *Official Gazette of RS,* No. 46/2011, 6/2013, 51/2014.

National Bank of Serbia, are calculated by multiplying the total risk-weighted assets by 12%. Total risk-weighted assets are obtained as the sum of risk-weighted assets under the standardized or the IRB approach, and risk-weighted assets for settlement/delivery risk. If a bank applies the standardized approach, its risk-weighted assets are obtained as the sum of the values of assets and off-balance sheet items multiplied by the appropriate credit risk weights. Depending on the rating grade of risk (low, moderate, medium, high risk), the value of off-balance sheet items is multiplied by the conversion factors (0%, 20%, 50% and 100%). Credit risk weights for each individual item of the balance sheet assets and off-balance sheet items are determined by the class of exposure and its credit quality. A bank must categorise all its exposures into one of the 14 exposure categories, starting from exposures to governments and central banks, exposures to territorial autonomies and local government units to exposure from investments into open investment funds and other exposures. The level of credit quality is determined based on the borrower's credit rating, i.e. credit ratings of the financial instruments assigned by the rating agency or credit assessments by export credit agency (for exposures to governments and central banks only). In order to mitigate credit risk, a bank may use two categories of credit protection instruments: funded and unfunded credit protection instruments. The funded credit protection instruments are: 1. Collaterals in the form of financial assets (cash, debt securities which meet stated credit quality criteria, equities, convertible bonds, gold); 2. Balance sheet netting (receivables and liabilities from loans and deposits); 3. Standardized netting agreements (repo and reverse repo transactions, lending or borrowing securities or goods and other transactions with the right to additional security); 4. Other funded credit protection instruments. The unfunded credit protection instruments include guarantees, other forms of sureties and counter guarantees, as well as credit derivatives (credit default swap and total return swap).[115]

A bank that receives approval for the implementation of the foundation IRB approach (FIRB) must calculate the PD parameter independently and use the prescribed assessment of LGD, conversion factors and effective maturity. If it is to apply the advanced IRB approach (AIRB), the bank must use its own estimates of PD, LGD, conversion factors, and preferably, effective maturity. In the IRB approach to credit risk management, all exposures of the bank are classified in one of the following six classes of exposure: to sovereign governments and central banks, banks, companies, private individuals, equity investments and other assets. The FIRB approach allows a greater degree of freedom for banks in terms of the methodology for monitoring and measuring

[115] For more information see: Decision on Capital Adequacy of Banks. *Official Gazette of RS,* No. 46/2011, 6/2013, 51/2014.

exposure to credit risk, but at the same time, banks that implement it are subjected to more rigorous analyses and checks by supervisors, in order to confirm the estimates obtained, regardless of whether internal or external data are used. The advanced IRB approach is therefore quite demanding, but also more flexible in relation to the foundation IRB and standardized approaches.

2.3. Solvency risk

A bank is solvent when it is able to withstand all the risks arising from its operations, and to fully settle all its liabilities without compromising depositors and other creditors. According to Sherman, insolvency of banks occurs if: a) liquidity is at such low level that it prevents payment of liabilities to customers; and b) when the market value of liabilities exceeds the total value of assets less costs of bankruptcy.[116] Solvency of a bank means that the real value of the assets is equal to the volume of liabilities.[117] Solvency of a bank is measured by the capital adequacy ratio (CAR), which is defined as the ratio between capital and risk-weighted assets of the bank. In other words, a bank's capital adequacy is its ability to absorb all the losses caused by non-performing placements. In Serbia, each bank must organize its business in such a way that its capital is not lower than the dinar equivalent of EUR 10,000,000.00, according to the official middle rate, at any given time. The capital adequacy ratio must not be less than 12%, i.e. that is the minimum percentage at which risk-weighted assets of banks in Serbia must be covered by capital.[118]

From the accounting point of view, when liabilities exceed the level of total assets, or when equity falls to zero or below zero, that is the state of insolvency. In the literature, there are three factors that determine insolvency of banks: the level of expected revenues and their collection, the probability of actual deviations from the expected revenues and the amount of the initial capital of the bank.[119] Problems may occur depending on the bank's risk profile. If a bank is too much profit-oriented, it may expose its operations to situations that can cause great losses. Virtually all the risks, ranging from credit risk, liquidity risk,

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[116] Sherman, J.M. (1979). Risk and Capital Adequacy in Banks. *The Regulation of Financial Institutions*. New Hapmshire: Proceedings of a Conference, p. 205.

[117] Vunjak, N., Ćurčić, U., Kovačević, Lj. (2008). *Korporativno i investiciono bankarstvo*. Bečej: Proleter, Faculty of Economics, University of Novi Sad, BLC Banja Luka College, p. 125.

[118] Decision on Capital Adequacy of Banks. *Official Gazette of RS,* No. 46/2011, 6/2013, 51/2014.

[119] Sherman, J.M. (1991). *Risk and Capital Adequacy in Commercial Banks*. Chicago: The University of Chicago Press, p. 6.

to interest rate, market and foreign exchange risks may initiate insolvency of a bank. For example, a problematic loan portfolio, combined with high liquidity risk, can cause a decline in market value of the share capital and thus jeopardize solvency of the bank.

The discrepancy between large volume of assets of the world's largest banks and all their liabilities under the influence of global macroeconomic changes, has led to problems in maintaining the solvency of the financial and banking system on a global scale. Some of the main goals of introducing Basel III standards are to strengthen capital requirements and improve liquidity, in individual, and in global terms. One of the changes brought by the new standards is to enhance the quality of the regulatory capital by increasing the minimum common equity capital ratio from 2% to 4.5%. Instead of Tier 3, which is defined as secondary capital within the standards of Basel II and served for covering market risk, a protective layer of capital is introduced. With the application of a protective level of capital, adequacy will now be 10.5%, instead of 8%, as determined by previous standards. The process of transition to the new capital requirements is shown in Figure 5.

Figure 5. Phases of harmonisation with new capital requirements introduced by Basel III

Phases	2013	2014	2015	2016	2017	2018	2019
Minimum Common Equity Capital Ratio	3,50%	4,00%	4,50%	4,50%	4,50%	4,50%	4,50%
Capital Conservation Buffer				0,625%	1,25%	1,875%	2,50%
Minimum common equity plus capital conservation buffer	3,50%	4,00%	4,50%	5,125%	5,75%	6,375%	7,00%
Minimum Tier 1 Capital	4,50%	5,50%	6,00%	6,00%	6,00%	6,00%	6,00%
Minimum Total Capital	8,00%	8,00%	8,00%	8,00%	8,00%	8,00%	8,00%
Minimum Total Capital plus conservation buffer	8,00%	8,00%	8,00%	8,625%	9,25%	9,875%	10,50%

Source: Basel Committee on Banking Supervision (2010), available at: http://www.bis.org/bcbs/basel3.htm.

At the end of Q3 2015, the capital adequacy ratio of banks in Serbia was 21.22 %[120], well over the regulatory minimum requirement of 12%, as well as the Basel standards minimum requirement of 8%. One wonders whether the banks in Serbia are overcapitalised, i.e. whether such high capital reserves might be invested more efficiently in the Serbian economy. One thing is certain, and that

[120] National Bank of Serbia (2015). *Bankarski sektor u Srbiji. Izveštaj za III tromesečje 2015. godine.* Belgrade: National Bank of Serbia.

is the fact that the financial system of Serbia has enough capital to absorb any disturbances on the market, and that it is relatively stable.

The assessment of capital adequacy of a financial institution, or the system as a whole, i.e. assessment of the ability to maintain solvency may be carried out by means of the solvency stress test. The test is performed in hypothetical terms by assuming that the bank is in a state of risk, by projecting a profit shock absorber, potential losses and assessing risks of changes in these factors. Modelling may be carried out by examining the impact of one or more risk sources (single factor tests or a multiple factor test), where the sources of risk can be combined randomly (a combined shock test) or generated according to the established macroeconomic scenario (macro scenario test). The macro scenario tests for assessing capital adequacy are carried out by applying macro-finance models which show dependence on key risk parameters (non-performing loans - NLP ratio, PD, LGD, credit rating, etc.) and relevant macroeconomic variables (GDP, unemployment, foreign exchange rate, interest rates, etc.).[121]

In addition to capital adequacy, other standard indicators of the solvency of banks that can be monitored are the level of indebtedness (the capital-to-assets ratio), share of losses in capital or required recapitalization.

2.4. Interest rate risk

As a financial intermediary, a bank faces one of the most important forms of market risk, the interest rate risk. This risk is defined as the sensitivity of capital and income to changes in interest rates.[122] The main function of a bank is concentration and allocation of available funds by collecting deposits and placing loans to borrowers. Through this transformation of funds, the bank is exposed to the interest rate risk arising from variability of interest rates and maturity mismatch between placements and sources.[123]

[121] IMF (2012). *Macrofinancial Stress Testing - Principles and Practices.* Washington, D.C: International Monetary Fund.

[122] Greuning, H.V., Brajović Bratanović S. (2006). *Analiza i upravljanje bankovnim rizicima.* Zagreb: MATE, p. 249.

[123] Madura, J. (2002). *Financial Markets and Institutions*. Ohio: Thomson - South - Western, pp. 534-544.

Banks are faced with various forms of interest rate risk: the maturity risk, the repricing risk, the yield curve risk, the basis risk and the optionality risk.[124] The maturity risk refers to the time mismatch in maturity (for fixed interest rates) and the risk of revaluation of interest rates on assets, liabilities, off-balance sheet items (for variable interest rates). Maturity mismatch is one of the characteristic for the banking business. If the long-term loans portfolio is financed by short-term deposits, increased interest rates could lead to a drop in yield. Higher interest rates result in a decline in the value of long-term loans portfolio, while taking new deposits at higher interest rates increases the expenses of the bank, which, eventually, results in a drop in banking yield. The probability of unexpected changes in the shape and inclination of the yield curve, with negative impact on yield or economic value of the bank is defined as the yield curve risk. The basis risk is the probability of lack of perfect correlation of adjustment to the moves of interest rates to be charged or paid on the various forms of financial assets, impacting the bank's operations. Banks are exposed to the optionality risk due to contractual provisions relating to interest sensitive positions (loans with the option of early repayment, deposits with the possibility of withdrawal and the like.). This risk is gaining on importance because options are included in many of the items in the bank's balance sheet.

In order to effectively manage the interest rate risk, banks must monitor interest moves of rate sensitive components of assets and liabilities on a daily basis. Supervisors require that the stress test of the effects of changes in interest rate moves is conducted at least once a year. There are different techniques for measuring this risk, such as the gap analysis technique, the measurement of sensitivity of the bank's earnings to moves in interest rates, the modelling techniques, the duration analysis and other. Experience has shown that each of these techniques has advantages and disadvantages, and a combination of several approaches is recommended, bearing in mind that the selected measurement techniques should be reflective of the bank's business policy and the structure of its assets.

2.5. Foreign exchange risk

addition to the interest rates risk, one of the main market risks affecting banks arises from changes in the exchange rate and mismatching values of assets and liabilities, denominated in different currencies. The foreign exchange risk is the ratio between the total foreign currency assets and liabilities, calculated in

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[124] BIS (2004). *Principles for the Management and Supervision of Interest Rate Risk.* Bank for International Settlements. Basel: Bank for International Settlements, Basel Committee on Banking Supervision.

accordance with the decision governing capital adequacy of banks. A bank's exposure to foreign exchange risk is usually accompanied by other types of risk, the liquidity risk, the interest rate risk related to the currency, the counterparty credit risk and so on. This risk particularly affects large banks that operate globally, since mismatches in currency and maturity are among basic features of their business.

Foreign exchange risk is speculative in nature, which means that its effects can be both positive and negative. For example, in case of net long positions in a given currency, depreciation of the domestic currency will have a positive effect on the bank's revenues, while the appreciation of the local currency will have the opposite result. In case of net short position, however, moves in exchange rates will have a reverse effect.

In the literature there are three possible variants of the bank's exposure to foreign exchange risk: transaction, balance sheet and economic exposures. Transaction exposure to foreign exchange risk occurs in every foreign exchange transaction in which there is a time discrepancy between commitments and their settlement. Balance sheet exposure arises from moves in exchange rates and their impact on the balance sheets of banks in situations where there is a gap between foreign currency assets and liabilities, at different times of the balance. Economic exposure to foreign exchange risk, or anticipated exposure, implies real moves in exchange rates of currencies in relation to the currencies of their competitors.[125] Identifying foreign exchange risk is primarily related to the consideration of the transaction and the balance sheet exposures, both at the level of exposure to individual currency, and the level of overall open foreign exchange position.

The National Bank of Serbia regulations stipulate that the ratio between foreign currency assets and liabilities is to be maintained in such a manner that the total net open foreign exchange position at the end of each working day does not exceed 20% of the bank's capital. The capital requirement for foreign exchange risk is calculated by multiplying the sum of total net open foreign currency position and absolute value of net open position in gold by 12% and the bank is obliged to calculate it if the sum of these positions is greater than 2% of the bank's capital.[126] According to the report for Q3 of 2015, the banking sector in Serbia reported long open foreign exchange position in the amount of RSD16.2

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[125] For more information see: Vunjak, N., Ćurčić, U., Kovačević, Lj. (2008). *op.cit,* p. 210.

[126] For more information see: Decision on Capital Adequacy of Banks. *Official Gazette of RS,* No. 46/2011, 6/2013, 51/2014.

billion, while the foreign exchange risk ratio amounted to 4.57%. The net foreign exchange position was long in euros (RSD12.73 billion) and US dollars (RSD2.61 billion), and short in Swiss francs (RSD1.07 billion). In addition to the assessment of exposure by using regulatory indicators measuring foreign exchange risk can also be done by using internally defined models and methods (sensitivity analysis).

2.6. Position risk

The last in a series of financial risks affecting banks is the position risk, which, by its nature, also belongs to the speculative risks. Position risk is the risk of changes in market prices of securities, financial derivatives or goods traded, or potentially traded, in the market. It can be said that this is the risk of negative effects on financial result and capital of the bank caused by changes in the value of the portfolio of debt securities and equity securities. Many authors equate this risk with market risk, while the interest rate and foreign exchange risks, due to their importance in the banking sector, are observed separately.

As with other forms of risk, the Basel Committee has defined mandatory capital requirement for open positions that are a product of debt and equity securities. Position risk is manifested in two basic forms, as a specific risk and a general position risk. Specific position risk is a result of unfavourable price moves of individual securities, while general position risk is a result of the loss caused by negative market moves, i.e. is not conditioned directly by changes in market prices of specific securities.

The Decision on the capital adequacy of banks stipulates that banks in the Republic of Serbia calculate capital requirement for position risk as the sum of capital requirements on debt securities and capital requirements on equity securities. Capital requirement for position risk, both on debt securities and equity securities, is calculated as the sum of capital requirements for general and specific position risks, multiplied by the risk weight of 1.5. When calculating general position risk on debt securities, a bank may use the maturity and the duration methods.[127] The capital requirement for specific position risk on equity securities should amount to 4% of the total gross position of the bank in such securities, and for general position risk, 8% of the total net position in equity securities.

[127] Decision on Capital Adequacy of Banks. *Official Gazette of RS,* No. 46/2011, 6/2013, 51/2014.

In practice, the position risk is mainly measured by the method of reducing to the market value of the instrument. After market values of each instrument are calculated and approximated and aggregated in the total portfolio of the bank, moves in the value of the portfolio are checked daily. This can then be used to calculate appropriate value at risk (VAR). Banks in Serbia are not significantly exposed to this type of risk, but, certainly, we should strive at reducing them to a minimum.

In the environment characterised by keeping abreast with the technological changes, financial innovation and increasing integration of the financial market, the development of international financial regulation is expected and necessary. One of the steps towards the harmonization of international banking regulations and strengthening the global financial system is the implementation of new standards outlined in Basel III. With the new guidelines, Serbian banking sector should increase the sensitivity to the growing risks and manage them better. The great challenge, both in terms of regulatory standards and the banks, is to keep up with potential new risks, which may arise.

Chapter 6.

RISK MANAGEMENT FOR SUSTAINABILITY OF PUBLIC PENSION INSURANCE

A well-defined system of public pension insurance is important for the development of a country and the financial security of the elderly population. For the proper functioning of the pay-as-you-go concept of financing public pension insurance, it is necessary to have positive economic and demographic factors. In most countries in the world, including Serbia, the aim is to provide conditions for achieving economically sustainable and socially acceptable system of public pension insurance. The chapter analyses the risks that affect sustainability of the public pension system in Serbia with the aim of proposing appropriate solutions for managing these risks.

1. BASIC ECONOMIC AND DEMOGRAFIC CHARACTERISTICS IN SERBIA

Serbia is characterized by prominent economic and demographic problems. It has low level of economic activity, high unemployment rate, unsatisfactory standard of living for the majority of the population, birth rates and fertility rates are not at a satisfactory level, and so on.

In particular, economic activities recorded a slight increase in 2015 compared to the previous year, but not sufficient to enable us to conclude that there are prerequisites for the proper functioning of the public pension insurance under the pay-as-you-go concept of financing. In 2015, gross domestic product in Serbia amounted to 3,973 billion dinars (current prices)[128], which represented a slight increase compared to 2014. Public debt in Serbia, in 2015, accounted for 76.6% of GDP, which is a reason for maximum concern.[129] In 2015, the unemployment rate was 17.9%.[130] The average net salary in the same year

[128] *Basic macroeconomic indicators*, www.mfin.gov.rs

[129] Government of the Republic of Serbia (2015). *Fiskalna strategija za 2016. godinu sa projekcijama za 2017 i 2018 godinu.* Belgrade: Government of the Republic of Serbia, p. 28.

[130] In 2014, unemployment rate of young population, between 15 and 19 years of age was about 37%.

amounted to 44,432 dinars,[131] and the average consumer basket for December 2015 amounted to 66,890.05 dinars, with minimal consumer basket amounting to 34,826 dinars.[132] In 2015, the average inflation rate was 1.5%.[133]

In terms of total population, in 2012, Serbia had a population of 7,199,077 (see information shown in Table 1). Population growth had been negative for a number of years (in 2012 it was -35,134). Population growth rate was the lowest in the Belgrade region (-1.4‰), and the highest negative growth rate was observed in the region of south-eastern Serbia (-7.7‰).

Table 1. Population and population growth in Serbia in 2000, 2005 and 2012

	2000	2005	2012
Population in mid year period	7,880,338	7,440,769	7,199,077
Deceased	104,042	106,771	102,400
Live births	73,764	72,180	67,266
Population growth	-30,278	-34,591	-35,134

Source: http://webrzs.stat.gov.rs

The average age of the population was 42.2 years. Life expectancy in Serbia (according to vital statistics) was 76.82 for women and 71.63 years of age for men. In 2011, the share of young population (15-29 years old) amounted to 18.4% (and in 1953, it amounted to 29.7%). In 2011, people over 65 years of age had a 17.4% share of total population, persons under 15 had a share of 14.27%, and those aged between 15 and 64 years had a share of 68.34%.[134] In 2012, the fertility rate was 1.32 children per woman. According to the World Bank methodology, the number of the poorest citizens of Serbia declined from 9.8% in 2003 to 9.1% in 2006, increased to 9.2% in 2011, and decreased to 8.6% in 2013.

The system of the pay-as-you-go concept of financing public pension system in Serbia cannot function adequately in the above environment of intense aging of the population, underemployment and adverse economic activities.

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131 *Basic macroeconomic indicators*, www.mfin.gov.rs

132 Ministry of Trade, Tourism and Telecommunications of the Republic of Serbia (2015). *Kupovna moć stanovništva - potrošačka korpa, decembar 2015.* Belgrade: Ministry of Trade, Tourism and Telecommunications of the Republic of Serbia, p. 2.

133 www.pks.rs

134 Devedžić, M., Gnjatović Stojilković, J. (2015). *Demografski profil starog stanovništva Srbije.* Belgrade: Statistical Office of the Republic of Serbia, p. 21.

2. FUNDAMENTALS OF PUBLIC PENSION INSURANCE IN SERBIA

The system of public pension insurance is functioning according to the pay-as-you-go principle of financing (i.e. financing from current sources). It is compulsory and follows the principles of solidarity and reciprocity.[135] Pension remunerations are paid in annuities, in one of the following ways: by direct payment to the pensiner's (recipient's) home address by method of payment order, where the cost of home delivery is borne by the insurance beneficiary; by direct deposit to the current account of the pension insurance beneficiary operated by a bank, with costs borne by the beneficiary, in accordance with the business policy of the bank; by deposit to the account of the institution where the beneficiary resides; or by deposit to the beneficiary's foreign currency account opened in the country in which the beneficiary resides.[136]

The Law on Pension and Disability Insurance of Serbia, adopted in 2003, outlines the fundamentals of the current system of public pension and disability insurance in Serbia. At the end of 2005, the Law on Amendments to the Law on Pension and Disability Insurance came into force, effective (in most of the provisions) as of 1 January 2006[137], and the largest number of the provisions of the Law on Amendments to the Law on Pension and Disability Insurance (Off. Gazette of RS, No. 101/10) became effective as of January 2011. Changes to legislation were also made in the period of 2011-2014.

As of 2014, the contribution rate for compulsory pension and disability insurance, is 14% paid by the employed and 12% paid by the employer (from gross salary of the employee).[138] The basis for the calculation of pension remunerations is the average earning throughout the employment period of the employed. Since 1 January 2008, the following pension and disability insurance

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[135] Kočović, J., Šulejić, P., Rakonjac-Antić, T. (2010). *Osiguranje.* Belgrade: Faculty of Economics, University of Belgrade, p. 497.

[136] www.pio.rs

[137] Rakonjac-Antić, T. (2008). Homogenizacija sistema penzijsko invalidskog osiguranja u Srbiji. *Proceedings from V International Symposium on Insurance*. Belgrade: Serbian Actuarial Association and the Faculty of Economics.

[138] Law on Compulsory Social Insurance. *Official Gazette of RS,* No. 84/2004, 61/2005, 62/2006, 5/2009, 52/2011, 101/2011, 7/2012 – adjusted amount in dinars, 8/2013 - adjusted amount in dinars, 47/2013, 108/2013, and 6/2014 - adjusted amount in dinars)

funds: employed, self-employed, and farmers have been joined into one fund- The Pension and Disability Fund of the Republic of Serbia.[139]

Table 2. The number of pension insurance beneficiaries, the number of insured and average pension remuneration in The Pension and Disability Insurance Fund of the Republic of Serbia

Funds	Insured	Pension insurance beneficiaries	Dependency ratio	Average monthly remuneration (in dinars)
Total employed (The employed fund and Army Servicemen)	1,466,785	1,454,332	1:1	26,055
Self-employed	230,901	77,047	3:1	24,767
Farmers	148,981	207,783	0,7:1	10,281
Total:	1,846,667	1,739,162	1,1:1	/

Source: www.pio.rs

Since 2012, The Pension and Disability Insurance Fund of the Republic of Serbia has been merged with The Pension and Disability Insurance fund for Army Servicemen of Serbia (statistically the name of Pension and Disability Insurance for employed is used to record data both for employed and for army servicemen). In 2014, the total number of insurance beneficiaries was 1,739,162 and 1,846,667 insured (see information presented in Table No. 2). Replacement ratio was 54.1%.[140] Approximately 60% of a pensioners were receiving below average pension remuneration.

In 2014, the majority of insurance beneficiaries were in The Pension and Disability Insurance Fund for employed persons (1,454,332), and the smallest number was in The Pension and Disability Insurance Fund for Self-Employed (77,047). One of the assumptions is that a system of public pension insurance can adequately function, among other things, in a situation when there are a great number of active insured relative to the number of insurance beneficiaries (pensioners). It is estimated that this is a situation where pension remuneration (pension) for one beneficiary is financed from contributions of 3-3.5 or more

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[139] Rakonjac-Antić, T. (2012). *Penzijsko i zdravstveno osiguranje.* Belgrade: Faculty of Economics, University of Belgrade, p. 151.

[140] Pension and Disability Fund of the Republic of Serbia (2016). *Annual Statistical Bulletin 2015.* Belgrade: Pension and Disability Fund of the Republic of Serbia, p. 13.

active insured persons.[141] According to these estimates, only the Pension and Disability Insurance Fund for self-employed could be economically self-sustaining.

The rights arising from pension and disability insurance are: the right to old-age pension and early retirement (in case of old age); the right to a disability pension (in case of disability); the right to a survivor pension (in case of death) and reimbursement of funeral expenses; the right to financial compensation for physical injury (in case of corporal injury caused at work or occupational disease); the right to financial compensation for care and assistance and other rights in accordance with the law on Pension and Disability Insurance.[142]

Within the most numerous one, the Pension and Disability Insurance for employed, the majority of insured belong to the category of pensioners entitled to old-age pension (58.7% in 2015).[143]

In 2016, the following categories may exercise their rights to pension:

- Males:
- aged 65, with minimum 15 years of service
- with 40 years of service and aged minimum 55 years and 8 months (early retirement).
- Females:
- aged 65, with minimum 15 years of service
- with 37 years of service and aged minimum 55 years (early retirement).

*both genders with 45 years of service, regardless of their age.[144]

Within The Pension and Disability Insurance Fund for employed, in 2015, the right to family pension remuneration was exercised by 22% of pensioners and the right to disability retirement remuneration by 19.3% of pensioners.

The right to a disability pension may be exercised from the moment when complete loss of working capacity is determined until the age required for old-age pension: if the cause of disability is work related injury or occupational disease, regardless of the length of service; if the disability is the result of an

[141] Rakonjac-Antić, T. (2012), *op cit.,* p. 17.

[142] Law on Pension and Disability Insurance. *Official Gazette of RS,* No. 34/2003, 64/2004 – decision of Constitutional Court, 84/2004 – state law, 85/2005, 101/2005 – state law, 63/2006 - decision of Constitutional Court, 5/2009, 107/2009, 101/2010, 93/2012, 62/2013, and 108/2013)

[143] Pension and Disability Fund of the Republic of Serbia (2016), *op. cit.,* p. 13.

[144] www.pio.rs

illness or injury outside work, minimum service of five years is required. The insured with whom the disability occurred before the age of 30 are excepted: the requirement for younger than 20 years of age is at least one year of service, for those up to 25 years of age, two years of service, up to 30 years of age, three years of service.[145] In case of death of an old-age pension beneficiary or disability pension beneficiary, that is, the deceased beneficiary with minimum five years of service or who had fulfilled the requirements for disability pension, their family members are entitled to survivor pension. If the cause of death is injury at work or occupational disease, family members are entitled to a pension regardless of the length of pensionable service of that person. In 2016, the spouse is entitled to survivor's pension if: the wife is aged 52 years and six months, provided that, at the time of death of the spouse, she was at least 45 years old; the husband, if at the time of death of his wife he was aged minimum 57 years and six months.

The so called actuarial penalties for early retirement have been outlined. Pension remuneration shall be permanently reduced by 0.34% for each month prior to reaching the age required for entitlement to old-age pension. The amount of reduction for early retirement shall amount to a maximum of 20.4%. If an insured is retired 12 months earlier, the reduction shall be: 12 * 0.34 = 4.08% of pension remuneration, and if an insured retires five years earlier, the reduction shall be: 5 * 4.08 = 20.4% of pension remuneration.

According to the provisions of the Law on temporary regulation of pension payments (2014), pension remuneration is paid in the amount that is obtained as follows:[146]

*for pension beneficiaries whose pension is greater than 25,000 dinars, but less than 40,000 – by deducting from the total amount of pension an amount which is obtained by multiplying the coefficient of 0.22 by the difference between the total amount of pension and 25,000 dinars;

*for pension beneficiaries whose pension is greater than 40,000 dinars – by deducting from the total amount of pension an amount which is obtained by multiplying the coefficient of 0.22 by 15,000 dinars and the amount which is obtained by multiplying the coefficient of 0.25 by the difference between the total amount of pension and 40,000 dinars.

For example, an insurance beneficiary (pensioner) whose pension remuneration is 26,000 dinars, it is established according to the following formula:

[145] *Ibid.*

[146] Law on temporary regulation of pension payments. *Official Gazette of RS,* No. 116/2014, articles 2 and 3.

PR=Personal point (PP)*General point (GP)

PP=Personal Coefficient (PC)* Service length (SL)

Personal coefficient shall be determined by dividing the sum of annual personal coefficients by the period (years, months and days) for which they are calculated. Annual personal coefficient represents the ratio of the total earnings of the insured or the insurance basis as of 1 January 1970, for each calendar year and the average annual salary in the country for that calendar year.[147] Currently, the value of the general point is 724.66 dinars. The general point is adjusted twice a year, on the first of April and the first of October, in the same manner as adjustment of pension remunerations.

According to the provisions of the Law on temporary regulation of pension payments, for the above insured, pension remuneration shall be:

26,000-(26,000-25,000)*0.22=26,000-220=25,780

If pension insurance beneficiary is receiving pension remuneration amounting to 41,000 dinars, according to the provisions of the Law on temporary regulation of pension payments, their pension remuneration shall be:

First reduction (40,000-25,000)*0.22=3,300

Second reduction (41,000-40,000)*0.25=250

Total reduction: 3,300+250=3,550

Pension remuneration after reduction: 41,000-3,550=37,450

"Indexation of pension remuneration is performed as of 1 April of the current year in line with the trend of consumer prices in the Republic of Serbia in the past six months. If the GDP (Gross Domestic Product) in the previous calendar year increases by more than 4% in real terms, pensions are adjusted on 1 April of the current year in the percentage that represents the sum of the percentage of growth or decline in consumer prices in the Republic of Serbia in the previous six months and the percentage representing the difference between the real rate

[147] Law on pension and disability insurance. *Official Gazette of RS*, No. 34/2003, 64/2004 – decision of Constitutional Court, 84/2004 – state law, 85/2005, 101/2005 – state law, 63/2006 - decision of Constitutional Court, 5/2009, 107/2009, 101/2010, 93/2012, 62/2013, and 108/2013)

of GDP in the previous calendar year and the rate of 4%. As of 1 October of the current year, pensions are adjusted in line with the trends in consumer prices in the Republic of Serbia in the previous six months."[148] According to the Law on Contributions to Compulsory Social Insurance, the lowest base is 35% of the average earnings in the Republic from the previous quarter, which is 22,449 dinars, and the highest one is five times the average earnings, or 320,695 dinars."

As a result of certain activities, inter alia, the reduction of pension remunerations under the Law on temporary regulation of pension payments, "in 2015, in the Pension and Disability Insurance Fund of the Republic of Serbia increased revenues from contributions by 5 percent, compared to 2014, and they accounted for about 61% of total revenues.[149]" Government subsidies were reduced to 37.3% and, in 2014, they amounted to 44.2%. In total, 2,479 years, 10 months and six days of service were connected, amounting to approximately 154,363,528 dinars. About 5.5 billion dinars were allocated for payment of debt to army servicemen. According to the Pension and Disability Insurance Fund of the Republic of Serbia, income and expenses for the year 2016 were planned in the amount of 590.3 billion dinars."

The Decision of the Government of the Republic of Serbia stipulates that the pension and other monetary remunerations that the Pension and Disability Insurance Fund of the Republic of Serbia is to pay in 2016 shall be increased by 1.25% (as of payment of pensions for December). Payment of thus increased pensions started as of pensions for January, paid in February, which is when the difference for December 2015 was also paid.

In mid 2015, a revalidation of capacity for work was conducted for 3,929 disability pensioners and it was determined that 210 pensioners did not meet the requirements for receiving pension remuneration.

About 74,000 beneficiaries are receiving assistance and care benefits amounting to 16,105.09 dinars. This amount is not income tested. Funeral expenses reimbursement, to be paid to the families of deceased pensioners (or to the person who paid for the funeral) in April, May and June 2016 amount to 35,196 dinars for all categories of pensioners. The amount of physical impairment benefits is determined in relation to the established percentage of physical impairment from 30% to 100% (as established by the competent Disability Panel), of the base amount prescribed by legislation that has been in force since

[148] www.pio.rs

[149] *Ibid.*

09 April 2003 and is adjusted in the same manner as pensions. The basis for its calculation is the amount of 6,710.27 dinars.[150]

3. PROPOSALS FOR RISK MANAGEMENT FOR SUSTAINABILITY OF PUBLIC PENSION INSURANCE

Based on the above it can be concluded that the key risks to the sustainability of the public pension system in Serbia are: economic, demographic, and actuarial (method of calculating pension remuneration, etc.). Economic self-sustainability of pension system means that the income from the pension insurance is used to finance expenditures, largely related to payment of pensions (pension remunerations). So far, for many years, the public system of pension and disability insurance has been financed from funds accumulated from contributions for this type of insurance and additional funds from the state budget. Since 1987, The Pension and Disability Insurance Fund has been in the state of financial insolvency. Coverage of expenditures from total revenues has been declining steadily: in 1987, it amounted to 94.1%; in 2004, to 78.56%; in 2007, to 65.43%, in 2011, to about 50%, and so on. In addition to the fact that the public pension and disability insurance system is not economically self-sufficient, average pension remunerations (pensions) are not sufficient to cover the minimum cost of living of the pensioners (please refer to the information laid out in the first part of the chapter). The public pension and disability insurance system needs to be redefined with the aim of creating better conditions for its financing from real sources, and ensuring higher standards of living for pension beneficiaries and disability insurance beneficiaries.

According to the 2011 census, Serbia had a population of 4,911,268 aged between 15 and 64 years, 605,333 pension beneficiaries younger than 65 years of age and 511,704 university and high school students. Maximum number of insured persons would thus be 3,794,231 (4.911.268-605.333-511.704). If we observe the ratio between the number of insured and the number of beneficiaries, 1,739,162, it becomes obvious that maximum dependency ratio is about 2,2:1.[151]

According to a great number of studies, if dependency ratio with pay-as-you-go concept of financing public pension insurance is below 2.5:1, the system cannot

[150] *Ibid.*

[151] Kalinović, D. (2013). *Presentation The Impact of Gray Economy on Pension System*, Belgrade: Pension and Disability Fund of the Republic of Serbia, www.pio.rs

function independently. It is obvious that it is necessary to seek effective solutions for establishing the economic viability of the system.

The theory and practice of pension insurance define several ways to reduce the fiscal burden of public pension systems:[152]

1. Parametric changes: an increase in the contribution rate for pension insurance, extension of age or length of service requirements for retirement, changing the indexation of pension remuneration, etc.
2. Along with parametric changes, proposed changes also include fiscal adjustment, tax hikes in some other areas of the economy, which would be used to cover expenses in the public pension system.
3. Systemic changes, i.e. changes in the funding of pension remunerations (introduction of the so called. second pillar, etc.).
4. As a form of systemic change, sometimes more prominent support for fully funded programs is proposed and a gradual displacement of the public pension insurance (the example of Chile, etc.).

In a situation where population is aging and a small number of employed makes contributions for payment of pension remunerations for a growing number of pensioners, one of the solutions predominantly proposed is increasing contribution rates for pension insurance. However, high contribution rates result in increase in the price of labour and encourage evasion of payment for contributions. Employees without contract with the employer are very common, i.e. they are working 'off the books'. The percentage of contributions in the form of payroll tax is corrected and adjusted periodically so as to provide a balance between revenues and expenditures of pension insurance fund. The funds from contributions, paid by the employed and the employer, as the main source of financing in the pay-as-you-go system, are periodically (or more often) suplemented from the funds provided by the state. A growing number of countries are finding it increasingly harder to cover current pension remunerations smoothly (there is shortage of funds). That is why these countries have a great influence of the state which is co-financing either from the budget funds, or due to their insufficiency, funds provided from a large number of taxes, for example, on petrol, tobacco, alcohol, etc. In addition to increased contribution rates, longer service and age requirements, there is one unpopular solution to the problems in the functioning of the pay-as-you-go system, which is reducing the amount of pension remunerations, leading to the worsening of the already proor financial circumstances of the pensioners. If the rate of contributions is not increased or pension remunerations are not lowered, it is safe to say that payment of pension remunerations will depend on the

[152] Rakonjac-Antić, T. (2012), *op. cit.,* p. 20.

capabilities and readiness of the younger generation to bear the burden of thus formulated pension system and on the capability of the state to suplement the lack of funds.[153]

The issue of transition of the pay-as-you-go system into the fully funded system is topical with a large number of countries (not yet in Serbia), but this transition is resulting in prominent dificulties. Namely, there is a question of what would happen if the pay-as-you-go system suddenly stops functioning and the younger generation switches to the fully funded system immediately. It would result in the problem related to the older generation, i.e. elderly population would be left without pension remunerations. However, if a joint form of a transition system is used, the employed may be taxed for the pay-as-you-go system, and thus pay contributions for current pensioners and save for their pension at the same time. When the time comes for these active insured persons to become pensioners, the then employed will be paying for their pensions within the pay-as-you-go system. It is clear that any transition from the pay-as-you-go system to the fully funded system will produce a host of issues, such as: creation of high transaction costs (the lack of funds for financing current pensions), social tensions and the creation of a higher level of burden for certain age groups of the insured. Financing transaction costs poses a huge problem, because, until final transformation of the pay-as-you-go system, all actively employed will be paying contributions to be used for current pensioners only, and with the transition to the new system of financing, actively insured persons will be directing only one part of their contributions for payment of pension remunerations for current pensioners. It is necessary to find the way how to secure funds for payment of entire pension remunerations for current pensioners.

It is especially important to be aware of the possible conflict of interest between the current and future pensionerss (actively insured). Namely, the employed are striving for greater earning and lower contributions for current pensioners, the ratonale behind this mainly being: 'why pay for current pensioners when, in the future, maybe, nobody will be paying for us (actively insured)? Thus, the actively insured tend to pay contributions to their personal accounts only. On the other hand, pensioners will be demanding and asking from the currently employed to pay contributions for their pension remunerations in the same way they were doing so for previous generations of pensioners, feeling that they are entitled to the pension remunerations they have earned. These issues (and there are more) will hinder the transformation of the pay-as-you-go system to the

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[153] *Ibid.,* p. 18.

fully funded system. One of the solutions is, of course, financial help from the state in terms of closing the gap in the funds.
So far, parametric changes have been carried out in the public pension system in Serbia. Following the amendments to the Law on Pension and Disability Insurance, in 2001, there was an increase in the age requirement for retirement, the transition to the so-called Swiss formula for adjustment of pension remunerations (50% compared to earnings growth and 50% compared to the growth of consumer prices), the reduction in the contribution rate from 32% to 19.6%, guarantee lowest amount of pension remuneration as a certain percentage of wages and so on. In 2003, a points system was introduced for calculating pension remunerations, using average earnings throughout the life of the active insured was introduced for the calculation of pension remuneration instead of the average earnings during the top ten years, as well as compulsory payment of contributions for authors' contracts and services contracts, etc.

The adoption of the Law on Amendments to the Law on Pension and Disability Insurance, in 2005, enabled a gradual increase of the age requirement for retirement; a gradual transition to the adjustment of pension remunerations with the cost of living only, since 2009, twice times a year instead of four times a year, previously used; extraordinary pension adjustment if the average pension remuneration is less than 60% of the net average earnings in the previous year; raising the level of the minimum pension remuneration, etc. In 2010, the Law on Amendments to the Law on Pension and Disability Insurance introduced changes regarding the exercise of the right to survival pension remuneration, as already stated; actuarial penalties, and the like, and in 2014, as already discussed, saw the adoption of the Law on temporary regulation of pension payments.

In the past 6 years there was:

1. Increase in contribution rate;
2. Incremental increase in the age requirement for pension;
3. Introduction of temporary reduction of pension remunerations pursuant to the Law on temporary regulation of pension payments;
4. Start of the application of actuarial penalties for early retirement;
5. More frequent validations of pensioners' capacity to work;
6. Increased amount of insurance basis, etc.

It is necessary to invest significant effort in boosting economic activity, to increase the employment rate because they are the main factors for the smooth functioning of the public system of pension and disability insurance in the pay-as-you-go concept of financing. The priority is to create environment favourable for employment growth through new investment projects, coordinated with stimulating tax policy and reducing administration in the operation of business entities.[154] Changes in the system of public pension and disability insurance must be coordinated with the development strategies for other important areas that should facilitate improvement of the quality of life and extend life expectancy of the population, notably the system of health insurance and unemployment income protection.[155] The collection of contributions for pension and disability insurance should be more efficient. At the end of 2013, employers owed 68.58 billion dinars in contributions for pension and disability insurance. From this amount, 63.19 billion dinars were collectible. It is necessary to redirect gray economy into legal channels. "According to the Survey on business conditions, in the sector of enterprises gray economy related to two most important forms of evasion (illegal trading of goods and working 'off the books') accounted for about 21% of GDP."[156]

The main objective of pension insurance is to maintain the standard of living of the participants at the level equal to that of the pre-retirement period and, if possible, to improve the standard of living (i.e. the quality of life) of all individuals in the community at their old age when their earning capacity is at a very low level, and their needs are still at a high level. Indirectly, the existence of a system of pension insurance results in level consumption throughout lifetime of the participants, the reduction of poverty in the years after retirement, etc.

Sustainability of the public pension system is affected by a large number of factors. The public pension system in Serbia has not been economically sustainable for years and, in most cases, it is not socially acceptable. Modest economic growth, high unemployment rate, low standard of living for the population, unfavourable dependency ratio, prominent gray economy, avoiding payment of contributions to public pension insurance, etc. do not provide a good basis for creating an economically sustainable system of public pension insurance. It is necessary to adequately manage the economic (by strengthening

[154] Rakonjac-Antić, T., Rajić, V., Lisov, M. (2012). Sustainability problems of the public pension and disability insurance system in Serbia. In: *Achieved Results and Prospects of Insurance Market Development in Modern World*, Kocovic, J., Jovanovic Gavrilovic, B., Jakovcevic, D. (eds.), Belgrade: Faculty of Economics, University of Belgrade.

[155] Rakonjac-Antić, T., Rajić, V. (2010). Analiza tržišta penzijskog osiguranja u Srbiji. *Proceedings from VIII International Symposium on Insurance,* Belgrade: Serbian Actuarial Association and the Faculty of Economics.

[156] FREN (2015). Preporuke za formalizaciju sive ekonomije i njeni efekti na ekonomski rast u Srbiji. *Policy brief,* Belgrade: Foundation for the Advancement of Economics, www.fren.org.rs.

the economy, creating new jobs, increasing employment, etc.), demographic (increasing population growth that will generate the active population, etc.) and the actuarial risks (implementing an adequate system of calculating a pension remuneration, how data are used, etc.).

Chapter 7.

RISK MANAGEMENT STRATEGY FOR REINSURANCE COMPANIES

Judging by all the relevant points, far-reaching effects of the global economic crisis will, even during year 2016, affect the insurance and reinsurance industry. The risks that will in future seriously endanger people's lives and property are extreme weather conditions, climate change consequences, interstate conflicts, the crisis concerning water supply, mass migrations and varying energy prices. The real threat is the correlation of these global risks that boosts their impact.

The global risk landscape is rapidly changing. Adapting to this changing risk landscape and identifying emerging risks is at the heart of reinsurers' business models.

The large variety, complex interdependencies and joint impact of risks require correspondingly sophisticated models. Over the last 20 years, global reinsurers have invested significantly in the development of their own internal models, which have proven crucial for sound risk management and steering.

Internal models have a number of benefits, making the risk profile of companies more transparent and enriching dialogue between the supervisor and the company. They also model risk more granularly, closely reflecting a company's risk profile.

But in the wake of the financial crisis, there has been significant debate on the merits of internal models versus more standardised approaches. Until recently, supervisors in Europe had accepted the important role that internal models play in advanced solvency frameworks with both Solvency II and the Swiss Solvency Test allowing for the use of internal models to calculate solvency for regulatory purposes. However, recent discussions amongst national supervisors within the IAIS on the allowance of models and at European Insurance and the Occupational Pensions Authority (EIOPA) on supervisory overlays to internal models – in the form of benchmarks, appropriateness indicators and standard formula corridors and scope limitations (e.g. partial models) – put this progress at risk and fail to recognise the benefits of internal models.[157]

[157] Paterson, C., Wilhemy, L. (2015). Reinsurers urge regulators not to overlook the benefits of internal risk models. Zürish: Swiss Re Reinsurance Company, http://www.swissre.com/rethinking/financial_stability.

Reinsurance as a process of dispersion of risks insured in local markets is particularly exposed to the negative effects that were caused by the world economic crisis and the globalization of world economy. Preserving the basic functions of this field primarily requires the establishment of the system of internal controls and risk management in a way that can provide its own risk and solvency assessment.

Risk assessment should be an integral part of business strategy of all reinsurance companies, with an aim to identify potential risks, minimize reinsurer exposure to potential risk or group of risks, ensure the long-term solvency and ensure adequate capital management.

1. REINSURANCE RISKS IDENTIFICATION

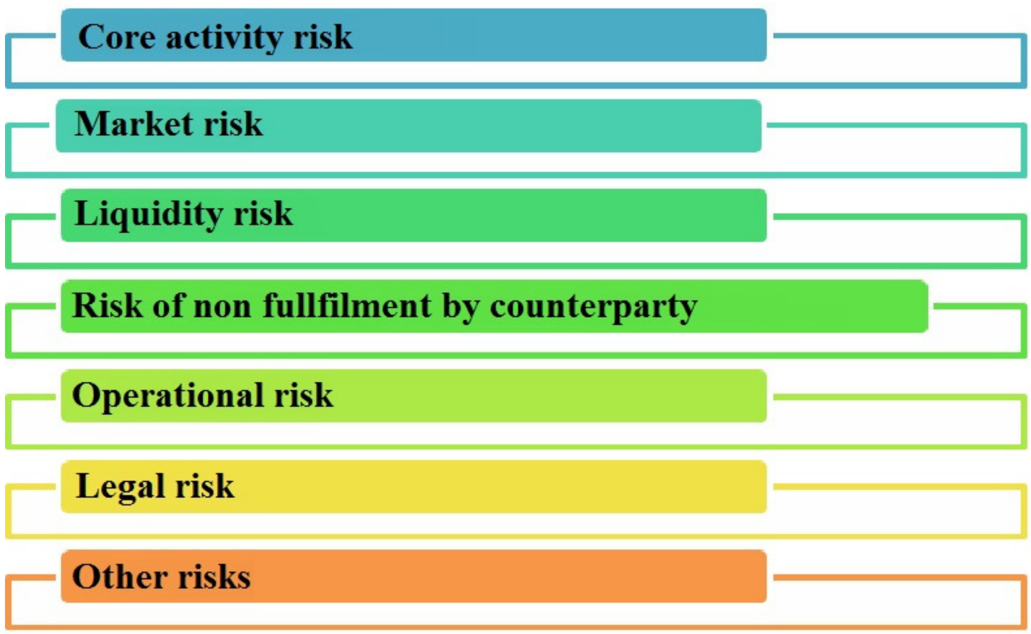
In reinsurance industry, as well as in all other industries, business processes are taking place in a very complex environment which makes the realization of the business policy goals and therefore the business strategy itself, vague and often hard to predict. Final and measurable effect, which certain risks or group of risks have to the business, is presented by deviation (positive or negative) achieved in relation to the expected.

Risk identification is the process of identifying potential hazards ranging from the very source of risk, over risk and "vulnerability" measuring to calculating the probability of the potential dangers until the consideration of the possible consequences, in case when some identified hazards come to realization.

Figure 1. Risk identification

When identifying risks in the reinsurance company it is necessary to group the related risks. General risk division in reinsurance companies includes seven groups of similar or related risks: core activity risks - reinsurance risks, market risks, the risks of non-fulfilment by the counterparty, liquidity risks, operational risks, legal risks and other significant risks.

Figure 2. Risks in reinsurance company



Each of these risk groups implies that within the group itself, company must identify the risk that can have certain impact on the business of reinsurance.

Core activity risks - reinsurance risks are those that directly affect the basic indicators of reinsurance company's performance and have a direct impact on the operating result of the core activity. Premium rate definitely has a direct impact on business result of the company. Inadequate premium rates bring a risk of reinsurance premium insufficiency. Within reinsurance business two sub-groups related to this risk can be identified. The first sub-group refers to the automatic contracts under which the reinsurer accepts original premium rates of the insurer. In unstable markets with underdeveloped methods of underwriting, negative effects of inadequate premium rates often appear. The second group refers to the premium rates set by the reinsurer itself, based on its own assessment of the risks taken into reinsurance. Given that reinsurers are doing business in the global market, inadequate determining of the premium rates often happens when the reinsurer does not have enough knowledge concerning the territory in which it operates, or has a lack of information or inadequate statistical data on the risk it takes. Risk degree depends on the structure of the reinsurer portfolio. Smaller portfolios are easier to amortize the consequences caused by the risk of inadequate premium rates, while that is certainly not the case with non-balanced reinsurance portfolios. Probability is difficult to be measured at the level of the reinsurance industry. It ranges from high with underdeveloped markets to very low in markets that have developed models with a variety of tools for determining premium rates.

One of the potential threats to the reinsurance companies are inadequate technical reserves. Technical reserves represent the most significant item on the liability side of the financial statements of the insurance and reinsurance companies. Technical reserves are formed from the reservations for unearned premiums, reservations for unexpired risks, reservations for bonuses and discounts, outstanding claims and incurred but not reported claims, mathematical reserves, reservation for insurance where the insured agreed to participate in the investment risk, reservation referring to risk equalization and other technical reserves. In number of countries, there is a general requirement that technical reserves should follow generally accepted accounting principles applicable to that type of reservation, while in some countries strictly prescribed methods of calculation of technical reserves are used. In markets with no special regulations, calculation of technical reserves may be in the zone which is extremely subjective. Thus the process of decreasing or increasing the reserves based on free estimation, when it comes to pending requests, may result in high insolvency risk. The fact is that compliance with international accounting standards and other regulations in recent decades decreases this risk.

The risk of inadequate determination of the retention level is present not only when determining the maximum retention by line of business, but also in the process of determining the reinsurers participation in reinsurance agreements which may be equal to or less than a predetermined maximum retention.

Reinsurer exposure is measured in accordance to the individual risk exposure or exposure to a single event. The amount of retention is determined by several factors: the type of insurance, the portfolio structure, statistical claim development, the amount of available capital and financial potential of a reinsurance company. When determining risk participation it is necessary to take into account the possible emergence of so-called shock claims or events that may threaten the financial stability of the business in the longer term. Correct choice of actuarial methods for determining retention and adequate retrocession programs may reduce the influence of the risk caused by inadequate retention level. The smaller and underdeveloped portfolios are more vulnerable in terms of the effects of this risk. In such cases, it is certainly safer to be circumspect with the determination of the retention level and use supplementary protection in the form of retro program in order to avoid the risk of large exposures.

In recent years, the damages caused by natural disasters are mentioned a lot. Claims caused by natural disasters in almost all the countries are covered by insurance and reinsurance. Climate change has caused frequent disasters from natural hazards, and they are by rule of large-scale. In terms of insurance and reinsurance that means their retentions are far more exposed to the risk of the occurrence of such events, which by their nature could endanger the operations of a reinsurance company. Bearing in mind the consequences caused by risk of inadequate retention and its impact on overall business of the company, it is necessary to apply the precautionary principle above all, when determining the company's exposure to certain risk.

Elements used when determining retention differ for each type of insurance separately, but the main ones are, for example, with fire risk - risk location, its structure, content, purpose and prevention, claims and protection measures.

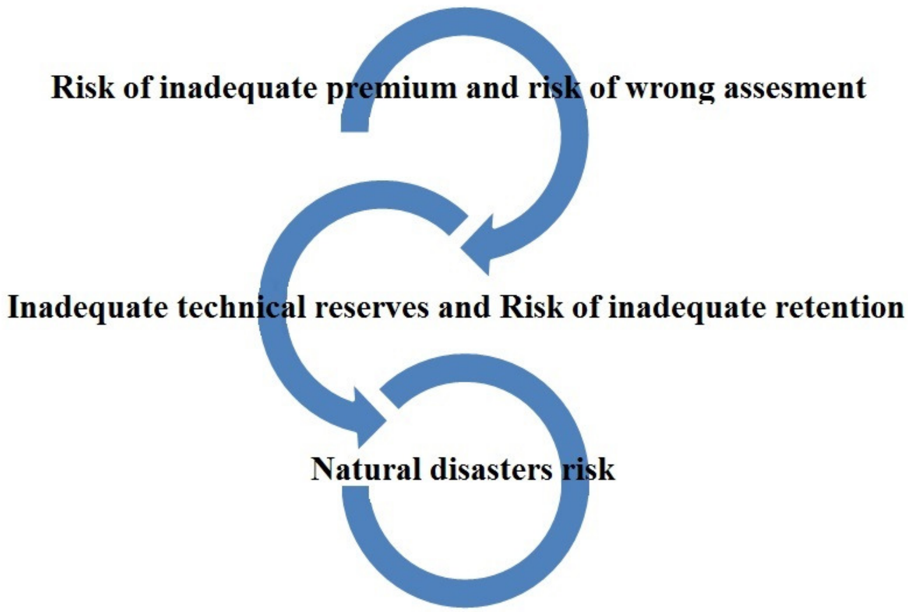
When it comes to cargo reinsurance one must take into account the type and quality of the goods and its packaging, the type of coverage and means of transport.

In case of marine hull, the most important factors are the classification, size, fleet age, the owner and the flag.

When it comes to technical branches, the retention levels are mainly determined on an individual basis, taking into account the specific characteristics of each risk. One usually takes into account the type of coverage (such as breakage of machines), risk location, protection measures, age, maintenance, insurance sum and the like. The decisive factors in reinsurance of aviation are accumulation of various reinsurance covers included in a single risk, hull, liability, personal accident, liability for passengers, etc.

The risk of inadequate risk assessment is the risk that reinsurers inevitably face in their daily operations. Given that the reinsurance risks are located throughout the world, there is a certain possibility of inaccurate risk assessment, since the risks taken over are mainly based on statistical data provided by cedants or reinsurance intermediaries. The source of danger in this case is incorrect or insufficiently accurate statistic data. With an aim of reducing this risk, a large number of reinsurers have designed so-called tools for risk assessment. The tools are based on the worst case scenario, where the importance of the data insufficiency or inaccuracy of certain important facts is being diminished.

Figure 3. Core activity risks in reinsurance



In addition to basic identified risks, reinsurance companies encounter potential dangers that belong to the market risk group. The market risks include changes in the business environment that may have smaller or larger negative effect on the financial result. One of the most significant market risks is interest rate risk. This risk is particularly interesting in last five years with the dramatic decline of interest rates. Reinsurance companies as a rule have substantial financial resources. Depositing of these funds in the period with stable interest rates contributes to the achievement of financial income.

Interest rates decrease may lead to a significant drop of financial income, which further indicates the negative effect when presenting the total business results.
Interest rates affect all insurers, but the impact differs by line of business and also by product. Add this to the fact that interest rates can be highly volatile, and that it would be foolish to believe that interest rates can be predicted mid- to long-term with any reasonable precision. Therefore, insurers/reinsurers need to be prepared for all possible interest rate scenarios. Swiss Re's sigma 4/2012, "Facing the interest rate challenge", explores the impact of interest rates on insurers and explains why a rapid rise in or sustained low interest rates can be a challenge for the road ahead. [158]

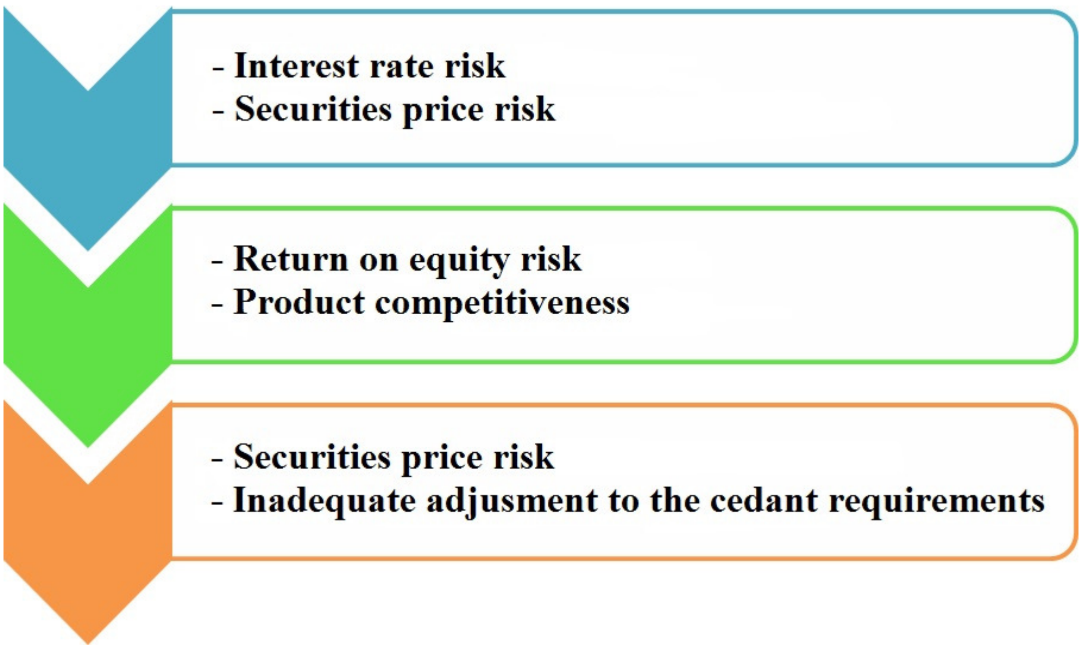
The same case is with the potential risk that refers to price changes of securities as a form of investment funds. As reinsurance companies cannot influence

[158] Swiss Re (2012). Facing the interest rate challenge. *Sigma*, 4/2012, Zürich. Swiss Re Reinsurance Company.

directly the above mentioned risks, it is necessary, in order to reduce these risks, to conduct permanent screening of the parameters that significantly change the image of the financial results in their balance sheets.

The market risk includes also the risk of return or decrease of return on equity. The decrease of return on equity is directly affected by the potential reduction of basic income and by decrease of reinsurance premiums in retention and indirect inadequate adjustment to the cedants requirements and product competitiveness. Since reinsurance companies indirectly identify these market risks as part of core activity risk, it is possible to take measures in order to reduce potential hazards carried by this risk.

Figure 4. Market risks in reinsurance



The risk of non-fulfilment by the counterparty is certainly a risk faced by all companies. The most important risks in this group are: the risk of the inability to collect the invested funds, the risk of the inability to collect return on invested assets and the risk of inability to collect receivables from the counterparty. The most significant risk group within financial institutions, such as reinsurance, is made out of the liquidity risks. The group of risk liquidity is made of: risk of wrong assessment, recording, presentation and disclosure of the asset value as well as income, expenses and operating results, the risk of failure to sell assets at book values as well as the inability to collect funds from the sale of assets, the risk of maturity mismatch of assets and their sources, risk of being unable to settle obligations arising from reinsurance and on other grounds. The greatest threat from this risk group is the risk of inadequate management of assets and liabilities, which in case of realization has a direct impact on the capital adequacy of reinsurance company.

Significant risk group is comprised out of the legal risks which include: the risk of possible losses from legal proceedings, risks referring to null and void contracts, the risk of non-efficient procedures for money laundering and terrorism financing and the risk of decision making and sentencing by the competent authority.

Legal responsibility risk includes legal system or regulations that may increase the frequency or intensity of damage, such as court judgments that are negative in relation to the perpetrators, high compensation damage with responsibility for the judgment, etc. [159]

Operational risks represent the risk group which includes: the risk of improper selection of board members, the risk of inadequate personnel policies, the risk of inadequate business organization, the risk of adverse economic engagements, the risk of fraud and abuse, the risk of contracting, organizing and carrying out reinsurance activities contrary to the rules of the profession, reputational risk and the absence of adequate internal control systems and procedures.

2. RISK MANAGEMENT STRATEGY IN REINSURANCE COMPANIES

One of the recent definition of the term risk management is identified with the intensity of exposure by identifying an organization's loss (loss exposure) and determining the best management methods for preventing loss occurence.[160]

The very process of risk management can be viewed as a set of methods used that are flexible and used together. It represents basically a multi-disciplinary process used to solve the problem of risk used together with different knowledge and discipline. In fact, it is a systematic process of identification, analysis and risk assessment, or the claim possibility in one organization, as well as selecting the best way to process, to treat t these potential risks, in accordance with the goals and aspirations of organization. [161]

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[159] Rejda, E.G. (2005). *Principles of Risk Management and Insurance*, 9th Ed., Boston, MA: Addison Wesly.

[160] Ostojić, S. (2007). *Osiguranje i upravljanje rizicima.* Belgrade: Data Status, p. 113.

[161] Williams, C.A., Heins, R.M. (1976). *Risk Management and Insurance*, New York: McGraw-Hill, p. 70.

Risk Management Strategy represents defined risk management policies, objectives, measurements, risk monitoring policy and measures undertaken, as well as methods of classification and probability measurements and the risk impact on the business of reinsurance company.

Risk Management Strategy defines the methods of establishing horizontal and vertical organization of risk management tasks. Specifically, this strategy provides the assumptions and determines the ways of information exchange between the risk management function from one and other organizational units on the other side.

Through establishing risk management policies, company defines the basics of management, monitoring and control of each risk, with an aim of sustainable business operations in the future. The main objective of risk management is to ensure conditions for minimizing exposure to risks in the long term as well as enabling the reinsurance company to absorb risks or become tolerant to them. In addition to that, no less important objectives are the realization of planned activities and figures, quality improvement of reinsurer services, as well as providing enough quality information about the risks that can be made available to the public interested in this matter.

The primary task of risk management is the risk elimination, which implies total risk elimination or leaving the business process which presents a risk for the company. The complete risk elimination is possible in situations where there are adequate alternative solutions that have the same or better positive effects on the business, with risk level reduced to zero. Within the core reinsurer activities one of possible scenarios is when a disproportionate retrocession program with low price is not appropriate in relation to the frequency and claim amount. The risk that such an arrangement bears may represent a risk to the result of the company. The complete elimination of this risk would mean moving to the retro proportional programs that are more expensive but represent a far lower risk to company in certain situations.

Besides simple risk elimination, reinsurance companies set goals related to the risk reduction, risk transfer to other carriers with certain fees and even the acceptance of a risk or a risk group. Risk reduction as the goal of risk management represents a process of increasing control and improving the efficiency of control checks. Those control checks could detect on time the change of risk level and assess the likelihood of its occurrence. Risk transferring and risk accepting are the goals that are defined in situations when the risk does not pose a significant danger to the company's operations or where the probability of its formation and realization is extremely small.

Beside identification, risk measurement is perhaps the most important stage in the process of risk management. The risks are being measured by quantitative methods, assessment of the event probability as well as by qualitative expert assessment.

Risk quantification involves the monetary expression of the negative effects that reinsurance company may suffer in case of occurrence of an unwanted event. When measuring impact and probability developed statistical models are used, that can be applicable to specific portfolio structures and operations of reinsurance companies.

According to the probability and the impact degree, the risks can be classified into the following groups: no significant impact, little impact, a significant impact, high impact and unacceptably high impact.

By using the simplest model, the probability can be divided as follows: unlikely, possible, probable and certain, while the impact on business can be critical, large, medium and minor.

In such a simple model it is possible to set up a matrix of probability and impact which can quickly and easily define the conclusions about potential risks to reinsurance business

Table 1. Matrix of risk probability and impact

<table>
<tr><td colspan="6">Probability</td></tr>
<tr><td colspan="2"></td><td>Unlikely</td><td>Possible</td><td>Probable</td><td>Certain</td></tr>
<tr><td rowspan="4">Impact</td><td>Critical</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>Large</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>Medium</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>Minor</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
</table>

For example: With a larger number of proportional facultative contracts, a reinsurance company has identified a risk of inadequate premiums. This is a situation where the original premium insurer’s rate is accepted. After examining the height of participation, reinsurance company "X" found that two average harmful events with risks reinsured in this way, can lead to a very negative technical result which would be a great burden for the retention of the company. Possible measures that can be used in order to reduce the potential risk by reinsurance company "X" are: using preventive measures, where company "X" by doing things differently, would eliminate the risk if feasible. In the present case, this means that the company "X" in case of no cancelation of the already concluded reinsurance contracts, which is likely the case in practice, should in time start the reputation of each cover. In that way, in the future, the company would not accept the original rates of the insurer or would inform the insurer about inadequate premium rates that present the potential risk of the insurer also.

Besides preventive measures, reinsurance companies have also at its disposal the risk reducing measures as well as measures for the transfer of risks to other risk carriers. Risk reduction represents a process of taking certain risk control actions in such a manner that would lead to reducing the likelihood of risk development or limiting its impact.

When the probability is small and impact is not large, reinsurance company can tolerate risk with constant monitoring of its development.

Today, risk management is in focus, bearing in mind the very dynamic business environment. However, as the time flows and markets are getting more stable, reinsurance companies may be at risk in terms of getting relaxed in relation to the prospective dangers. Reduced attention can easily lead to problems because it is common knowledge that the greatest source of failure is a long period of success.

Unfavourable developments on the global economic scene had caused the increase of the precaution measures. Stakeholders of this approach to potential risks are the shareholders, auditors, regulators, and of course management itself that is ultimately responsible for the success or failure of the business.

The fact is that the very business operations can be largely enhanced by reduction or complete elimination of the potential threats. This is why throughout large number of companies special organizational units are being formed with the task of identifying, grouping and timely alerting to possible threats. It is very important to link these organizational units with the organizational part that deals with compliance issues.

Frequent changes to existing laws and adoption of new laws impose the need to improve the risk management process. In the European Union, Article 41 of the Eighth Directive contains even the part that refers to a committee or revision committees, which should supervise the internal control, internal audit and risk management systems.

Insurance and reinsurance companies as well as most financial institutions must ask their managements to give clear and unambiguous answers to the following questions: Has the company considered the option of an integrated risk management system? Are certain levels having the responsibility for the risks? Does the staff support or obstruct the process of risk management? Does the company properly identify and assess potential risks? What resources are being used when identifying the risk? Insight into all business processes is being provided in what manner? Does the company control the compliance issues? What is the number of identified risks and what measures are defined in order to eliminate or mitigate those risks? Does the company have a plan for crisis situations?

Answers to these questions will provide guidelines for the proper coping with potential dangers on the one hand, and on the other, they will prevent the so-called effect of being lulled into success and failure of attention.

PART II

RISK MANAGEMENT IN THE BANKING SECTOR

Chapter 8.

FLUCTUATIONS ON THE INTERNATIONAL CURRENCY MARKET AND POSSIBLE IMPLICATIONS FOR THE DINAR

The ECB's continued expansionary monetary policy in 2016, in which the Fed will increase the key interest rate, which is certainly more cautious than the original plan, will cause great oscillations of the USD against the euro and other currencies. The further weakening of the Chinese yuan at the beginning of 2016, which is linked to a basket of currencies and no longer to the US dollar, and fractures on the stock exchange in China, where trade had to be temporarily suspended, show that a new currency war has begun despite the risk of the outbreak of a new global financial crisis. Investors' pursuit of higher yields, which they will be able to obtain in the United States in 2016 and subsequent years, will further serve to strengthen the dollar against the euro and other currencies.

Due to the serious risk of new fractures on the financial markets as a result of the position of over-indebted euro zone member countries as well as possible changes to the entire architecture of the euro zone into a new constellation of geopolitical relationships, the sudden ride of the dollar cannot be ruled out. The nervousness of investors and the weakening of the dollar against the euro in early 2016, despite the expansionary monetary policy of the ECB, may be misleading. A possible reason for this lies in the restructuring of the Chinese Central Bank's portfolio of government securities in favour of securities denominated in euros and the yen, at the expense of those denominated in dollars. This paper deals with: divergence of monetary policy in developed industrial countries and trends on the international currency market; possible effects on Serbia's level of public debt and the interest rates on loans; and possible effects on the dinar exchange rate.

1. THE DIVERGENCE OF MONETARY POLICY IN DEVELOPED INDUSTRIAL COUNTRIES AND TRENDS ON THE INTERNATIONAL CURRENCY MARKET

After the outbreak of the global financial crisis in 2008, the central banks of developed industrial countries resorted to a long term expansionary monetary policy which in terms of its intensity was unparalleled in the last century. However, seven years later they have not yet managed to return their national economies on the path towards the long-term economic growth rates as they stood before the crisis. In the third quarter of 2015, the real gross domestic product (GDP) in the euro zone showed an annual growth rate of 1.2%, in the US 1.5%, while in Japan it dropped by 0.8%.

The public debt to GDP ratio - after the outbreak of the global financial crisis - increased dramatically between 2008 and 2015: from 64 to 104% in the US; from 66 to 93% in the euro zone, and in Japan from 176 to 237%, which created additional pessimism among investors in terms of willingness to purchase government bonds in order to finance public spending in the aim of stimulating economic growth.[162]

In the euro zone and Japan additional measures were necessary to prevent the slowdown of economic activities because there was still no basis for high, sustainable economic growth. The market reaction to the Governing Council of the European Central Bank's (ECB) decision from 3rd December 2015 best confirms this. That day, the ECB announced a new package of measures aimed at:

- Solving the problem of exceptionally low (almost zero) inflation rates;
- Eliminating the risk of entering a deflationary spiral; and
- Solving the problem of banks' insufficient crediting activities.

The ECB's package of measures extended the "quantitative easing" program for a further six months, until March 2017, therefore until that time state securities, but also the debt securities of local territorial-political units and regions will be purchased every month to the value of EUR 60 billion. In addition, the negative penalty interest rate on banks' deposits with the ECB was increased somewhat earlier from -0.2 to -0.3%, while the key interest rate remained at 0.05% - the level that had existed since September 2014.[163] The ECB Governing Council made the decision about the aforementioned stimulation measures with a majority of votes at the moment the key market actors in the world were expecting the US Federal Reserves (Fed) to increase key interest rates. How did the market react to the ECB's measures? It interpreted them as the minimum

[162] Source: *The Economist* (2016). February 20th, p. 14.

[163] For the ECB's previous anti-crisis measures see: Đukić, Đ. (2015). Nove antikrizne mere Evropske centralne banke i posledice po privredu Srbije. *Ekonomska politika Srbije u 2015. g.* Živković, B., Cerović, B. (eds.), Belgrade: Serbian Scientific Society of Economists with the Academy of Economic Sciences and the Faculty of Economics in Belgrade, pp. 75-85.

measures Mario Draghi could have taken. They were below their expectations, because they had hoped for stronger stimulants, and the scepticism of the actors on the financial markets was consequently manifested through the sudden rise of the euro exchange rate against the dollar by 2.2% (after a high of 1.0892, the euro was worth 1.0845 dollars at the end of the day), a 2.8% drop in the share price (Stoxx Europe 600 Index) and the biggest drop in bond prices since June 2015.

The continuation of the ECB's expansionary monetary policy during 2016, when after increasing the key interest rate to the level of 0.25-0.5% (in December of the previous year) the Fed will continue to increase it, more cautiously in comparison to initial expectations (four times, by 0.25 percentage points), will cause large fluctuations of the dollar against the euro. Exchange rate trends over the past five years indicate remarkably large fluctuations, and in Figure 1 you can see that in the last 52 weeks the euro has ranged from a minimum of 1.0458 to a maximum of 1.1714 dollars.

Figure 1. EUR/USD exchange rate development (4.03.2011 - 3.03.2016)

Source: Bloomberg, http://www.bloomberg.com/quote/EURUSD:CUR, 4.3.2016.

Those oscillations in 2016 could be greater than in 2015 if the ECB is forced to stimulate economic activities with new aggressive measures and to prevent re-entry to the deflation zone by weakening the European currency. The fact that this is possible is confirmed by the ECB's latest revised projections published at the beginning of March 2016: a reduction in the inflation rate from 1.0 to 0.1% in 2016, and from 1.6 to 1.3% in the following year; a reduction of the predicted economic growth rate in 2016 from 1.7 to 1.4% and its decrease from 1.8% to 1.7% in 2017.[164] According to this projection the inflation rate in the euro zone would stand at 1.6% at the end of 2018, therefore it would still remain below the targeted rate for the midterm – close to 2%.

Because of the unsatisfactory effects of the previous package of measures in the euro zone, new measures from the ECB quickly followed. At a session held on 10th March the ECB Governing Council decided to:

- Reduce the key interest rate on main refinancing operations from 0.05% to 0.00%;
- Increase the negative interest rate on deposit benefits from 0.3% to 0.4%;
- Reduce the interest rate on bank lending additional benefits (in the form of overnight loans) at the national central banks that are part of the Euro system (marginal lending rate) from 0.3% to 0.25%.

In addition to the aforementioned, it was also decided to extend the program of "quantitative easing", so that starting from April 2016, each month the ECB will purchase 80 billion euros of government securities, debt securities issued by local territorial-political units and regions, but also the bonds of non-banking corporations which have headquarters in the euro zone. It was decided that starting in June 2016 the ECB will offer four targeted long-term refinancing operations (targeted longer-term refinancing operations - TLTRO II) with a maturity of four years. The interest rate for these operations may be as low as that on deposit benefits. [165] The continued unprecedented expansionary monetary policy of the ECB in 2016 is directly related to its estimates that the price of crude oil on the world market will remain on a low level for a longer period - US$ 34.9 per barrel in 2016, 41.2 US$ in 2017 and US$ 44.9 in 2018. [166]

By increasing the monthly purchases of various types of financial assets from EUR 20 to EUR 80 billion per month, the ECB's projected expansion of the balance sum from 2007 will be increased by over 20 percentage points of the GDP in the euro zone. As presented in Figure 2, at the end of December 2017 it will exceed the levels of the US Fed and the Bank of England (BoE).

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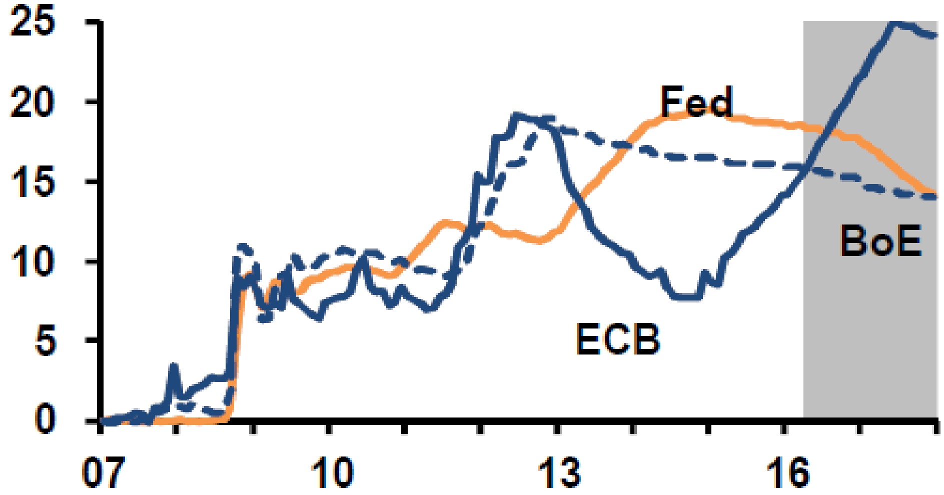
[164] ECB (2016). *ECB staff macroeconomic projections for the euro area*, Frankfurt: European Central Bank, March, p. 1. https://www.ecb.europa.eu/pub/pdf/other/ecb staffprojections201603.en.pdf?b04a09832bebde6edaa77 98807a7ea28, 17.3.2016.

[165] https://www.ecb.europa.eu/press/pr/date/2016/html/pr160310.en.html, 14.3.2016.

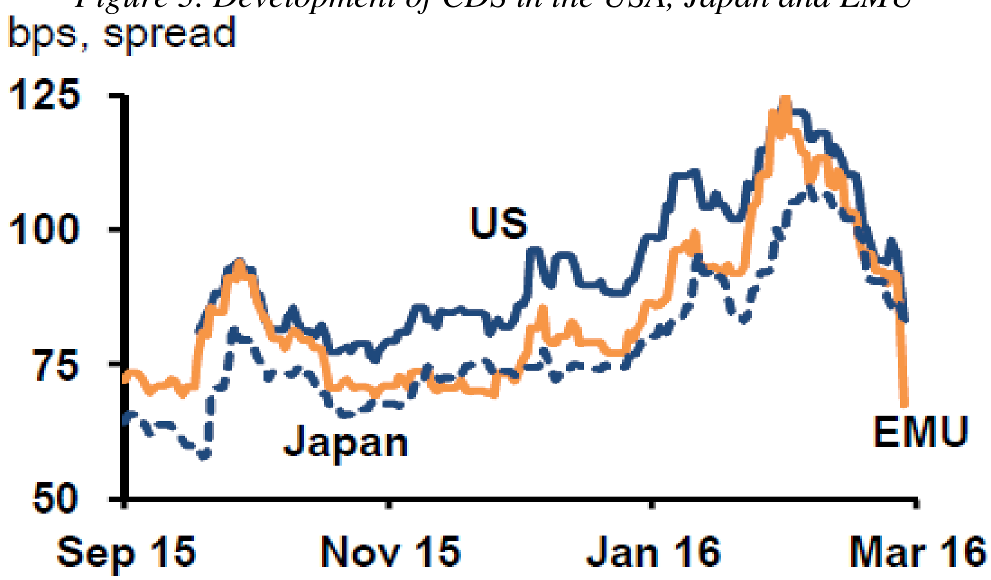
[166] ECB (2016). *op. cit.*, p. 3.

Figure 2. Development of central bank balance sheet since January 2007 and projection until December 2017 (in percentage points of GDP)



Source: J.P. Morgan (2016). Economic Research, Global Data Watch. March 11, p. 1.

Figure 3. Development of CDS in the USA, Japan and EMU



Source: Ibid, p.1.

The introduction of purchasing bonds from non-bank corporations ranked in one of the four top categories (investment grade) as well the ECB's new measures, which in their nature will be limited and concentrated on France and Germany, had a strong influence on the movement of credit default swap spreads (Credit Default Swaps - CDS). As presented in Figure 2, CDS in the United States, Japan and the EMU recorded a sharp drop in the last part of 2016, with the most obvious decline in the EMU.

Considering the fact that the new TLTRO II program will favour banks taking loans from the ECB for a four year period, at a zero interest rate or potentially negative interest rate on deposit benefits (which currently stands at - 0.4%), the package of measures adopted in March 2016 could affect the increase of the ECB balance sum for an additional EUR 1,500 billion (which constitutes 14% of the GDP of the euro zone).[167]

The significant strengthening of the US currency in the medium term which was briefly halted, among other things, by the postponement of the next increase of the key interest rate by the Fed, probably until the second half of 2016, will increase the burden of servicing the foreign debts of those countries which make the biggest foreign exchange inflows in euros, and which failed to protect themselves from exchange rate differences. The further weakening of the Chinese yuan at the beginning of 2016, which is linked to a basket of currencies and no longer to the US dollar which was strengthening, and fractures on the stock exchange in China, where trade had to be temporarily suspended, show that a new currency war has begun despite the risk of the outbreak of a new global financial crisis. In 2015, the yuan depreciated by 4.7% against the USD, and the possibility of the further weakening of the Chinese currency, which the authorities may resort to in order to promote exports, is one of the risks that present a threat to the markets at the beginning of 2016. The Purchase Managers Index (PMI) shows that this is a permanent slowing down of the growth of the Chinese economy. In March 2015, it amounted to over 50.0, while at the end of February 2016 it was 49.0 (Figure 4).

Despite the fact that the Fed on one side, and the ECB and the Central Bank of Japan (BoJ) on the other, are in totally different positions in terms of the direction of monetary policy, there is no doubt that all three central banks are firmly linked through the behaviour of the USD exchange rate and the impact of the policy which they implement on the growth of the real GDP of the world economy. The Fed's decision to increase the key interest rate in response to the low unemployment rate and rapid growth of the real GDP in the US has resulted in a reduction of pressure on the ECB and the BoJ to implement a more expansionary monetary policy. On the other hand, the reduction of the ECB and the BoJ's interest rates to some extent limits the Fed through the strengthening of the dollar, in terms of the speed of the increase of key interest rates.

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[167] J.P. Morgan (2016). Economic Research, *Global Data Watch*. March 11, pp. 1-2.

Figure 4. Development of the Purchase Managers Index in Chine (31.3.2015-29.2.2016)

Source: http://www.bloomberg.com/quote/CPMINDX:IND, 4.3.2016.

Following the large fluctuations on the markets at the beginning of 2016, the general opinion is that the US economy is strong enough to withstand them. If the intensity of these fluctuations remains on the same level as in the first two months of 2016, they could affect the drop of the growth rate of the US's real GDP by 20-40 basis points. In addition, according to the forecasts of researchers from Bank of America Merrill Lynch in New York, the growth rate of the real GDP will amount to 2% in 2016 in comparison with the previous year.[168] All this supports the thesis that the delay in the further increase of the Fed's key interest rates is short-lived. The latest information that the unemployment rate in the US economy has been reduced to only 4.9% provides the basis for the claim made by some of the Fed's officials, such as the vice-president Stanley Fischer, that it is time to increase interest rates in order to keep price growth under control. This increase should take place soon and at a slow tempo in order to curb inflation. Sticking to Phillips curve as the macroeconomic framework, Fischer warns of the following:[169]

[168] Weil, D. (2016). Market Volatility May Bring Pain but Not Recession. *Institutional Investor*, February 29, http://www.institutionalinvestor.com/Article.aspx?ArticleID=3533442, 9.3.2016.

[169] Szustek, A. (2016). Fed Vice Chair Stanley Fischer Shares His Inflation Fears. *Institutional Investor*, March 21, http://www.institutionalinvestor.com/article/3539399/asset-management-macro/fed-vice-chair-stanley-fischer-shares-his-inflation-fears. htm, 23.3.2016.

"A persistent large overshot of our employment mandate would risk an undesirable rise in inflation that might require a relatively abrupt policy tightening which could inadvertently push the economy into recession… Monetary policy should aim to avoid such risks and keep the expansion in sustainable trek."

The sooner monetary policy is "normalized", not only in the US but also in other developed industrial countries, the easier it will be to manage because it will be designed and implemented in the zone of positive, and not negative interest rates, as is the case now.[170] The role of interest rates in the transmission mechanism of monetary policy will return to what it was before the outbreak of the global financial crisis.

After the meeting between the finance ministers and central bank governors of the G20 countries in Beijing at the end of February 2016, Chinese Premier Li Keqiang announced a series of initiatives for implementing stimulus measures in order to maintain the growth of the Chinese economy in 2016. Under considerable pressure from the IMF and the G20, he wanted to send a reassuring signal to the world markets at the beginning of March 2016. The new measures include:

- Investment in the infrastructure during 2016 in the amount of USD 245 billion;
- A reduction in the compulsory bank reserves ratio with the central bank;
- A reduction in cash deposit requirements for mortgage approvals; the extension of the reduction of value added tax to encompass all industry branches.

These measures which are backed by the new growth model based on the expansion of domestic consumption, will increase the share of the state budget deficit in the GDP from 2.3% to 3% (according to official statistics), which will be the highest level since 1949. A lower target zone for the growth rate of the real GDP of 6.5 -7%[171] was established for 2016. In any case, the stabilization of the growth of the Chinese economy is a precondition for the stabilization of

[170] Compare with: Fischer, S. (2016). Reflection on Macroeconomics Then and Now. In: *Policy Challenges in a Interconnected World*, 32nd Annual National Association for Business Economics Economic Policy Conference, Washington, DC, http:// www. federal reserve.gov/newsevents/speech/fischer20160307a.htm, 22.03.2016.

[171] Cheng, T.A. (2016). To Congress, China's Li Keqiang Emphasizes Need to Sustain Growth. I*nstitutional Investor*, March 07, http://www.institutionalinvestor.com/ article/3535633/, 9.3.2016.

the yuan exchange rate, which is a key factor in limiting the outflow of capital from China[172] and a further reduction of its foreign exchange reserves.

2. POSSIBLE EFFECTS ON SERBIA'S LEVEL OF PUBLIC DEBT AND INTEREST RATES ON LOANS

The continuation of the drop in interest rates in the euro zone will have the most significant positive effect on the economy in Serbia in 2016 and 2017:

- First, the cost of the new state debt will decrease due to both the new issue of government securities denominated in euros as well as that denominated in dinars.
- Second, a further reduction in interest rates on new bank loans for the household sector and the sector of non-financial legal entities will follow.

Thanks to the fall in interest rates in the euro zone, the government was able to borrow on the domestic market by issuing bonds (22nd March 2016) with a maturity of five years in the amount of 75.0 million euros at a nominal interest rate of only 2.5%. For the same bonds that were issued at the end of October 2015 (an issue of 50.0 million euros) the nominal interest rate was 3.0%, and for those issued in March 2015 (an issue of 100.0 million euros) 4.0%.

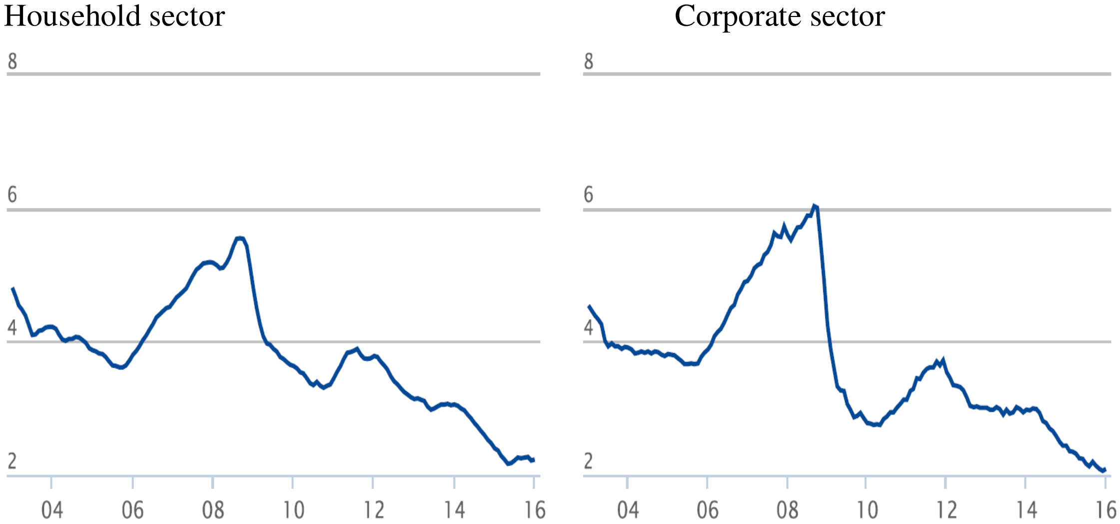
As regards the tempo of the reduction of interest rates on loans in Serbia over the last year and the beginning of 2016, it is noticeably slower than that of the reduction of interest rates for deposits and savings. From January 2015 until January 2016 the average cost of dinar, non-indexed loans to citizens fell from 18.34% to 12.07%. A more rapid fall was recorded for the cost of such loans in the sector of non-financial, legal entities from 10.94% to 5.92% respectively. As for household loans in foreign currencies and dinars, indexed in foreign currencies, interest rates recorded a slight drop from 6.83% to 5.36%. There was a similar trend with the interest rates on these loans in the sector of non-financial legal entities - a fall from 4.41% to 4.04%, respectively. In contrast, the representative interest rate on term deposits for the household sector, in dinars and indexed in foreign currencies and in foreign currencies, with

[172] The capital outflow was mostly generated from loans which Chinese companies took from foreign investors until the middle of 2014 and the outflow of assets from the household sector which suddenly increased in the second half of 2015 because of the expectation of the further devaluation of the yuan after August 2015.

maturities up to 12 months, fell from 1.20% in January 2015 to only 0.69% in January 2016, which is almost on the same level as in the euro zone - 0.64%.

Figure 5. Composite cost for new loans from banks in the euro zone (January 2003 – January 2016)

(in %)



Source: ECB, https://www.euro-area-statistics.org/bank-interest-rates-loans?cr=eur&cr1=eur&lg=en&page=2, 4.3.2016.

As can be seen in Figure 5, after the long-term downward trend, in January 2016 the composite cost for new loans from banks in the euro zone for the household sector (for house purchases) was only 2.23%, while in the corporate sector it was 2.09%.

In January 2016 the interest rate on consumer loans up to 12 months for the household sector in the euro zone stood at 5.31% and 5.42% for those with a maturity of 12 to a maximum of 60 months. For mortgages with an initial fixed period of over 10 years, the interest rate was only 2.41%.[173]

The most significant negative effect of the ECB and the Fed's divergent key interest rate trends on the Serbian economy in 2016 and the coming years will be the further strengthening of the dollar against the euro. This is due to the increased burden of servicing one third of Serbia's public debt, which is denominated in US currency. This effect could be mitigated by the announced new long-term loan in dollars from the United Arab Emirates. In this way,

[173] Sources: ECB, *Press release*, 2 March 2016, https://www.ecb.europa.eu/press/pdf/mfi/mir1603.pdf; NBS, http://www.nbs.rs/internet/cirilica/80/index.html, 15.3.2016.

however, the burden of exchange rate differences only moves to the medium and long term, when the time will come to pay off this loan.

The Government and NBS have responded indolently to my proposal presented at the meetings of the Scientific Society of Economists of Serbia in December 2014 and December 2015 to sit with foreign investors and negotiate the restructuring of foreign debt because of the strengthening of the dollar.[174] This proposal was feasible because before the announcement of early parliamentary elections the governing party had an absolute majority in parliament. It could have quickly adopted an agreement with creditors in the public interest and reduced the debt burden for future generations.

Due to the great risk of new fractures on the financial markets as a result of the position of over-indebted euro zone member countries such as Italy, whose debt to GDP ratio has reached the level of Greece in 2009, as well as possible changes to the entire architecture of the euro zone, the sudden ride of the dollar cannot be ruled out. In addition, investors' pursuit of higher yields, which they will be able to obtain in the United States in 2016 and subsequent years, will further serve to strengthen the dollar against the euro.

The intensity of the differences in the positions of certain euro zone country members, in terms of the perception of investors on the market, can be best seen from Figure 6 which shows the movement of Bloomberg's index of government bonds with a maturity of 10 years for Germany, Greece, Italy, Spain and Portugal, and Figure 7, which shows the yields on long-term government bonds with a maturity of 10 years in January 2016.[175] The drastic deviation of Greece in terms of income for long-term bonds demanded by investors is visible in both cases.

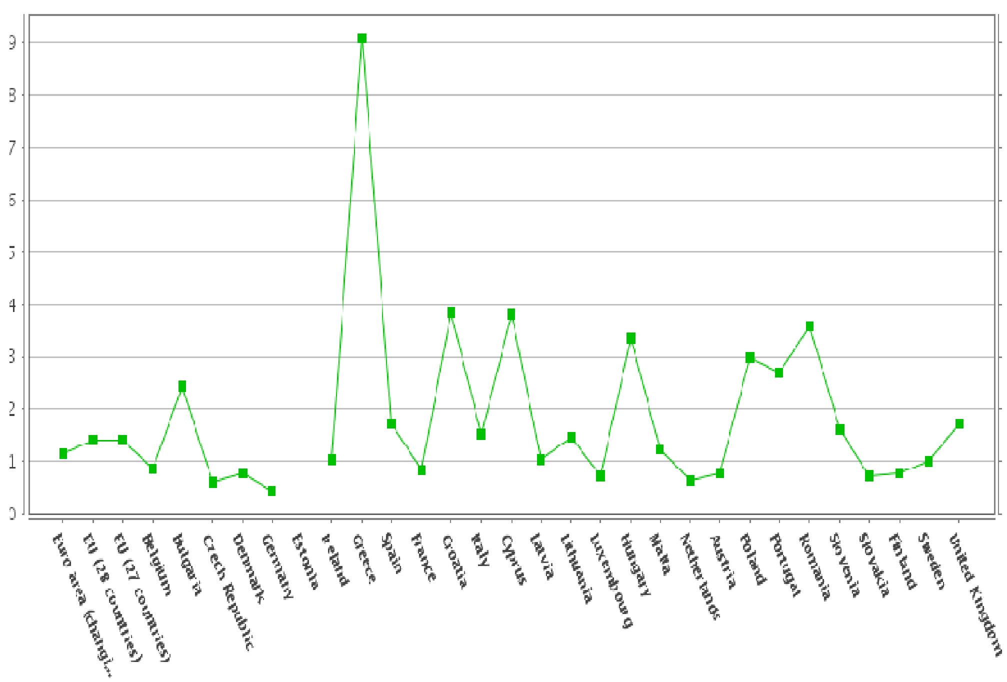
[174] See: Đukić, Đ. (2016). Kretanje kamatnih stopa u zoni evra i efekti na privredu Srbije. *Ekonomska politika Srbije u 2016. godini*, Šoškić, D., Arsić, M. (eds.), Belgrade: Serbian Scientific Society of Economists with the Academy of Economic Sciences and the Faculty of Economics in Belgrade, pp. 413-414.

[175] For difference in fundamentals in Eurozone members see: Baber, A., Brandt, M.W., Luis, M. (2014). Eurozone Sovereign Yield Spreads and Diverging Economic Fundamentals. *Working Paper,* June, https://faculty.fuqua.duke.edu/~mbrandt/papers/working/eurospreads.pdf, 4.3.2016; Fontana, A., Scheicher, M. (2010). Analysis of Euro Area Sovereign CDS and their Relation with Government Bonds. *ECB Working Paper Series*, No. 1271, December, https://www.ecb.europa.eu/pub/pdf/scpwps/ ecbwp 1271.pdf?679eaae7fe76ff71f896b1b7c26b8032, 4.3.2016.

Figure 6. Bloomberg's index of government bonds with a maturity of 10 years for Germany, Greece, Italy, Spain and Portugal (4.3.2011-3.3.2016)

Source: Bloomberg, http://www.bloomberg.com/quote/BGER:IND, 4.3.2016.

Figure 7. Yields on long-term government bonds with a maturity of 10 years in January 2016



Source: European Central Bank, Eurostat, http://ec.europa.eu/eurostat/tgm/graph, 4.3.2016.

At the beginning of 2016 it was clear that the fluctuations in the euro exchange rate against the dollar in 2016 could be greater than in the previous year, if the ECB was forced to encourage the growth of economic activity and prevent re-entry into the deflation zone by means of new aggressive measures thus weakening the European currency. The nervousness of investors and the weakening of the dollar against the euro in early 2016, despite the expansionary monetary policy of the ECB, may be misleading. A possible reason for this lies in the restructuring of the Chinese Central Bank's portfolio of government securities in favour of securities denominated in euros and the Japanese yen at the expense of those denominated in dollars.

3. POSSIBLE EFFECTS ON THE DINAR EXCHANGE RATE

The dinar is likely to weaken insignificantly against the euro until the establishment of the government after the early parliamentary elections in Serbia, due to the NBS's highest reference interest rate in relation to the interest rates of the Central Banks of the countries in the region, which the NBS will not be allowed to reduce, and because of the NBS's manifest willingness to intervene on the foreign exchange market whenever needed in order to stabilize the dinar exchange rate. While the NBS is not allowed to reduce the reference interest rate from the current 4.25% at a time when the rate of inflation (1.5%) is well below the target (4.0 +/- 1.5%) in the function of stabilizing the dinar exchange rate, the central banks of Central and Eastern Europe, which apply the concept of inflation targeting, reduced their benchmark interest rates more rapidly. The National Bank of Hungary lowered its key interest rate (22 March) by 15 basis points to 1.2%, while the interest rate on deposit facilities was reduced to 0.05%. For a long period the key interest rate of the central bank in the Czech Republic has stood at the level of 0.05%, in Poland 1.50% and in Romania 1.75%.[176]

Investors in government bonds denominated in euros in Serbia earn interest which cannot be achieved in other countries in the region, therefore they will probably continue with their purchases. Domestic banks will continue to direct the excess liquidity in the euro mainly to the purchase of government securities. This will further impact on the stabilization of the dinar against the euro until the establishment of the new government, and afterwards the evaluation of the

[176] Sources: http://dailynewshungary.com/the-national-bank-of-hungary-cuts-key-rate-by-15-bp/; https://www.cnb.cz/en/; http://www.centralbanking.com/tag/national-bank-of-poland; http://www.centralbanking.com/tag/national-bank-of-romania, 28.3.2016.

fourth revision of Serbia's arrangement with the IMF. In fact, the function of the dinar exchange rate policy is to protect the debtor from a wave of bankruptcies, and is the consequence of the wrong choice of exchange rate regime before the outbreak of the global financial crisis. If the NBS had implemented the freely floating exchange rate regime since 2000, which I have continually advocated, citizens, companies and countries would not have fallen into debt so easily, but would have been afraid of taking out new loans indexed in foreign currencies because of the possible rapid depreciation of the dinar and the inability to pay them off.[177]

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[177] For arguments in favour of the introduction of the freely floating exchange rate regime instead of the current "dirty fluctuating exchange rate", see: Đukić, Đ. (2014). Institucionalni aspekt monetarne politike i privredni razvoj. In: *Moguće strategije razvoja Srbije*. Ocić, Č. (ed.), Book XIII, Belgrade: Serbian Academy of Sciences and Arts, pp. 500-503.

Chapter 9.

EVALUATION AND MANAGEMENT OF INTEREST RATE RISK OF BANKS (SOME MODELS)

Management in banks should be understood as a process that is closely connected with the creation of profit in the bank, and therefore all efforts of bank managers are aimed at maximizing this objective. The term bank manager refers to expert who in addition to banking techniques perform business activities related to:

(a) planning of bank's operations,
(b) making business decisions,
(c) execution control of decisions in the bank.

On the other hand the dynamic expansion of investment banking in modern conditions significantly affected the expansion of the range of risks to which banks are exposed in their operations. Regardless of whether they operate on domestic or international financial markets, this risk is equally present and therefore not inconsiderable. To this undoubtedly led many innovations in financial markets, globalization and internationalization of financial flows, the rapid growth of technology and the expansion of international economic and trade flows, which inevitably follows the development of financial instruments. Another factor that is important is the emergence of non-banking organizations that offer the same services as banks, so the competition is more pronounced. Therefore, before the management of the bank in terms of development of new banking products raises an issue of efficient risk management in banking. This not at all simple, but on the contrary, complex and demanding problem, is the key to resolving the issue of achieving optimal conception of a banking business.

1. THE CONCEPT OF STRATEGIC MANAGEMENT OF THE BANK

Management presents a combination of areas: business policy, management methods and people who make a decisions and exercise control necessary for the implementation of business objectives in achieving this stability and growth of the bank[178]. Formulation of business policy requires an analysis of all the factors that have a short-term and long-term impact on the achievement of the bank's profit. Managing bank business system is based on three key interrelated systems relating to: (1) control system, (2) operating system, (3) information system. The control system of the bank includes elements of business planning and processes of banking operations, organizing and carrying out the tasks in the bank, as well as control of performance of bank's achieved results. The operating system of the bank includes professional, qualitative and quantitative performance of activities or tasks that have the objective of generating income and expenditure, with the aim of making a profit. The information system is an integral part of the bank's business system and does not constitute a purpose for itself, but should meet the specific needs for information and support the control and operating system of the bank.[179]

The essence of the activities of the bank as a business system refers to the cash transactions expressed through deposit and credit functions of a particular bank. The bank should operate positive respecting two very important business principles: safety and liquidity underlined by the trust and its solvency. The bank's strategy can be defined as a planned decision to direct the business activity of a bank towards achieving set goals. The strategy may refer to the achievement of the primary goals of the bank and the realization of partial, i.e. individual business goals of the bank. A typical example of such a strategy is:

(1) bank marketing strategy,
(2) bank capital price (interest rates) strategy,
(3) strategy of banking products and services quality,
(4) strategy of the use of human potentials in the bank.

The bank's strategy represents a vision, or a framework in which the nature and course of action of a particular bank is determined. The strategy is usually: what the bank wants to be, how it operates, which way to go according to where it wants to arrive.

The bank's strategy should have two key dimensions, namely: operational and strategic dimensions of the bank. The operational dimension refers to the internal efficiency, or that the bank "does things the right way" and that performs rationally. The strategic dimension means that the bank is "doing the right things" and to be effective in the financial market (offers banking products

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[178] Downes, J., Goodman, J.E. (1997). *Dictionary of Finance and Investment Terms*. New York: *Barrons Financial Guides*, p. 240.

[179] Cummins, J.D., Mahul, O. (2009). *Catastrophe Risk Financing in Developing Countries: Principles for Public Intervention.* Washington, D.C.: World Bank, p. 7.

and services that have mobility in the financial markets and bring profit to the bank). Due to the above mentioned reasons for the bank is very important the relationship between strategy and operations. The bank's strategy is "what is done in the bank", and operational strategy is "which way the things are done in a bank."

2. RISK MANAGEMENT IN THE BANK

The risks in banking are the characteristic of each banking business, so even neutral banking transactions are not without risk, and with the conquest of new instruments, new strategies and techniques, financial engineering, new banking products and in particular financial derivatives, the list of risks is constantly expanding.

For bankers and lenders in general, the uncertainty increases with changes in interest rates, changes in deposits and the inability of the borrower to repay the loan, but also under the influence of such factors as deregulation, moral hazard, as well as the entry of banks in operations that previously weren't part of traditional banking. Thereby, the globalization of banking operations and trends of mega integrations and acquisitions of major banks instincts bank management to identify the most important risks. This applies primarily to systemic risks, and in particular to the risks arising from the lag in monitoring the management of the banking business in the unknown, geographically remote areas and markets and to monitor business with unfamiliar instruments and techniques. Risk management can be defined as a bank's function in risk insurance, i.e. under the risk management a set of activities are implied:

1. identification of risk exposure for all categories of assets, with the estimate of potential losses;
2. the risk assessment that includes measurement and analysis of losses in the past to assess the variables that will influence the future;
3. risk control, in terms of reducing or eliminating the risk of loss by applying all kinds of security;
4. financing risks by ensuring reserves, including insurance;
5. development of administrative techniques and use of expertise (risk management).

The main objective of risk management in banking is to optimize relations (trade-off) between risk and return. In this sense, the focus of banking risk is management of credit and market risks, of which crucially depends the risk of solvency as a definite risk of banks. Interest rate and currency risks as integral components fit into market risk, while aside remains the liquidity risk as specific banking risk by which modern banks, ultimately, can manage through the financial markets, provided they have a strong solvency position and high credibility. Finally, there are various non-financial (operational) risks, such as risks to the payment system, the computer and other technological risks, legal risks, and so on.

Risk management in the banking industry has two main goals. The first objective is to avoid the insolvency of a bank; a second objective is to maximize the risk-adjusted rate of return on capital - RAROC). Namely, if the risks of the bank were undervalued it would have a negative effect on the profitability of banks, as the actual losses would brought down the rate of return on equity below the expected level. The modern concept of central banking risk management has the following components:

1. adequate evaluation of credit and market risks,
2. billing price of risk by the appropriate banking services,
3. extracting the charged risk prices into reserves and capital of bank,
4. covering expected risks from the bank's share capital,
5. covering unexpected risks from the share capital,
6. formation of the bank's economic capital adjusted for risk (risk based capital)
7. managing risk portfolio,
8. monitoring (control) of risk by foreign special services in the bank.

The management of banking risks can be qualitative and quantitative. Qualitative risk management is based on empirical estimates of bank experts, and it is especially important for those risk factors that cannot be quantified. However, concerning the risk factors that can be quantified, general trend in the banking industry include increasing use of quantitative methods of risk management.

Quantitative assessment of banking risks for the basic approach has the assessment of the average amount of the loss, and the rate of loss dispersion trend values. The maximum amount of loss for the bank is determined by three factors[180]:

- the amount of exposure to loss,
- standard deviation,
- selected level of tolerance.

[180] Petrović, P., Živković, A. (2011). *Marketing u bankarskoj industriji*, Belgrade: Čigoja štampa, p. 67.

Value at risk (VAR or VaR) is the maximum loss that may occur in a given tolerance level. Tolerance level implies the probability of losses exceeding mathematically projected limit. If the level of tolerance is, for example 5%, this means that the calculated value at risk applies for 95% of cases, but, according to the science of probability in 5% of cases would be breached.

So, VAR is the value of all the risks that bank takes, i.e. the maximum potential loss that the bank may have in its operations and that can only be exceeded in a small and precisely defined percentage of all possible cases, and that percentage of probability, which is not covered by accepted VAR is called the tolerance level. The value of VAR can be calculated at all levels of business banks (at the level of each business unit and the entire bank), as well as by groups operating business transactions. The meaning the quantitative determination of VAR is to ensure an adequate level of quantitative economic capital of the bank, and capital at risk (CAR or CaR). Accordingly banking risk management boils down to calculating the amount of VAR, to determine on that basis adequate level of CAR. In doing so, the CAR is treated as the ultimate protection of banks from insolvency. CAR is the amount of capital required for a bank to cover in advance most of the potential losses in the future and it, unlike the VAR can be calculated only on the level of banks, i.e. the portfolio level (VAR bank level is the same as CAR). If CAR is 100 units at the level of tolerance of 1% that means that an unexpected losses will not exceed 100 units in 99%. Level of tolerance is a matter of choice of a bank management. Values VAR and CAR should be continuously adjusted in the dynamic functioning of the bank. If it is assumed that the level of risk is given size, then it should come to an appropriate adjustment of the value of CAR. For example, if the level of risk in general increases (VAR is increasing), then CAR must be increased (for example, by increasing margins and fees). Conversely, if it is estimated that the capital level is given size, then the imbalance between the CAR and VAR should be corrected on the side of risk (for example, changes in the structure of investments in order to reduce the share of deposits with higher rates of risk).[181]

Unlike traditional commercial banking, powerful explosion of investment banking in modern conditions significantly affected the expansion of the range of risks that banks are exposed to in their operations, provided that this applies primarily to banks that operate globally, i.e. not only in the domestic financial market, but also in the international financial market.

[181] Kapor, P. (2005). *Bankarstvo sa osnovama bankarskog poslovanja i međunarodnim bankarstvom.* Belgrade: Megatrend University, p. 125.

In addition to these basic categories of banking risks there are a number of risks that are manifested in the banking business, to a greater or lesser extent, and can be classified into one of these categories.

In any case, everything speaks in favor that banks need to move away from defensive or reactive perceptions of risk, by which one measures the risk that would primarily meet regulatory requirements and to avoid losses and to turn to the offensive proactive stance, according to which the risks are actively managed at the bank, in order to efficiently use capital and achieving high profits.

3. RATIO ANALYSIS IN THE BANK

Ratio analysis of the bank's income statement should be viewed via the sources of income generation of expenditure of the bank. The difference between interest incomes and interest expenses represents net interest income, i.e. interest margin. If the interest margin is reduced by the amount of provisions for credit losses (distressed assets) the result is net interest income after reservations (productive assets). This income can be used for coverage of general expenses of the bank. Non-interest income includes incomes from fees, commissions, rental of safe deposit boxes, cashing travelers' checks, revenue from travel insurance and the like. Non-interest expenses include expenses for wages and employee benefits, as well as rental costs, operating costs (administrative fees, insurance, and procurement of office supplies) and the like. The difference between interest income and non-interest expenses is called net non-interest expenses and net general expenses of the bank. If from the net interest income after provision is deducted net non-interest expenses, then their difference represents net income (profit) before tax. If from these net incomes (profit) are subtracted taxes, then is obtained a net income (profit) after tax.

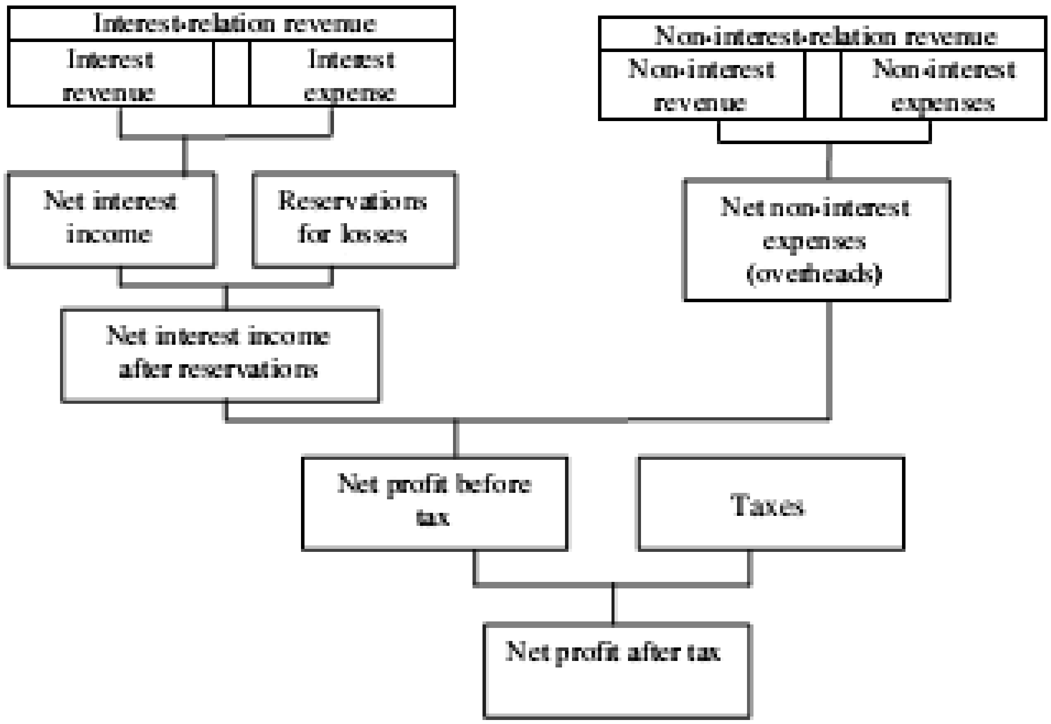
Banking analysts can based on categories such as interest income, non-interest expenses, net income (profit) before and after taxation, rapidly draw a conclusion about general performances of banking institutions.

Ratio analysis in bank comprises a larger number of assumptions, including in particular the following assumptions:

(1) a summary analysis of the bank's operations,
(2) an analysis of the bank's management team,
(3) analysis of the structure of bank's assets,
(4) analysis of the structure of liabilities of the bank,
(5) analysis of the bank's share capital,

(6) analysis of income (profit) of the bank,
(7) open issues regarding the analysis of the bank's operations.

Figure 1. The flow of interest and non-interest incomes of the bank



Source: Austin, D.V., Hakala, D.R., Scampini, T.J. (1999). Modern Banking, Rolling Meadows: Bankers Publishing Company, Bask Administration Institute, p. 80.

Resume of ratio analysis of bank must be clear, concise, short and user-friendly to management team in bank. Ratio analysis of the management team of the bank refers to the assessment of the quality of engagement managers, their position in decision-making and control, their position in relation to the bank's financial policy and risk management process of the bank. For the management team of the bank can be said to be successful if value of the share capital is rising. Ratio analysis of the structure of bank assets is focused on liquidity ratio of bank funds, the maturity structure of assets, the structure of the loan portfolio and the portfolio of securities.

4. THE PRESENCE OF INTEREST RATE RISKS IN THE BANKING BUSINESS

Reduction in profits due to changes in interest rates represents the interest rate risk for the bank. The bank's exposure to this type of risk arises from the fact that most of their balance sheet items generate income and expenses which are harmonized with interest rates. The interest rate changes in assets and liabilities affect the amount of interest margin in a positive or negative direction. For example, a bank which approved a loan to a customer at a variable interest rate (related to market interest rate) is at risk to achieve the revenue decline in the event of a drop in market interest rates. Conversely, the client will have higher costs (and a bank higher income) if there is a jump in market interest rates. On the other hand, interest rate risk arises from the incomplete work of synchronization of changes in interest rates on the assets and liabilities of banks, whereby banks often grant loans with longer terms in relation to deadlines funds. Therefore, the increase in market interest rates quickly affects the adjustment of the interest rates bank must pay on sources of funds compared to the adjustment of interest rates on loans.

As a striking example of poor management of interest rate risk is stated the business of savings and credit institutions in the US during the 70's. These institutions have formed their liabilities based on short-term deposits with variable interest rate, while on the other side (assets) have been concentrating large amounts of long-term loans (mainly mortgages) at a fixed interest rate. Due to the sudden rise in interest rates at the beginning of the 80s of the last century, these institutions have been exposed to a large interest rate risk, as the interest that they had to pay on deposits went beyond the income from interest on loans, which led to the collapse of many of these institutions and high costs for compensation of citizens through FIDC.[182] The basic measure of interest rate risk represents the ratio between assets sensitive to changing interest rates and liabilities items sensitive to changing interest rates. This ratio reflects the bank's readiness to accept risk in forecasting future movements in market interest rates, particularly in periods of fluctuations in market interest rates. If there is a decline in interest rates, and the bank has indicated coefficient greater than 1, its revenues will decrease, and in the case of a jump in interest rates, they will rise. In order to minimize exposure to the interest rate risk, and because of the difficulty in predicting future trends in interest rates, some banks have resorted restructuring balance sheet assets and liabilities sensitive to interest rates, so that the coefficient of sensitivity to interest rate tends to unity. This is not easily achieved in certain cases.

Interest rate risk has basically two forms:

1. the risk of base, which is used to determine the interest rates when the bases which determine interest rates on loans and obligations are different,

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[182] FIDC - Federal Deposit Insurance Corporation.

2. risk of timing mismatches in which there is change in interest rate (as a result of various deadlines for contracted specified interest rates or periods in which under the influence of a base change comes to a change in interest rate).

5. MODELS OF ASSESSMENT AND MANAGEMENT OF INTEREST RATE RISK

Nowadays, the banks are implementing three assessment models of interest rate risk:

1. model of reassessing the value or revaluation model (repricing model)
2. maturity model and
3. duration model.

Revaluation model comes from maturity imbalance positions on the assets and liabilities of the bank, bearing in mind that these sizes can be revalued in the forthcoming period due to changes in interest rates. This only concerns interest rates on assets and liabilities that by contract should be revised in successive periods, taking into account changes in interest rates on the financial market. All assets and liabilities are structured into segments according to the criteria of audits maturity interest rates, for example, interest rates from one day to three months, from three to six months, from six to twelve months, and so on. Within each maturity segment is being calculated the amount of assets and liabilities of the bank and the amount of imbalance with positive and negative sign, and on that basis the bank calculates for each segment the effect of changes in interest rates on interest margin.

Maturity model is better than the models for understanding the effects of interest rate changes on the balance sheet position of the bank. This model is based on the change in market value of the assets and liabilities of banks (especially bonds) arising from changes in interest rates. Here, the assets and liabilities of banks (securities) are not valorized at carrying (historical) prices, but at market prices, which can be applied to loans as long as there is secondary loan market. Into this model is embedded the principle that an increase in interest rates reduces the market value of the assets and liabilities of the bank, while the fall in interest rates increases the market value of banking assets and liabilities. At the same time there is a principle that the length of the maturity of assets and liabilities affects the change of market assets and liabilities of banks. If the maturity of the assets is longer than the maturity of liabilities of the bank, with the rise in interest rates, the market value of the assets falls more than the market value of liabilities. Since the value of the assets and liabilities of banks balances through the economic value of a bank's capital, a negative effect on the change in the market value of assets and liabilities must be offset by reducing the value of the bank's share capital.

Duration model measures the weighted average time of maturity of assets and liabilities through the use of the relative value of current cash flows as weights. This model emphasizes the timing of cash terms of loans and deposits.

As a technique of managing assets and liabilities of the bank, gap analysis has long been used in the exposure to interest rate risk, provided that it is often used in combination with other techniques. Using word gap in this context implies the difference between assets sensitive to interest rate and liabilities sensitive to interest rate, for a predefined maturity interval of assets and liabilities. When applying the gap analysis in the management of interest rate risk, banks must follow certain procedures:

- gather all the liabilities items to arrive at the total liabilities in each group of defined maturity intervals;
- gather all asset in order to reach the total assets in each group of defined maturity intervals;
- deduct from total assets total liabilities for each group of defined maturity intervals, correcting it for amount of gaps at the off-balance sheet items; gaps for off-balance sheet items are calculated in the same manner as for balance sheet items;
- gather all the gaps for certain groups of defined maturity intervals in order to obtain the cumulative gap;
- assign the cumulative gap to total assets to obtain the percentage share of the cumulative gap in total assets.

The gap may have:

- a positive value, when the assets sensitive to interest rate are exceeding liabilities sensitive to interest rate, and
- a negative value when the liabilities sensitive to interest rates are higher than the assets sensitive to interest rates.

In this connection, the gap coefficient is calculated when the ratio consists of: assets sensitive to interest rate and liabilities sensitive to interest rates. Only in ideal case the gap ratio has a value of 1, when the sensitivity of assets and liabilities sensitivity are aligned. If a bank has a coefficient of gap greater than 1, the increase in interest rates will cause a larger rise in yields on the assets of the bank in relation to the cost of mobilization of funds, since higher interest rates as well as higher prices, are being charged primary in the assets and than in liabilities items; and vice versa, if the gap ratio is less than 1, the decline in interest rates will result in reduced yields.

In banking business in countries where operate developed financial markets, the settled rule is that a negative gap of more than 10% compared to assets is considered the initial high value indicating that this position should be subjected to detailed analysis.

Benefits of gap analysis are:
• ease of application,
• relation with the accounting systems,
• makes acceptable and convenient indicator for banks with relatively simple balance sheet,
• meets the standards and requirements of regulatory authorities.

Disadvantages and limitations of the gap analysis are that this analysis is a static method and therefore ignores temporal mismatch between assets and liabilities.
In order to benefit from the advantages of a gap analysis in the management of interest rate risk, it is considered the best is to combine this model with an analysis of the duration and the simulation analysis.

Unlike gap analysis that emphasizes the carrying value of assets and liabilities from the balance sheet of banks, the duration analysis emphasizes their market value. Analysis of duration allows for the possibility that in the given items of assets or liabilities, exist differences between their average lifetime and their maturity. By the analysis of the duration of the application in risk management, for the first time was achieved in bonds with a coupon (payable at the end of the year), because in these types of securities the period of duration is shorter than the period at the end of which the last coupon is paid.

Synthesized expression of the bank's exposure to interest rate risk in the expression of duration gap (DG) is obtained through the relation:

$$DG = \text{duration of assets} - \left(\text{duration of liabilities} \times \frac{\text{duration of liabilities value}}{\text{duration of assets value}}\right)$$

Resulting value of gap duration for a given part of the bank's balance sheet will be equal to zero only if the duration of the selected items of assets and liabilities is in line. As for the size of gap duration for which defines BNAK in asset and liability management, it is in direct proportion to the degree of reliability of the forecasts by the bank on the future path of interest rates. Method of simulation analysis has been used as a part of asset and liability management (ALM) [183] to establish possible effects on the risk and return of the bank, through selected variety of scenarios in which levels of interest rates are varying. Thereby, the expected return is defined as the probability of weighted average profitability which is characteristic for different scenarios, as measured by the interest income or net present value of the balance sheet (for selected scenarios conversion of all interest income and expenses is carried out, as well as conversion of all cash flows by using net present value). Simulation analysis is a dynamic concept whose results can be easily interpreted, with the precise scope of the dynamics of the cash flows, although the model can become outdated due to changes in the bank's operations or its environment and requires highly qualified personnel in the field of programming.

In any case, the bank's exposure to interest rate risk is determined by the strategy that the bank uses in terms of acceptance or rejection of entering into risky business.

In operational terms, the basic strategy of banks’ protection against interest rate risk consists in the revision of interest rates in the predetermined time intervals which typically amount to three or six months (rollover period). For bank is particularly important to periodically audit the interest rates on loans with longer periods in order to narrow imbalance between interest rates on loans and the interest rates on the sources of funds. In doing so, banks can use as a benchmark a benchmark interest rate, which is formed in the financial market (LIBOR or the interest rate on short-term government bonds).[184] To that base interest rate the bank adds interest margin, which is different for different classes of borrowers, according to the credit risk.

6. MONITORING AND RISK MANAGEMENT

For a bank management to be successful and to use adequate measures related to risk, it is necessary timely recognition of different types of risks that come from the environment or from inside the bank itself. Thus, one should pay attention to the risks coming from the environment and on the other to the risks arising from within the bank. Also, unlike the traditional approach that focuses

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[183] ALM - (short of *asset – liability management*) which includes the management of assets and liabilities.

[184] LIBOR - (*London Inter Bank Offered Rate*), this is proportionally the most famous reference rate in the international financial market.

on assets and liabilities of the bank's balance sheet, a modern approach includes management of risks arising from a wide range of off-balance sheet activities of banks. Thus, it is only possible to integrate risk management at the level of the bank as a whole. The necessity for this approach stems from the fact that the change of a single market parameter can have different effects on the balance and off-balance sheet positions of the bank. This should be borne in mind, because unlike the eventual losses in balance sheet positions of the bank, the losses recorded in the trade books directly affect the level of profits and capital. A risk known by the banking business are: credit, liquidity, payment, interest rate risk, foreign exchange or currency risk, country, market, operational risk.
Contemporary approach to the monitoring, analysis and management of banks risks have a number of procedural actions that need to be implemented in order to avoid the risk of various conditions that can pull away the bank from the positive business performance. Thus, under these activities we can indicate the following:

- identification,
- understanding,
- measurement,
- analyzing,
- management,
- reporting.

Risk identification involves timely identification of occurrence of risk of a harmful event which provides the management structure to get to know the facts about the same. Recognition or identification of intermittent or latent risks should be performed by operational service for monitoring risk status (employed in the credit department, loan officers, etc.).

Understanding the real danger of the occurrence of a risk situations and the necessity of recognizing them is a very important moment in the system and the risk management process. We are not only thinking at the understanding of risk as a real category in modern banking business, but also at understanding that bank employees and responsible ones for monitoring risk must find in the bank's management. This is one of the necessary conditions for overcoming or avoiding possible risk situations.

Measuring and analyzing risk represent the next major step in monitoring and risk management. For these purposes often is used gap analysis. Through gap analysis the Committee for asset and liability management in the bank gets an image of discrepancies in the total income of the bank.

Risk management in the bank is a complex job. Its complexity stems from a number of processes and actions that are necessary to establish and implement the banking organization. When it comes to operational risk, it is necessary to define the roles and responsibilities for its management, draw up analysis and a map of operational risks. All of this should be included in the program of operational risk management. When it comes to credit risks, it is essential to have ongoing insight into the functioning of the credit process whose flow can be directed through necessary management recommendations. Of immediate importance is the bank's credit policy, loan tracking system, establishing credit limits, establishing a framework for reporting, support for the implementation etc. If we keep in mind market risks it is necessary to define the key processes for managing those risks. This involves defining policies and procedures, as well as the roles and responsibilities of personnel. Measuring market risk can have a different methodology from the methodology of measuring other types of risk, so in that sense it should be determined.

Management reporting about possible risks, as they arise, or their successful / unsuccessful elimination presents the last stage within the given bank's activities in managing banking risks. But as banking risk management isn’t passive and doesn’t only have a role of the report recipient, it is also actively involved in the risk management process. This includes the development of strategic plans and policies for risk management and proposing them for adoption; implementation of strategic plans; implementation of an effective system of internal control of all risks that could jeopardize the fulfillment of the bank’s objectives; development and implementation of information systems that provide adequate disclosure of business risks.

It is common practice for banks to send their quarterly abridged financial statements relating to the status of assets, liabilities and equity. In this way we achieve continuity in transparent informing shareholders, correspondents and banks partners. Of particular importance is that the bank reports sent to partners at home and abroad, are compiled to be short, clear, concise and illustrative. Only by using appropriate methods and principles of risk management and in particular interest rate risk management, the bank can provide timely overview of problem of risk. In this sense, the appropriate instruments that stand out are: revaluation model, maturity model, and duration model. Optimum concept of the bank’s operations requires continuous monitoring and management of different types of risks that banks face in their business. The heterogeneity of risks and approaches to monitoring and managing the same, suggest the necessity to involve all relevant factors. They are primarily related to bank management and boards which have the greatest responsibility in this business. However, not a small significance have special departments, credit departments, officers and other employees in the prevention of risks and of implementing measures to eliminate them. This is the way the bank's objectives can be fully met, and a serious approach to each of these activities in the banking risk management (identification, understanding, measurement, analysis, management, reporting) leads to a reduction or complete elimination of risk.

Chapter 10.

THE INTERCONNECTEDNESS OF STATE SECURITIES' CREDIT RATING AND BANKING CRISIS

Economic history evidenced a strong link between sovereign default and banking crisis in both advanced and emerging economies. Although the latest crisis episode seems like an unprecedented one, as empirical evidences show, there were at least five sovereign debt crisis episodes in the 1800-2009 period and more than 12 banking crisis in each of the large financial center (UK, USA and France).[185] With the development of financial markets in smaller and poorer economies the frequency of banking crises increases.[186]

The latest sovereign debt crisis in Eurozone confirmed the historically long connectedness between banking and sovereign debt crisis. The banking crises preceded sovereign crises.

The first shock came from the so-called subprime mortgage market. The role of the credit rating agencies in this phase led to dramatically underestimated default risks. Conceptual error agencies made was splitting of the credit risk of original mortgage loans and asset backed security (ABS) that emerged through their securitization. The crisis in this market has led to a massive devaluation of mortgage backed securities (MBSs) and ABSs that were significant part of assets in large banks around the world. The principle "too big too fail" started massive government interventions.

The second phase of the process was the activation of default risk on large amounts of mortgage and related loans. Banks were forced to withdraw their placements from special purpose vehicles that they have created and to regain in their balance sheets non performing loans. This increased the need for public debt issuances and fastened its expansion. The role of rating agencies in this process was the disregarding of the credit risk of major borrowers of mortgage loans.

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[185] Reinhart, C.M., Rogoff, K.S. (2010). From Financial Crash to Debt Crisis. *NBER Working Paper* 15795, http://www.nber.org/papers/w15795, p. 10.

[186] The total sample includes 209 sovereign debt crises and 290 banking crises in different countries. See: Reinhart, C.M., Rogoff, K.S. (2010). From Financial Crash to Debt Crisis. *NBER Working Paper* 15795, www.nber.org/papers/w15795, p. 18.

The third phase of the process is the crisis of the public debt. Main reasons for expansion of public debt above the critical values are related to the consequences of the banking crisis. The role of rating agencies in this process is overvaluation of government bonds' credit risk. This type of behavior is obvious after the 2008 crisis. Until this breakpoint agencies had underestimated the public debts' credit risk. After that point the contrary behaviour started. Rating agencies have systematically reduced credit ratings of countries that were forced to intervene extensively in their banking sectors.

The main hypothesis of this chapter is a feedback effect: the banking crisis vs debt crisis may be amended by introduction of the third member – credit rating agencies. Their role in generating the crisis is almost certain: underestimation of credit risk, in ABSs and MBSs was visible and significant. Authors believe that this phenomenon is caused by changes in credit rating agencies' regulation during the 1970s, i.e. switching from the regime of unsolicited to solicited (required) rating. The effect of rating agencies on the public debt crisis has not been so far exactly proven in many papers. Although this relation is not easily visible authors assume that in this case too exists previously registered bias towards overestimation of credit risks of highly indebted countries. The main reason for formulating this hypothesis is the unchanged status of credit rating agencies which continue to strive to increase their income. With the expected reduction in price of government bonds their yield to maturity increases and consistently required return for investors.

Thus, information asymmetry and moral hazard of banking crisis (excessive risk exposure of deposits aimed at higher returns) is combined with the moral hazard of public debt (moving of present costs into the future), and both are amplified by the moral hazard behaviour of credit rating agencies.

1. INSTITUTIONAL CAUSES OF MORAL HAZARD BEHAVIOUR OF CREDIT RATING AGENCIES

1.1. Vague definition of the term rating and its binding use

Credit rating scores provided by different rating agencies are not fully comparable. Definitions vary from the statements that the rating assessment is the probability of default to the statement that rating is an opinion about the characteristics of the bond issuer or other borrower. The definition of Moody's Investors Service is the following: rating is the forward-looking opinion on relative credit worthiness of the particular security and it does not represent a recommendation to keep, buy or sell that security.[187] A similar definition is given by the Standard&Poor's: credit rating is the forward-looking opinion of the credit risk of an issuer or a security and is not an absolute measure of risk of default, given that future events can not be accurately predicted.[188]

Thus, rating is an opinion and not the obligation of any kind for the rating agency. The definition of credit rating as an 'opinion' is a source of moral hazard, especially for investors who do not have the possibility of forming their own 'opinion' on certain security or issuer. If investments are explicitly affected by rating agencies' 'opinions' then objectively those are recommendations. The proof for this statement can be found in the way those opinions are used. There is almost total dependence of banks on external ratings in the context of the so-called standardised approach as defined in the Basel II standard. In standardised approach the external rating is in fact the only possible and necessary condition for investment decisions. "Due to different risk weights, it is sometimes better not to have credit rating at all than to have a bad credit rating."[189] The obvious is a dual rating definition: while agencies use the definition by which this is the view/an opinion, which de facto does not entail any responsibility, the standardised approach of Basel II defines rating as obligation for banks to its strict application. On the other hand, rating agencies do not take any responsibility if the rating is biased or non-objective. Duality in definition is causing asymmetry in responsibilities: the investors are by regulation forced to use the rating while rating agencies are protected from liability by the First Amendment of US Constitution on freedom of speech.[190] This possibility agencies use when they are sued by an investor or an issuer based on the claim that actions of rating agencies caused them damage.[191]

1.2. Solicited vs unsolicited rating

The important characteristic of solicited credit rating is the fact that it is initiated by the security issuer. This is the mostly often seen credit rating

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[187] https://www.moodys.com/ratings-process/Ratings-Definitions/002002

[188] https://www.standardandpoors.com/en_US/web/guest/article/-/view/sourceId/504352

[189] Hull, C.J. (2015). *Risk Management and Financial Institutions.* New Jersey: John Wiley & Sons, Inc., p. 180.

[190] Partnoy, F. (2009). Rethinking Regulation of Credit Rating Agencies: An Institutional Investor Perspective. *Council of Institutional Investors*, http://frankpartnoy.com/wp-content/uploads/2012/06/CRAWhitePaper04-14-09.pdf, p. 5.

[191] White, J.L. (2010). Markets: The credit Rating Agencies. *Journal of Economic Perspectives,* 24, p. 212.

process for government securities. This type of rating shows systematic overvaluation of the issuers' credit worthiness. The main cause for this phenomenon is the moral hazard behaviour of the rating agency. Empirically is confirmed that before the crisis and 2006 systematic rating overvaluation bias occurred, while in post-crisis period emerged systematic rating undervaluation bias. The process of generating this kind of rating contains a high risk of bias because the agency presents a preliminary rating to the purchaser, who is entitled to accept the public announcement of the rating or to refuse it. If the purchaser accepts, the agency makes the issuer's rating public, but if he does not accept it then it can lead to rating re-assessment. The issuer of securities in this type of rating process has an incentive to publish the rating only if it will cause a positive reaction by investors. This feature of solicited rating process systematically causes rating overvaluation bias in terms of increase in rating. Moral hazard problem may, except for government bonds, also occur in the process of rating of so-called complex financial instruments that result from the process of securitization.

In the alternative scenario, the rating agency can provide credit assessment to security issuer without his request. It is the so-called unsolicited rating, which is simpler process with shorter duration because interaction between rating agency analysts and entities rated is not necessary. The reason: there is no contractual agreement between the agency and the issuer. This type of rating requires less time and has lower costs that result in less detailed rating. Paradox related to this type of rating is the fact that market participants highly evaluate this kind of rating because "…price sensitivity to changes in unsolicited rating is higher."[192] With this important finding significant are the following questions too – why rating agencies have an incentive for that business activity? Why are unsolicited ratings, on average, lower than required (solicited) ones?

Higher market confidence to this type of rating has led to a kind of absurdity: unsolicited ratings are becoming a significant part of the total scores given. In circumstances where the issuer pays for the rating service there is a need for investors to obtain more information about credit risk in their investments. Rating agencies use unsolicited rating as a typical case of free riding. Based on the numerous cases of unsolicited rating agencies create the market for solicited (required) ratings that brings them profit. Standards&Poor's explains the increasing need for unsolicited rating as "... meeting the market need for wider rating coverage." Unsolicited rating is sometimes considered a hostile rating. Large agencies with lower grades in unsolicited rating actually penalize issuers

[192] Mattarocci, G. (2014). *The Independence of Credit Rating Agencies: How Business Models and Regulators Interact.* Oxford: Elsevier Inc., p. 11.

who do not want to subscribe to their services. The case of the German insurance company Hannover Re is often used as a proof of the hypothesis that unsolicited ratings are, on average, lower than solicited ones and that unsolicited ratings are hostile ratings.[193]

The market for ratings solves the problem in the following way: by selling the required credit ratings, that overestimate the creditworthiness of the debtor, credit agencies increase short-term profits. By publishing unsolicited ratings, agencies increase their long-term profits.[194]

The first effect of this kind of market equilibrium is the following: the publication of overstated ratings brings short-term profits to the agency, and, in the long run, reputational costs. The risk of an imbalance in this trade-off arrangement is the loss of confidence in rating agency that would reduce its market share and long-term profit. If agencies would tend to publish exclusively truthful ratings, then it would, in the short term, mean the loss of potential profits. At the same time the competition would lead to an increase in profits of competitor agencies. Thus, the optimum for individual agency is balancing between higher charges for the required ratings and higher long-term profits for unsolicited (exact or nearly exact) ratings. With the required rating, therefore, there is a trade-off. Unsolicited rating, on the other hand, does not face trade-off. There are two effects that reinforce each other, namely: higher price for the rating services in solicited ratings and stable (or higher) prices over the long term based on unsolicited ratings. The required rating, which immanently overestimates creditworthiness, allows the agency to also disclose understated unsolicited ratings. This is a threat to issuers that do not want to pay for the services of this agency. Market rating market, thus generates incentives to

[193] After Hannover Re refused to pay for the rating service to Moody's, Moody's announced its unsolicited rating, giving him a grade Aa2, which was one level below the rating given by S&P. During the next two years, Moody's lowered the assessment to Aa3 and then to A2. In the meantime, the agency was trying to sell its service to the company. In March 2003, Hannover Re was still refusing to pay, and the agency has, as a coincidence or not, once again lowered company’s debt rating for three additional levels to "junk" status, which had an impact on the stock market, and caused company’s stock prices fall by 10%. The case would not be so specific if the agencies, to which the company was paying for the services of credit scoring, S&P and A. M. Best, did not continue to give, as initially, high credit ratings to Hannover Re - Klein A. (2004). Credit Raters' Power Leads to Abuses, Some Borrowers Say. *The Washington Post* - dated 24 November 2004.

[194] Fulghieri, P., Strobl, G., Xia, H. (2014). The Economics of Solicited and Unsolicited Credit Ratings. *Review of Financial Studies,* 27(2), p. 487.

issuers to pay for the rating and increases their propensity to pay higher equilibrium price for the service.

Another effect of this kind of equilibrium is the fact that publication of unsolicited rating gives a signal to investors that the agencies very cautiously assesses credit risk. In the case of unsolicited rating high ratings are not assigned to issuers. Long-term usefulness of this type of ratings (reputation) may explain the occurrence where rating agencies also publish these types of assessments for government bonds completely free of charge. The consequences of this imbalance are unfavorable for issuers who do not pay for their ratings. The question that arises is the following: why do they participate in this process?

In general, there are two explanations: incentive (auto-selection) and compulsion (penalty policy) of rating agencies.[195] First motive is relevant to issuers that have ability for self selection in the rating group that requires and pays for the rating. The issuers that have low creditworthiness do not require a rating. In this concept credit assessments are not biased. Consistently, there is no penalty policy towards those who do not require and do not pay for credit rating. The alternative view: unsolicited ratings are the kind of penalty policy towards the issuers that do not pay for credit ratings. In this case the biasness of rating agencies is present.

Capital adequacy rules, known as Basel II, determines the capital requirements based on ratings assigned by credit rating agencies. Foundation and advanced Internal Rating-Based Approach can be used by banks that have sophisticated mathematical and statistical programs for the calculation of credit risk. On the other hand, standardized approach is implemented by smaller banks, measured by balance sheet’s total. In the standardized approach external ratings are used, i.e. rating agencies’ credit ratings. Considering that the scale of risk weighting in the calculation of risk-weighted assets is broad, the situation is possible in which the assets of the bank has extremely low credit rating and the capital that a bank must set aside is higher than if there was no assessment of the relevant assets’ rating. These are situations in which it is actually better not to be rated by the agency than to be rated. While banks and other financial intermediaries have a duty to implement ratings provided by credit rating agencies, rating agencies themselves do not bear almost any consequence if credit risk assessments provided were inadequate. This is confirmed in practice by large and unexpected bankruptcies. Furthermore, according to the current regulations,

[195] Fulghieri, P., Strobl, G., Xia, H. (2014). The Economics of Solicited and Unsolicited Credit Ratings. *Review of Financial Studies,* 27(2), p. 486.

insurance companies and pension funds are limited in investing process to only the safest securities in their assets, i.e. securities with investment grade from AAA to BBB. Given that by 2007 a majority of structured financial products (in whose creation were involved the rating agencies) had precisely the highest rating, AAA, pension funds and insurance companies were buying these financial instruments and have later realized large losses.

1.3. Paying for the credit rating service

At the beginning of the market for ratings development, the first agencies had implemented a model in which the investor pays for a service (User fee model). Today, there is a small number of agencies that implement the model in which the investor pays the subscription. However, significant changes occur nowadays. It seems that this process was triggered by the crisis and compromised ratings during its lifetime. A credit rating agency may apply to the SEC for registration as a nationally recognized statistical rating organization (NRSRO). The Egan-Jones Ratings Company, from the United States, in December 2007 became the first credit rating agency that uses the user fee model after the certification as NRSRO. The agency believes that there is a conflict of interest caused by the model in which the issuer pays for the rating service and that this practice causes an overvaluation of corporate credit ratings.[196] Egan-Jones stated that Standard&Poor's agency, which applies the model according to which the issuer of the security pays for the rating service, is exposed to serious conflict of interest. As evidence it gives example that firms with more short-term debt, with the newly appointed director or financial director and a smaller percentage of previously issued bonds rated by S&P, have a significantly greater chance of being rated higher by S&P agency. The basic advantages of the user fee model are shorter evaluation period and lower costs due to predominantly quantitative analysis of rating agencies that apply this model. Agencies become more sensitive to new market conditions. They revise the ratings before the rating agencies that use the model in which the issuer pays for the rating service.

The biggest disadvantage of this model is the problem of *free rider* and as a result Pareto inefficiency occurs because the problem can not be solved based on completely free market principles. For the same costs of agencies free rider problem reduces the number of rating service users that would result in an increase in prices, whereas an increase in prices would lead to decreasing demand and again reduce the number of users. This negative process has a tendency to repeat. With the development of advanced computer technologies

[196] https://www.egan-jones.com/studies

free rider problem today becomes potentially larger than before, and its resolution is an another problem.[197]

Credit ratings are often used as a basis for ranking financial capabilities, i.e. investments, based on credit risk. They improve the position of both sides of the transaction, investors and the entities being evaluated. The entity has the possibility to reduce the cost of capital as a source of funding and gain access to international capital markets, while investors by using a range of additional information can perceive a more complete picture of the potential investment.

The dominant model of payment for rating services today contains a paradox: investors are the dominant users of these services. Investors are equally interested in an objective and timely assessments, both for good and for bad information on the issuer or the debt security in which they are interested. In models in which the issuer pays a fee to the agency, the issuer is interested in a better assessment of his creditworthiness, but also are agencies because of the fear of losing a client due to a possible "purchase rating" effect, i.e. a situation in which at similar prices issuer chooses agency that awards the best credit rating.

Many authors are finding cause for unethical behaviour and moral hazard exactly in this model, because the high revenues agency generates depend on the borrowers (issuers) rather than investors who actually invest their money and take care of the safety of their investments. Investors and issuers have different preferences towards the level of interest rates, i.e. risk. Issuers will choose the agency that offers them the best rating. Purchase of the best expected rating by itself brings overpricing. The predominant number of agencies uses this model in which the issuer pays fee for the service to rating agency, and in fact the most important fact is that it is used by the three largest agencies that hold around 90% of the rating market. It is a model that may create a risk of collusion between issuers and agencies and moral hazard behaviour, at the expense of investors. This model is nowadays facing growing challenges as markets expressed a high degree of doubt to independence of credit rating agencies.

[197] Rating agencies feared from a drop in revenues from the sale of rating manuals as a consequence of the application of fast copiers (which has just entered the wide application), that would allow a large number of investors' free ride after obtaining copies from their friends - White, J.L. (2010). Markets: The credit Rating Agencies. *Journal of Economic Perspectives,* 24, p. 214.

At this, still dominant model, an entity selects among various agencies, requests an assessment of credit risk and pays for this service. When the agency conducts evaluation of the credit risk, the issuer has the right to choose whether or not the rating will be publicly released. It is possible, therefore, that in the case of evaluation that is lower than expected the issuer's rating is not made public. Given that there is not only one agency, in the market, the issuer could pay and apply for assessment to the second, third and so on agency until it gets the expected rating. "Rating agencies publish on websites information on the applied price policy, declaring whether they receive fees from the rated entity (issuer fee model), or from its users (user fee model). In more than 86% of the cases, agencies charge fees mainly or exclusively from the issuers."[198]

Benefits of the application of the issuer fee model had both agencies and issuers. The basic advantages of this model include facilitated access to national and international financial markets, reduced price of financing sources and high income and profitability of rating agencies.

2. THE LINKS BETWEEN SOVEREIGN AND BANKING CRISES

The history of repeated crises seems to be much longer than initially assumed.

The important regularities that precede or go in parallel with crisis and are evidenced throughout the history include the following:[199]

1. Private debt based on domestic banking credit or foreign borrowing surges before banking crisis
2. Banking crises precede or accompany sovereign debt crises
3. Public borrowing increases significantly before the sovereign debt crises

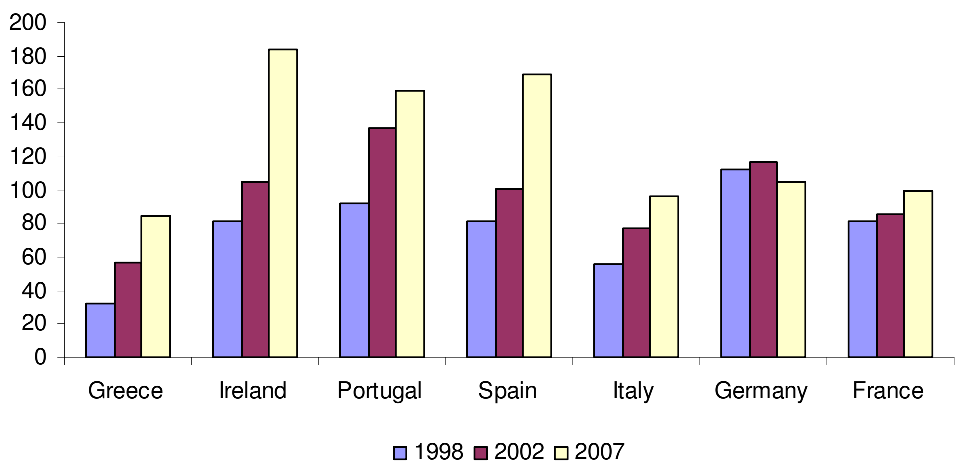
What is usually seen before the banking crisis or a sovereign default is significant increase in private debt (both domestic and external). With the increase of countries' external debt (private and public) the probability of sovereign and banking crises rises. What Reinhart and Rogoff (2010) document based on the sample of 22 advanced economies in 1999-2009 period is that average external debt/GDP ratio doubled in this period leading to global

[198] Mattarocci, G. (2014). *The Independence of Credit Rating Agencies: How Business Models and Regulators Interact.* Oxford: Elsevier Inc., p. 74.

[199] Reinhart, C.M., Rogoff, K.S. (2010). From Financial Crash to Debt Crisis. *NBER Working Paper* 15795, http://www.nber.org/papers/w15795, p. 1-2.

financial crises starting with subprime crises in US in 2007.[200] The similar debt buildup happened in emerging markets in earlier 1981-1998 period followed by similar pattern starting in 2008 led by Eurozone periphery countries. Concerning the maturity structure, in particular short-term debts escalate before the crisis. And as Diamond and Dybvig's (1983) several decades ago suggested and is confirmed in practice at least several times - any short term borrowing to finance illiquid assets makes the debtor prone to crisis of confidence.[201] Capital inflows to emerging countries boom in the years before the crises and then suddenly stop just before or during the crisis when foreign investors withdrew from those markets. Also, domestic credit rises sharply before the crisis.

Graph 1. Loans to private sector as % of GDP



Source: Authors' presentation based on World Bank's data

Household and consumption related debts in OECD countries accumulated significantly before the crisis 2007-2008 due to low interest rates and the absence of the FX risk. During the expansion the financial sector becomes richer and more influential. The overconfidence leads to underestimation of future shocks that is resulting in insufficient asset holdings or to much debt accumulation. The result is usually the decreased regulation and obvious moral hazard behaviour that increases financial sector's profitability at the expense of the society.[202]

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[200] Reinhart, C.M., Rogoff, K.S. (2010). From Financial Crash to Debt Crisis. *NBER Working Paper* 15795, http://www.nber.org/papers/w15795, p. 20.

[201] Diamond, D., Dybvig, P.H. (1983). Bank Runs, Deposit Insurance, and Liquidity. *Journal of Political Economy,* 91(3), pp. 401-419.

[202] Reinhart, C.M., Rogoff, K.S. (2008). This Time is Different: A Panoramic View of Eight Centuries of Financial Crises. *NBER Working Paper* 13882, http://www.nber.org/papers/w13882.pdf

Sovereign debt crises are often accompanied by banking crises. Public debt increases significantly prior and during the sovereign debt crises. One of the reasons for this may be the hidden debts and liabilities in implicit government guaranties to government agencies or private domestic borrowers (e.g. case of Fannie Mae and Freddie Mac in US and Greece in latest crises). The second reason for this outcome may be the open massive debt taking by sovereign from the private banks affected by the crisis. Private debts to great extent become public debt after the crisis. Even without bailouts, since state revenues decrease in crisis periods, sovereign debt rises leading to rating downgrade and even default. Debts prolong to increase after the default as obligations continue to accumulate and in the same time the GDP contracts.[203] Episodes of high indebtedness are also often followed by inflation crises as an indirect form of default. What evidences show is that soon after the debt is restructured countries again start to re-leverage. In addition, if the banking crisis precedes the domestic currency crash in situations of the "twin crises" the decreasing value of the domestic currency may lead to insolvency of both private and sovereign borrowers that have huge amounts of foreign currency debt in their balance sheets.

2.1. The causal relations between sovereign debt crisis and banking crisis

The causal relationship between debt and banking crisis can go in both directions. The long history of crises suggests that banking crises often precede the sovereign debt crises. The precise trace is the following – the banking crisis in large financial centers causes banking crises in other countries, and domestic banking crises then lead to sovereign debt crises. The opposite relationship where public debt/GDP accumulation leads to domestic banking crises is more often seen in recent history, after 1950s. Private debt surges explain this shift in influence. Increase of the public debt affects directly the default probability of the sovereign. Concerning the external debt accumulation (both private and public) it increases the chance of the banking crises.[204]

The latest global financial and debt crisis in euro area follows the explained patterns. The contaminated assets held in bank balance sheets led to massive banks' insolvencies. The government interventions resulted in deficit and debt accumulations. The hidden debts in Eurozone periphery were consequently revealed. Both, financial repression and capital flow controls on one side and

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[203] Reinhart, C.M., Rogoff, K.S., Savastano, M.A. (2003). Debt Intolerance. *Brookings Papers on Economic Activity,* 1, pp. 1-74.

[204] Reinhart, C.M., Rogoff, K.S. (2010). *op. cit.,* p. 37-38.

liquidity requirements on the other, imposed commercial banks to hold often significant amounts of government securities on their balance sheets, as the safest assets. Financial and debt crisis and government default in those circumstances resulted in securities rating downgrade, significant risk premium and yield increase accompanied by sharp drop in securities' prices. Ones secure and liquid assets held on the balance sheet suddenly became less liquid and almost worthless that in parallel with private debt defaults raised liquidity and solvency issues for the affected banks preventing them to meet capital adequacy requirements.

Finally, the cycle closed – moral hazard in regulation and credit rating led to private debt accumulation – private debt default led to massive banks' insolvencies – what happened next was pass through of those debts to sovereign level- results were sovereign debt crises and defaults – that caused sudden and significant government securities' downgrading with final strong second wave negative impact on banks' balance sheets.

3. THE LATEST SOVEREIGN DEBT CRISES IN EUROZONE

The global financial and afterwards sovereign debt crises in Europe have put forward the shortcomings of the decade of financial integration process. Euro area has never reached the unification level which exists in US since monetary union was not accompanied by banking and fiscal union.

The Stability and Growth Pact was predominantly oriented on the discipline in the member states' public sectors. It set limits on the annual budget deficit to 3% of the GDP and the public debt/GDP ratio to maximum of 60%, followed by "no bailout" clause. The private sector was assumed to be stabile and rational. The macroeconomic models and schools of the time neglected the fact that financial sector may have significant effects on real economy and that those effects may be destabilizing and obviously not just short-term in nature. The crisis has proven the contrary. First, Stability and Growth Pact failed in disciplining adequately public sector players and fiscal policy conduct. Second, in supervisory sense, marginalized private sectors have accumulated significant debt that was financed by domestic banking sectors. The banks were on the other side funded by European markets and financial institutions.

The elimination of national currencies in circumstances where banking regulation remains the national responsibility means that national governments continue to carry the risk of banking crisis - the direct one (if bailing out affected banks) and indirect one (since GDP and tax revenues tend to remain low after the crisis). The national fiscal policies became the main countercyclical macroeconomic policies.[205]

Opposite to public debt behavior in the previous period, the private debt increased significantly in first years of the EMU in periphery countries of the euro area (Greece, Ireland, Spain and Portugal). Although the public deficit in Greece had greater role in debt accumulation, in Spain, Ireland and Portugal private debt of the mostly non-financial sector had dominant influence. Private sector financing and excessive credit growth was provided by both domestic and foreign banks that led to macroeconomic imbalances and mortgage market price bubbles.

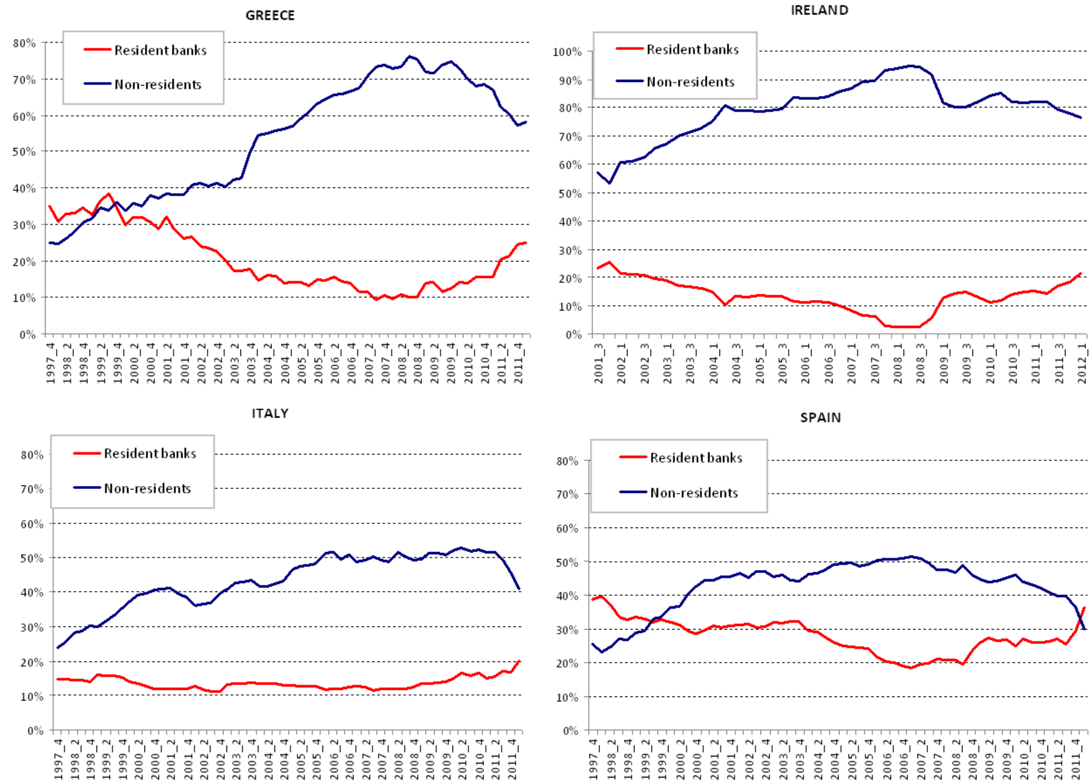
The local supervisory bodies were in a sense permissive towards a national banking sector. The support provided to a local banking sector was reflected in infrequent rating downgrading. Therefore, uplift of supervision on the supranational level was needed to help the reduction of the captive behavior of regulators.

The 1999-2007 was period of good growth performances and stable financial environment that masked the accumulation of macroeconomic, financial and fiscal vulnerabilities of periphery member states. The rising private debt and accumulation of current account deficits was intensive in 2003-2007. Unfortunately, due to poor risk management, the fiscal policies have not been tightened and were less countercyclical in this period. With global financial crisis markets awoke in 2008 bringing accumulated structural weaknesses of mostly peripheral countries of the Eurozone into light and strong divergence process started. It was followed by market fragmentation and reversed capital flows towards the core countries. Banks faced loan loses and liquidity squeeze.

During 2008-2009 debt markets remained calm. Demand for sovereign debt securities was even increasing since banks needed safe collateral for borrowing from ECB. The combination of domestic recessions, banking crises and withdrawal of foreign investors made basis for the sovereign debt crisis. In late 2009, countries of the euro area periphery reported higher than expected budget deficit/GDP ratios followed by rising bank losses and consequent fiscal risks that had negative impact on sovereign bond prices and yields.

[205] Lane R.P. (2012). The European Sovereign Debt Crisis. *Journal of Economic Perspectives,* 26(3), pp. 49-50.

Graph 2. Sovereign Bonds shares held by Resident Banks vs Non-Residents

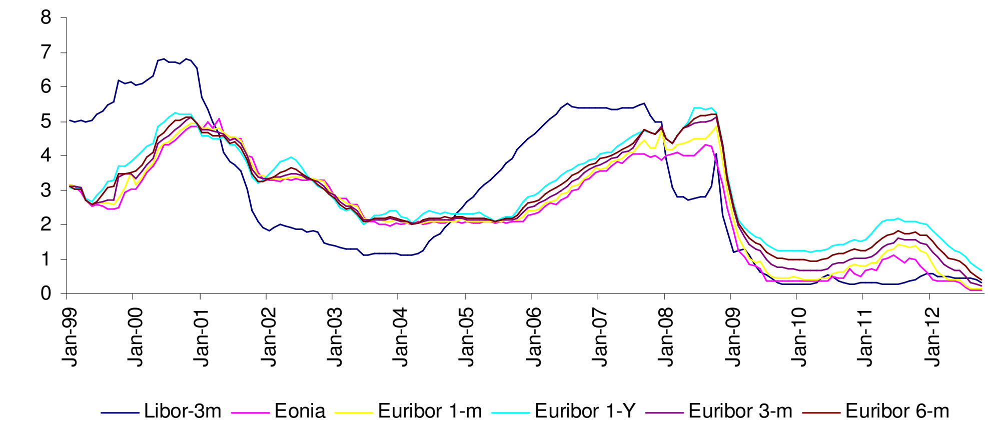


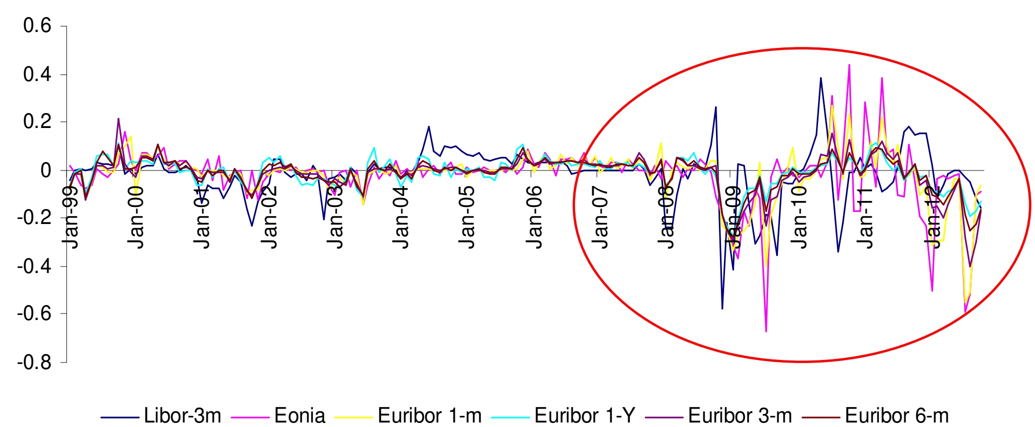
Source: Merler, S., Pisani-Ferry, J. (2012). Bruegel dataset of sovereign bond holdings, http://www.bruegel.org/nc/blog/detail/article/874-introducing-the-bruegel-dataset-of-sovereign-bonds-holdings -and-more/

In the member states with already weak sovereign the national banks were taking on a higher portion of public debt from 2009. It is especially profound in the euro area periphery where foreign investors were selling risky bonds and domestic banks were buying them. This process indicates an increasing fragmentation of the sovereign bond markets. Core countries, like Germany, have on contrary experienced increase in sovereign bond holdings by non-residents due to the "flight to safety and quality".[206] Interestingly, despite the increased loading with sovereign debt instruments, they remained a less significant share of banks' total asset. It is important to notice that before 2007, public debt in euro area countries was mostly financed by foreign investors and not domestic financial sector.

[206] Merler, S., Pisani-Ferry, J. (2012). Bruegel dataset of sovereign bond holdings. http://www.bruegel.org/nc/blog/detail/article/874-introducing-the-bruegel-dataset-of-sovereign-bonds-holdings -and-more/

Graph 3. Reference money market rates in % and their monthly changes in Jan 1999-Jan 2012 period





Source: Authors' calculation and presentation based on ECB data

This potentially relaxes the idea that public sector was the dominant driver of the macro imbalances of the non-core euro area states. With an exception of Greece the imbalances were mostly created on the side of the private sector expenditures that were financed by the financial sector.[207]

The monetary transmission channel was significantly jeopardized and the ECB was forced to take on dual role of both monetary area regulator and sovereign debt market stabilizer.

An obvious example of disintegration is the behaviour of reference money market rates that indicate reduced money market's volumes in particular to periphery countries. Rates decrease over time but also show dispersion and

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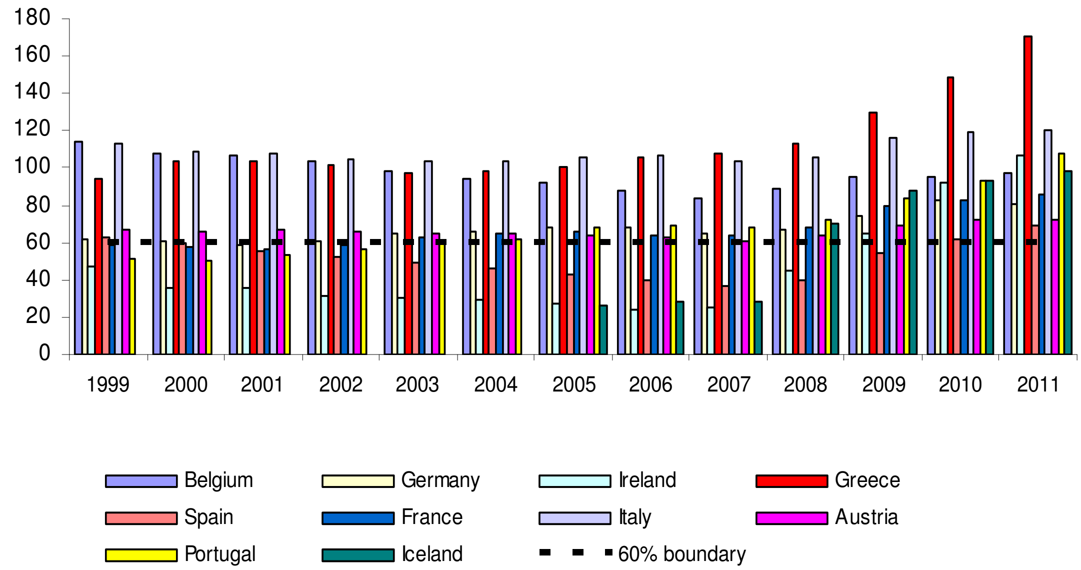
[207] Constancio, V. (2012). *Towards a European Banking Union,* http://www.ecb.europa.eu/press/key/date/2012/html/sp120907.en.html

significant volatility after the beginning of the crisis that is connected to increasing sovereign debt risk.

Graph 4. The General Government Consolidated Gross Debt as % of GDP for selected EU countries



Source: Authors' presentation based on the selected Eurostat data

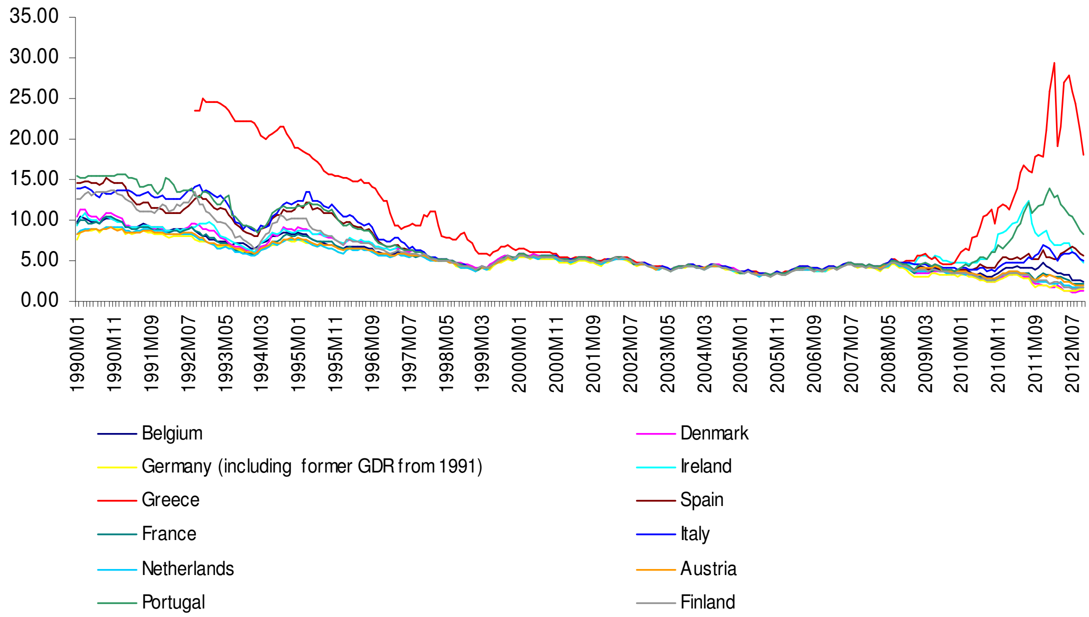
The disintegration process after the beginning of the crisis is also significant and obvious in the banking sector. Both active and passive bank interest rates began to diverge across markets while the core countries started to withdraw liquidity from stressed countries back to headquarters. Foreign bank subsidiaries lost in share of the total banking sector assets.

Although the sovereign debt levels were decreased in most countries in the first years of the monetary union existence the crisis caused public debt increase in great amount due to the bailout of financial sector in 2008.

Markets reacted to rising credit risk and increased the yields to maturity on government debt securities while lowering their rating and prices.

The negative repercussions occurred due to the high share of now less valuable sovereign debt securities in the banks' balance sheets.

Graph 5. Convergence and fragmentation of sovereign bond yields



Source: Authors' presentation based on Eurostat data

Financial disintegration burdens the ECB monetary policy transmission process and its effect on interest rates' unification among member states. Thus, for the effective conduct of the monetary policy it is essential to reduce the financial fragmentation and to restore the monetary transmission mechanism. That is possible only if the ECB gets a chance to refocus on its primary goals while the proper crisis resolution mechanism is introduced in parallel. The joint EU/IMF programs were organized to provide a three year funding to vulnerable countries that have to implement fiscal austerity measures and structural reforms. The European Financial Stability Facility (EFSF) and European Stability Mechanism (ESM) were formed to provide funding to affected countries by issuing bonds on the basis of guarantees from all member states.

In order to be able to affect the risk premiums related to a fear of euro area break-up ECB had to impose strict conditionality to adequate EFSF or ESM programs. The proposed scheme of Outright Monetary Transactions (OMT) is based on this rationale. On conditionality based bond market interventions were aimed at reduction of the euro area survival risk and to help debt crisis resolution. But the three year period was to short for significant structural adjustments.

An idea of a banking union that emerged in that period had potential to support an effective monetary policy. It encompasses single supervision, common crisis resolution tools and deposit insurance. All these elements potentially help the financial integration process and renew bank diversification activity. It also helps the discontinuation of the bank-sovereign crisis cycle. The proper supranational supervision reduces the national supervision biases and lagging behind the integration process that led to a creation of the macroeconomic imbalances in previous period.

Chapter 11.

SYSTEMIC RISK OF AN INTERBANK LENDING NETWORK: AN EMPIRICAL ANALYSIS FOR SERBIA

Financial stability and systemic risk in banking have gained renewed interest of researches and regulators alike. Earlier empirical studies that assessed systemic risk mostly focused on the outcomes of historical banking crises. A thorough survey of models of systemic risk can be found in Freixas and Rochet (2008). Davis (1992) and Kaufman (1995) provide an overview that includes empirical evidence and political implications, and discuss various conceptual issues.

More recently, the researchers recognized the importance of interbank lending for financial stability and potential impact of interconnectedness of financial institutions on systemic risk, especially after the freezing of the interbank market following the collapse of Lehman Brothers in 2008. Espinosa-Vega and Solé (2010) introduce a model of a global interbank network that simulates its stability to credit and funding shocks. Nier *et al.* (2007) study various effects of contagion in banking systems. They explore the relationship between network topology and financial stability. Several studies use single-country micro data. Furfine (2003) quantifies contagion risk for US interbank market. Boss *et al.* (2004) and Elsinger *et al.* (2006) analyze the Austrian interbank network. Iori *et al.* (2008) study the network stability of the Italian overnight money market. Márquez Diez Canedo and Martínez-Jaramillo (2009) introduce a model of contagion and apply it on micro data for Mexican banks. Memmel *et al.* (2008) and Upper and Worms (2004), develop similar models and apply them on German data. Sheldon and Maurer (1998) and Müller (2006), Wells (2004), and Tabak et al. (2013) study the interbank networks of Switzerland, United Kingdom and Brazil, respectively. Upper (2011) uses the Bankscope database to simulate contagion effects. Chan-Lau (2010) introduces the concept of financial institutions that are “too connected to fail” and analyze possible regulatory implications. Haldane and May (2011) draw analogies between banking system contagions and dynamics of ecological food webs and spread of infectious diseases.

This chapter shows how network analysis can be used for financial stability monitoring by simulating credit shocks in a banking system. In addition, the chapter illustrates how the non performance of loans that banks extend to the private sector propagates throughout the interbank network. The empirical analysis is based on the balance-sheet data for Serbian banks in 2015. The goal of this chapter is not to make specific conclusions about particular banks, but to illustrate the technique described in the chapter as a useful tool for financial stability surveillance and macro-prudential regulation.

1. THE MODEL

This study views systemic risk as a potential for industry-wide distress resulting from a loss spillover. Our empirical analysis will track the sequence of events following the failure of a single bank. A contagion effect may be triggered through other banks linked to the failed bank. The links are formed through interbank loans, creating a network though which a single failure may spread as a contagion, or a domino effect. Several aspects of contagion could be analyzed, including the extent and the path of the shock propagation. By concentrating on the first link in a potential chain reaction, we can examine whether a default of a single bank is likely to cause systemic distress or, instead, it remains confined, simply dissipating in the first round of contagion.

We follow Sheldon and Maurer (1998) and assume that a single exogenous shock causes an individual bank to default on its interbank loans. This event leads to its insolvency, wiping out its entire equity. Hence, the default is complete. Unlike Sheldon and Maurer (1998), we assume that the default of the shock originator does not necessarily mean that the lending banks will lose the entire book value of their loans to the defaulting bank. Instead, we use the approach of Espinosa-Vega and Solé (2010) and introduce loss given default (LGD) as a parameter $\lambda \in [0,1]$.

We begin our analysis by considering a stylized bank balance sheet that focuses on interbank exposures. This stylized balance sheet of bank *i* satisfies the following identity:

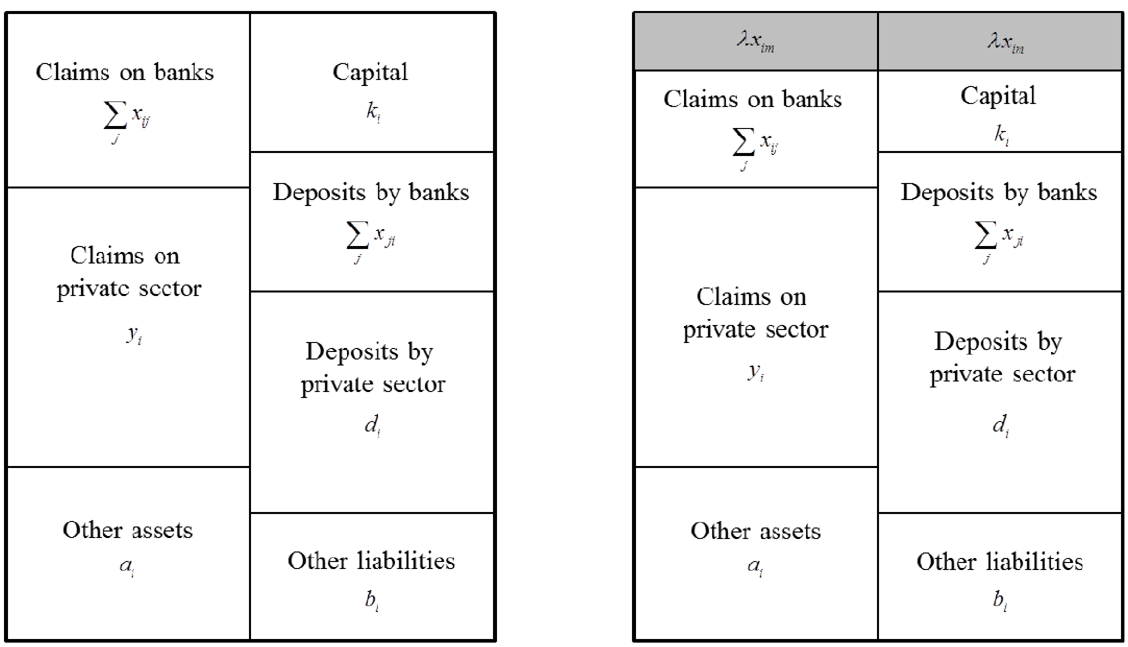
$$\sum_{j=1}^{n} x_{ij} + y_i + a_i = k_i + \sum_{j=1}^{n} x_{ji} + d_i + b_i\,, \tag{1}$$

where x_{ij} is the book value of loans extended by bank *i* as a lender to bank *j* as a borrower, y_i is the value of loans extended by bank *i* to the private sector (i.e., firms and households), a_i is the value of all other assets of bank *i*, k_i is the value of its capital, x_{ji} is the book value of loans extended by bank *j* to bank i, d_i is the value of deposits to the private sector, b_i is the value of all other liabilities of bank i, and n is the total number of banks in the system.

We examine the contagion effects of a credit shock triggered by the default of an individual bank m on its interbank obligations. The simulation starts by setting the entire capital of bank m to zero, and creating a sequence of losses equal to λx_{im} incurred by all other banks $i \neq m$. We assume that the lender's capital absorbs the loss. This is illustrated in Figure 1, where the shaded area represents the loss. In case that the capital of bank i is not sufficient to absorb the shock entirely, i.e. if $\lambda x_{im} > k_i$, the bank i defaults, and triggers the second round of contagion. The chain reaction continues until all the losses are completely absorbed by the capital of surviving banks, or (in the extreme case) until the entire banking system collapses. To simplify the analysis, we assume that no fire sale of assets is possible.[208]

Figure 1. Effect of a credit shock triggered by bank m on bank i's balance sheet

Pre-shock balance sheet | Post-shock balance sheet

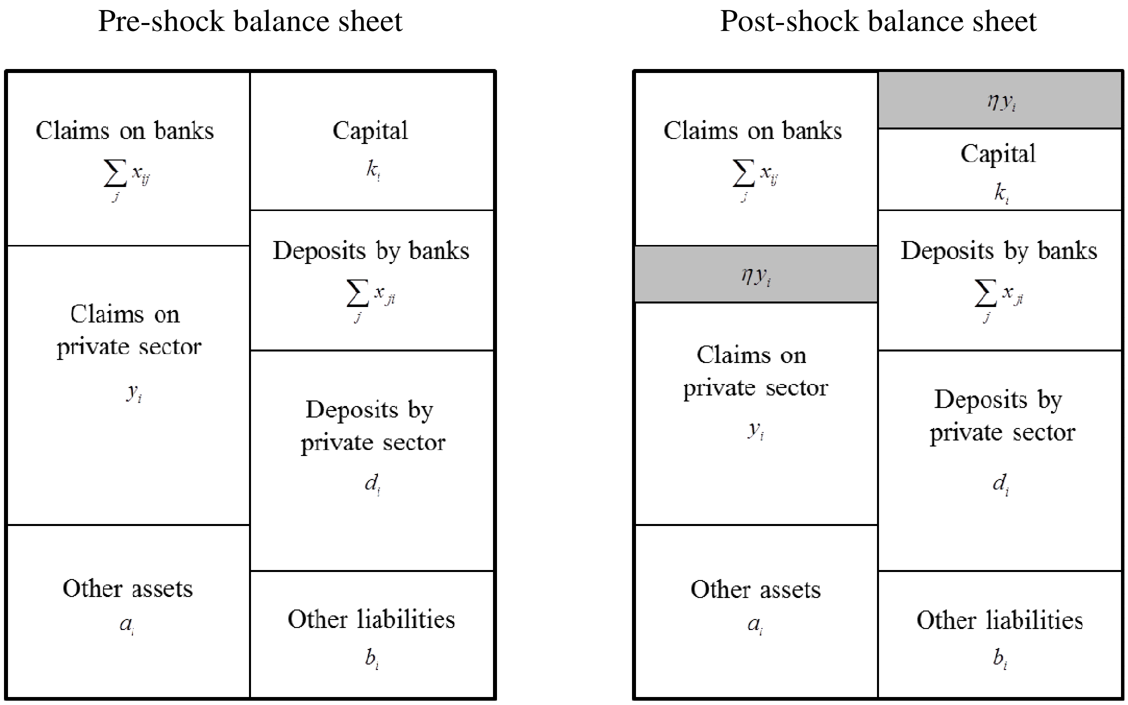


The second type of contagion effect that we will focus on is a result of a credit shock triggered by non-performing loans to the private sector. We introduce the non-performance ratio $\eta \in [0,1]$. Initial shock will therefore create a loss of

[208] Such an assumption is even more justified if the assets are illiquid, or bear high liquidity costs. This is often the case in underdeveloped financial systems.

ηy_i to the lender i, which is absorbed by its capital. This is illustrated in Figure 2. Again, if the capital of bank i is not sufficient to absorb the shock entirely, i.e. if $\eta y_i > k_i$, the bank i defaults, and triggers the second round of contagion. The contagion then spreads through the banking system via interbank loans, as in the first type of simulation.

Figure 2. Effect of a credit shock triggered by non-performance of loans to the private sector on bank i's balance sheet



Both simulations are fairly simple given the detailed structure of the interbank loans, i.e. the entries in the matrix x_{ij}. However, this level of details may not be available to all researchers. Typical level of observation is an individual bank's balance sheet, containing aggregate data on exposures and liabilities to banks and other entities. In terms of our stylized balance sheet, one typically observes only $\sum_j x_{ij}$, y_i, $\sum_j x_{ji}$ and d_i.

To overcome this problem, we follow a simple method proposed by Sheldon and Maurer (1998). We introduce the matrix of weights **W** through

$$W_{ij} = \frac{x_{ij}}{\sum_{l,m=1}^{n} x_{lm}} \tag{2}$$

to represent the relative shares of interbank loans. Each element in the matrix W_{ij} represents a fraction of loans from bank i to bank j relative to the total amount of loans in the system. The sum across the columns in row i is equal to the fraction of all interbank loans provided by bank i,

$$r_i = \sum_{j=1}^{n} W_{ij} , \tag{3}$$

while sum over rows in column j gives the share of all interbank loans received by bank j,

$$c_j = \sum_{i=1}^{n} W_{ij} . \tag{4}$$

The vectors defined by equations (4) and (5) represent the marginal distributions of loans across lenders and borrowers, respectively, resulting in the following property:

$$\sum_{i=1}^{n} r_i = \sum_{j=1}^{n} c_j = 1 , \tag{5}$$

which is trivial to show using equation (2). The row vector **r** and the column vector **c** are the only information related to interbank loans that can be obtained from the balance sheet. Therefore, it seems natural to seek a solution which injects the minimum amount of additional and potentially non-verifiable information into the available data. This can be achieved by maximizing the entropy of the interbank-lending matrix. In the present context, entropy can be defined as

$$S = -\mathbf{w}' \ln \mathbf{w} , \tag{6}$$

where the prime symbol (') denotes a vector or matrix transpose (see Shannon and Weaver, 1949). The column vector **w** introduced in equation (6) is obtained by stacking the columns of the matrix of weights **W**, i.e.

$$\mathbf{w} = \begin{pmatrix} \mathbf{w}'_{1\cdot} \\ \mathbf{w}'_{2\cdot} \\ \vdots \\ \mathbf{w}'_{n\cdot} \end{pmatrix}. \tag{7}$$

Therefore, we solve the following optimization problem:

$$\max_{\mathbf{w}} S = -\mathbf{w}' \ln \mathbf{w}, \tag{8}$$

subject to the constraints given by equations (3) and (4). It is relatively straightforward, albeit tedious, to show that the solution to the optimization problem (8) can be represented by

$$\mathbf{W} = \mathbf{rc}'. \tag{9}$$

Sheldon and Maurer (1998) argue that this solution represents the natural lower bound on the actual amount of systemic risk that resides in a given banking system. Using equation (2), we can reconstruct the most likely interbank lending matrix x_{ij} simply by multiplying the matrix of weights given by equation (9) by the total book value of all interbank loans:

$$x_{ij} = W_{ij} \sum_{l,m=1}^{n} x_{lm}. \tag{10}$$

2. THE SERBIAN INTERBANK NETWORK

The data used in this analysis consist of detailed balance sheets of the 30 Serbian banks for December 31, 2015, available from the web page of the National Bank of Serbia (www.nbs.rs). The dataset contains all on- and off-balance sheet positions. However, for the purpose of simulation of the shocks we have aggregated some of these positions such that they match the stylized balance sheet introduced in Section 1. All positions are reported in Serbian dinars (RSD).

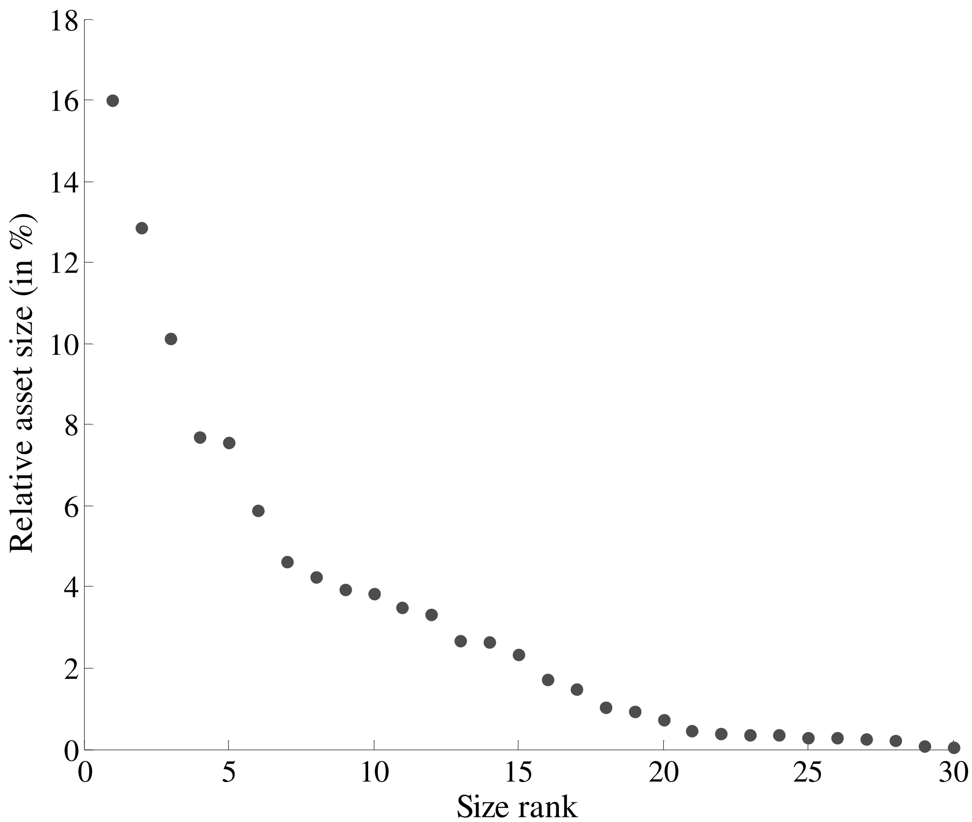
Table 1. Summary of bank assets as of December 31, 2015

Rank	Bank name	Total assets (in millions of RSD)	Relative asset size (in percent)
1	Intesa	487,799	16.0
2	Komercijalna banka	391,857	12.9
3	UniCredit	308,284	10.1
4	Raiffeisen	234,426	7.7
5	Société Générale	230,537	7.6
6	AIK	179,079	5.9
7	Eurobank EFG	140,583	4.6
8	Poštanska štedionica	129,866	4.3
9	Vojvođanska banka	120,328	3.9
10	Erste Bank	117,488	3.9
11	Sberbank	106,836	3.5
12	Hypo	101,513	3.3
13	ProCredit	82,080	2.7
14	Alpha	81,175	2.7
15	Crédit Agricole	71,549	2.3
16	Piraeus	52,547	1.7
17	OTP banka	45,144	1.5
18	Halkbank	31,935	1.0
19	NLB	28,705	0.9
20	Marfin	22,432	0.7
21	Findomestic	13,895	0.5
22	Opportunity	11,744	0.4
23	VTB	11,216	0.4
24	JUBMES	10,416	0.3
25	Srpska banka	8,897	0.3
26	KBM	8,893	0.3
27	Telenor banka	7,876	0.3
28	mts banka	7,133	0.2
29	Mirabank	2,249	0.1
30	Jugobanka	1,341	0.0
	Total	3,047,824	100.0

Source: National Bank of Serbia

Table 1 summarizes the total value of banks' assets. The banks are sorted according to their relative asset size. The first five banks attribute to more than a half of the total bank asset in Serbia, indicating a high degree of concentration in the banking system.

Figure 3. Distribution of relative assets size for Serbian banks



Source: National Bank of Serbia and author's calculations

Figure 3 shows the distribution of banks by their relative assets size. The distribution is typical for banking systems in most countries and indicates the presence of Gibrat's power law. The power-law behavior can be described by the following relationship:

$$A = s_i r_i^b , \tag{11}$$

where s_i is the market share of the *i*-th firm in the industry and r_i is its size rank (1 being the largest and n being the smallest firm), while *A* and *b* are positive constants (Ijiri and Simon, 1971). The Gibrat's law implies that the larger the power-law exponent *b*, the greater the difference in size between two firms with a given ratio of their ranks. Alternatively, th e relationship given by equation (11) can be written as

$$\ln s_i = a - b \ln r_i , \tag{12}$$

where $a = \ln A$. For a given market, the parameters *a* and *b* can be estimated as coefficients in a linear regression of log market share on log size rank. Table 2 summarizes the results of an ordinary least squares regression based on equation (12). Both the intercept *a* and the rank-size coefficient *b* are highly significant, and the regression has a relatively high R^2 of 0.77. As Nissan (2003) points out, high levels of market power occur when $b > 1$, which leads to a conclusion that the Serbian interbank market with $b = 1.59$ exhibits a relatively moderate potential for market power that could be exerted by the largest banks.

Table 2. Results of a power-law regression $\ln s_i = a - b \ln r_i$

	coefficients	standard errors	*p*-value
a	4.30	(0.43)	$< 10^{-4}$
b	1.59	(0.17)	$< 10^{-4}$
R^2	0.77		

Source: Author's estimates

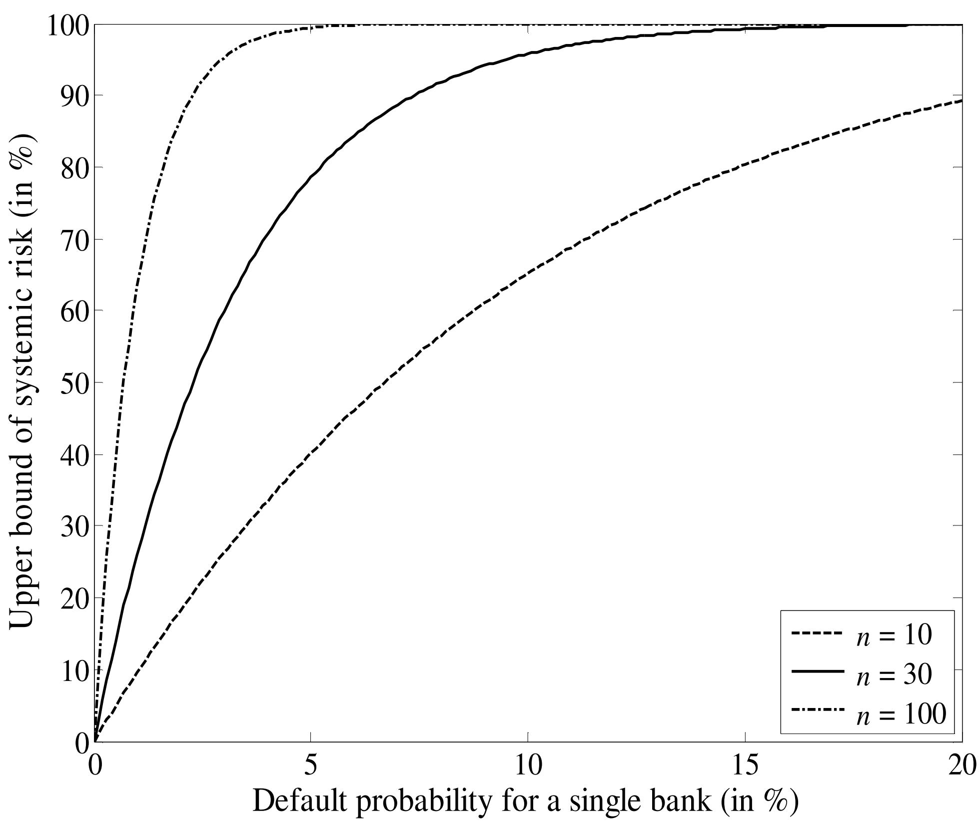
Size of the banking system can be used to determine the upper bound on the level of systemic risk. Let p_i be the probability that the bank *i* will default in a given period. If individual default probabilities are initially independent across banks, and if $p_i \equiv p$ is the same for all the banks, then it is easy to show that at least one bank fail within the given period with a probability of

$$1 - (1 - p)^n . \tag{13}$$

If contagion is triggered by at least one bank failure, equation (13) determines the upper bound on the level of systemic risk in a banking system consisting of *n* banks with a uniform default probability *p*. The path that a credit shock will take within the system depends on the structure of interbank lending relationships – more specifically on the structure of the matrix x_{ij}.

Figure 4 shows the upper bound for the level of systemic risk for different values of the probability that a single bank fails. The curves are produced using equation (13) by setting three different values for the number of banks *n* in the system. The figure shows that the higher the number of banks in a banking system, the smaller the individual probability required to trigger the chain reaction that will result in at least one bank failure. For instance, in a banking system with 100 banks, even a probability as small as 0.1% that a particular bank will fail results in the likelihood of 9.5% that at least one of the banks in the system will collapse. For a probability of 1%, this likelihood increases to 63.4%, while for probabilities above 5% it becomes almost certain. The domino effect is smaller in a banking system with fewer banks: for 30 banks, a default probability of 1% translates to a 3% chance of a single bank failure, while a default probability of almost 20% is required for a single failure to become certain.

Figure 4. Systemic risk as a function of bank failure probability, for banking systems consisting of 10, 30 and 100 banks



Source: Author's calculations

3. SIMULATION RESULTS

3.1. Credit shocks triggered by bank defaults

Our first set of simulations examines the transmission of a credit shock triggered by default of individual banks, as illustrated by Figure 1. The shock propagates via the interbank network. The simulation results are summarized in Tables 3 and 4. The first column of these two tables indicates the shock originator, i.e. the bank that initiates a potential chain reaction by its default. The second column is the percentage of the total capital of all the banks in the system wiped out through a cascade of defaults. The third and fourth column indicate the number of induced failures and the number of contagion rounds necessary to produce these failures, respectively. The fifth and sixth column show, respectively, the absolute and the relative number of simulations in which that particular bank defaults as a consequence of contagion – that is, indirectly through the propagation of a credit shock originating *elsewhere* in the system. Hence, the third and the fifth column add up to the same number. The numbers in the fifth and sixth column are referred to as the absolute and the relative hazard rate.

We use two values for LGD parameter: $\lambda = 1$, in which case all exposures to a defaulted bank are fully lost (Table 3), and $\lambda = 0.5$, which represents a more realistic case where banks recover a half of their exposures to the defaulted institution (Table 4). What immediately emerges as a result is that the contagion is spread by only 8 banks that are in the top half in terms of their asset size. However, these are not simply the largest banks. In fact, the greatest impact on total capital in the banking system comes from the default of Intesa, UniCredit, Société Générale and Erste Bank – the first, third, fifth and eight largest bank, respectively. With an LGD of 100%, their downfall would evaporate more than 90 percent of the capital – practically the entire banking system. These banks also induce the largest number of failures. For LGD of 50%, the number of induced failures drops to single digits for all banks except UniCredit, the third largest one, whose hypothetical default would still produce a major distress. The failed capital would remain at an extremely high level of 95.7%, making UniCredit probably the most important financial institution in Serbia in terms of systemic risk and contagion potential.

On the other hand, Komercijalna banka and Raiffeisen (the second and the fourth in terms of the size rank) would be the most frequent "victim" of contagion within the top five banks. Other banks with particularly high hazard rates are Crédit Agricole, Marfin, VTB, JUBMES, KBM and mts banka, all of them in the bottom 50% in terms of their absolute asset size.

Table 3. Simulated transmission of credit shocks: LGD = 1

Shock originator	Failed capital (% of total)	Induced failures	Contagion rounds	Absolute hazard	Hazard rate (%)
Intesa	94.8	23	29	3	10.0
Komercijalna banka	61.6	8	29	4	13.3
UniCredit	98.9	27	22	1	3.3
Raiffeisen	15.7			7	23.3
Société Générale	97.5	26	27	3	10.0
AIK	21.9			4	13.3
Eurobank EFG	17.4			4	13.3
Poštanska štedionica	3.4			1	3.3
Vojvođanska banka	20.8			5	16.7
Erste Bank	95.0	23	29	3	10.0
Sberbank	77.5	11	28	4	13.3
Hypo	29.0			0	0.0
ProCredit	43.7	5	30	4	13.3
Alpha	51.3	6	29	2	6.7
Crédit Agricole	53.4	7	30	8	26.7
Piraeus	16.1			5	16.7
OTP banka	7.8			4	13.3
Halkbank	2.8			7	23.3
NLB	4.4			4	13.3
Marfin	22.3			9	30.0
Findomestic	6.7			4	13.3
Opportunity	1.1			4	13.3
VTB	1.1			9	30.0
JUBMES	0.8			8	26.7
Srpska banka	0.5			5	16.7
KBM	0.6			9	30.0
Telenor banka	0.3			4	13.3
mts banka	3.2			9	30.0
Mirabank	0.2			2	6.7
Jugobanka	0.2			0	0.0

Source: Author's calculations

Table 4. Simulated transmission of credit shocks: LGD = 0.5

Shock originator	Failed capital (% of total)	Induced failures	Contagion rounds	Absolute hazard	Hazard rate (%)
Intesa	53.8	6	30	1	3.3
Komercijalna banka	30.5			1	3.3
UniCredit	95.7	24	29	0	0.0
Raiffeisen	12.3			2	6.7
Société Générale	66.3	8	26	1	3.3
AIK	15.2			1	3.3
Eurobank EFG	12.5			1	3.3
Poštanska štedionica	3.1			0	0.0
Vojvođanska banka	12.0			1	3.3
Erste Bank	45.1	5	29	1	3.3
Sberbank	31.5	1	29	1	3.3
Hypo	16.3			0	0.0
ProCredit	20.9	5	30	1	3.3
Alpha	22.3	6	29	0	0.0
Crédit Agricole	24.2	7	30	4	13.3
Piraeus	9.1			1	3.3
OTP banka	4.9			1	3.3
Halkbank	1.8			2	6.7
NLB	2.7			1	3.3
Marfin	11.4			4	13.3
Findomestic	3.7			1	3.3
Opportunity	0.7			1	3.3
VTB	0.7			4	13.3
JUBMES	0.6			3	10.0
Srpska banka	0.4			1	3.3
KBM	0.4			5	16.7
Telenor banka	0.3			1	3.3
mts banka	1.7			4	13.3
Mirabank	0.2			0	0.2
Jugobanka	0.2			0	0.2

Source: Author's calculations

Table 5. Simulated transmission of credit shocks:
NPL ratio in the private sector increases by 25%

Shock originator	Failed capital (% of total)	Induced failures	Contagion rounds	Absolute hazard	Hazard rate (%)
Intesa	10.4			2	6.7
Komercijalna banka	6.6			2	6.7
UniCredit	7.3			1	3.3
Raiffeisen	4.7			3	10.0
Société Générale	97.5	26	27	1	3.3
AIK	3.5			2	6.7
Eurobank EFG	3.5			2	6.7
Poštanska štedionica	1.8			0	0.0
Vojvođanska banka	2.7			2	6.7
Erste Bank	95.0	23	29	1	3.3
Sberbank	2.7			2	6.7
Hypo	2.2			0	0.0
ProCredit	43.7	5	30	2	6.7
Alpha	51.3	6	29	1	3.3
Crédit Agricole	53.4	7	30	4	13.3
Piraeus	1.3			2	6.7
OTP banka	1.2			2	6.7
Halkbank	0.8			3	10.0
NLB	0.5			2	6.7
Marfin	22.3			5	16.7
Findomestic	0.4			2	6.7
Opportunity	1.1			2	6.7
VTB	0.2			5	16.7
JUBMES	0.1			4	13.3
Srpska banka	0.0			2	6.7
KBM	0.1			5	16.7
Telenor banka	0.1			2	6.7
mts banka	0.1			5	16.7
Mirabank	0.0			1	3.3
Jugobanka	0.0			0	0.0

Source: Author's calculations

3.2. Credit shocks triggered by defaults in the private sector

Table 5 reports the results of the second set of simulations, corresponding to contagion effects originating from a credit shock triggered by non-performing loans to the private sector. The results are presented for a non-performance ratio of $\eta = 0.25$, corresponding to an increase in NPL ratio by a quarter. The contagion is now spread by only 5 banks, none of them within the major four. The highest potential for shock transmission would come from Société Générale and Erste Bank, resulting in 97.5 and 95.0 percent loss in total banking capital, respectively. Some of the moderate propagators of credit shocks in the first set of simulations, such as ProCredit, Alpha and Crédit Agricole, remain to be among the contagion transmitters, with an unchanged number of induced failures. Players with high hazard rates also remain relatively unchanged, once again emphasizing the specific role of network topology in transmissions of shocks.

3.3. Summary and concluding remarks

Our analysis has reinvigorated the conclusions of the similar works in the literature that the effects of interbank network topology on transmission of credit shocks could be a very useful tool for financial stability monitoring and surveillance of systemic risk. Both sets of simulations conducted in this chapter have indicated that systemically important financial institutions are not necessarily the largest ones, as naive intuition would suggest. We have also shown that the interbank linkages would spread any type of credit shocks triggered by defaults in the private sector. The results help us get a sense of how a potential financial crisis may unfold once the initial shocks have taken place.

Financial regulators and other institutions in charge of the systemic stability should focus on network effects resulting from interbank lending. This study is among many that point out the significance of identifying financial institutions that are too connected (rather than too big) to fail. It illustrates a way in which the perimeter of spillovers can be identified and how to distinguish which types of banks should be under regulatory scrutiny or offered a safety net. Network models can assist policymakers facing tough choices, such as how to design capital surcharges or identify financial institutions that should (and should not) be bailed out.

To the best of our knowledge, this is the first study of the role of interbank network topology conducted on Serbian data. Our results have pointed out the importance to collect and analyze these data in a more systemic way. Once again, we emphasize that our findings should not be used from its face value, certainly not for specific conclusions or policy measures regarding particular banks, but rather as an indicator of usefulness of the analysis of interlinkages between banks.

There are many avenues for potential extensions of this research. In particular, using the detailed dataset of interbank loans could render a more accurate picture of the interbank network topology. The Global Financial Crisis has shown that strong interlinkages exist not only within the banking sector, but perhaps as importantly, within the non-bank financial institutions. In addition, a more elaborate model that includes the network of firms would be more appropriate for understanding the propagation of shocks originating from defaults in the private sector.

Chapter 12.

RISK MANAGEMENT IN ISLAMIC BANKING

Banks today can be observed as financial supermarkets because degree and level of products and services that banks offer has changed significantly in the last twenty years. Uncertainty in financial markets, political turmoil in countries around the world, the emergence of the financial crisis, turbulence in foreign exchange markets are the factors that make the bank environment more risky as well as the conditions in which banks operate. Some reference studies show that conventional banks allocate approx. 53% of their economic capital to credit, 21% to the market and 26% on operational risk, repricing of assets and liabilities and other risks (Kozarević, 2015, 1). On the other hand, Islamic banks, according to 15 largest Islamic banks in the world (Khan & Ahmed, 2001), allocate approx. 26% of its economic capital on the market risk, 25% on operational risks, 25% on liquidity risk and 24% on the credit risk. Beside these "classical risks" Islamic banks are exposed to the specific risks in their operations, such as Shari'ah complaint risk, which complicates the operations of these financial institutions and makes them an attractive topic to explore, and in this regard the subject of this chapter is the analysis of risk faced by Islamic banks compared to conventional banks and how the process of risk management in Islamic bank is carried out.

Islamic financial system is not limited to Islamic banking; it covers capital formation, capital markets, and all types of financial intermediation and risk transfer. According to „*Islamic Financial Services Industry Stability Report 2015*“, the global Islamic finance industry's assets are estimated to be worth USD1.87 trillion as at 1H2014, having grown from USD1.79 trillion as at end of 2013. The largest segment of the global Islamic finance industry is the Islamic banking sector because the Islamic banks have increased the value of their assets by 600 billion US dollars in 2007 up to 1.3 trillion US dollars in 2012 (ECB, 2013, 19), achieving a growth rate of around 15-20%. Hence, the focus in this chapter is Islamic banking because it is its most developed part. Some of the key features of Islamic banking are as follows:

1. The operations of Islamic financial institutions are carried out in accordance with Islamic religious law *(Shari'ah),* which includes a complete set of rules and values, which clearly define every aspect of human existence and activity. Shari'ah is based on the holy book of Muslims, the Quran and the *Sunna*, the sayings and actions of the

Prophet Muhammad. That means that every product, service or transaction offered by Islamic banks must be in compliance with Shari'ah.

2. Islamic banks operate on the principle that every economic activity which is being implemented must have a basis in the real sector and the money is seen only as a medium of exchange, which means a strict ban on paying and charging of interest (arab. Riba) which means that Islamic banking is an interest-free banking. In their terminology Islamic banks use the term profit rather than interest because it is closer to the ethics underlying Islamic banking.

3. The parties are bound by agreement that includes the Profit and Loss Sharing Paradigm and Risk Sharing. This idea of sharing the risks of gains and losses means that the partners are considered equal.

4. Islamic economy forbids speculative activities, (uncertainty – arab. *Gharar*) in which the partners do not have enough information on the subject of the contract, for example, derivative securities (forward, futures contracts, options and other financial derivatives) because there is no certainty that the subject of the sale will actually exist in the moment when the trade has to be executed. *Maysir* (gambling) is also forbidden where in the *„zero sum- game"* one side wins and another losses where there is a transfer of wealth from one party to another without creating new values.

5. Any economic activity that the bank is undertaking must be approved by the Shari'ah Board, which is another specific of Islamic banks. "The Shari'ah Supervisory Board is comprising of Shari'ah scholars and advisors that should be independent and qualified to give rulings that pass moral judgment on proposed contracts and transactions as well as to ensure that business conducted is in accordance with with the requirements of the Shari'ah."[209]

The conventional financial system is focused only on the financial aspects of transactions, without taking into account the effort, knowledge and social effect that the transaction will have on community, while Islamic banking takes in account all of these elements including ethical, moral and social dimensions of financial activity. As en economic activity, Islamic banking is present in over 75 countries around the world, where some of the world's largest and most important banks such Citibank, HSBC, UBS provide Islamic banking services especially through *"Islamic windows",* which can be defined as specialized

[209] http://www.islamic-banking.com/glossary_I.aspx (Accessed: 20 March 2016).

setups within conventional financial institutions that offer only Shari'ah compatible instruments. Islamic windows contribute the internationalization of Islamic banking.

1. DEVELOPMENT AND GROWTH OF ISLAMIC BANKING

Islamic financial system began to develop when the process of decolonization started which resulted in the emergence of new countries with majority Muslim population. According to the Quran, trade is allowed and interest is forbidden what motivated Islamic scholars to make an alternative solution to conventional economy, which is based on interest, by creating a framework of interest-free business. It comes to the creation of two contracts: Mudarabah (profit- and loss-sharing contract) or Wakal (unrestricted investment account in which the Islamic bank earns a flat fee). The historical development of Islamic banking can be observed through the following events:

Table 1. Establishment of Islamic banks and institutions: a brief historical perspective

Year	Event
1963 (Egypt)	The first Islamic bank: **Mit Ghamr Savings**. Followed the model of German Savings Bank.
1963 (Malaysia)	**Pilgrims Fund Corporation** with the goal to enable Muslims from Malaysia to save money for the holy duty of Hajj
1971 (Egypt)	**Nasser Social Bank** – the first social bank and non profit institution.
1975 (Saudi Arabia)	**Islamic Development Bank -** the purpose to foster the economic development and social progress of member countries and Muslim communities individually as well as jointly in accordance with the principles of Shari'ah, i.e. Islamic Law. The present membership of the Bank consists of 56 countries
1975 (Dubai, UAE)	**Dubai Islamic Bank** – the first major Islamic commercial bank
1977 (Sudan)	**Faisal Islamic Bank of Sudan**
1977 (Egypt)	**Faisal Islamic Bank of Egypt**
1978 (Luxembourg)	**Islamic Finance House was established.**
1980	**Iran, Sudan and Pakistan** convert their conventional financial systems into Islamic financial systems
1981 (Saudi Arabia)	**The Islamic Research and Training Institute (IRTI) -** organizing and conducting basic and applied research with a

	view to developing models and methods for the application of Shari'ah in the fields of economics, banking and finance. **Islamic Fiqh Academy -** an initiative of the Organization of the Islamic Conference, the Islamic Fiqh Academy (IFA) is an international body of Muslim experts on subjects of both religious and secular knowledge.
1991 (Bahrain)	**AAOIFI (the Accounting and Auditing Organization of Islamic Financial Institutions)** - to do standardization and harmonization of international Islamic finance practices and financial reporting in accordance to Shari'ah.
1999 (Bahrain)	**The Dow Jones Islamic Market Index' (DJIM) -** this index combines Islamic investment principles with the transparency and rules-based methodology of the traditional Dow Jones Index. It covers thousands of blue chips, fixed income investments and indices arranged along thematic lines.
2000 (Malaysia)	Issuance of first domestic **Sukuk** - an Islamic bond that grants the investor a share of an asset along with the commensurate cash flows and risk.
2001 (Bahrain)	**Issuance of first international sovereign Sukuk**
2002 (Bahrain)	**International Islamic Financial Market -** a standard-setting organization for the Islamic Financial Services Industry focusing on standardization of Islamic financial contracts and product templates relating to the Capital & Money Market, Corporate Finance and Trade Finance segments of the industry.
2002 (Malaysia)	**IFSB (The Islamic Financial Services Board)** - an international standard-setting organization that promotes and enhances the soundness and stability of the Islamic financial services industry by issuing global prudential standards and guiding principles for the industry, broadly defined to include banking, capital markets and insurance sectors.
Current	Several other Islamic financial institutions (IFIs) were established: **International Islamic Rating Agency (Bahrain, 2005)** **International Islamic Centre for Reconciliation & Arbitration (2005)** **etc.**

Source: Authors

The development of Islamic Banking in Europe can be seen from the next table:

Table 2. Presence and the development of Islamic banking in Europe

Country	Description
France	Strong support by authorities Sukuk allowed in 2007 Compensation paid by Sukuk is deductible from taxable income Non-resident Sukuk investors are exempt from withholding tax in France No double stamp duties on Sukuk issuances Launch of Shari'ah compliant deposit schemes Tax regulation for Musharakah and Mudarabah High trade flow with Islamic countries Population originating from Islamic countries
Germany	First Western country to tap into the Islamic capital market in 2004 (Saxony-Anhalt Sukuk) In 2009 the regulator accepted a Shari'ah compliant banking operation request Largest Economy in Europe Strong demand for alternative sources of funding Trading partnership with Islamic countries (Turkey)
Italy	Islamic retail banking deposits are planned to rapidly increase (USD 5.8 billion by 2015; 33.4 billion by 2050) Generate significant revenues (USD 218 million by 2015; 1.2 billion by 2050) Plan to launch a "Mediterranean Partnership Fund" in collaboration with Arab governments and Islamic development bank
Ireland	Comprehensive tax treaty network Specific tax code for Islamic instruments Home to more than 50 world-class fund service providers Home to 20% of Islamic funds outside Middle East Easy access to European market
UK	Islamic financial activities started in 1980s First fully fledged Shari'ah compliant retail bank in Europe Major global provider of the specialist legal expertise required for Islamic finance Government Islamic Finance Task Force Abolition of double taxations in 2004 The whole Islamic financial sector operates under a single piece of legislation (Financial Services and Market Act 2000)

	Initiatives to ensure consistent regulatory treatment of Islamic finance with its statutory objectives and principles
Luxembourg	The Central Bank of Luxembourg is the only EU country that is an active member of the Islamic Financial Services Board First European country to list a Sukuk (2002) 16 Sukuk have been listed Strong government promotion to attract Islamic funds Flexible and efficient regime for securitization vehicles Second largest investment fund center in the world Regulated Islamic funds reaching USD 5 billion AuM Competitive pricing, incentives and access to European market

Source: Deloitte (2014). Islamic Finance in Europe, The 2nd International forum for Islamic banks and financial institutions.

When we talk about the region, there is only one Islamic bank, Bosna Bank International, based in Sarajevo, Bosnia and Herzegovina. Bosna Bank International (BBI) was established on October 19, 2000 as the first bank in Eastern Europe to operate on the principles of Islamic banking. The share capital of BBI amounted around EUR 23 million, which at that time, was the largest paid in capital compared to other banks in the country. The bank founders are Islamic Development Bank (the major shareholder of BBI with 45,46% share capital), Dubai Islamic Bank (shareholder of BBI with 27,27% of the share capital) and Abu Dhabi Islamic Bank (shareholder of BBI with 27,27% share capital). BBI bank in cooperation with its shareholders and other international partners, is organizing the Annual Investment Conference - Sarajevo Business Forum; gathering of businessmen and project owners from Bosnia and Herzegovina, Albania, Croatia, Macedonia, Montenegro, Serbia and Slovenia and from more than 30 countries worldwide.

The first Islamic Economics course was introduced in 1967 at Umm Durman Islamic University in Sudan and although the history of Islamic banking is relatively new, the importance of this business activity was recognized by the universities around the world both in the East and the West.

2. PRODUCTS OF ISLAMIC BANKING

Islamic banking, as a financial activity, has its own principles that every transaction includes the following:

1. There must be a mutual trust and transparency between the partners in every part of a transaction,
2. The use of Profit and Loss Sharing paradigm,

3. Ownership - you can sell the commodity or the subject of the contract only if you own it.

There are two main types of product: a) profit and loss sharing instruments (PLS) and b) mark-up (cost plus) contracts.

The further division would be the following:
a) sales based (Murabaha, Istisn'a, Ijarah, Tawarruq),
b) equity based (Musharakah, Mudarabah),
c) fee based (Wakalah, Kafalah, Rahn),
d) Islamic deposits (Wadai'ah, Qarḍ, Tawarruq),
e) Investment Accounts (Mudarabah, Musharakah) and
f) Investment Accounts (Wakalah).

Table 3. Basic contracts of Islamic banking

Contract	Description
Murabaha	A cost-plus sales contract; One of the most popular contracts for purchasing commodities and other products on credit; Used for short-term financing; The investor undertakes to supply specific goods or commodities, incorporating a mutually agreed contract for resale to the client and a mutually negotiated margin; The payment is delayed.
Salam	Deferred-payment sale (*bay' mu'ajjal*) and deferred-delivery sale (*bay'salam*) contracts, in addition to spot sales, are used for conducting credit sales. In a deferred-payment sale, delivery of the product is taken on the spot but delivery of the payment is delayed for an agreed period. Payment can be made in a lump sum or in installments, provided there is no extra charge for the delay. A deferred-delivery sale is similar to a forward contract where delivery of the product is in the future in exchange for payment on the spot market.
Istisnah	An istisnah contract facilitates the manufacture or construction of an asset at the request of the buyer. Once the manufacturer undertakes to manufacture the asset or property for the buyer, the transaction of istisnah comes into existence. Both parties—namely, the buyer and the manufacturer— agree on a price and on the specification of the asset to be manufactured. There is flexibility in regard to the payment, and it is not necessary for the price to be paid in advance
Leasing	Medium-term financing instrument;

(Ijarah)	Leasing is designed for financing vehicles, machinery, equipment, and aircraft. A contract of sale but not the sale of a tangible asset; it is a sale of the usufruct (right to use the object) for a specified period of time. The leasing agency must own the leased object for the duration of the lease and there is absence of compound interest.
Mudarabah	This is identical to an investment fund in which managers handle a pool of funds. The agent-manager has relatively limited liability while having sufficient incentives to perform. The capital is invested in broadly defined activities, and the terms of profit and risk sharing are customized for each investment. The maturity structure ranges from short to medium term and is more suitable for trade activities.
Musharakah	In conventional banking, this type of a contract can be compared with joint venture. Both entrepreneur and investor contribute to the capital (assets, technical and managerial expertise, working capital, etc.) of the operation in varying degrees and agree to share the returns (as well as the risks) in proportions agreed to in advance. Traditionally, this form of transaction has been used for financing fixed assets and working capital of medium- and long-term duration.
Qard Hassan	Qard Hassan is a type of loan with no fees and expenses, or loan to which it is obliged to return the same after a certain period. In essence it is donated or free credit. This type of loan is popular among students or groups of the population who are in poor economic condition.

Source: Van Greuning, H., Iqbal, Z. (2008). Risk Analysis for Islamic Banks. Washington DC: World Bank.

That Islamic banking is still a relatively new way of doing business is shown by the fact that there are some instruments, like Twarruq[210] model, where there is an open discussion among the scholars to whether they are Shari'ah-compliant or not. But nevertheless, Islamic banking has its own rules,

[210] Tawarruq is known as a "reverse or commodity Murabahah" operating by borrowing cash including two separate transactions. There are two basic types. The first type, "classical tawarruq", implies that an individual buys goods from a bank, deferred, which later sold to another person or a bank for money in order to obtain the necessary liquidity. The second type is "organized tawarruq" that involves a transaction in which an individual buys goods from Islamic banks on credit. It is a kind of standardized types such as metal or wheat.

instruments and mechanisms by which it differs from the conventional banking in the following:

1) the principles and ways of doing business are based on a Shari'ah law,
2) the money is seen only as a medium of exchange and it is prohibited to make money from money - there is no interest,
3) the use of profit rate,
4) it promotes risk sharing between the investor and entrepreneur,
5) the use of PLS paradigm,
6) transactions could only be asset based or asset backed
7) avoidance of economic activities including speculation,
8) participation in the partnership business,
9) in case of a default Islamic banking has no provision to charge any extra money,
10) penalty charged on defaults is given to NGO.

3. RISK RELATED TO ISLAMIC BANKS

Risk is a part of everyday human activity and the meaning of risk has changed during the time. Oxford Dictionary defines the term "risk" as a chance or possibility of danger, loss, injury or other adverse consequences. E. Vaughan & T. Vaughan (1999) defines risk as the situation which includes the probability of diverging from the paths that lead to the expected or common result. Conventional economy teaches us that there is a trade-off between risk and return; the greater the risk taken the higher the return is. Bank's business is to charge calculated risks and its competitive advantage depends on how well it manages risk. To quantifie risk we use risk measurement and to identify the amount of risk involved in some transaction we use risk management. In conventional banks risk management process is consisted of risk identification, measurement, mitigation, monitoring, reporting and control. Islamic banks have the same risk management like conventional banks.

Most common risks that bank faces are the following: credit, market, liquidity, and operational risks.

a) Credit Risk is a probability where a counterparty fails to meet its obligations in accordance with agreed terms and conditions of a credit-related contract. In conventional banking, credit risk is present in every transaction. In Islamic banking credit risk is more related to Istnah, Murabahah and installment sale because they are contract with a delayed payment.

b) Market Risk is a potential impact of unfavourable price movements, such as benchmark rates (interest rate risk), foreign exchange rates (FX risk), equity prices on the economic value of an asset (price risk). The risks relate to the current and future volatility of market values of specific assets. In Islamic Banking, market risk can be related to Ijarah contract when an residual value of a leased asset is being reduced.

c) Liquidity Risk is the potential loss arising from the Bank's asset and liability mismatches. To manage their liquidity risk, Islamic banks must have sufficient Shari'ah-compatible money market instruments avaliable.

d) Operational Risk is the potential loss resulting from inadequate or failed internal processes, people and system or external events. These type of a risk in Islamic banks can be related to a problem of cancelation in a murabahah contracts.

Islamic banks are faced with the same risks as conventional banks what can be seen from the next table.

Table 4. Basic risks in Conventional and Islamic banks

Type of financial risk	**Conventional banks**	**Islamic banks**
Credit risk	Default value at risk	Default value at risk Income expectation for sharing-based assets
Market risk	Volatility of market variables	A lower degree of market volatility
Liquidity risk	Maturity mismatches and alternative funding sources	Maturity mismatches and alternative funding sources
Operational risk	Hardware/system problems and fraud	Hardware/system problems and fraud, Compliance with Shari'ah rules, fiduciary risk

Source: ECB (2013). Islamic Finance in Europe. Frankfurt: European Central Bank.

In the history of Islam there is one situation with Prophet Muhammad that can explain the understanding of risk. One day Muhammad noticed a Bedouin leaving his camel without tying it and he asked the Bedouin, "Why don't you tie down your camel?" The Bedouin answered, "I put my trust in God." The

Prophet then said, "Tie your camel first, then put your trust in God." IFSB categorizes risks in Islamic Financial Institutions into six categories:

a) Credit risk,
b) Investment risk,
c) Market risk,
d) Liquidity risk,
e) Rate of return risk and
f) Operational risk.

Beside this „classical" risks there are some risks that are unique for the Islamic banks such as follows: displaced commercial risk, withdrawal risk, governance, fiduciary risk, transparency, Shari'ah risk, and reputational risks.

Table 5. Types of risks that are unique for the Islamic banks

Type of risk	Characteristic
Displaced Commercial Risk	A special risk Islamic banks are exposed in a situation when an Islamic bank is under pressure to pay its investors-depositors a rate of return higher than what should be payable under the "actual" terms of the investment contract. This can occur when a bank underperforms during a period and is unable to generate adequate profits for distribution to the account holders. There are some tools Islamic banks are using to mitigate this risk such as Profit Equalization Reserves (PER) and Investment Risk Reserve (IRR). „The PER is a mechanism act to mitigate the fluctuation of Rates of Return arising from the flux of income, provisioning and total deposits."[211] The formula for how much PER can be allocated is as follows: *PER (maximum monthly provision) = (15% x gross income) + net trading income + other income + irregular income such as recovery of non-performing financing (NPF) and write back of provisions.* On the other hand the investment risk reserve (IRR) „refers to the amount appropriated by an Islamic bank or financial institution out of the income of investment account holders (IAHs), after the mudarib share is allocated. This reserve is

[211] https://islamicbankers.me/focus/profit-equalisation-reserve-per/ (Accessed: 25 March 2016).

	used as a cushion against future losses that IAHs may incur."[212]
Withdrawal risk	This risk occurs as a result of competitive pressure from Islamic or conventional banks in terms that depositors of Islamic banks, due to higher rates of return offered by competitor bank, withdraw their deposits. If the trend of withdrawal the deposits continues and the bank continues to be given low returns, it may jeopardize the value of the bank.
Governance risk	This risk refers to the risk of poor management and govern the institution, non-fulfillment of contractual obligations and weak internal and external institutional environment.
Fiduciary risk	This risk arises from banks failure to do business activities in mismanagement of funds by the bank. The following are some examples of fiduciary risk: Mismanagement of the funds of current account holders, which are accepted on a trust (amanah) basis, can expose the bank to fiduciary risk as well. It is common practice for Islamic banks to use the funds of current account holders without being obliged to share the profits with them. However, in the case of heavy losses on the investments financed by the funds of current account holders, the depositors can lose confidence in the bank and decide to seek legal recourse.
Shari'ah risk	Shari'ah risk is one of the risk that distinguishes the Islamic banking from conventional banking. This risk is related to the structure and functioning of Shariah boards at the institutional and systemic level. Situations in which this risk appear are when IFI can't comply with Shari'ah rules and nonstandard practices of different contracts because of different jurisdictions. The best example of this situations is the case of Tawarruq model because some Scholars think this model is permissible while others think it is not permissible. The differences in opinion comes because of the

[212]http://investment-and-finance.net/islamic-finance/tutorials/differences-between-profit-equalization-reserve-and-investment-risk-reserve.html (Accessed: 1 April 2016).

	different schools of thought in Islam. There are four well-known schools of thought; Maliki (founded by Imam Malik Ibn Anas), Hanafi (founded by Abu Hanifah Numan ibn Thabit), the Syafi'i School (known after Al-Shafi‟i Mohammad ibn Idris) and the Hanbali School. While different schools of thought consider different practices to be acceptable, the bank's risk is higher in nonbinding cases and may lead to litigation in the case of unsettled transactions.
Transparency	This risk is related to lack of transparency when the public doesn't have reliable and timely information to make an accurate assessment of a bank's financial condition and performance, business activities, risk profile, and risk management practices. Transparency risk arises from the use of nonstandard conventions for reporting Islamic financial contracts and the lack of uniform set of standards.

Source: Van Greuning, H., Iqbal, Z. (2008). Risk Analysis for Islamic Banks. Washington DC: World Bank.

The relations between Islamic banking contracts and risk are given in the next table.

Table 6. Islamic banking contracts and risk

Contract	Type	Inherent risk
Ijarah	Debt-based	
Murabaha	Debt-based	Credit risk
Salam	Debt-based	Market risk
Istisnah	Debt-based	Operational risk
Musharakah	Equity-based	Credit risk Operational risk
Mudarabah	Equity-based	Displaced commercial risk Operational risk
Qard	Debt-based	Credit risk Displaced operational risk

Source: ECB (2013). Islamic Finance in Europe. Frankfurt: European Central Bank.

Islamic finance promotes financial transactions with links to the real economy. In that case every type of contract used in Islamic banking can change the shape and volume during the time of transaction what means that, for example, in the case of Murabaha or Istisnah the risks of financing may be transformed from credit to market and vice versa at different stages of the contract. Because of the special conditions in which Islamic banks operate and types of products they are offering it is for sure that risk they are facing will be higher in the future.

Conditions in which banks operate are significantly different compared to the previous period. This situation has become evident especially after the global economic crisis when the world market was shaken. Understanding of the risk has changed significatly but also the way of doing business. In that case many participants on financial markets saw an opportunity in Islamic finance. Although already present for a couple of years, Islamic finance started to be in the focus of public attention because of the principles that is based on.

The operations of Islamic financial institutions are carried out in accordance with Islamic religious law *(Shari'ah)* where every economic activity, which is being implemented, must have a basis in the real sector and the money is seen only as a medium of exchange. Interest, speculative and uncertain activities as well as gambling are forbidden. As en economic activity, Islamic banking is present in over 75 countries around the world, where some of the world's largest and most important banks such Citibank, HSBC, UBS provide Islamic banking services.

In 2014 global Islamic finance industry's assets are estimated to be worth USD1.87 trillion what is impressive if we consider the fact that first steps of crating and using Islamic banking date from 1963 when in Egypt first Islamic bank was opend. Sience then many Islamic institutions were found with a goal to develop and improve Islamic finance. Islamic financial institutions are special because of the rules that need to be accomplished such as that there must be a mutual trust and transparency between the partners in every part of a transaction, the use of Profit and Loss Sharing paradigm in certain types of contract and if you want to sell a commodity you must own it.

During the time Islamc financial instituons created the instruments that correspond the conventional financial instruments but that are based on the trade and not on money transactions. Trade is allowed and intrest is forbidden. In that case products of Islamic banking are sales-based (Murabaha, Istisn'a, Ijarah, Tawarruq), equity-based (Musharakah, Mudarabah), fee-based (Wakalah, Kafalah, Rahn), Islamic deposits (Wadai'ah, Qarḍ, Tawarruq), Investment Accounts (Mudarabah, Musharakah) and Investment Accounts (Wakalah). Each of this instrument has its specifics what has been explained in the text in details.

Because of the specific way of doing business, Islamic banks are faced with a different way of risk where, among the credit, market, liquidity and operational risk there are displaced commercial risk, withdrawal risk, governance, fiduciary risk, transparency, Shari'ah risk, and reputational risks. Each of these risks influences the business of the Islamic bank in a different way. In that term this is an ideal subject for further research.

Chapter 13.

BANKING UNION FOR DECREASING SYSTEMIC RISK IN EMU

According to Mundell[213], successfully introducing a common currency for a group of countries requires three conditions: there is no great asymmetry of shocks that affect given countries, the high degree of labor mobility and/or wage flexibility and centralized fiscal policy. Member countries can not use autonomous monetary policy as an answer to different shocks. If countries in the monetary union are affected by the same type of shocks, it will require a similar response from monetary policy. That is why the correlation of shocks in the monetary union is important. In the case of asymmetric shocks, a high mobility of labor between Member States can help, while the unemployed from the country hit by the recession could find job in other member countries. Similar effects would have a sufficient wage flexibility. If employed in a country affected by asymmetric shock are willing to accept lower wages, reduced labor costs would enable higher price-cost competitiveness of domestic products and the growth of economic activity. Alternatively, disorders caused by asymmetric shocks can be more lenient if there is a centralized fiscal authority, which will transfer tax revenues from the countries with good performances to the countries with worse results. This conditions are not met in EMU. Labor mobility is weak, wages show downward rigidity. There is no common fiscal authority.

Introducing common currency was expected to facilitate the convergence of economic performances in Euro zone member states. Unfortunately, that didn't happen. There was a divergence of economic performances between two groups of countries: group of mainly Southern European countries - Portugal, Italy, Ireland, Greece and Spain, on the one hand, and countries of mostly Northern Europe - Germany, the Netherlands, Austria, Belgium, Finland, Luxembourg and France, on the other hand. The lack of economic and fiscal convergence and thus progress toward optimum currency area, together with the lack of political union that would support the project of monetary union, had a consequence that the euro area doesn't have a sufficient level of homogeneity. Financial and debt crisis revealed systemic weaknesses in the functioning of EMU.

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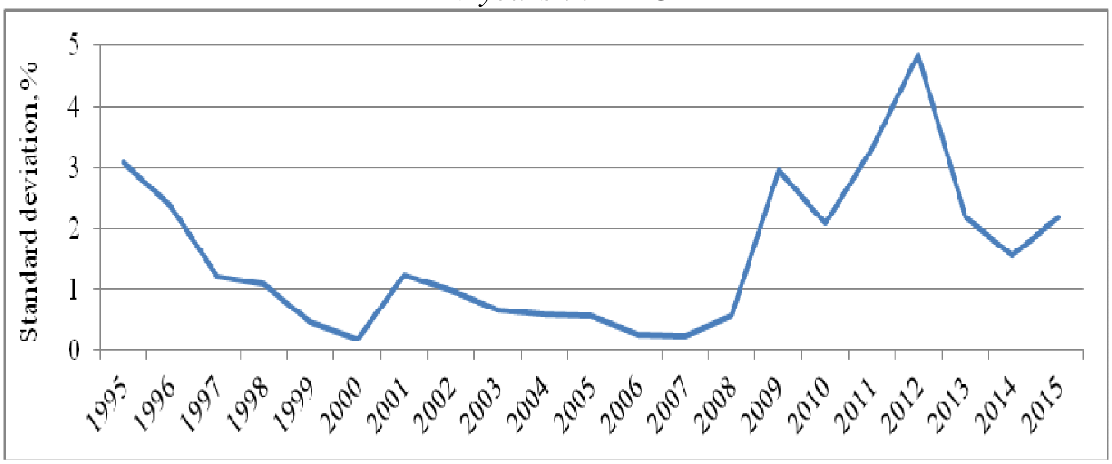
[213] Popović, S., Bošković O. (2012). Teorija optimalnog valutnog područja i Evropska monetarna unija. *Ekonomska politika i razvoj*. Belgrade: Faculty of Economics, University of Belgrade, p. 1-2.

1. FINANCIAL CONVERGENCE IN EMU

The convergence process in EMU was the most intense in financial sector. Before crisis, cross border capital mobility was high, as a result of the single financial market. Interest rates on government bonds with 10 years maturities converged significantly, as a result of decreasing yields of peripheral countries, thanks to the elimination of currency risk. Graph 1. shows the differences in government bond yields, measured by the standard deviation.

Graph 1. Dispersion of interest rates on government bonds with maturities of 10 years in EMU

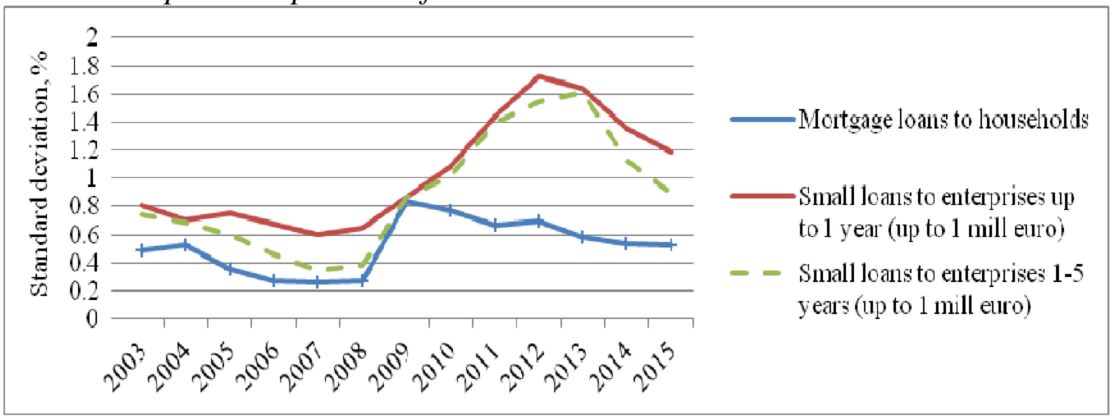


Source: Author calculations based on Eurostat Database, European Commission: http://ec.europa.eu/eurostat/data/database

Higher degree of convergence was achieved also on bank credit markets, since there is a significant reduction of differences in bank interest rates on observed loans to companies and households. Yet on credit markets convergence process was slower than in the bond market, since interest rate differentials are slightly larger (Graph 2). Probably this is the result of the local nature of the information needs of lenders, as well as the heterogeneity of the borrowers.

Crisis led to significant divergence in financial markets. Although the differences in observed interest rates levels in the last few years declined, they remained at a level significantly above the pre-crisis. Credit markets are of great importance for finansing companies in EMU. Further integration process on credit markets requires regulator interventions. It should remove the remaining bariers to financial convergence, but also high risks of jeopardizing financial stability (with higher financial integration, shocks spred more quickly).

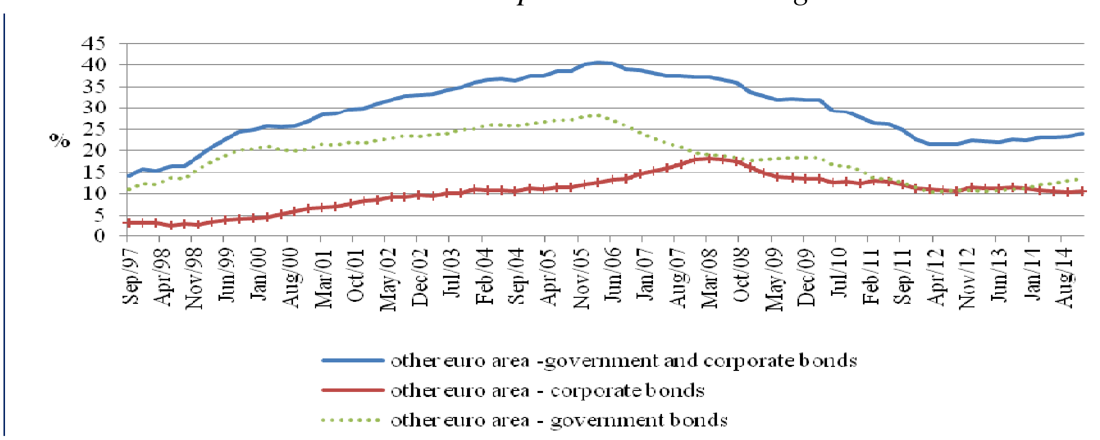
Graph 2. Dispersion of interest rates on bank loans in the EMU



Source: Author calculations based on Eurostat Database, European Commission: http://ec.europa.eu/eurostat/data/database

The increase in financial integration is facilitating the convergence of business cycles, because it is a part of adjustment mechanism to idiosyncratic shocks. Cross-border portfolio diversification supports equalizing income and consumption over time, the more efficient reallocation of capital and more uniform spread of ECB monetary policy. That way, financial integration mitigates asymetric shocks through capital flows.

Graph 3: Share of MFI cross-border holdings of debt securities issued by euro area and EU corporates and sovereigns

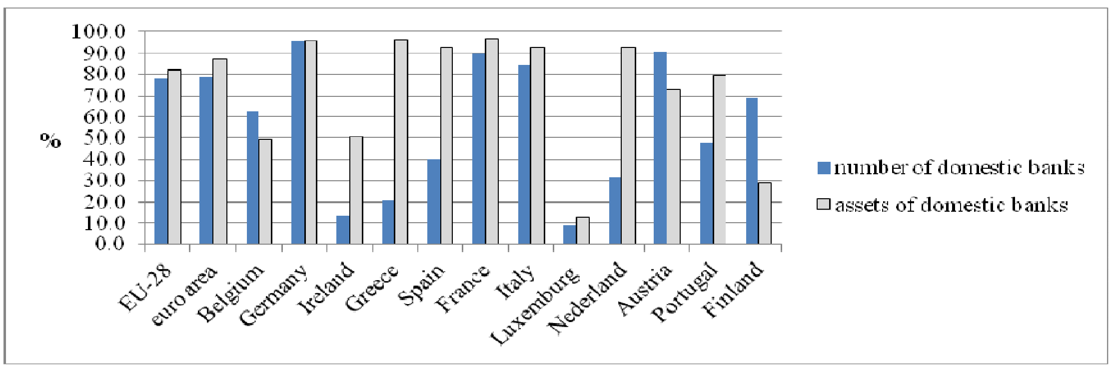


Source: European Central Bank. Financial integration indicators: https://www.ecb.europa.eu/stats/finint/html/index.en.html

Economic agents in a country affected by negative shocks can borrow from countries that experienced a positive shock or can sell foreign assets, which evens intertemporal consumption, and reduces the variations among a given group of countries. A shown in Graph 3, untill mid 2006, financial integration in EMU was increasing (for corporate bonds until mid 2008). After that banking sector started to “withdrew behind national borders”, which made EMU more sensitive to shocks.[214]

Crises led to significant fragmentation of EU single market. One of the explanations, according to Geeroms and Karbownik is the fact that EU banks are dominantly national owned banks. Graph 4. shows the share of domestic owned banks in total number of banks and the share of assets owned by domestic banks in total assets of the banking system, in June 2014. In Euro area, as well in EU, only slightly above 20% of total number of banks are foreign-controlled subsidiaries and branches. The largest states- Germany, France and Italy have the smallest proportion of foreign owned banks (and bank assets).

Graph 4. The number and assets of domestic owned banks as a share of total bank number and assets



Source: European Central Bank. Statistical Data Warehouse: http://sdw.ecb.europa.eu

Domestic banks are supervised by national prudentional authorities, that set rules on their banks, having in mind domestic situation and needs, which is resulting in restrictions on international capital flaws. In order to have a shock absorber that would prevent or diminish destabilising capital flows, Monetary union needs banking union.

2. INTERDEPENDENCE BETWEEN BANKING AND SOWEREIGN CRISIS

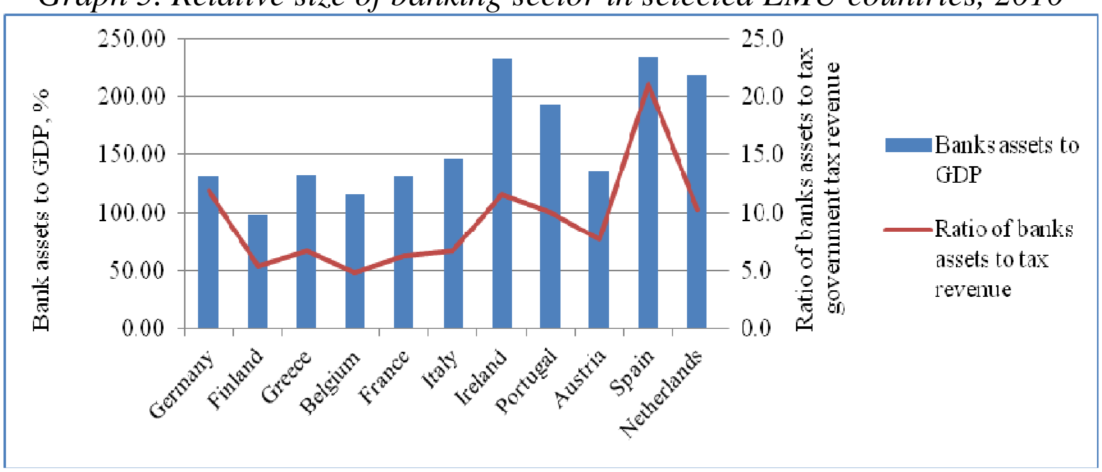
An important cause of significantly higher intensity of crisis in the euro area, compared to other economies, is a strong interdependence between the banking and sovereign crisis. In EMU, when the crisis emerged, there was no

[214] Geeroms, H., Karbownik, P. (2014). A Monetary Union Requires a Banking Union. *Bruges European Economic Policy Briefings,* 33/2014. College of Europe, Department of European Economic Studies, p. 14.

supranational banking resolution framework. ECB didn't have the role of the lender of last resort, and national governments where responsible for rescuing their national banking system. Considering the size of the national banking systems, that placed a heavy burden on government budgets. On the other side, national banks have high holdings of national sovereign debt, so raising investors doubts about the sustainability of national public debt puts pressures on their balance sheet. This "doomed loop" between banks and sovereignes makes euro area more vulnerable to self fulfilling spiral of market expectations and intensity of crisis.

In European monetary union, both channels of contamination are identified- from banks to sovereigns and from sovereigns to banks. With the rise of expected bank losses increases the pressure on the sovereigns because the expected costs of bank bailouts are higher. So, having in mind that bank resolution costs are borne by national states, in the environment of rising stress and uncertainty, markets raise doubts on sovereigns capacity to pay off their debts. Such fear of investors is not unjustified considering the relative size of banking sector (Graph 5). Some countries have high presence of large banks with significant cross- border businesses. Costs of recapitalizing such banks place significant burden on the tax revenues of these countries.

Graph 5. Relative size of banking sector in selected EMU countries, 2010

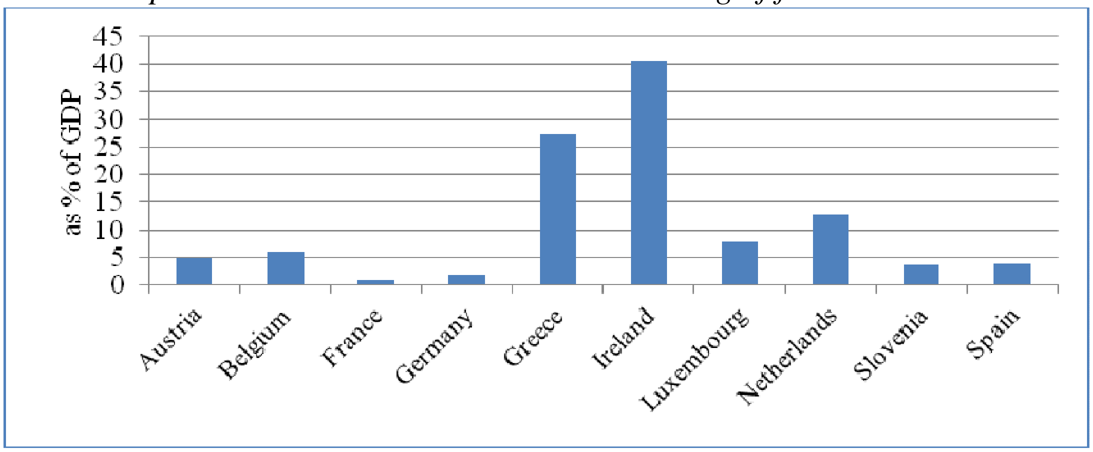


Source: The Worldbank: http://data.worldbank.org; The Milken Institute Center for Financial Markets, Globalbanking.org, http://www.globalbanking.org/global banking.taf?section=data-set&set=gfd&data=years

Graph 5 shows high level of financial intermediation in some countries- like Ireland, Spain and Nederlands, where the level of bank assets is more than double of the countries GDP. Secondary vertical axes shows the ratio between bank assets and government tax receipts, which are supposed to compensate for losses. In 2010. in some countries ratio was very high- in Spain, banks assets was more than 20 times higher than government tax receipts.

According to European Commission data, in the period from October 2008. to December 2012, European governments spent 1,6 trillion euro to save their banks. That is amount equal to 13% of EU annual GDP[215]. In some countries, the costs of rescuing banks were enormous compared to GDP. Graph 6. shows fiscal costs for the restructuring of the financial sector, as the percentage of countries GDP. They include fiscal costs associated with bank recapitalizations, but exclude asset purchases and direct liquidity assistance.

Graph 6: Fiscal costs related to restructuring of financial sector



Source: Laeven, L., Valencia, F. (2012). Systemic Banking Crises Database: An Update, IMF Working Paper, WP/12/163, jun, p. 24-26.

In Ireland, direct state support to domestically owned banks amounted to 62,8 billion euro until the mid of 2011, which is more than 40% of GDP in 2010[216]. Beside this, European Commission estimates the total cost of bank collapse for private sector in Ireland round 65 billion euro. As a consequence, the country with very sound public finance- with government debt to GDP ratio of 23,9% and government net borrowing to GDP ratio of only 0,3% in 2007, became highly indebted country, with ratios 86,8% and 32,3% respectively, in 2010 (Graph 7). Government debt- to-GDP ratio reached a pick in 2012- slightly more than 120%. Beside Ireland, ratio of debt-to-GDP higher than 120% in 2012 had Greece (159,4%), Portugal (126,2%) and Italy (123,2%).

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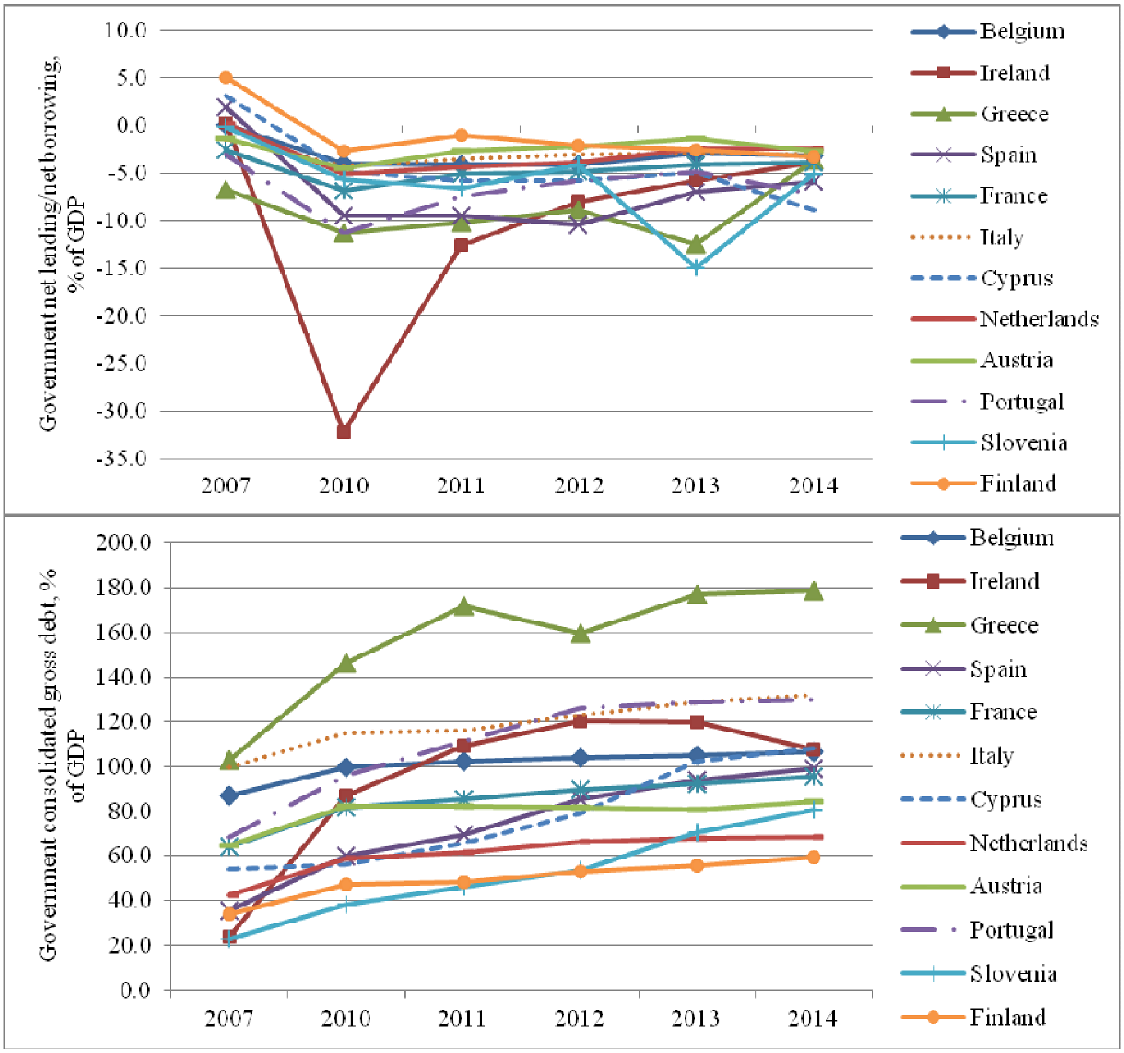
[215] EU Commission (2016). *Responding to the financial crisis*. Brussels: European Commission, http://ec.europa.eu/ economy_finance/explained/the_financial_and_ economic_crisis/responding_to_the_ financial_crisis/index_en.htm, 01.04.2016.

[216] EU Commission (2011). Economic Adjustment Programme for Ireland. Autumn 2011 Review. European Economy. *Occasional Papers,* No.88. p. 18.

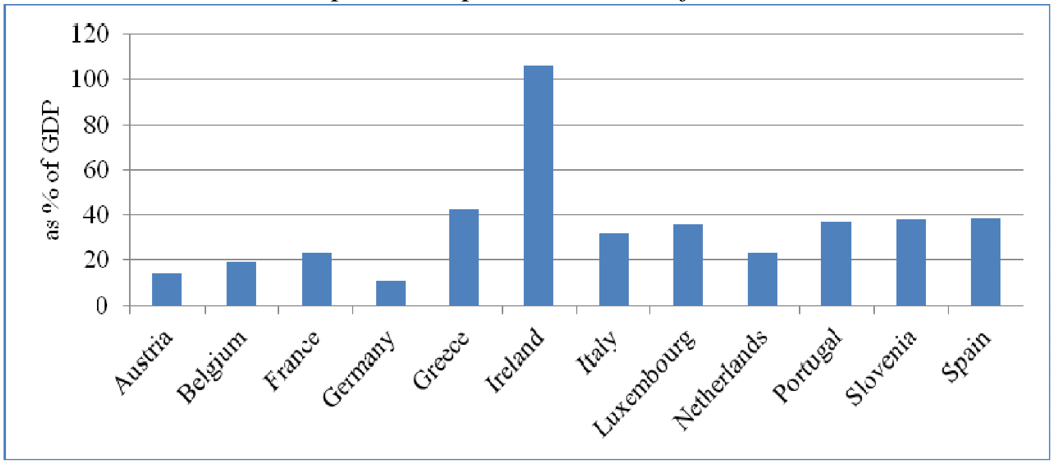
Graph 7. Change in public finance as a consequence of financial and debt crisis in selected EMU states



Source: Eurostat. European Commission: http://ec.europa.eu/eurostat/data/database

Not all increase in government debt is due to costs of rescuing banks. Part of those debts is the result of indirect economic costs, especially drop in tax revenues due to worsening of the economic conditions. Unfortunatelly, banks also have an important role in determining economic situation. If banks are under stress, illiquid, with hudge losses and forced to deleverage, they will cut credit to non financial sector. That decreases the aggregate demand, diminishes growth rates and prospects and leads to decrease in tax revenues, which raises doubts about public finance. In EMU, new regulations and capital standards, introduced in 2013 also influenced deleveraging proces and tightening bank credits. Graph 8. shows output loss in percent of GDP. Output losses are computed as the cumulative sum of the differences between actual and trend real GDP over the period [T, T+3], expressed as a percentage of trend real GDP, with T the starting year of the crisis.

Graph 8. Output loss, as % of GDP



Source: Laeven, L., Valencia, F. (2012). Systemic Banking Crises Database: An Update. IMF Working Paper. WP/12/163. june, p. 24-26.

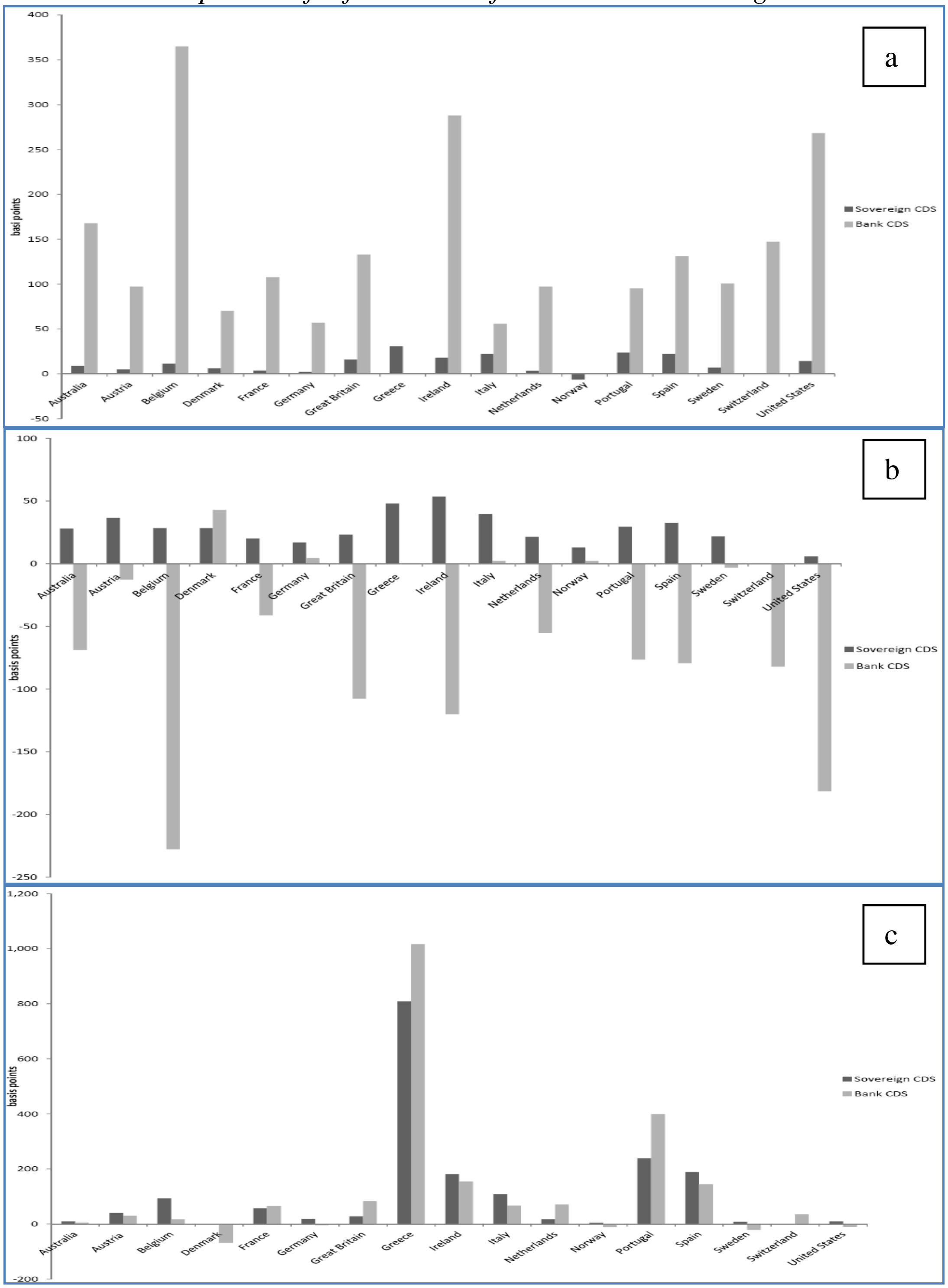
The bank crisis in Ireland was the costliest, both in terms of fiscal costs and output loss. Ireland was the most affected during the recent global financial and the Eurozone crisis. In the decade before the financial crisis, it had very high GDP growth rates, and its financial system experienced rapid expansion. The crisis has been caused by large housing price and mortgage credit bubble, triggered by low interest rates after the introduction of euro. The Irish government, encouraged by European authorities, guaranteed almost all bank liabilities which, when crisis emerged added substantially to government debt.

When, in september 2008 government announced nationalization of Anglo-Irish bank, which is relatively small, but systemically important for Ireland, it was a clear sign to financial markets that important banks would be rescued by governments[217]. That increased the focus of markets on domestic factors like the outlook of financial sector when pricing sovereign risk. Acharya, Drechsler and Schnabl[218] show that the announcement of financial sector bailouts led to shift of credit risk from banks to governments. They have studied the interdependence of banks and sovereign CDS in the period from 2007 to 2011.

[217] Merler, S., Pisani-Ferry, J. (2012). Hazardous Tango: Sovereign-bank Interdependence and Financial Stability in the Euro Area. Public Debt, Monetary Policy and Financial Stability. *Banque de France, Financial Stability Review*. No.16. April, p. 4.

[218] Acharya, V., Drechsler, I., Schnabl, P. (2012). A Pyrrhic Victory? Bank Bailouts and Sovereign Credit Risk, https://www.ecb.europa.eu/events/pdf/conferences/intmacfin/3.3_Schnabl_paper.pdf?4e401bca6487c5ddf708b7363db9bdbe, pp.1-4.

Graph 9. Shift of credit risk from banks to sovereigns



Source: Acharya, V., Drechsler, I., Schnabl, P. (2012). A Pyrrhic Victory? Bank Bailouts and Sovereign Credit Risk, https://www.ecb.europa.eu/events/pdf/conferences/intmacfin/3.3_Schnabl_paper.pdf?4e401bca6487c5ddf708b7363db9bdbe.

When the crisis emerged, untill the anouncement of the first bail out in Ireland, Acharya et al. found large, sustained rise in bank CDS, but sovereign CDS spreads remain very low (Graph 9-a). This was the period of significant increase in the default risk of the banking sector, but with little efect on sovereigns. Graph 9-b covers the period from end of September to end of October 2008, when sovereigns bailed out banks. It shows the decline in bank CDS in all observed countries and a corresponding increase in sovereign CDS, which proves that bank bailouts produced a transfer of default risk from the banking sector to the sovereigns. In the period following the bank bailouts, until 2011 (Graph 9-c), both sovereign and bank CDS increased. Authors found larger increase for countries whose public debt ratios were higher and whose financial sectors were more distressed in the pre-bailout period. They also found a strong, positive relationship between public debt ratios and sovereign CDS, in postbailout period, which is confirming that the bailouts shifted banks' credit risk to the sovereigns and triggered the rise in sovereign credit risk.

Similar conclusions were found by Gomez-Puig at al.[219]They used Contingent claim analysis to study the interconnection between bank and sovereign risk in EMU, and Granger- causality to test which channel of contamination prevailed in a given period. They found that after the emerging of financial crisis and government support to financial institutions (fourth quarter of 2008) the direction of contamination was in majority of cases from banks to sovereigns.

In the case of France, Greece and Ireland, that was the only channel of contamination, for Portugal and Netherlands this channel was identified in more than 70% of episodes, in Spain, Italy and Austria there was a similar number of episodes of both channels of contagion. In Belgium and Finland contagion spread mostly from sovereigns to bank. In the period from Q4 2009 to Q3 20011, when sovereign debt crisis reached a peak and rescue packages for Greece, Ireland and Portugal were provided, authors found contagion spread from banks to sovereigns in all South countries. In Italy and Portugal also other channel of contamination was active- from sovereigns to banks, but this was the dominant channel of contagion in North countries- Austria, Belgium, Finland and Netherlands. Sudden fall in investor confidence and the fear of the contamination spread in the euro zone, influenced the flight of investors into safe German Bund, resulting in higher yield spreads, not just between South and North members, but also between some North countries. Higher sovereign risk was shifted to banks which held significant amounts of sovereign debt. In the

[219] Gomez-Puig, M., Sosvilla-Rivero, S., Singh, M. (2015). Sovereigns and Banks in the Euro Area: a Tale of two Crisis. *Research Insitute of Applied Economics. Working Paper* 2015/04 1/52. Universitat de Barcelona.

period from Q4 2011 to Q2 2012, there were more episodes of contagion from bank to sovereigns in South members- Greece, Ireland, Italy and Portugal. This was the period when ECB reintroduced some of unconventional monetary policy measures as a response to a new wave of strengthening the financial and debt crisis. More than a half of ECB liquidity went to banks from 3 countries- Greece, Ireland and Portugal, and partly was used to increase the holdings of sovereign debt! That increased further their interdependence. From July 2012. both channels of contamination were active, and they were amplified by week economic growth.

Channel of contamination from sovereigns to banks arises from the fact that banks in euro area hold a large portion of their national sovereign bonds, although the share of MFI cross-border holdings of debt securities issued by EMU and EU corporates and sovereigns increased. As a consequence, a stress on sovereign debt market shifts quickly over the national banking system. Table 1. shows that in some EMU countries bank holdings of national government securities was very high before the crisis, in Germany it was almost 30%, in Spain more than 20%, in France, Italy and Greece more than 10%. Regulation encourages banks to invest in these securities, because they are considered as investment without risk and used as a collateral in various loans- from the central bank and on the interbank market. Bonds issued by South member sovereigns were popular by foreign investors also, due to higher yields. Although introducing euro decreased significantly sovereign spreads across member states, they still were not perfect substitutes.

ECB[220] stressed that one of the most immediate effects of the euro area sovereign debt crisis had been on the bank funding conditions. Decreasing the quality of government debt weakens bank balance sheets, which increases their riskiness as counterparties and makes funding more costly and more difficult to obtain. Beside, higher sovereign debt risk reduces the value of collateral that banks can use to raise wholesale funding. About 30% of euro area banks attributed the deterioration of funding conditions to the sovereign debt crisis, mostly through the effect of reduced collateral value. Also weaker financial positions of governments have lowered the bank funding benefits from implicit or explicit government guarantees. Existence of such government guarantees for banks increases the pressure on sovereigns, but also on banks, because they are more difficult to be granted if sovereigns have huge and rising debt burden. On the other side, having in mind that bank resolution is on governments only, those bank guarantees are more likely to become a new government liability.

[220] ECB (2012). *The Euro Area Bank Lending Survey*. January, p.11.

Table 1. Breakdown by sector of holdings of government securities

	Domestic banks		Central bank		ECB		Other public		Other residents		Non-residents	
	2007	2011	2007	2011	2007	2011	2007	2011	2007	2011	2007	2011
Greece	10.6	19.4	1.4	2.6	…	22.9	11.3	10.1	2.9	6.5	73.8	38.5
Ireland	2.6	16.9	n/a	n/a	…	16.1	0.3	0.9	3.9	2.4	93.1	63.7
Portugal	9.1	22.4	0.0	0.8	…	11.2	…	…	15.0	13.5	75.9	52.1
Italy	12.1	16.7	4.6	4.8	…	6.4	…	…	34.2	29.3	49.1	42.8
Spain	21.1	27.0	2.6	3.2	…	5.4	7.6	10.2	20.9	20.0	47.7	34.2
Germany	29.7	22.9	0.3	0.3	…	…	0.0	0.0	20.6	14.1	49.4	62.7
France	13.0	14.0	n/a	n/a	…	…	…	…	32.0	29.0	55.0	57.0
Netherlands	8.9	10.7	n/a	n/a	…	…	0.4	1.1	21.4	21.4	69.2	66.8
UK	-1.6	10.7	0.5	19.4	…	…	0.2	0.1	68.5	39.5	32.5	30.2
US	1.4	2.0	8.2	11.3	…	…	50.0	35.5	14.9	19.9	25.5	31.4

Source: Merler, S., Pisani-Ferry, J. (2012). Hazardous Tango: Sovereign-bank Interdependence and Financial Stability in the Euro Area. Public Debt, Monetary Policy and Financial Stability. Banque de France, Financial Stability Review. No.16, p. 7.

Table 1. shows the influence of crisis to sector structure of sovereign debt holdings. For South member countries there is a significant drop of government debt holdings by non-residents, which proves that investors tended to pull back behind national boundaries, and that there is a strong disintegration of European financial market along national borders. German Bund was a safe heaven, the proportion of German debt held by non-residents increased significantly. What is worrying is the increase of national debt holdings by domestic banks in all problematic South countries. The size of bank sovereign debt holdings in Italy reached one-third of GDP, in Portugal, Spain and Greece one fifth, in the second half of 2011[221].

Financial and debt crisis revealed some systemic weaknesses in the design of EMU bank regulation and resolution framework. They are the crucial cause of interdependence between the banking and sovereign crisis, which makes Euro area more vulnerable to self fulfilling spiral of market expectations and intensity of crisis. To stop a loop between banks and sovereigns, euro area countries need credible source of unconditional liquidity- lender of last resort that is able to provide liquidity when it is needed and in any necessary amount. Beside, avoiding future market distortion requires both national and supra-national efforts. Creating banking union should move supervision of national and internationaly important banks and the responsibility for rescuing them to European level. That should halt both channels of contamination- from banks to sovereigns and from sovereigns to banks in the situation of financial crisis.

3. BANKING UNION AS SOLUTION TO EURO ZONE CRISIS AND EUROPEAN INTEGRATION PROCESS

As the response to eurozone crisis, significant reforms were introduced at EU level[222]:

1. Regulations which formed European System of Financial Supervision (ESFS) in 2010. ESFS consists of European Systemic Risk Board (ESRB), European Banking Authority (EBA), European Securities and Markets Authority (ESMA) and European Insurance and Occupational Pensions Authority (EIOPA);

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[221] Merler, S., Pisani-Ferry, J. (2012). Hazardous Tango: Sovereign-bank Interdependence and Financial Stability in the Euro Area. Public Debt, Monetary Policy and Financial Stability. *Banque de France, Financial Stability Review*. No.16, p. 8.

[222] Cavallo, G.M.R. (2014). European Banking Union: An Immediate Tool for Euro Crisis Management and a Long-Term Project for the Single Market. *Istituti Affari Internazionali, IAI Working Papers.* 14/11-October, p. 6-7.

2. The Capital Requirements Directive IV package (CRD IV) which introduced the new global standards on bank capital (Basel III Agreement) into the EU legal framework, and which entered into force on 17 July 2013;
3. The Bank Recovery and Resolution Directive (BRRD) adopted on 15 April 2014, where the tools for dealing with bank crises across the EU have been harmonised and upgraded;
4. The recast of the Directive on Deposit Guarantee Schemes (DGS) to strengthen further the protection of depositors.

The establishment of European Banking Authority contributed to better cooperation of national supervisors and harmonizing regulation for financial services. Unfortunately, some problematic issues remained- bank supervision and resolution is left at the national level and that was crucial for developing the interdependence between bank and sovereign crisis.

Therefore, the Euro zone authorities recognized the need for better coordination of the economic policies for stronger cooperation and integration of member states. On the 26 June 2012. President of the European Council, together with the Presidents of the Commission, the Eurogroup and the European Central Bank presented a report[223] that set a roadmap to strengthen the economic performances of EMU. Report recognized the fact that euro area is quite diverse and that often economic decision are made on the national level, but their effects quickly spread to the euro area level. That is why it is very important to reach some level of convergence in order to have monetary union to function effectively. Report proposes four building blocks:

1. An integrated financial framework to ensure financial stability and minimize costs of bank failures-Banking union.
2. An integrated budgetary framework which would be a move towards a fiscal union. It should ensure sound national and European level fiscal policy, encompassing coordination and joint decision making. This framework could include some forms of fiscal solidarity and steps towards common debt issuance.
3. An integrated economic policy framework as necessary supplement to banking and fiscal union. It should ensure that national and European economic policies facilitate sustainable economic growth, employment and competitiveness, to foster economic convergence and smooth functioning of EMU.

[223] Van Rompuy, H. (2012). Towards a Genuine Economic and Monetary Union, European Council. EUCO 120/12. Brussels.

4. Democratic legitimacy and accountability of decision making within the EMU, which would be a step towards a political union.

It is recognized that banking union is necessary for the successful and well functioning EMU. The soundness of bank's balance sheet is crucial in providing adequate credit to the economy, and thus for investment and demand. This is especially important for eurozone countries, since banks finance around 75% of eurozone economy[224]

4. PILLARS OF BANKING UNION

Banking union is based on three pillars: a single supervisory mechanism (SSM), a single Resolution Mechanism (SRM) and a European deposit insurance scheme (EDIS).

The first Pillar- the single supervisory mechanism started on 4 November 2013[225]. Its goal is to establish an independent and powerful institution for supervising European banks, that would be independent from national political factors. It should reduce the moral hazard problem stemming from the fact that banks were motivated to engage in riskier activities knowing that domestic governments would rescue them, since they are too big (for their national economy) to fail. SSM is based on the principle that not all banks would be bailed out, which puts pressure on reducing their risk. ECB is responsible for supervising all banks in Europe, but it will directly supervise all significant banks. Significant banks are defined as banks with assets of more than 30 billion euro or at the least 20% of their home country GDP- around 130 banks. Less significant banks will be monitored by national supervisors, who will be accountable to the ECB. ECB can decide to directly supervise any of these credit institutions.

The problem of deteriorating bank balance sheet should be resolved more quickly. The banks in trouble will be immediately submitted under control and more detailed examined by ECB. Bank bankruptcy procedures should be shorter.

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224 Geeroms, H., Karbownik, P. (2014). A Monetary Union Requires a Banking Union. *Bruges European Economic Policy Briefings.* 33/2014. College of Europe, Department of European Economic Studies, p. 5.

225 EU Commission (2014). A Comprehensive EU Response to the Financial Crisis: Substantial progress Towards a Strong Financial Framework for Europe and a Banking Union for the Eurozone. *MEMO/14/244.* Brussels: European Commission.

SSM will monitor the implementation of Basel III standards. Banks are obliged to reconstruct their balance sheet in order to increase the level and quality of their capital. The Common equity Tier 1 ratio should increase to 4,5% in 2015 and 7% after 2016 (adding Capital conservation buffer of 2,5 % and Counter cyclical capital buffer of 0-0,25%, starting from 2016), Tier 1 will increase from 4 to 6% in 2015 and than 8,5%. This means that total capital should increase from 8 to 10,5% after 2016[226]. ECB is in charge for coherent and consistent application of the single rulebook in the euro area. The Rulebook is prepared by EBA, and it provides a single set of harmonized prudential rules for the EU financial sector that should complete the single market in financial services. This will ensure uniform application of Basel III in all Member States[227].

In order to preserve the credibility of ECB, the SSM regulation includes compulsory Comprehensive Assessment procedure (CA), to ensure that the banks are adequately capitalized and can withstand possible financial shocks. That is a risk assessment exercise of the banks balance sheet, in order to determine all types of risks present in funding, liquidity, management, business model etc. (it was conducted in Q3 of 2013 for the first time). CA consists of two main pillars: an asset quality review (AQR) that should enhance the transparency of bank exposures, including the adequacy of asset and collateral valuation and related provisions and a stress test to test the resilience of banks' balance sheets, conducted together with the European Banking Authority. According to ECB[228], CA should increase transparency thanks to better quality of information on bank conditions available, identify problems and implement necessary corrective action timely, and restore confidence in banks. This should facilitate better functioning of the interbank market, banking channel of monetary policy transmission mechanism and reduce interest rates differentials.

The second Pillar of bank union is the Single resolution mechanism (SRM), that became fully operational from the beginning of 2016 and implements the EU-wide Bank recovery and resolution directive (BRRD). Its task is the resolution of failing banks with minimum consequences on the real economy and on public finances[229]. It should change bank bail-out trend into bail-in. It has a

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226 PWC (2016). Banking Regulation: Understanding Basel III with the CRD IV navigator. http://www.pwc.com/gx/en/industries/financial-services/regulation/basel-iii/basel-iii-crdiv-navigator.html

227 EBA (2016b). *The Single Rulebook,* London: European Banking Authority, http://www.eba.europa. eu/regulation-and-policy/single-rulebook, 03.04.2016.

228 ECB (2016a). *Comprehensive Assesment*, Frankfurt: European Central Bank, https://www.bankingsupervision.europa.eu/banking/comprehensive/html/index.en.html, 03.04.2016.

229 The Single Resolution Board, http://srb.europa.eu/en

crucial role in breaking the loop between bank and sovereign crisis, beacuse tax payers money wouldn't be used any more for rescuing of troubled banks. There is a ranking order in bail-in procedure. First, all ordinary, unsecured, non-preffered creditors are bailed-in, like shareholders, bondholders and deposits from large corporations. If that is not sufficient, next for bail-in are large deposits from households and SMEs. Deposits up to 100.000 euro are protected. Covered bonds, liabilites to employees, liabilities from payment operations and some interbank liabilities are also excluded from bail-in. Shareholders, creditors and large deponents would be liable for absorbing losses that amount up to 8 % of total bank liabilities[230]. If that sum is not sufficient to cover all losses, the rest should be covered from the Single resolution fund (SRF). All financial institutions in participating member countries are obliged to pay contributions in this fund based on their liabilities, adjusted for risk. The targeted level of this fund is 55 billion euro and it should be reached in the period of 8 years. This fund should ensure medium term funding while bank is being restructured.

Another important element of SRM is the Single Resolution Board (SRB), that is in charge of drafting resolution procedures. ECB via SSM notifies to the SRB possible troubled banks and Board decides about placing a bank into resolution. It decides on the application of resolution tools and the use of SRF. Its decisions, if Council doesn't object, enter into force within 24 hours.

The third pillar of banking union is the European deposit insurance scheme (EDIS). Banking union needs a single deposit guarantee scheme, in addition to the single supervisory mechanism and the single resolution fund. Its aim is to renew the confidens of deponents in the banking system and thus prevent the posibility of bank rush. In March 2016, European Commission published its proposals[231] to introduce common deposit insurance system as of 2024. It will be introduced gradually, in three separate phases between 2017 and 2024, complementing national deposit guarantee schemes. EDIS will distribute the risk of protecting depositors from local bank failures to the Banking Union as a whole, which will ultimately halt the interrelationship between banks and sovereigns. This will reduce the vulnerability of national deposit guarantee schemes to large local shocks and thus increase resilience against future financial crises.

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[230] Geeroms, H., Karbownik, P. (2014). A Monetary Union Requires a Banking Union. *Bruges European Economic Policy Briefings.* 33/2014. College of Europe, Department of European Economic Studies, p. 21.

[231] EU Parliament (2016). European Deposit Insurance Scheme Completing the Banking Union, *Briefing, EU Legislation in Progress*, Brussels: European Parliament.

Deposits up to 100.000 euro per deponent and bank will be granted. EU countries should start to fill up ther national guarantee funds with bank annual contributions, up tu sum of 0,8% of all deposits covered with the scheme. Banks would also have to pay contribution to EDIS. In 2024, the EDIS would take over the guaranteeing of all covered deposits in the euro zone from the national schemes, but national funds would remain in existence. In the the period 2017-2019 national funds will pay off the deponents of failing bank, and if it is not enough- the national governments. In 2024 banks will have to pay into the scheme the full 0,8 % of all covered deposits. Riskier banks would pay higher contributions than those rated as safer.

Banking union should facilitate further financial convergence in EMU. Supervision of significant banks is moved from national to supranational level, risk requirements are stricter and the banks already started to "clean" their balance sheets in order to increase capital. Stress tests are now regularly conducted by credible institution- ECB, as a part of comprehensive assessment procedure. That should restore confidence in the banking system and reduce bank failures through timely intervention of ECB and Single resolution Board (that is independent from national political factors). Introducing the Single resolution fund replaces the costs of bank rescue from the national governments to EMU level fund, which will be funded by bank contributions. This should stop the interdependence between bank and sovereign crisis, which made euro area very vulnerable to changes in market expectations, and led to significant deepening of crisis and deterioration of economic conditions. Common deposit insurance scheme will contribute to creating a common playground for all financial institutions in participating countries. It will shift the risk of protecting depositors from local bank failures to supranational level, thus ultimately stopping the bank-government loop. All of these measures should increase the resilience of EMU to future financial crises.

However, some issues remained unresolved. Will ECB and SRM interventions be a subject of democratic debate? ECB is more focused on inflation level and proper functioning of financial markets than on functioning of real economy. Banking union is expected to be a step towards federalism, by transferring competences to European level authorities. But can there really be a monetary union without fiscal and political union? How to address national differences with a single monetary policy? In previous decade common monetary policy led to significant economic divergence, due to differences in economic structure and national policies. How to solve a problem that a single interest rate, given the different level of inflation and risk premia, leads to different credit conditions across member countries? Obviously there is still a lot of work in improving EMU structural flaws. All implemented and planned reforms are very significant. Although they are pushed by the crisis and probably wothout crisis they wouldn't be implemented, economic and financial integration is an ongoing process. It takes a time to foster financial and economic stability in the euro area. Establishing banking union is considered to be the first real European reform since the common currency. It should foster financial integration, by unifying credit and deposit markets across Europe.

Chapter 14.

BANKASSURANCE RISK MANAGEMENT

The bankassurance topic is increasingly present on the domestic insurance market, where the synergy effect is expressed between different economic entities, linked with the same goal. The banking sector is even more connected with the insurance sector in the process where the Insurance company buys off the banking risk of inability to collect receivables, or the client's risk of banking insolvency. Worldwide, there are variety of cooperation models between banks and insurance companies, while all three entities benefit from the process: the Insurer, the Bank and the client.

From the Insurers point of view, it opens up an entirely new client database, which is directly streamed into the Insurers IT system by the bank. At the same time, those clients represent potential buyers for many other available types of insurance products. From the Insurers approach to the risk underwriting and management, depends the financial outcome, which is the final objective of any business entity establishment.

During the bankassurance process, the Insurer takes over a certain risk from the bank, where the risk involves basic and additional risks covered by the terms of insurance. Among the underwritten risks, there are risks that are known to the Insurer at the moment of conclusion of the insurance contract. Those risks can be classified as **the visible bankassurance risks**. They are easier to control, due to the fact that the Insurer is already familiar with their structure at the moment of contract conclusion. This is the case with mortgaged real estate insurance and other similar types of bankassurance, where the covered risk is no different from risks contained in some other property insurance product. The other, more hazardous risks will be referred to as **the invisible bankassurance risks**. Their characteristic is that not every necessary information regarding the client is available to the Insurer at the moment of policy issuing.

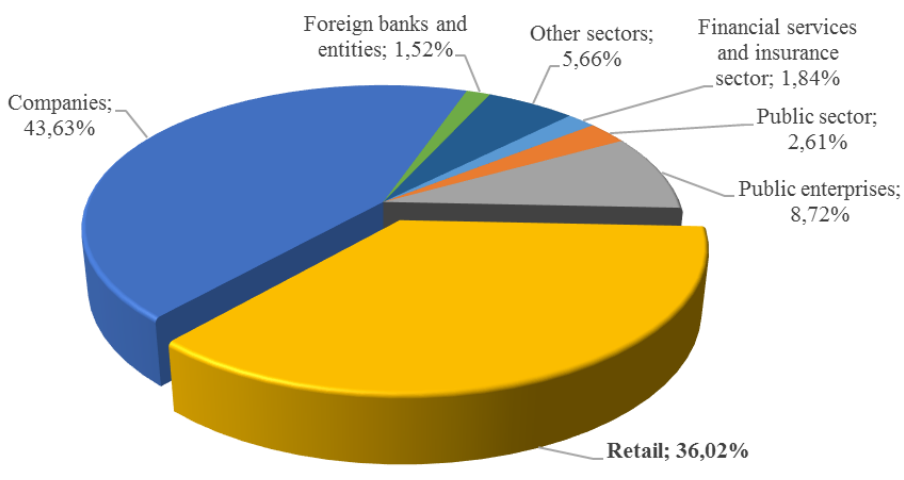
Taken into consideration the fact that the biggest part of banks assets refers to undesignated loans to retail clients, this creates a massive market for Insurance industry. On the other hand, massive market implies a greater range of risks involved. From an Insurers perspective, it is frivolous to let fate manage the risks which should be carefully segmented and analyzed, in order to thrive through this relentless market race**.**

1. THE RISK MARKET

The most developed sector, in all transition affected countries, is the banking sector. According to the data of 2014[232], the biggest share of bank assets refers to loans and receivables (64,1%), of which the retail clients make 36,02%. This information tells us that the target group of potential bankassurance customers are banks that wish to insure the loan amount in a case of potential inability to collect receivables. The product range itself varies with maturity structure of loans, and their purpose. The price, which should be created by the Insurer, must be sufficient to pay out the claims of every covered risk, and to cover all the expenses. It difficult to assess sufficient premium level for long term insurance contracts such as bankassurance, and the uderwritten risk is directly proportional to the portfolio size.

When it comes to insurance premium, the bank does represent a giant potential as an insurance product sales channel. But on the other hand, it could cause a severe damage to the Insurer, unless the risk is assessed adequately and in time. This quantity of risk absorbed through small timeframe is often very hazardous. Since in most cases, the sum insured can not be limited by the Insurer in order to reduce the underwritten risk, the Insurer must create tarrif model that enables him to cover all claims and expenses, and to pass the premium share to the reinsurer:

Figure 1. Net loans structure



Source: National Bank of Serbia (2015). Bankarski sektor u Srbiji – izveštaj za 2014. godinu. Belgrade: National Bank of Serbia, p. 15.

[232] National Bank of Serbia (2015). *Bankarski sektor u Srbiji - izveštaj za 2014. godinu.* Belgrade: National Bank of Serbia, p. 13.

The loans maturity structure is dominated by long-term loans (over one year), with more than 80% of all given loans. This only speaks of an extent of the Insurers risk exposure, unlike other short term risk coverages contained in classical insurance products that involve personal injuries.

2. INVISIBLE RISK COMPONENTS

The invisible risks vary by their structure and probability from case to case. When it comes to life insurance, in most cases, two individuals of the same sex and identical age often have very different assessed risks, which results in different premium and sum insured calculation. These kind of risks, where the probability of insured event varies from person to person, can be segmented into four components:

- Risk of death due to accident,
- Risk of death due to illness,
- Risk of temporary incapacity to work (sick leave),
- Risk of unemployment.

The first two refer to a single outcome, which is death, due to two risk components – accident and illness, assuming that the illness symptoms were not reported in clients medical charts at the moment of policy conclusion.

Instead of complete insight into client's health condition, occupational hazards and life habits, the only data given by the bank is the client's age in the moment of insurance contract signing. That way, a large number of various and unstructured individual risks, enters in ones Insurers portfolio, and extends throughout a very long coverage period. Once they enter a portfolio, from the Insurers perspective, the process itself is most similar to the black box model. The input consists of a variety of invisible risks, where the output is measured by its claim structure. Therefore, it is necessary to separately analyze all segmented risk components, and ultimately their impact on claim structure, technical indicators and financial result.

2.1. Risk of death outcome

This component has the biggest impact on the output, since its coverage extends throughout the entire policy period, while the other two are usually limited to a certain period within the policy. The impact of death hazard is not only determined by its long term duration, but also with the insured sum at the moment of incurring. When speaking of a loan owner insurance, the risk of death assumes that the remaining loan amount is paid out by the Insurer.

Therefore, it has the biggest impact of all other risk components, which are limited by number of instalments and duration.

The most common causes of death in 2014. were bloodstream and cardio vascular system diseases (53.22%), following by tumors and maligned diseases (21.53%).[233] This implies that 74.75% of all deaths were caused by health conditions which often do not have long developing period, like some other chronical diseases. The risk of death due to accident has far smaller frequency, with the share of only 3.04% of all deaths. When it comes to gender structure, female are less endangered with only 1.65% of accidental death causes. This confirms the fact that the largest number of claims refers to death due to illness.

Table 1. Causes of death share in total deaths count

Cause of death	**Male**	**Female**	**Total**
Bloodstream and cardio vascular diseases	48.40%	58.32%	53.32%
Tumors	24.26%	18.77%	21.53%
Injuries, poisoning, and effects of extarnal factors	4.40%	1.65%	3.04%

Source: Statistical Office of the Republic of Serbia (2015). Demografska statistika u Republici Srbiji, 2014. Belgrade: Statistical Office of the Republic of Serbia, p. 106.

The real question is how is it possible to have large claim share of deaths due to illnesses, given the fact that the insurance policy is not covered if the symptoms were reported at the moment of policy signing? Considering the fact that almost 75% of all deaths were caused by two worldly spread diseases, why aren't these symptoms discovered in time? Every paid claim due to this cause suggests that the Insured was not experiencing any of the numerous symptoms prior to his „sudden“ death. In order to answer these questions correctly, attention will be focused on health condition and prevention.

a) Health condition and hazardous habits

Among adults who are aware of the risk of developing heart and bloodstream diseases by practicing unfavorable habits, such as lack of physical activity, smoking and alcohol consumption, even 91% of them practices those habits. Similar to that, among adults aware of lung disease risk, there are 71.4% of smokers and persons prone to developing lung disease.[234] With low prevention

[233] Statistical Office of the Republic of Serbia (2015). *Demografska statistika u Republici Srbiji, 2014*. Belgrade: Statistical Office of the Republic of Serbia, p. 106.

[234] Ipsos Strategic Marketing (2014). *Istraživanje zdravlja stanovnika Republike Srbije, 2013*. Belgrade: Ipsos Strategic Marketing, p. 34.

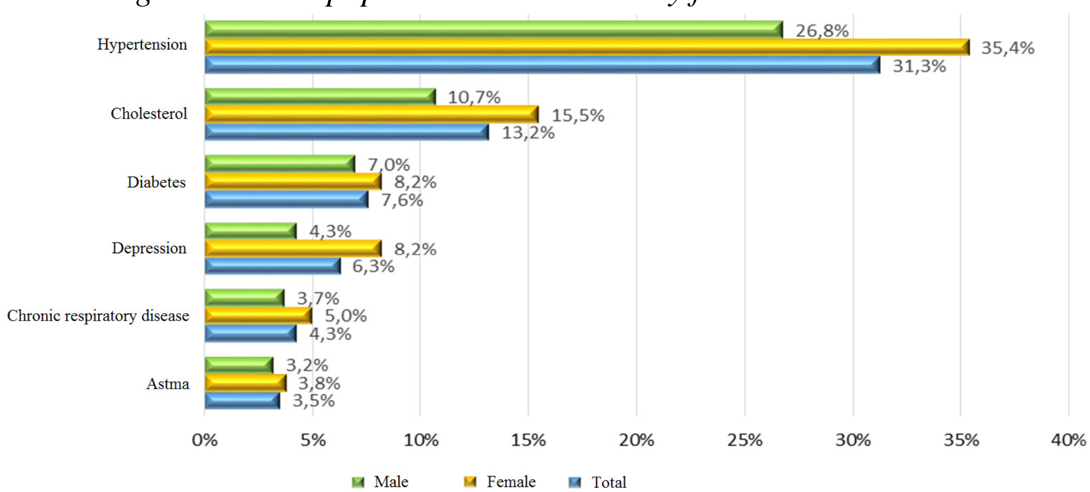
rate, people address to the doctor only when they experience some severe symptoms of deteriorated health. This puts the Insurer in an unfavorable position to pay the claims incurred by illness (often with death outcome) which was not recorded in Insureds medical charts when he signed the policy, and which could have been prevented if it was discovered in time.

One of the major causes of cardio-vascular diseases is smoking. Percentage of adult population that smokes on daily basis or occasionally is 34.7%. If we observe population over 20 years old, which is exactly the bankassurance population, 35.8% smokes regularly or occasionally. 17.4% smokes more than 20 cigarettes a day. This information is very important to the Insurer, but he doesn't have the possibility to control the clients negative selection.

b) Chronical diseases

Most frequent disease refers to high blood pressure (31.3%), followed by cholesterol (13.2), diabetes (7.6%), depression, chronical respiratory diseases etc. Female population experienced all of the named conditions more frequently than male.

Figure 2. Adult population and morbidity from chronic diseases



Source: Ipsos Strategic Marketing (2014). Istraživanje zdravlja stanovnika Republike Srbije, 2013. Belgrade: Ipsos Strategic Marketing, p. 17.

In comparison with 2006, when bankassurance first appeared on domestic market and when the tariffs were first created, there is higher percent of population between 25 and 64 years old with hypertension (27.2% compared to 23.2% in 2006.).Very few Insurers decide to change and recalculate their tarrif models, but since it is the case of long term insurance coverage, an Insurer would have to test the tarrif on force every once in a while, to control the future portfolio input. All of the above named diseases are highly affected by obesity. The percentage of obese and pre-obese population is 56.3% (pre obese 35.1% and obese 21.2%).[235] If compared with regular smoker's rate, the risk of cardio-vascular diseases, bloodstream diseases and tumors reaches extremely high proportions.

c) Prevention

Although prevention is known to be the best remedy in improving the quality of health, in this region there is still a very small number of those who take care of their health before onset of an illness symptoms. The public health system assumes a family physician, as the first instance that a patient should address to. Further on, he issues referral to a specialist only in case of already existing illness, while the preventive health examination is often omitted or reduced to basic, in most cases superficial, routine check. Private medical care represents a financial challenge for majority of citizens, even when it comes to treatment of much severe medical conditions, than a simple preventive checkup.

If taken into account the unemployment rate, the black economy rate, along with the share of those whose employer did not pay health care contributions, conclusion sets itself that it has become a luxury to get ill. A large number of people is unable to afford medical care, even in cases of serious health problems, and therefore it makes the population even more vulnerable, in addition to exposure to everyday stress.

As a consequence, the percentage of people whose blood pressure was measured by a medical worker in the past five years or was never measured at all, is 12.7%. If compared with the data that the highest mortality rate is from cardio vascular diseases, it sums to a very high risk factor of mentioned medical conditions incurrence. Measuring a cholesterol level in the past five years od never was recorded with 17.3% of population, where the male population made the majority of reported cases (cholesterol level 20.9%, blood pressure 15.7%, blood sugar 21.2%)

2.2. Risk of temporary incapacity to work (sick leave)

When it comes to the impact of above mentioned health condition impact on work, in the past year 14.6% of population was absent from work due to health problems, while the average absence lasted 34.5 days. Women are more likely to be absent due to health problems (16.6%).

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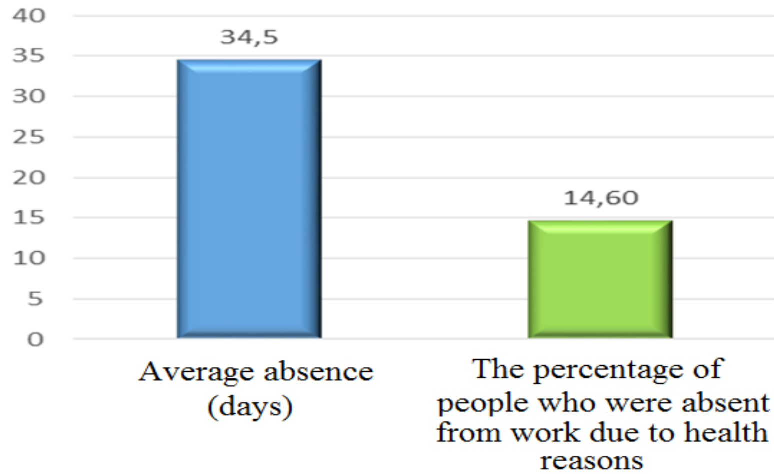
[235] *Ibid,* p. 31.

Figure 3. The frequency and average number of days of absence from work due to health problems



Source: Ipsos Strategic Marketing (2014). Istraživanje zdravlja stanovnika Republike Srbije, 2013. Belgrade: Ipsos Strategic Marketing, p. 17.

From the Insurers perspective, in most cases the risk of temporary incapacity for work has limited time coverage, therefore the sum insured is also limited.

2.3. Risk of unemployment

In 2015, the unemployment rate was 18.5%[236] among the working-age population. It is important to emphasize that the unemployment rate calculation is based on available data of registered unemployment in Republic of Serbia's National employment service, while the real unemployment rate remains unattainable due to the population removed from the employment bureau (administrative flaws in bureau application) and the black economy employment market.

Table 2. Employment and unemployment rates in working-age population

Working-age population (15-64)	Q4 2014	Q1 2015	Q2 2015	Q3 2015	Q4 2015
Employed	51,3%	49,9%	51,7%	53,2%	51,9%
Unemployed	**18,0%**	**19,9%**	**18,4%**	**17,3%**	**18,5%**

Source: Statistical Office of the Republic of Serbia (2016). Anketa o radnoj snazi u Republici Srbiji, IV kvartal 2015. Belgrade: Statistical Office of the Republic of Serbia, p. 3.

236 www.stat.gov.rs

The share of employed population was 51.9% in the last quarter of 2015, which discloses a large share of inactive population. Assuming that the bank does a god job in assessing the stability of client's workplace and income situation, the risk of unemployment should be minimized. The banks are usually well educated for a thorough client assessment. If compared with the information that the significant share of employed population works in public sector, it makes the job even easier.

Table 3. Contract and employer types in employed population

Type of contract		Type of employer	
Indefinite	**77,5%**	Private registered entity	57,1%
Definite	17,7%	Private unregistered entity	1,1%
Seasonal	1,8%	**Public entity**	**40,3%**
Occasional	3,0%	Other	1,5%

Source: Statistical Office of the Republic of Serbia (2016). Anketa o radnoj snazi u Republici Srbiji, IV kvartal 2015. Belgrade: Statistical Office of the Republic of Serbia, p. 9.

77.5% of all employed population has indefinite contracts. Along with the fact that over 40% of the employed population works in public sector, it provides additional security that the banks receivables can be collected. Still, the banking sector was affected by the economic crisis, and the loan demand was reduced due to economic and financial uncertainty. Nevertheless, the banks have no interest in borrowing the money at any price. The terms of obtaining loans are still strict when it comes to workplace quality and clients financial solvency. Therefore, it makes the unemployment risk smaller than other reasons of client’s inability to pay out the loan. The major problems occurs when the receivable is passed on to a family member or a successor, that bank had no contact with.

3. THE STRUCTURE OF CLAIMS BY RISK COMPONENTS

The behavior of underwritten risk, after its incorporation in a portfolio, is best to be observed through the occurrence of the insured events. From the Insurers perspective, this is represented with claim structure. As the insured event, there will be analyzed the invisible bankassurance risks involving loan and overdraft insurance. In cases of a large portfolio, it is sometimes difficult to calculate results based on the entire portfolio. In these cases, an actuary can turn to portfolio sample analysis. Since this is a massive insurance branch, considering the number of bank clients, there are many statistical methods on disposal for this kind of calculations.

Primarily, it is necessary to determine the number of incurred claims which is representative for interpretation, that is, the size of statistical sample which best represents the underwritten portfolio. In order to determine the size of the claim sample for analysis, it is necessary to start from the following assumptions:

- The portfolio has normal distribution, since it constitutes solely of banks clients, without prior gender, age, health, or any other type of selection. This is exactly what the invisible risk management problem is all about-the inability to select banks clients, which approximates the portfolio structure to normal distribution.
- The invisible risks claim frequency is derived from its claim ratio, which is 3,6052%[237]. At the same time, it represents the proportion of elements with a specific attribute, which is used in determining the size of a sample with a specific attribute. Therefore, in this case, as the proportion of elements with an attribute is considered to be the proportion of invisible risk claims in a portfolio.
- The confidence level is 97,5%, taking into account that all inccured claims are reported in the moment of sample detemination, since the IBNR share is already incorporated within the claim frequency data.

According to the named assumptions, the sample size can be calculated by following formula:[238]:

$$n = \frac{z_{\alpha/2}^2 \cdot \pi(1-\pi)}{E^2}$$

Where the symbols have meaning:

$z_{\alpha/2}$ confidence level for α=0.025 (α/2=0.0125)

π proportion of elements with a specific attribute in the portfolio, represented by the invisible risk claims; π = 0.036052

E Interval of allowed error size; E = 0.025

$$n = \frac{2{,}24^2 \cdot 0{,}036052\ (1 - 0{,}036052)}{0{,}025^2} = 278{,}9966$$

This sample size is sufficient to determine the Insurers portfolio. Every actuary can determine it's own interval of allowed errof for the sample size

[237] Insurance Agency of the Republic of Srpska (2015). *Statistika tržišta, 2015.* Banja Luka: Insurance Agency of the Republic of Srpska.

[238] Dragović, V. (2008). *Statistika.* East Sarajevo: Institute for textbooks and teaching resources, p. 572.

determination, and can apply their own claim frequency. This frequency represents the entire market. Also, confidence level can be smaller, or larger, depending on the Insurers portfolio size. If the portfolio is well developed, the confidence level can be even smaller, distribuded equally on both distribution sides.

3.1. Risk components claim frequency

These situations occur in cases where the insured risk already incurred by the time of insurance contract conclusion. Such cases are, i.e. when the fatal illness was already diagnosed. Those negative selection risks are born by the bank, while the Insurer pays the claims occurred by risks that were not incurred or recorded by the moment of contract conclusion. When it comes to rejected claims with death outcome due to accident, there was established the Insured's contribution in claim incurrence (i.e. driving under the influence, etc.)

Therefore, the Insurer still has some sort of protection from banks negative selection of clients, in the process of underwriting the invisible risks. The other claims are covered by the insurance policy, where the Insurer has agreed to insure the invisible bankassurance risks.

Both types contain the same risk, which means the same cause. It can equally affect both types, since it refers to insurance of loan owners and overdraft account owners, and covers the same risk. The risk of death due to illness is most frequent risk, and the biggest part of sum insured is paid by these claims. The second place is reserved for risk of death due to accident. The risk of unemployment has no significant impact on paid sum. Work incapacity usually has irrelevant frequency and paid amount.

3.2. Average entry age

The most common entry age data can be calculated by statistical value of mode, for every portfolio. As a measure of central tendency, the mode is more significant data than portfolio's arithmetic mean. I average entry age is relatively homogenous within the tariffs and in entire portfolio, despite the fact that some tariffs have significantly smaller number of Insured's.

Since the average entry age is correlated with health hazard risk and the probability of risk occurrence, this data is significant only in death outcome risks, while the other risks (unemployment and work incapacity) have smaller degree of correlation with entry age. Given the fact that the risk of death outcome is the most frequent risk, it can be concluded which groups of Insured's carry the biggest risks, from the Insurer's perspective.

The riskiest Insured's category is from 46 to 63 years old, while those over 64 years old continue to have the high mortality rate. Before engaging in bankassurance business, the bank gives the Insurer data regarding the average client's number, particular loans amount and duration, along with the clients average entry age data. If the last data differs from the calculated portfolio data, it can be concluded that it indeed is the case of negative risk selection, and the contracted premium rates with such bank should be reviewed. However, if the data given by the bank is consistent with the calculated values, but the entry age and the claim ratio are still high, the Insurer has a couple of options on his disposal, instead of unpopular premium increase measures. He can either give the more favorable terms of insurance for younger population, or focus more attention to promotional methods and actions for certain client groups.

The negative risk selection can be deceitful for an Insurer, especially in a situation where the portfolio is still insufficiently developed, and therefore is not possible to see the entire picture of the underwritten risks. One of the measures in Insurer's disposal can be to limit the duration of the risk coverage for some client groups that exceed the certain entry age, while on the other hand, the bank could decide to redirect not only that client share, but the healthy share as well, to the other Insurer or to keep it for itself.

The biggest share of all claims refers to the risk of death due to illness, according to the medical statistics. As pointed out earlier, the main cause of deaths due to the illnesses are bloodstream diseases, cardiovascular diseases and tumors that make 75% off all death outcomes. Most commonly, they are medical conditions with short development period and sometimes no early symptoms. This is the reason why the main cause of death of this risk is named to be the disease which was not documented in Insured's medical charts. Combined with poor prevention, bad health habits and the fact that the Insurer has no insight into health condition and those habits at the moment of policy issuing, it makes the entry age non insignificant factor in premium rate calculation.

Therefore, from the Insurers perspective, there is a significant risk of negative risk selection of older population, and is necessary to perceive the claim and premium ratio for these age groups in order to determine whether the earned premium is sufficient for liabilities coverage.

3.3. Earned premium structure by risk components

Not every risk participates equally in claim frequency nor in their amount. The crucial business indicator in insurance is claim ratio. It is necessary to calculate the individual risks ratio, and whether the earned premium is sufficient for settling the claims. From the Insurers perspective, the most important is to know where the margin of positive business is, where he is still able to continue insuring clients at a favorable cost. If the bank has given the accurate data, it's up to the Insurer to provide sufficient premium for business operations, favorable price for the Insured's, and the funds for unobstructed claim liabilities payment.

Since the risk of death outcome is most influenced by entry age, the Insurer should segment the claim ratio by Insured's entry age groups. Despite the fact that the younger groups have favorable claim ratio, there is no justification to maintain the poor claim ratio in older groups, which is even insufficient for own claim coverage. This should not be a signal that the situation on a portfolio level is satisfactory, but that the Insurer did a poor job in premium rates assessment with those groups. The reason can be within the business relations between the Insurer and the Bank, where there was a case of deliberate concession to these categories, in course of lowering loan expenses. Instead, those promotional measures should primarily be focused on attracting those groups which make positive business result.

During the process of premium rate calculation, the actuary must bear in mind that in every entry age group, according to the underwritten risk components, premium can not only take future claim ratio level as its single component, but all the expenses such as acquisition and administrative costs. The banker's commissions are not insignificant, and they are frequently negotiated under subsidized terms, in banks favor. Also, as a deductible item, there are allocated and unallocated claim settlement costs, which take into account the salaries of all the participants in the claim settlement process.

When the portfolio has this structure, the Insurer has following measures, or their combination, on his disposal:

1. **Premium rate modification**, the premium rate is corrected by the risk of death due to illness in elderly clients.
   Result: Earned premium increase, more expensive insurance cover.

2. **Terms of insurance modification**, decrease of the insurance coverage for the risk of death du to illness, for the same targeted group.
   Result: Smaller claim amount, the risk of terms unexeptance by the bank.

3. **Premium rate modification**, the premium rate is corrected by the risk of death due to illness in younger clients.
   Result: Earned premium decrease per insured, portfolio increase, better claim ratio.

4. **Terms of insurance modification,** decrease of risk duration cover in elderly clients.
   Result: Portfolio decrease, earned premium decrease, risk exposure decrease, claim amount decrease, the risk of terms unexeptance by the bank.

5. **Promotional activities,** marketing campain with purpose of informing young potential Insured's with the possibility of simpler loan processment and lower costs if they insure it, by recomending the partner bank.
   Result: Portfolio increase, earned premium increase, the risk that the new potential Insured who decided to insure their loans due to the campaign, turn to another Insurer with whom they already cooperate.

Decrease of insurance coverage is the last resort an Insurer should turn to. Despite the lower insurance price, the bank does not get the adequate insurance protection, and this lower premium only benefits the Insured who pays back the loan. Raising awareness among young potential clients of existence of bankassurance products is always a good choice. Still, the Insurer must consider the possibility that those new potential Insured's who actually informed themselves of bankassurance products and decide on purchase through this expensive marketing campaign, address to their current bank which has the contract with an another Insurer. Finally, every action meant for bankassurance popularization among the population is a good one, and can only bring positive effects on entire market and development of bankassurance products.

4. REINSURANCE RISK

In the process of retention calculation, an actuary must thoroughly analyze the portfolio's structure, and based on the collected data, choose the best method, in accordance with the Insurer’s needs. That way, he will prevent the unnecessary premium flow toward the Reinsurer, but enough to protect the Insurer in cases of major adverse events. Personal accident insurance is limited with the sum insured, which is, most commonly, within the Insurers retention. However, when it comes to bankassurance products, the sum insured is related with the outstanding principal loan amount, which is determined accordingly to the Insured's needs. Since it represents the risk that the Insurer has taken over from the bank, it is necessary to determine the retention according to the underwritten portfolio (sum insured), premium rate level, insurance cover period, etc.

The domestic business environment is highly speculative, and the Reinsurers, especially with foreign ownership structure, are reluctant to take over such risks. If they do, they do it under very unfavorable terms. Sometimes, there is a possibility to engage in certain facultative arrangement, which require significant amount of data to be collected, more than the Insurer is capable of acquiring. In cases when Insurers are in the process of induction of the bankassurance products to their portfolio, and obtaining quality reinsurance coverage, it is difficult to acquire quality market data, projected ratios, premium incomes, entry age, etc.

If the Insurer takes into account all constituents of risk underwriting, along with their individual and synergetic effect, he can establish a quality bankassurance portfolio, which can be the most stable of all, in the long run.

The decision of risk management policy is left up to actuarial and expert services, which enables them to achieve the best financial result, in accordance with their company needs, and to the satisfaction of their clients and business partners.

Chapter 15.

CREDIT RISK MANAGEMENT IN THE BANKING SECTOR IN SERBIA

Following the transition in Serbia from the beginning of 2000s the banking sector has dramatically changed. This was particularly related to foreign banks entry in domestic financial market. Raiffeisen International was first to set up its affiliate in 2001. After that, Intesa Sanpaolo acquired Delta Banka to established Banca Intesa a.d Belgrade. Foreign banks entry was followed by new business banking models which are designed according to Banking Groups directives and which are at the same time in compliance with EU directives and Basel Committee accords.

Basel standards are designed to regulate multinational banks and to promote financial stability in global financial markets. Banks are subjects of public interests and according to that, they must be more strictly regulated than commercial entities. Capital adequacy is one of the subject of this strict regulation and it is inscribe in Basel accords because the banks are facing with risks such as credit risk, market risk, operational risk which must be supported with adequate reserves or provisions in sources of financing bank's activities. Banks must have sufficiently amount of regulatory capital to maintain its solvency regarding counterparty risk and risk profile of the portfolio in certain Bank. More precisely, loans approved to State and Startup Company are not the same. Basel standards methodology tends to put these loans in the same risk-yield position.

This chapter deals with credit risk in banking sector in Serbia, because credit risk is still the most dominant risk above all other risks (liquidity risk, market risk, operational risk). In recent past we have experience with Agrobanka, Universal Banka, Privredna Banka Beograd which did not manage with credit risk well and which therefore gone to bankruptcy. This chapter describes characteristics of Basel I, Basel II and Basel III. However, the main goal of this chapter is to analyze the implementation of Basel II in Serbia and to present basic characteristics and new ideas of Basel III which implementation is to be in force from 2018.

1. BASEL I AND BASEL II

Basel I was thought to be the beginning of banking regulation. From that time (Basel Accord, 1988) the bank regulation is constantly being changed. But why the bank regulation is necessary? The answer is systemic risk. The failure of one bank may have "ripple effect". When one large bank fails, this will turmoil the whole financial system. That is the reason why governments bail out large banks. More precisely, governments want to have depositors insurance. Before 1988, bank regulators tended to set minimum ratios of capital to assets differently from country to country. The problem was that banks were competing globally while there were no international standards to tight minimum capital adequacy ratio. At the same time, transactions with derivatives (interest rate swaps, currency swaps, options, futures) were growing fast. Global financial system was at high systemic risk. The solution to this problem was to set unique standard in order to establish fair competition and global financial stability.

1.1. Basel I

The Basel Committee set up in 1974 consisted of representatives from Belgium, Italy, Japan, Netherlands, United States, Canada, Germany, France, United Kingdom, Switzerland and Luxembourg. In 1988 their meeting resulted in creating "The 1988 BIS Accord" or simply Basel I. One of the significant contribution of Basel I is Cooke ratio. This ratio relates to measuring credit risk. Exposure to credit risk is divided into three groups:[239]

1. On-balance sheet assets without derivatives
2. Off-balance sheet assets without derivatives
3. Over-the-counter derivatives.

Each on-balance sheet asset is assigned a risk weight credit risk. Therefore, cash balances and securities issued by OECD governments have a risk weight 0%. Further, loans to agencies and financial institutions from OECD governments have a risk weight 20%, uninsured residential mortgages with assigned risk weight of 50% and finally loans to corporations with assigned risk weight of 100%. Second group or category includes guarantees, bank's acceptances, loan commitments and etc. Each of them have unique conversion factor which tends to convert off-balance sheet asset to similar on-balance item. Third group consists of credit default swaps, forward contracts, options, futures and etc. Exposure to these assets is intrinsic value of derivative. For example if we have

[239] Hull, J.C. (2015). *Risk Management and Financial Institutions*. Prentice Hall, p. 328.

an call option on shares and strike price is less than market price the exposure to this asset is V= market price – strike price or Expected = max(V,0), which means that if the intrinsic value is zero bank has liability not asset. Difference between Pre-Basel Accords and Basel I is assigning risks to different types of banking products (loans, guarantees, derivatives), as before Basel as it was mentioned, regulators tend to define unique ratio between assets and capital without considering the different credit risk profile of products. Eventually, according to risk-weighted assets Basel accord require to each bank to keep capital minimum 8% of these assets. However, regulatory capital is divided into two categories.

1. *Tier I* – Common shares, surplus, non-cumulative perpetual preferred shares minus goodwill.
2. *Tier II*- Cumulative perpetual preferred shares and subordinated debt (more than five years originated life).

The final formula is **regulatory capital= 8%*RWA** for which RWA is risk-weighted assets.

1.2. Amendment to Basel I (1996)

Amendment 1996 to Basel I deals with market risks. This means that bank are required to keep capital for trading activities. Marking to market means that certain financial statement's positions are valued at fair value. These items are derivatives, securities held for trade, foreign currencies and commodities. Most often these are referred as bank's trading book. For the first time, Amendment involves Value at Risk technique to measure market risk. Before this Amendment market risks related to these kinds of assets and liabilities were treated separately and therefore the capital assigned to this risks was formed separately. Value at Risk is more sophisticated technique which takes it account correlation between these assets.

The value at risk is measure used in internal model based approach. Calculating Value at risk most often includes period of 10 days and 99% confidence. Value-at-risk means that loss has 1% of chance to exceed certain amount (loss in worst case) over 10-day period. Finally according to this amendment Value at Risk is equal[240]: max(Value at risk t-1, m×Value at Risk average) + SRC, where m is multiplicative factor and SRC is specific risk charge. Multiplicative factor is 3. The purpose of this Amendment is as follows: Specific risk of one corporate bond is related to interest rate risk and credit risk. Value at Risk apply to the

[240] *Ibid*, p. 334.

interest rate risk by assigning multiplicative factor to the market risk which must be at least 4.

Total capital = 0.08×(credit risk RWA + market risk RWA)

This amendment also uses 'back testing' (ex-post comparison between model results and actual performance) to arrive at the 'plus factor' that is added to the multiplicative factor.

Eventually, Basel Amendment 1996 makes innovation to the capital used for market risk. Both Tier I and Tier II can be used for market risk as well as Tier III which consist of subordinated debt with maturity of at least 2 years. Consequences to the credit risk is that regulators are more aware that there is a certain differences between credit and market risk and that market risk should be treated with more exact measures of assigned capital.

1.3. Basel II

Regulators have figured out that Basel I Accord with its Amendment has a lot of weaknesses. First of all is that Basel I risk weights are too narrow and therefore unrealistic. Loans to Corporation with AAA rating and corporation with BBB rating are not exposure to same level of risk. Therefore, banks with highly qualitative portfolio is undervalued in comparison with those banks which run their businesses with problematic clients.

Basel II consists of three pillars:

1. Minimum Capital Requirements
2. Supervisory Review
3. Market Discipline

Credit risk capital under Basel II is specified with three approaches:

1. The Standardized approach
2. The Foundation Internal Ratings Based or IRB approach
3. The Advanced IRB approach.

Approaches for measuring credit risk capital under Basel II are different from each other in calculating three parameters relevant to credit risk: LGD (loss given default), PD (probability of default) and EAD (exposure at default).

Banks which implement standardized approach use all of three parameters externally, i.e parameters provided by credit ratings agencies, supervisors, etc.

In based IRB approach, banks calculate by themselves parameter PD while EAD and LGD are used from external sources. Eventually, the most sophisticated approach is advanced IRB. Banks which implement this methodology calculate all parameters on the basis of their historic statistical data. These approaches will be further analyzed as it was mentioned that primary focus of this chapter is credit risk.

1.4. The Standardized Approach

The first is standardized approach which is used by less sophisticated banks. Simply, banks which implement this approach rely on external data. According to that standardized approach is very similar to Basel I. The difference is calculation of risk weights. They are more elaborated under this approach. It is not anymore important whether the bank is from OECD country or not. Loans to corporation are now differently treated depends on corporation credit rating. The risk weights of sovereigns would be as follows:

Table 1. Risk weights of sovereign according to credit assessment

Credit Assessments	**AAA to AA-**	**A+ to A**	**BBB+ to BBB-**	**BB+ to B-**	**Below B**	**Unrated**
Risk Weights	0%	20%	50%	100%	150%	100%

Source: BIS (2001) The standardized approach to credit risk. Basel: Bank for International Settlements, Basel Committee on Banking Supervision, p. 3.

Also, collateral is used for adjusting credit risk. There are two ways banks use collateral for that. First is *simple approach*. Under this approach, banks adjust gross exposure for collateral covered. Required capital is calculated on new exposure after netting gross exposure with collateral. Second approach is considered to be *comprehensive*. It is more rigorous. Banks adjust the size of their exposure upward to allow possible increases in the exposures and adjust the value of the collateral downward to allow for the possible decreases in the value of collateral. The standardized approach proposes to adopt broader definition of collateral than Basel Accord 1988. The following instruments are eligible for recognition in both simple and comprehensive approach:

- cash on deposits with the lending bank,
- securities rated BB- and above issued by sovereigns,
- bank, securities firm and corporate securities rated BBB- and above,
- equities that are included in a main index, and
- gold.

The comprehensive approach to credit mitigation includes *haircut* parameter for collateral. It means that this approach takes into account realization of collateral in the future and market volatility for all non-cash collateral. More precisely, banks face with two risks when they rely on collateral as credit risk mitigation instrument:

- Bank may be unable to sell collateral because it is turn out to be worthless,
- Cash value of collateral realization may be less than its book value.

Therefore, *haircut* is a real value of collateral used for credit risk mitigation. Haircut under standardized approach is divided into three categories: volatility of exposure, volatility of collateral received and any currency volatility. Also there are two ways in using these haircuts: standard supervisory approach and own estimates approach. Under standard approach each collateral receives prescribed haircut by supervisor. On the other hand, in own estimate approach banks are allowed in certain extent to calculate haircuts. In conclusion, this approach is introducing a wider differentiation of a risk weights and a wider recognition of credit mitigation techniques. Risk weights will still be determined by supervisor as it was mentioned.

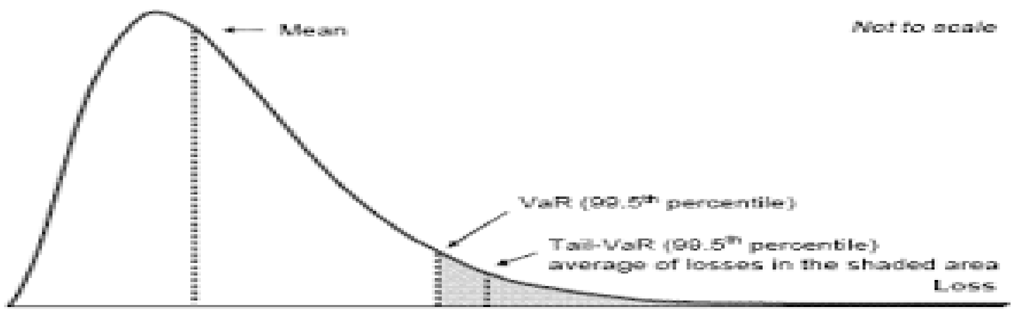
1.5. The Foundations Internal Ratings Based Approach

This approach is particularly based on Bank's own assessment risk methodology. Banks under this approach calculate PD on the basis of their statistical data. Value at risk is calculated using a one-year horizon and a 99.9% confidence level. Value at risk represents method according to which Bank can expect minimum loss at the crisis period. For example, this methodology set the amount of loss which will be exceeded in the worst cases.

Total loss can be divided into two categories[241]. Expected and unexpected loss. Expected loss is covered by the way banks calculate their interest rates. This can be usually seen as a *risk premium* of certain counterparty. Unexpected loss is calculated as following. First, as it was mentioned, banks are using their statistical data. Gaussian copula is usually used to reflect loss distribution. Refer to the Figure 1.

[241] Jorion, P. (2011). *Financial Risk Manager Handbook Plus Test Bank*, 6th Ed., New Jersey: John Wiley & Sons, p. 589.

Figure 1. Gaussian copula and Value at risk



Source: Society of Actuaries in Ireland (2011). Risk Measurement - Is the VaR the right measure, Dublin: Society of Actuaries in Ireland, p. 9.

When the bank has a huge portfolio i.e a very large number of obligors then *i*th obligor has one year probability of default of PD*i.* Further, correlation between each pair of obligors is *ρ*. Therefore, the worst case default rate for representative obligor is:

$$\text{WCDR}= N\left[\frac{N^{-1}(\text{PD}i)+\sqrt{\rho}N^{-1}(0.999)}{\sqrt{1-\rho}}\right]$$

This formula explains that the bank 99.9% it will not exceeded WCDR of its counterparty *i*th. According to that Value at Risk is

$$\sum_{i} \text{EAD}i \times \text{LGD}i \times \text{WCDR}i$$

The expected loss is:

$$\sum_{i} \text{EAD}i \times \text{LGD}i \times \text{PD}i$$

Therefore the capital which is required by regulators is equal to calculating unexpected loss is:

$$\textstyle\sum_{\text{i}} \text{EAD}i \times \text{LGD}i \times (\text{WCDR}i - \text{PD}i)$$

To sum up, this approach enables banks to calculate regulator capital or required capital on the basis of its own risk profile. Therefore, Foundation based approach has two main goals. First is *risk sensitivity.* Capital requirement based on internal ratings can prove to be more sensitive to the drivers of the credit risk and economic loss of bank's portfolio. Second goal is *incentive compatibility* which means that this approach encourages banks to improve their internal risk management practices[242].

As it is known there are certain parameters which are used in calculating capital requirement under this approach- PD, LGD, EAD and M. The last is maturity adjustment and it is somehow similar to duration. It is necessary time for loan to be repaid. Now, let's take a look how these parameters are determined. First of all is **EAD** (exposure at default) parameter. Banks manage their credit-related business in broad business lines or portfolios, each of which may encompass a variety of specific borrower or exposures types. These lines are divided into six categories or groups: corporates, sovereigns, banks, retail, project finance and equity. Second parameter **PD** (probability of default) is internally estimated. For each group of homogeneous business lines PD is calculated by dividing historical defaults with total number of parties in a group. **LGD** (loss given default) is specific. This parameter or such a loss is closely influenced by key transaction characteristics such as presence of collateral. It represents the actual loss (in % of EAD) in case of borrower's default. LGD is determined in two ways. First, it is determined by supervisors. In determining LGD, supervisors differentiate the level of LGD upon characteristics of underlying transaction. The starting point is 50%, more risky transactions are assigned with 75%. Maturity is the fourth parameter. It is provided by bank to supervisor. Maturity is some kind of the adjustment which tend to reflect how much time the loan is to be repaid. Therefore, maturity is designed to make difference between exposures within same business line.

1.6. The Advanced IRB approach

The differences between the Advanced IRB approach and the Foundation IRB approach are calculation of LGD and EAD. Under Advanced IRB approach, the bank itself calculate LGD to be applied to each exposure, on the basis of own data and analysis which is capable of being approved by supervisors or regulators. The bank which calculates LGD internally therefore must be capable to differentiate LGD values on the basis of wider set of transactions such as by product line, collateral type and borrower characteristics. As similar as to LGD, under this approach banks individually estimate EAD parameter. There are differences between corporate exposures and retail exposures. The corporate exposure is defined as a debt obligation of corporation or partnership. Although, the most significant difference between corporate and partnership exposure is

[242] BIS (2004). *International Convergence of Capital Measurement and Capital Standards, A Revised Framework,* Basel: Bank for International Settlements, Basel Committee on Banking Supervision, p. 1.

whether the repayment plan is based on ongoing borrower's operations or on the basis of cash flow from a project or property. Corporation exposures include large multinational corporations, medium sized enterprises and in some cases small businesses (SME).

To sum up, IRB approaches, whether Foundation or Advanced is more sophisticated and more suitable for assessing risk for a certain bank. This means that each bank has a specific risk profile business which depends on type of business, product lines or client characteristics. However, nowadays in a post crisis period there are many voices which blame IRB approach to be one of the trigger of the 2008 global financial crisis. They argue that IRB approach has let banks to undertake risky operations with low capital base.

2. BASEL II IN THE BANKING SECTOR IN SERBIA

Serbian banking sector as at on December, 31st 2015 consists of 30 banks. The banking sector is dominant in a whole Serbian financial sector with market participation of over 90%. National Bank of Serbia commenced the implementation of Basel II standards. The Executive Board of National Bank made decision to issue following documents[243]:

1. Decision on capital adequacy (which relates to Basel II *Pillar I*);
2. Decision on management risks in banks (which relates to Basel II *Pillar II*);
3. Decision on announcing information and data (which relates to Basel II *Pillar III*).

These documents were issued with main goals such as strengthening financial stability and assurance, enhancing supervisory function and finally but not less important is harmonization with European legislature. Implementation of Basel II in Serbia was finalized in June 2011. Decision on capital adequacy classified bank's assets into five categories (A,B,V,G,D) which are assigned with risk weights (0%,2%,15%,30%,100% respectively). This was done to assure NBS that banks' internal methodologies for calculating provisions are pretty much the same. More precisely, it means that this decision is not allow banks to underestimate their provisions as supervisor requires minimum level of provisions to be calculated. In short, Decision on management risks in banks defines strategies and procedures for identifying, measuring and management of risk in banks, adequate internal organization structure of bank (front office, middle office, back office, definition who is in charge for specific job, etc),

[243] http://www.nbs.rs

effective internal controls, information system and adequate process for assessing capital adequacy.

The main difference between General rules of Basel II Accord, which proposed minimum capital requirements at 8% of risk weighted assets, is that National regulations under Decision on capital adequacy proposed minimum capital requirements at 12% of risk weighted assets. The characteristics of banking sector in Serbia is that the most dominant financial risk is credit risk which participated with 86% in all financial risks. Therefore in following parts of the chapter the focus will be on credit risk management in dominant banks in Serbia.

2.1. General macroeconomic environment of banking sector in Serbia

On September, 30th 2015. the largest bank in Serbia was Banca Intesa a.d Beograd with gross assets amounted to RSD 478 billion. Second largest bank in Serbia is Komercijalna banka A.D Beograd with gross assets amounted to RSD 380 billion. It must be mentioned that 10 largest banks hold 75% of market share. However, according to Herfindahl-Hirschman Index this market is still considered to be competitive as Index which was 800 at the end of third quarter in 2015, was much below optimal value of 1,800. Profitability is much better than it was in previous years. It increased by 27% comparing with the same period in 2014. This increase was due to interest income, income from investment in securities and lower loss due to credit default. Credit portfolio of banking sector mostly consists of loans in foreign exchange or loans indexed with foreign exchange with market participation of 73.6%. Euro loans are the most dominant with market share at 87.8%. Loans in Swiss francs and USA dollars follow with market share of foreign exchange loans at 7.9%. According to that, there is high foreign exchange risks which indirectly increases credit risks too[244]. Non-performing loans or NPL are very important subject of matter in banking sector in Serbia. This is because in previous years banks have had enormous problems with repayments of these loans. To be clear, NPL are loans for which:

-Borrower is in default more than 90 days,
-Borrower is in default less than 90 days, but the Bank has estimated that borrower credit rating is not capable,
-Interest income is capitalized, refinanced or postponed.

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[244] National Bank of Serbia (2015). *Bankarski sektor u Srbiji- izvestaj za III tromesecje 2015. godine*: Belgrade: National Bank of Serbia.

NPL gross loans was 22% of loan market at the end of third quarter. Loans to corporate sector has had greatest share in total non-performing loans. However, besides relatively high participation of NPL in total loans share, the banking sector in Serbia is considered to be stable as reserves are sufficient to cover loss of NPL portfolio. Coverage ratio was 115% at the end of the period.

2.2. Basel II implementation in Serbia

As it was mentioned, the banking sector is highly liquid and stable. Therefore, in the following parts of the chapter it will be described how the Basel II methodology is implemented through examples of two banks in banking sector in Serbia.

Both banks implement Basel II Standardized approach for calculating regulatory capital. **First bank** implements methodology which clearly defined rating system of borrowers which assigned risk weights to each rating (this is according to IAS 39). Borrowers are classified into corporate, retail, municipality and financial institutions (this can be seen as homogeneous groups). For each segment, there are wide set of ratings from 1 to 10 (based on qualitative and quantitative characteristics of the borrower such as financial performances, management expertise, market potential, organizational structure and etc). Further these sets 1, 2,..10 are also divided into further sub groups (1A, 1B, ..., 9A, 9C, 10A..).

The criteria for which borrowers are classified into these groups are:[245]
-Poor financial capability,
-Non-compliance with contract conditions,
-Possibility that the borrower gone to bankruptcy,
-Expected future cash flow is lower than firstly estimated,
-Market for financial instrument does not exist anymore.

Loan provision is calculated as:
-Individual loan loss provision,
-Group loan loss provision.

Group loan loss provision is calculated on the basis of group of borrowers with nearly the same characteristics, more precisely the groups consist of homogeneous borrowers. Each group has credit rating described above. This ponder multiples gross exposure adjusted with adequate collateral to calculate

[245] IASB (1998). IAS 39 *Financial Instruments: Recognition and Measurement.* London: International Accounting Standards Board, paragraph 59.

loan loss provision for that borrower. Collateral is discounted with effective interest rate to define real value of collateral to adjust gross exposure. This means that the Bank considers the possibility of realization of collateral such as how much time it is necessary for workout department to realize collateral and liquidity of that instrument. Therefore for each collateral there are predefined haircuts which are multiplied with fair market value of the instrument to calculate real value for adjustment. Individual loan loss provision is calculated when the borrower is in default more than 90 days and when the exposure for that borrower is above certain limit. The method is quite complicated than calculating group loan loss provision. First of all, the Bank must estimate future cash flow of the entity. Then, discount these cash flows with effective interest rate (IRR) and after that to compare with gross exposure or discounted collateral if it exists. If the discounted cash flow is greater than gross exposure then the difference is considered to be loan loss provision. This is *comprehensive approach* in determining loan loss provision because the collateral is adjusted downward to reflect possible realization. Assets which are exposure to credit risk are categorized as similar as they are defined according to Decision on capital adequacy of NBS. These are: loans and receivables, deposits within other banks, Interest and fee income, securities, investment in equity, etc. Total exposure is sum of all these exposures to borrower.

The second bank has similar definition for default borrowers or more precisely criteria for classification borrowers into different risk level groups. Exposure is divided into two groups: non-performing exposure and performing categories. Non-performing borrowers are classified into doubtful, unlikely to pay and past due clients. Doubtful clients are those which are in state of insolvency, which are unlikely to pay and past due more than 90 days. State of insolvency is state when the client has loss above capital. Unlikely to pay is the result of the Bank's assessment to the improbability that the borrower will thoroughly fulfil its credit obligations (by way of repayment of principal and interest) without actions such as the enforcement of guarantees or collateral. Performing categories are all loans which are not classified as Doubtful, Unlikely to pay or Past Due. Within performing categories there are problem loans, which are not necessarily openly but also potentially at risk unless not timely dealt with. Assessment of impairment can be performed according to different methodologies: collective or individual assessment. Collective assessment is calculated for performing categories, by dividing borrowers into sub-groups (criteria for dividing is homogeneity of credit risk) and assigning risk weight to each group after adjusting the discounted value of collateral. Individual assessment is performed on significant exposures and on those exposures on which there exists objective evidence of impairment. If the Bank determines that no objective evidence for an individually assessed exposure, it includes the asset in a group of exposures with similar credit risk characteristics and collectively assesses them for impairment and recognizes provision accordingly. The individual assessment of exposures shall be based on the review and analysis of the borrower's situation, including the critical review of the following sources of information. Provision is measured as the difference between exposure at default and recoverable amount or:

Provision = EAD – RA

Firstly the person who is in charge of individual assessment (usually workout manager) will have to evaluate the expected cash-flows at least every twelve months or each time an event occurs that may positively or negatively influence recovery on the subject recovery. Exposure at default is total exposure subject to credit risk provisioning. This amount includes on-balance sheet and off balance sheet items. Exposure at default is calculated based on the following formula: *EAD= Principal + Interest + Other + CEE* where other is overdue fees and CEE is credit exposure equivalent. ($\sum_{i=1}^{N} CCFi * OFFBSEi$), where CCFi is credit conversion factor and OFFBSEi is off-balance exposure. The Recoverable amount represents the net present value of all recoveries that the Bank may attain on the exposure. Regarding on balance sheet items, the recoverable amount would represent the net present value of estimated future cash flows, discounted at the exposures' applicable effective interest rate. When discounting future cash flows the following tasks are with high importance:

- Activation of collaterals, enforcement proceedings, bankruptcy proceedings,
- Timing of cash flows,
- Estimation of amount of expected cash flow.

The calculation is as follows:

$RA = \sum_{t=0}^{T} \frac{CFi}{(1+EIR)^{i}}$

Eventually, the Recoverable amount can be determined either using the going concern or the gone concern approach. Under the going concern approach cash flows continue and can be used to repay the exposures to all creditors. On the other hand gone concern approach assumes that operational cash flows of debtor will be repaid through the collaterals are executed or sold.

Both banks implement the Standardized approach as they use parameters such as PD, LGD, EAD and M externally. We can say that majority of banks implement the Standardized approach. This is because most banks in Serbia follows the instructions of their Banking groups so they implement internal methodology which is designed by these groups and which are compatible with NBS regulations or Decision on capital adequacy.

Regarding organizational structure of credit risk department, almost all banks have back office which is in charge of estimating risk of loans and calculating provisions assigned to these loans. Back office also approves loans to the extent of certain limits while Executive board approves loans which exceed certain amounts limits define by certain bank. Executive board is also responsible for monitoring and implementing procedures regarding management of credit risks while Board of Directors is in charge of establishing these procedures.

3. BASEL III

Basel III firstly was published in December 2009, while final version was published in December 2010. There are six parts related to Basel III:[246]
-Capital Definition and Requirements,
-Capital Conservation Buffer,
-Countercyclical Buffer,
-Leverage Ratio,
-Liquidity Risk,
-Counterparty Credit Risk.

Under Basel III there are Tier I equity capital, Additional Tier I and Tier II. Tier I includes share capital and retained earnings but not include goodwill and deferred tax assets. This is due to illiquidity of those assets, in financial difficulties, those assets are the least likely to be sold. The additional Tier I consists of non-cumulative preferred shares while Tier II includes subordinated debt to all depositors that has maturity over five years. It must be mentioned that, Tier I is considered to be *going concern capital* while Tier II is considered to be *gone concern capital.* Basel III requires that Tier I capital must be at least 4.5 % of risk-weighted assets. Also total Tier I capital (with additional Tier I) must be 6% of risk-weighted assets. Tier I and II must be at least 8% of risk-weighted assets. **Capital Conservation Buffer** is first part of Basel III. It is simply additional provisioning in normal times for ensuring loss in period of financial difficulties. This Buffer amounts 2.5% of risk-weighted assets. **Leverage ratio** is the ratio of a capital measure to an exposure measure. Capital measure is Tier I, while exposure measure consists of on-balance sheets, off-balance sheets, derivative exposures and securities financing transactions (REPO agreements and security lending). Regulators proposed Tier I capital to be at least 3% of risk-weighted assets. **Liquidity risk** arises when banks tend to finance long-term needs with short-term funding. For example, long-term loans

[246] Hull, J.C. (2015). *Risk Management and Financial Institutions.* Prentice Hall, p. 357.

are financed with short-term deposits. Basel III requires two ratios to ensure that the banks are liquid:

-Liquidity Coverage Ratio (LCR),
-Net Stable Funding Ratio (NSFR)

Liquidity Coverage Ratio is based on bank's ability to repay its liabilities in a 30-day period. It is calculated as follows:

$$\frac{\text{High} - \text{Quality Liquid Assets}}{\text{Net Cash Outflows in a 30} - \text{Day Period}}$$

The ratio is supposed to be greater than 100%.

Net Stable Funding Ratio covers period of liquidity over one year. It is defined as:

$$\frac{\text{Amount of Stable Funding}}{\text{Required Amount of Stable Funding}}$$

Amount of Stable Funding is calculated by multiplying each category of funding with ponder which reflects its stability. Categories are Tier I and II capital, Preferred stock, deposits with maturity less than one year provided by either retail or small business customers, wholesale deposits and etc. On the other hand, Required Amount of Stable Funding is also calculated by multiplying assets with each ponder reflecting its stability. However, those categories are: cash, short term instruments, corporate bonds with rating of AA- or higher, gold, equity securities, residential mortgages and etc.

Basel III imposed more equity capital requirement than previous accords. Therefore it imposes two types of buffers as an additional reserves in crisis period. It also focuses on liquidity measures as many of the problems in the banking sector during the crisis were problems with liquidity.

PART III

MODELS FOR MEASURING RISKS IN INSURANCE

Chapter 16.

MEASURING RESERVE RISK IN DETERMINING SOLVENCY OF NON-LIFE INSURERS[247]

In accordance with contemporary dynamic approaches insurers` solvency is determined on the basis of risks threatening their business. The most relevant example is the concept of Solvency II, as a new regulatory framework for the insurance companies in the Member States of the European Union. In the context of risk-based approach risks should firstly be identified and then measured in order to determine the amount of capital required to cover them. The flow of the business cycle in insurance is inverse compared to a typical manufacturing, trade or service company. The insurance premium is determined and charged in advance, while the compensation is paid if and when the agreed insured case happens. Due to this discrepancy between the inflows and outflows of the insurance fund, loss reserves which will be used to settle obligations to policyholders in the future are extracted from premiums in the present.

Since the number and volume of claims in non-life insurance is not known at the moment of conclusion of the insurance contract, the insurer's financial position is particularly sensitive to the impact of actuarial risk. One of the crucial actuarial risks in non-life insurance is the reserve risk, as a possibility that loss reserves will not be sufficient to cover losses that have been incurred but not yet settled. The subject of this chapter is the measurement of reserve risk in determining non-life insurers` solvency. The research aims to highlight the importance of this risk and to propose concrete internal model that could be used for its measurement for the purposes of calculating solvency capital requirements of non-life insurers.

The results of numerous empirical studies show that the risk of loss reserve adequacy is one of the main causes of insolvency of non-life insurers.[248] The

[247] The authors gratefully acknowledge the financial support of the Ministry of Education, Science and Technology of the Republic of Serbia, Grant No 179005 and No 174020.

[248] See, for example: American Academy of Actuaries (1991). Study of insurance company insolvencies from 1969-87 to measure the efectiveness od casualty loss reserve opinions. *CAS Forum Winter 1991,* Arlington: Casualty Actuarial Society; A.M. Best Company (2004). Best’s Insolvency Study, Property/Casualty US Insurers 1969-2002. *A.M. Best Company Special Report.* New Jersey: A.M. Best

internal dynamic models for measuring this risk in order to determine the solvency of insurers appear in the literature in the field of actuarial science only recently. In the model proposed by Doff (2006), the required capital to cover reserve risk is determined by the upper limit of the chosen confidence level of the loss reserve distribution obtained using Mack`s (1993) reserving method. A model developed by Dos Reis *et al.* (2009) measures the reserve risk on the basis of the loss reserve distribution which is generated by applying bootstrapping technique on the residuals obtained from the chain ladder reserving method. As a measure of reserve risk, Slim and Mansouri (2011) use the variation coefficient of loss reserve estimate and the Value at Risk of their distribution (which is carried out using bootstrapping technique in relation to the parametric stochastic reserving method with incremental losses Poisson or gamma distributed). In the focus of an internal model formulated by Bermudez *et al.* (2011) is a unified measurement of premium and reserve risks. On the basis of a simple linear regression model, the authors extrapolate net technical result in the following year by lines of business using historical data for the whole non-life insurance market. Obtained results are aggregated by applying Monte Carlo simulations with copulas being used to model the dependence between lines of business. Solvency capital requirement is determined by the expected value and the extreme quantile of the derived technical result probability distribution.

1. RESERVE RISK

Risk of loss reserve adequacy, or simply reserve risk (i.e. reserving risk) stems from the uncertainty regarding the future payments of benefits for known and unknown losses already occurred in the past, but not yet settled. Loss reserves as largest single item within liabilities in the balance sheet of non-life insurer represent the actuarial estimate of future payments needed to compensate losses resulting from accidents that have already occurred.[249] If the actual loss payments are higher than expected, the formed reserves will not be sufficient to cover them.

Company; Dibra, S., Leadbetter, D. (2007). *Why insurers fail - The dynamics of property and casualty insurance insolvency in Canada*. Toronto: Property and Casualty Insurance Compensation Corporation (PACICC); Sharma, P. *et al.* (2002). Prudential Supervision of Insurance Undertakings. *Conference of Insurance Supervisory Services of the Member States of the European Union.* Brussels: European Commission.

[249] Panning, W. (2006). Measuring Loss Reserve Uncertainty. *CAS Forum Fall 2006*. Arlington: Casualty Actuarial Society, p. 238.

Key sources of reserve risk are random deviations of actual payments arising from losses incurred from their expected values and errors in the assessment of loss reserves.[250] Therefore, three components can be distinguished within this risk at first: process risk, model risk and parameter risk. Process risk as a risk of stochastic fluctuations in the actual frequency and/or intensity of losses is simply inherent in the development of non-life insurance losses. The other two components of reserve risk reflect ignorance of the actual model according to which this development takes place and of the actual values its parameters. Given model is described and its parameters estimated starting from past experience that, due to the limited number of observations, is not absolutely reliable basis for predicting future loss development, and applying actuarial reserving methods which, in themselves, are not free from the theoretical and/or practical disadvantages.[251] The effect of errors in the reserving process is manifested through deviations of actual from expected risk realizations which are not random but systematic. In contrast to process risk, it is not possible to fully diversify model risk and parameter risk, as total risk components. Therefore, reserve risk is a particular threat for relatively young companies with a smaller insurance portfolio, lacking their own experience in terms of loss development.

In addition to the mentioned, specific component of reserve risk refers to possible changes in loss development pattern caused by factors that are of internal (e.g. changes in volume and structure of insurance portfolio, insurance terms, tariff rates or insurer`s claim resolving procedures) or external nature (e.g. changes in inflation rates, legislation or court practice). Their realization distorts the total loss prediction accuracy, even if the applied model is correct, and its parameters are estimated on the basis of extensive empirical experience. Hence, reserve risk is more prominent as the participation of long-tail lines of business in the total insurance portfolio is greater.

If loss reserves are underestimated, the financial position of the company, as the starting point of the process of making business and investment decisions, appears better than the real. In such a situation, the available capital of the company is overvalued. At the same time, in terms of application of static factor

[250] Slim, N., Mansouri, F. (2011). Reserve Risk Analysis and Dependence Modeling in Non-Life Insurance: The Solvency II Project. *XXVIII Journées de Microéconomie Appliquée Communications*. Sousse, p. 3. (Retrieved 17.12.2012. from: www.jma 2011.fr/fichiers/152/the%20final%20 paper.pdf)

[251] Jovović, M. (2015). Merenje rizika pri utvrđivanju solventnosti neživotnih osiguravača. *Doctoral thesis.* Belgrade: Faculty of Economics, University of Belgrade, p. 180.

approach, the required capital of insurance company will be underestimated, and credibility of solvency assessment will thus be violated twofold.

2. INTERNAL MODEL FOR RESERVE RISK MEASUREMENT

In terms of Solvency II concept application, in addition to a single standard approach, insurers can apply alternative internal models for the purpose of calculating solvency capital requirement (SCR) to cover all, or certain types of risks with the prior review and approval by the supervisory body.[252] The internal model is defined as the risk management system in order to analyze the overall risk situation of the insurance company, to quantify risks and/or to determine required capital amount on the basis of the specific risk profile of the company.[253] Depending on whether they cover all or certain risks only, internal models can be full or partial. They can be the result of modifications of the standard approach, or completely innovative approaches, which are fully adapted to the specific features of the company. The most significant differences between internal models and standard approach are reflected in greater use of stochastic techniques as well as the company's own data for the evaluation of risk parameters. Result of internal model implementation is the economic capital requirement which, in contrast to the regulatory capital requirement, should provide not only the minimization of losses for policyholders, but also the continuation of the normal functioning of the company in the event of financial difficulties.[254]

One of the most important tasks in the risk management process within financial institutions, in general, is to determine the amount of funds needed to cover consequences of risk realizations.[255] Losses immanent to natural course of

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[252] The supervisory authority may even require the use of an internal model, if insurer`s risk characteristics significantly deviate from standard approach assumptions. See: Directive 2009/138/EC of the European Parliament and of the Council of 25 November 2009 on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II), *Official Journal of the European Communities,* 2009/138/EC, article 119.

[253] CEA, Groupe Consultatif (2007). *Solvency II Glossary*. Brussels: European Federation of National Insurance Associations (CEA), p. 35.

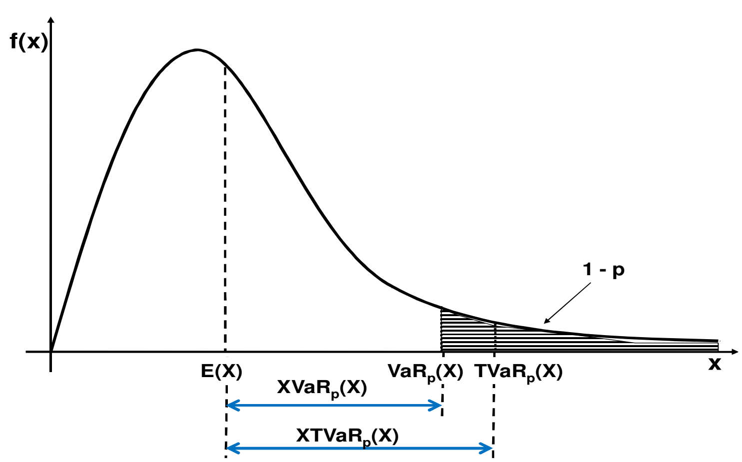
[254] EU Commission, KPMG (2002). *Study into the methodologies to assess the overall financial position of an insurance undertaking from the perspective of prudential supervision*. Brussels: European Commission, p. 219.

[255] Navarrete, E. (2006). Practical Calculation of Expected and Unexpected Losses in Operational Risk by Simulation Methods. *Banca & Finanzas: Documentos de Trabajo,* 1(1), p. 1.

business can, as "expected", be funded from the respective reserves that the institution holds. The excess of actual against expected losses represents "unexpected" losses, which directly threaten the security of the institution and require an additional amount of capital to cover them. According to the guidelines of the Basel Committee, capital requirement on behalf of particular risks of banking institutions can be defined as the difference between the total risk exposure at the selected level of confidence and expected losses from risk realization.[256] An equivalent approach can be applied when measuring the solvency of insurers, i.e. determining the required amount of capital to cover the non-life insurance risks.

Technical reserves in insurance are intended to compensate for expected losses, while unfavourable deviations of actual against expected losses are neutralized b means of insurers` available capital (solvency margin). The expected value of loss reserves is estimated using the chosen reserving method. Solvency capital requirement to cover reserve risk within the internal model can be defined as the difference between the Value at Risk (or Conditional Value at Risk) at a sufficiently high confidence level of loss reserve probability distribution and the expected value of that distribution (see Figure 1).

Figure 1. Capital requirement as a difference between actual and expected value of a risk variable



Source: Navarrete, op. cit., p. 3.

For the purposes of the formal expression of such capital requirement, two risk measures are introduced. Given a confidence level $p \in (0,1)$, the Excess Value

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[256] BIS (2006). *International Convergence of Capital Measurement and Capital Standards. A Revised Framework. Comprehensive Version.* Basel: Bank for International Settlements, Basel Committee on Banking Supervision, p. 52. and 151.

at Risk (XVaR) of the random variable X, approximating risk exposure, is defined as:

$$XVaR_p(X) = VaR_p(X) - E(X), \quad (1)$$

while the Excess Tail Value at Risk (XTVaR) is defined as:

$$XTVaR_p(X) = TVaR_p(X) - E(X),$$ [257]

(2)

where $VaR_p(X), TVaR_p(X)$ are the Value at Risk and Conditional Value at Risk of the random variable X with confidence level p.

The resulting capital amount is conditioned by the chosen measure of risk and the level of confidence. For reasons of consistency with the standard approach of Solvency II concept, economic capital requirement within the partial internal model can be determined at the level that ensures protection from reserve risk with a probability of 99.5%.

The explained conceptual framework, by itself, does not represent a novelty in actuarial science, although cases of its implementation in the context of evaluating insurers` solvency appear only recently. A common characteristic of internal models previously defined in the same conceptual framework[258] is the implicit *a priori* assumption that insurance premiums and reserves are sufficient to cover expected losses. If such an assumption is not fulfilled in practice, the obtained amount of required capital will not be reliable. This potentially calls into question an insurer`s solvency estimate and, consequently, the appropriateness of such models. In other words, at the same level of confidence, the amount of capital that is really needed can be higher (or lower) than the calculated, if the amount of company`s loss reserves is smaller (or larger) than the expected value of the corresponding probability distribution. Therefore, an important contribution of the partial internal model which is proposed in this chapter, inter alia, refers to the completion of a given conceptual framework by an inevitable critical element, which implies check of the real sufficiency of

[257] Sandström, A. (2011). *Handbook of Solvency for Actuaries and Risk Managers: Theory and Practice*. Boca Raton: Chapman & Hall/CRC, p. 210.

[258] See: Doff, R.R. (2006). *Risk Management for Insurance Firms - A Framework for Fair Value and Economic Capital*. London: Risk Books; Dos Reis, A.E., Gaspar, R.M., Vicente, A.T. (2009). Solvency II - An important case in Applied VaR. *The VaR Modeling Handbook: Practical Applications in Alternative Investments, Banking, Insurance and Portfolio Management*. Gregoriou, G.N. (ed.), Ch. 12, New York: McGraw-Hill, pp. 267-296.; Slim, Mansouri, *op. cit.*

reserves before calculation of the solvency capital requirement. Practical implementation of proposed internal model requires prior definition of methodology for carrying out loss reserve probability distribution which follows in the sequel of the chapter.

2.1. The bootstrap method

Since the reserve estimates are, themselves, the sum of random variables, it is difficult to obtain their predictive distribution analytically, because of the variability due to the underlying statistical process and the variability due to the estimation of parameters.[259] Therefore a need for the simulation techniques arises. Some idealized assumptions and also idealized models have been the traditional approach to statistic problems. One alternative to this tradicional approach and asymptotic approximation is the bootstrapping method, introduced by Efron (1979), as resampling method, which is applicable on realistic models and which is high computer intesive method.

The main idea behind the bootstrap method is the assumption that it is possible to draw repeated samples of the same size from the population, a large number of times and solving a problem without external help. This implies sampling from an existing sample itself without using external samples. A statistic of interest will fluctuate from sample to sample and it is important to know the magnitude of these fluctuations around the corresponding population parameter. It is possible to get a good idea about the sampling distribution from these repeated samples. That sampling distribution is the picture of all possible values of a sample statistics presented in the form of a probability distribution. Resampling with replacement from the sample data generates a large number of „phantom" samples known as bootstrap samples, so that statistic of interest is computed on each of them. Then a small percentage, usually $100(\alpha/2)\%, \alpha = 0.05$, is being removed from the upper and lower end of calculated statistic values.

There are a number of reasons for using bootstrap methods instead of asymptotic approximation. For example: in order to get better approximation accuracy than the asymptotic distribution, to bias correct an estimator, to avoid the calculation of the estimated asymptotic variance, many models are so complicated that computing the standard error analytically is very difficult, and bootstrap method is a good approach when asymptotic distribution of the estimator has not been developed. However it could been showed that bootstrap

[259] England, P., Verrall, R. (2002). Stochastic claims reserving in general insurance. *British Actuarial Journal,* 8(3), p. 496.

standard errors are sometimes too large and sometimes too small. Because of that, bootstrap is an alternative to asymptotic approximation, it is not alternative to asymptotic theory and there are some count examples that show the bootstrap produces wrong solutions, i.e. inconsistent estimators. Nowadays, the bootstrap comprises a large number of resampling methods including the nonparametric bootstrap, the parametric bootstrap, the residual bootstrap and the wild bootstrap.

For example, we can consider the bootstrap method on the problem of estimating variability and sampling distribution of a location. The observations $x_1, x_2, ..., x_n$ are realisations of independent random variables with common distribution function F. If we denote the location estimate as $\hat{\theta}$, it is a function of the random variables $X_1, X_2, ..., X_n$ and has a probability distribution, its sampling distribution, as a function of F and n. We have two problems: we do not know F, and even if we knew F, $\hat{\theta}$ may be too complicated function of $X_1, X_2, ..., X_n$. First, suppose we knew F. Our goal is to find the probability distribution of $\hat{\theta}$. That can be done by computer simulation. We generate many samples, say B, of size n from distribution F, and from each sample we calculate the value of statistic $\hat{\theta}$. An approximation to the distribution function of $\hat{\theta}$ is the empirical distribution of the resulting values $\hat{\theta}_1^*, \hat{\theta}_2^*, ..., \hat{\theta}_B^*$, which is good for large B. But usually we do not know F. We will consider two cases. First case is when F is unknown up to an unknown parameter η, i.e. $F(x \mid \eta)$. This is the parametric bootstrap approach and the idea is to simulate data from $F(x \mid \hat{\eta})$, where $\hat{\eta}$ is a good estimate of η. Second case is when F is completely unknown. That is the nonparametric bootstrap approach and the idea is to simulate data from the empirical cumulate distribution function F_n. A sample of size n from F_n is a sample of size n drawn with replacement from the collection $x_1, x_2, ..., x_n$. The standard deviation of $\hat{\theta}$ is estimated by:

$$s_{\hat{\theta}} = \sqrt{\frac{1}{B} \sum_{b=1}^{B} (\hat{\theta}_b^* - \hat{\theta}^*)^2}\ , \tag{3}$$

where $\hat{\theta}_1^*, \hat{\theta}_2^*, ..., \hat{\theta}_B^*$ are produced from B samples of size n from the collection $x_1, x_2, ..., x_n$ and $\hat{\theta}^* = \frac{1}{B} \sum_{b=1}^{B} \hat{\theta}_b^*$.

The default bootstrap method used in applications is the nonparametric bootstrap. In general, there are five steps for nonparametric bootstrap procedure, suggested by Efron and Tibshirani (1993). The first step is to construct an empirical distribution function F_n from the sample. The second step is to draw a random sample of size n with replacement from the empirical distribution function F_n. This is a resample. In the third step, the statistic of interest, T_n, for this resample is calculated, yielding T_n^*. The fourth step is to repeat above two steps B times, which is at least equal to 1,000. The fifth step is to construct the relative frequency histogram from B number of T_n^*'s by placing a probability of $1/B$ to each point, $T_n^{*1}, T_n^{*2}, ..., T_n^{*B}$. The distribution obtained is the bootstrap estimate of the sampling distribution of T_n and it can be used to make inferences about the parameter θ, which is estimated by T_n.

We introduce notations to illustrate the bootstrap method. Let $X_1, X_2, ..., X_n$ be i.i.d. samples from population distribution F and the goal is to estimate the distribution $H_n(x) = P(R_n \le x)$, where $R_n = R_n(T_n, F)$ is a function of F and statistic T_n of interest. Let $X_1^*, ..., X_n^*$ be a bootstrap samples i.i.d. from F_n, $T_n^* = T_n(X_1^*, ..., X_n^*)$ and $R_n^* = R_n(T_n^*, F_n)$. A bootstrap estimator of H_n is $\hat{H}_n(x) = P_*(R_n^* \le x)$, where for the given $X_1, X_2, ..., X_n$, P_* is the conditional probability with the respect to the random generator of bootstrap samples. The estimator $\hat{H}_n(x)$ is a random variable and will depend on F_n and will change as the data $x_1, ..., x_n$ change. In general, the bootstrap estimate of the sampling distribution of T_n is computed using Monte Carlo methods. Often we are only interested in one characteristic of the sampling distribution of T_n, for example the standard error or the bias.

In parametric bootstrap, the knowledge about F is incorporated into the bootstrap algorithm by substituting the parametric distribution $F(x | \hat{\eta})$ for the empirical distribution. The steps in this case are the analogues as in previous.

Primary applications of bootstrap are in approximating standard error of a sample estimate, bias correction and confidence intervals. Let us suppose that $\hat{\theta}$ is a function of the data $X_1, X_2, ..., X_n$. It is a sample estimator of θ, which is a population parameter. Our goal is to estimate standard error of $\hat{\theta}$ by bootstrap approach. First step is to compute $(\hat{\theta}_1^*, ..., \hat{\theta}_B^*)$, using formula as the one used for $\hat{\theta}$, but now base it on B different bootstrap samples of size n. Some recommendation is $B = n^2$, unless that is too large. In that case it is recommended $B = n \log n$. The standard error is defined by:

$$se_B(\hat{\theta}) = \sqrt{\frac{1}{B-1}\sum_{b=1}^{B}(\hat{\theta}_b^* - \hat{\theta}^*)^2}, \hat{\theta}^* = \frac{1}{B}\sum_{b=1}^{B}\hat{\theta}_b^* . \tag{4}$$

An older resampling method which can be used for this situation is Jackknife, but bootstrap is widely used. The example where $\hat{\theta}$ is the sample median, is the situation where Jackknife fails while bootstrap gives still good result.

For the bootstrap estimate of bias also we can suppose that the parameter θ is estimated by the statistic $\hat{\theta}$. The bias of that estimator is defined as:

$$bias(\hat{\theta}) = E(\hat{\theta}) - \theta . \tag{5}$$

If we substitute distribution function F with the empirical distribution function F_n, we obtain the bootstrap estimate of bias:

$$bias^*(\hat{\theta}^*) = E^*(\hat{\theta}^*) - \theta^* , \tag{6}$$

where θ^* is a function of F_n. Note that $\hat{\theta}$ and θ^* can be different.

For standard confidence interval we will suppose that $\hat{\theta}$ is approximately normally distributed with mean θ and variance $se(\hat{\theta})^2$. An approximate $(1-\alpha)$ confidence interval for θ is given by:

$$(\hat{\theta} - z_{\alpha/2} se_{\hat{X}}(\hat{\theta}), \hat{\theta} + z_{\alpha/2} se_{\hat{X}}(\hat{\theta})) , \tag{7}$$

where $se_{\hat{X}}(\hat{\theta})$ is an estimator of $se(\hat{\theta})$ based on the sample X. For bootstrap t interval, we calculate T_b^* from the bootstrap samples X_b^*, by the formula:

$$T_b^* = \frac{\hat{\theta}_b^* - \hat{\theta}}{se_{\hat{X}*}(\hat{\theta})} . \tag{8}$$

From above value we can estimate the critical values $t_{1-\alpha/2}$ and $t_{\alpha/2}$ by $\hat{t}_{1-\alpha/2}$ and $\hat{t}_{\alpha/2}$, such that:

$$\frac{1}{B}\sum_{b=1}^{B} I(T_b^* \le \hat{t}_{1-\alpha/2}) \approx \frac{\alpha}{2} \text{ and } \frac{1}{B}\sum_{b=1}^{B} I(T_b^* \ge \hat{t}_{\alpha/2}) \approx \frac{\alpha}{2} , \tag{9}$$

and an approximate $(1-\alpha)$ bootstrap confidence interval for θ is given by:

$$(\hat{\theta} + \hat{t}_{1-\alpha/2} se_B(\hat{\theta}), \hat{\theta} + \hat{t}_{\alpha/2} se_B(\hat{\theta})) . \tag{10}$$

2.2. Bootstrap loss reserve estimate

In order to apply bootstrapping technique for the formation of loss reserves, chosen stochastic reserving method must be presented in the context of generalized linear models (GLM). From common assumptions of the given family of models, for each k^{th} observation of a random variable X follows:

$$E(X_k) = \mu_k \text{ and } Var(X_k) = \frac{\phi\nu(\mu_k)}{w_k}, \tag{11}$$

where μ_k denotes expected value for k^{th} observation of the random variable X, ϕ is a scale parameter, w_k are prior weights and $\nu(\cdot)$ is the variance function.[260]

Further, all observations should be mutually independent and identically distributed. Therefore, in the context of loss reserving, it is appropriate to apply the bootstrapping technique to the residuals, rather than the loss data itself.[261] The scaled Pearson residuals r_k, defined as:

$$r_k = \frac{x_k - \hat{\mu}_k}{\sqrt{\hat{V}ar(X_k)}} = \frac{x_k - \hat{\mu}_k}{\sqrt{\frac{\hat{\phi}\nu(\hat{\mu}_k)}{w_k}}}. \tag{12}$$

could be used for this purpose. In each individual bootstrap iteration, based on the set of actual residuals $\{r_k : k = 1,...,n\}$ we produce a new sample of the residuals $\{r_k^* : k = 1,...,n\}$ which are added to the estimated values $\hat{\mu}_k$ in order to get a sample of „pseudo" data $\{x_k^* : k = 1,...,n\}$:

$$x_k^* = r_k^* \sqrt{\frac{\hat{\phi}\nu(\hat{\mu}_k)}{w_k}} + \hat{\mu}_k. \tag{13}$$

The scale parameter ϕ is estimated as the Pearson χ^2 statistic (as the sum of the squares of the unscaled residuals) divided by the degrees of freedom (difference between the number of observations n and the number of parameters being estimated p):

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260 Renshaw, A.E., Verrall, R.J. (1998). A Stochastic Model Underlying the Chain-Ladder Technique. *British Actuarial Journal,* 4(4), p. 911.

261 Pinheiro, P.J.R., Andrade e Silva, J.M., Centeno, M.L.C. (2003). Bootstrap methodology in claim reserving. *Journal of Risk and Insurance,* 70(4), p. 706.

$$\hat{\phi} = \frac{\sum_{k=1}^{n} (r_k')^2}{n-p}, \tag{14}$$

where

$$r_k' = \frac{x_k - \hat{\mu}_k}{\sqrt{\frac{v(\hat{\mu}_k)}{w_k}}} \tag{15}$$

represents unscaled Pearson residuals which, as opposed to the scaled residuals, defined with (12) do not include the scale parameter. Alternatively, the scale parameter estimate (14) can be displayed in the form (18):

$$\hat{\phi} = \frac{n}{n-p} \cdot \frac{\sum_{k=1}^{n} (r_k')^2}{n} = \frac{\sum_{k=1}^{n} \left(\sqrt{\frac{n}{n-p}} r_k' \right)^2}{n}. \tag{16}$$

Therefore, the scale parameter estimate $\hat{\phi}$ can be considered as the average of the squared residuals r_k' multiplied by a bias correction factor r_k' $\sqrt{n/(n-p)}$.[262] The statistical model based on which the residuals are originally calculated is applied to the "pseudo" data in order to obtain the bootstrap parameter estimate in the first iteration, and the shown procedure is being repeated arbitrarily large number of times in order to carry out the probability distribution of that estimate. The standard deviation of such distribution is the estimation of the estimation error, as the only one of the two components of the prediction error. To incorporate the process error, as the other component, the future values of the observed variable have to be simulated in each iteration, based on the assumed probability distribution whose expected value corresponds the obtained bootstrap estimate values, which will be explained in more detail in the case of a concrete reserving method below.

Bootstrapping technique can be used for estimating error that occurs under the various stochastic reserving methods. Non-parametric stochastic method developed T. Mack[263] is based on the following assumptions regarding the expected value and variance of the cumulative claim amounts:

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[262] England, P., Verrall, R. (2006). Predictive Distributions of Outstanding Liabilities in General Insurance. *Annals of Actuarial Science*, Vol. 1, p. 263.

[263] Mack, T. (1993). Distribution-free calculation of the standard error of chain ladder reserve estimates. *ASTIN Bulletin*, 23(2), pp. 213-225.

$$E\left(C_{i,j+1} \middle| C_{i,1},...,C_{i,j}\right) = C_{i,j} f_j \tag{17}$$

$$Var\left(C_{i,j+1} \middle| C_{i,1},...,C_{i,j}\right) = C_{i,j}\sigma_j^2,\ 1 \le i \le I,\ 1 \le j \le I-1, \tag{18}$$

where $C_{i,j}$ denotes the cumulative claim amount of accident year i ($i = 1,...,I$), which are either paid or incurred up to development year j ($j = 1,...,J$), f_j is a development factor and σ_j^2 is a dispersion parameter, corresponding to development year j both.

Simulation of the loss reserve probability distribution requires introduction of the assumption regarding a specific type of distribution, which is not present in the Mack's reserving method. However, it has been proven that identical standard error of prediction can be obtained if one assumes that the cumulative claims follow a normal distribution.[264] England and Verrall (2006) gave an equivalent formulation of Mack's reserving method, based on the expected value and variance of individual development factors $f_{i,j} = C_{i,j+1}/C_{i,j}$:

$$E\left(f_{i,j} \middle| C_{i,1},...,C_{i,j}\right) = f_j \tag{17a}$$

$$Var\left(f_{i,j} \middle| C_{i,1},...,C_{i,j}\right) = \sigma_j^2 / C_{i,j},\ 1 \le i \le I,\ 1 \le j \le I-1. \tag{18a}$$

Taking that in the GLM context applies: $X_k = f_{i,j}$, $\mu_k = f_j$, $\phi_j = \sigma_j^2$, $v(\mu_k) = 1$ and $w_k = C_{i,j}$, the scaled Pearson residuals for the Mack's reserving method $r_{i,j}$, can be defined in the following form:

$$r_{i,j} = \frac{\sqrt{C_{i,j}}\left(f_{i,j} - \hat{f}_j\right)}{\hat{\sigma}_j},\quad 1 \le i \le I-1,\ 1 \le j \le I-1, \tag{19}$$

where development factors f_j are estimated using the chain ladder reserving method, and the dispersion parameter σ_j^2 is estimated based on (20):

$$\hat{\sigma}_j^2 = \frac{\sum_{i=1}^{n_j}\left(r'_{i,j}\right)^2}{n_j - 1} = \frac{\sum_{i=1}^{n_j} C_{i,j}\left(f_{i,j} - \hat{f}_j\right)^2}{n_j - 1},\quad 1 \le j \le I-2, \tag{20}$$

[264] England, Verrall (2002), *op. cit.,* p. 453.

where n_j denotes number of residuals for development year j. In order for the bootstrap estimate of the prediction error to be unbiased and comparable with the corresponding analytical grade, England (2002) proposes correction of the residuals $r_{i,j}$ with the factor $\sqrt{n/(n-p)}$ for a total of n observations of p parameters being estimated.[265] Based on a drawn new sample of corrected residuals $r^*_{i,j}$,[266] starting form (19), we come to „pseudo" individual development factors $f^*_{i,j}$, arranged in a the form of a new run-off triangle:

$$f^*_{i,j} = r^*_{i,j}\frac{\hat{\sigma}_j}{\sqrt{C_{i,j}}} + \hat{f}_j,\quad 1 \le i \le I,\quad 1 \le j \le I+1-i. \tag{21}$$

Chain ladder method, based on which the residuals are initially calculated, is applied in relation to each new triangle of "pseudo" data in order to obtained a new estimated development factors $\tilde{f}_j$, using:

$$\tilde{f}_j = \frac{\sum_{i=1}^{I-j} f^*_{i,j} C_{i,j}}{\sum_{i=1}^{I-j} f^*_{i,j}},\quad 1 \le j \le I-1. \tag{22}$$

Future cumulative claim amounts for accident years $i = 2,...,I$ are projected by successive development periods in each of the bootstrap iterations. At first, starting from the last realized values $C_{i,I+1-i}$ (located on the diagonal of the run-off triangle) we project values $\tilde{C}_{i,I+2-i}$ by simulating drawing a random sample of data from a normal probability distribution whose parameters are $\tilde{f}_j C_{i,I+1-i}$ and $\hat{\sigma}^2_j C_{i,I+1-i}$, so that: $\tilde{C}_{i,I+2\text{-}i} \big| C_{i,I+1-i} \sim \mathcal{N}\left(\tilde{f}_j C_{i,I+1-i}, \hat{\sigma}^2_j C_{i,I+1-i}\right)$. Starting from

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[265] Since in the case of Mack's reserving method the dispersion parameter σ^2_j is not is not constant but varies between development periods, whereby one parameter f_j is estimated for each of development periods, it is logical to use factor $n_j/(n_j-1)$, $j = 1,...,I-1$ for given purposes.

[266] From the relation: $f_{1,I-1} = C_{1I}/C_{1,I-1} = \hat{f}_{I-1}$, it follows that $r_{1,I-1} = 0$, which is the residual value that is not taken into consideration when designing the new sample of residuals of size $n = I(I-1)/2$. The justification for such a practical approach has been empirically confirmed by Pinheiro *et al., op. cit.,* p. 6.

the values thus obtained for each subsequent development year we project the cumulative claim amounts taking that:

$$\tilde{C}_{i,j+1}\Big|\tilde{C}_{i,j} \sim \mathcal{N}\left(\tilde{f}_j \tilde{C}_{i,j}, \hat{\sigma}_j^2 \tilde{C}_{i,j}\right), \ i = 3,4,\ldots,I, \quad j = I+3-i, \ I+4-i,\ldots,I-1.$$

However, if the simulation based on normal distribution results in negative cumulative claim amounts, a proper pragmatic solution is to use the gamma distribution with the same expected value and variance.[267] Repeating a large number of iterations we obtain sufficiently large sample of "pseudo" data on loss reserves, firstly per accident years:

$$\tilde{R}_i = \tilde{C}_{i,I} - C_{i,I+1-i}, \tag{23}$$

and then in the total:

$$\tilde{R} = \sum_{i=2}^{I} \tilde{R}_i \ , \tag{24}$$

whose arithmetic mean represents the bootstrap estimate of loss reserves, while its standard deviation gives the standard error of prediction.

Without requiring the application of complex analytical forms, bootstrapping technique makes it possible to determine the overall probability distribution of loss reserves in a relatively simple manner. For calculated Value at Risk of that distribution at the selected level of confidence, economic capital to cover reserve risk (C_R) is equal to:

$$C_R = VaR_{0.995}\left(\tilde{R}\right) - E\left(\tilde{R}\right), \tag{25}$$

where $\tilde{R}$ denotes total amount of insurer`s loss reserves, $E\left(\tilde{R}\right)$ is the expected value of the simulated los reserves probability distribution and $VaR_{0.995}\left(\tilde{R}\right)$ is the Value at Risk for that distribution at 99.5% confidence level.

Expression (17) implies that insurer`s actually established loss reserves at the end of the year $\hat{R}$ are equal to the expected value of the simulated loss reserve distribution $E\left(\tilde{R}\right)$. However, if the reserves are overestimated so that $\hat{R} > E\left(\tilde{R}\right)$, the required amount of capital C_R can be reduced by the amount of the difference $\hat{R} - E\left(\tilde{R}\right)$. Conversely, if the reserves are underestimated so that:

[267] England, Verrall (2006), *op. cit.,* p. 236.

$\hat{R} < E(\tilde{R})$, calculated required amount of capital should be increased the amount of the difference $E(\tilde{R}) - \hat{R}$.

3. APPLICATION OF INTERNAL MODEL IN MEASURING RESERVE RISK

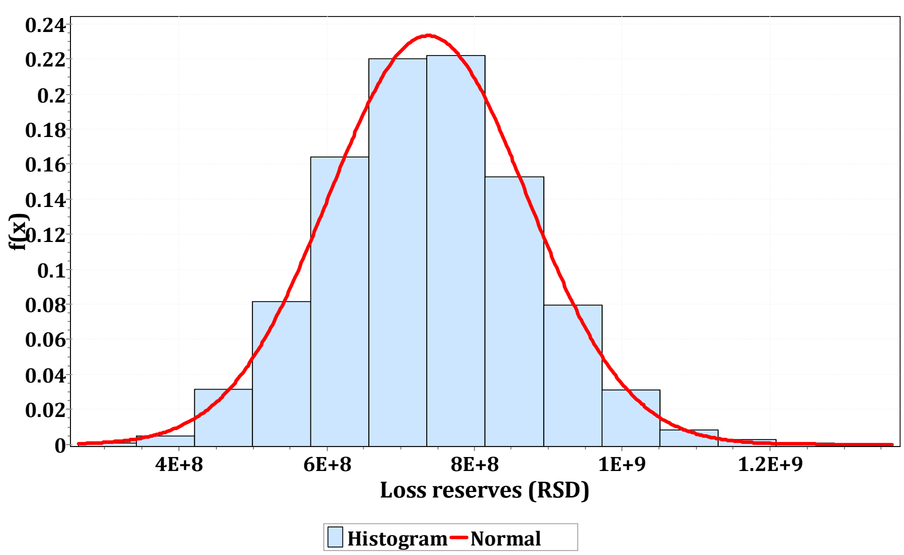
Basis for application of bootstrapping technique in loss reserving are loss development triangles by individual lines of business. Table 2 presents run-off triangle of cumulative loss payments in one line of business in the case of a hypothetical insurer.

Table 2. Cumulative loss payments

(in mil. RSD)

Accident year	Year of development									
	1	2	3	4	5	6	7	8	9	10
2005	104.38	167.54	194.95	246.40	294.60	353.27	358.04	362.43	370.43	374.24
2006	101.63	187.25	255.08	300.77	359.08	378.99	392.88	393.06	404.13	
2007	119.01	249.09	328.77	427.81	446.15	464.31	486.50	493.73		
2008	190.19	373.76	432.71	473.22	514.31	558.37	574.58			
2009	215.07	354.04	424.81	462.09	494.01	501.94				
2010	201.42	295.03	374.82	403.70	425.94					
2011	110.71	176.01	215.99	262.98						
2012	101.22	184.60	196.82							
2013	105.86	180.25								
2014	133.23									

Figure 3. Frequency histogram and probability density function of total loss reserves



Source: Author's calculation on the basis of the hypothetical example

By applying the chain ladder reserving method, loss reserves are estimated and established in the total amount of 737,169,818 RSD.[268] As a result of 10,000 bootstrap simulations, we obtained the loss reserve amounts that can be approximated by a normal distribution, with parameters whose estimated values are: $\hat{\mu} =$ 736,938,913 and $\hat{\sigma} = 134{,}576{,}062$. Figure 3 shows the histogram for simulated data and the corresponding probability density function. According to the Kolmogorov-Smirnov test, since p-value 0.20733 > 0.05, at 5% significance level the null hypothesis is not rejected and the normal distribution is a plausible model.

Table 3. Calculation of the capital required capital to cover reserve risk

Calculation	Indicator	Amount (in RSD)
1	Value at Risk of total loss reserves	1,083,583,877
2	Expected value of total loss reserves	736,938,913
3	Formed total loss reserves	737,169,818
4 = 3-2	Under / over estimation of total reserves	230,905
5	Retention rate	0.95
6 = (1-2-4)*5	Capital required to cover reserve risk	329,093,356

Source: Author's calculation on the basis of the hypothetical example

Value at Risk at a confidence level of 99.5% for the simulated distribution is equal to 1,083,583,877 RSD. Since the actually established loss reserves in the given line of business are greater than the expected value of the respective probability distribution, the difference between the two amounts reduces the amount of capital required to cover reserve risk. In order to acknowledge the effects of reinsurance, bearing in mind that a given calculation is based on gross loss reserves, the resulting capital requirement can be corrected by the retention rate, as the quotient between net incurred claims and gross incurred claims in the previous year. Assuming that this rate is equal to 95%, we come to the final capital requirement on the name of reserve risk in a given line of business of 329,093,356 RSD (see Table 3).

As a possible future direction of research, it would be interesting to examine the impact of different possible reinsurance schemes on the distribution of loss reserves in the proposed internal model. The other risk measures, such as conditional value at risk, could also be used for the determination of individual capital requirements. In order for the underwriting risk estimate to be complete,

[268] See more on the application of the chain ladder method in: Kočović, J., Rajić, V., Jovović, M. (2012). Prednosti i nedostaci Chain Ladder metoda za procenu rezervi za štete. In: *Proceedings of the XXXIX International Symposium on Operations Research,* Ćirović, G. (ed.), Belgrade: Construction-Geodetic High School, pp. 90-93.

the proposed model should be integrated with partial models for measuring premium risk[269] and catastrophe risks.[270]

4. IMPORTANCE OF INTERNAL MODELS IN DETERMINING SOLVENCY OF INSURANCE COMPANIES

In order for the solvency capital requirement, resulting from the use of internal models, to be admissible, it is necessary to provide a comprehensive and reliable database, appropriate methodology and its correct implementation, taking into account the relevant theoretical principles. Therefore, the iterative process of developing models for risk measurement is denoted as "as much art as engineering and science".[271] The internal model is expected to meet appropriate criteria in terms of statistical quality and compliance with the basic principles of the Solvency II concept and it should be really integrated into the risk management system of insurance company. The periodic validation of the model, as an integral element of the company's internal audit, is equally important. Insurance companies will be motivated for usage of internal models for the purposes of risk measurement and solvency evaluation if higher costs of their implementation can be compensated with relatively lower capital requirements compared the standard approach. Large companies with great possibilities of risk diversification and mitigation through other risk management methods, whose effects cannot be fully recognized in standard approach, are primarily interested in the internal models. At the same time, such companies have sufficient financial, technical and professional capacity for development and implementation of these models. On the other hand, the question of complexity of control over the implementation of internal models, checking their performance and preventing their abuse by insurers arises.

Adoption of principle-based internal models contributes to the reduction of insurance sector exposure to the systemic risk, which arises from a single standard approach.[272] However, their usage for the purpose of solvency

[269] See more in: Jovović (2015), *op. cit.*

[270] See more in: Kočović, J., Rajić, V., Trifunović, D. (2014). Measurement of Catastrophic Risks and Models for Managing these Risks. In: *Risk measurement and control in insurance,* Kočović, J., Jovanović Gavrilović, B., Rajić, V. (eds.), Belgrade: Faculty of Economics, University of Belgrade, pp. 3-20.

[271] Ronkainen, V., Koskinen, L., Berglund, R. (2007). „Topical modelling issues in Solvency II“. *Scandinavian Actuarial Journal,* 2007(2), p. 142.

[272] Eling, M., Schmeiser, H., Schmit, J.T. (2007). The Solvency II Process: Overview and Critical Analysis. *Risk Management and Insurance Review,* 10(1), p. 80.

evaluation is limited by adequacy of the standard approach, as a kind of benchmark from the aspect of supervisory authorities. If the standard model is not sufficiently "sensitive" to risks, the results of two models will be significantly different and verification of the internal model validity, therefore, will not be very convenient.[273] However, regardless of the prescribed solvency capital requirement, the internal model can certainly be used to determine the optimal level of insurer`s capital, as a support to the management.[274] By establishing a direct link between the required return and the level of risk in individual segments of business, the internal model can also contribute to a more efficient allocation of available capital.[275] The special role of partial internal models is reflected in facilitating the transition from standard approach to full internal model, enabling a better understanding of the risks and encouraging innovation and specialization in certain segments of insurance business.[276].

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[273] AISAM, ACME (2007). AISAM-ACME study on Non-life long tail liabilities: Reserve risk and risk margin assessment under Solvency II. *Joint Report*. Brussels, p. 8. (Retrieved 12.10.2011. from www.amice-eu.org/Download.ashx?ID=12779).

[274] Atchinson, B.K. (1997). Remarks on the American Risk Based Capital Model. *Geneva Papers on Risk and Insurance,* 22(82), p. 63.

[275] EU Commission (2002). Risk models of insurance companies or groups. *Note to the Solvency subcommittee,* MARKT/2515/02-EN. Brussels: European Commission, p. 4.

[276] Ronkainen *et al.* (2007)*, op. cit.,* p. 139.

Chapter 17.

BOOTSTRAPPING CHAIN LADDER AND APPLICATION IN RISK RESERVE CALCULATIONS

The risk management system of the insurance company is a comprehensive process, led and supervised by the company's management. It is designed to identify events that may have a negative impact on the company, with the aim to reduce the exposure of the company to potential losses. The risk management system combines the strategies, policies, processes, responsible people – risk owners, technology and knowledge in order to assess and manage the risks to which the company is exposed.

This Own risk and Solvency report is the final product of implementing a Solvency II and Risk Management in insurance companies. This report is also a new regulatory requirement, and by that all insurance companies will need to develop qualitative and quantitative assessing methods for all risks that are exposed to in their work.

Reserving risk is a risk that insurance company is exposed to, and it is located in insurance risk category. This work is written in order to give further explanation and possibility of implementation of Bootstrapping model in claims reserving process and solvency capital requirements of the ORSA report.

Generally ORSA is proposing that the risks should be measured at a 99.5 value at risk confidence interval, which can in words be explained as the one in two hundred year adverse event. Bootstrap method for Chain ladder calculated reserved claims will be used for obtaining the data from which this measure can be estimated. Generated empirical distribution for reserved claims will provide some estimates for the mean and standard error of this variable.

In the following chapters basic concept of the bootstrapping method will be explained, and its application in the Chain ladder Over dispersed Poisson model for incremental paid claims triangle and Mack model for cumulative paid claims triangle. The dataset that will be used will be Taylor and Ashe (1983) which has been used by several authors.

1. BOOTSTRAPPING METHOD

Statistical science basically tends to give answers about population parameters according to a given samples. Bootstrapping method also tends to give conclusions about a population but based on just one sample (X_1, X_2,…, X_n) , by a resampling the elements of the first sample with replacement.

The method was developed and presented by American mathematician Bradley Efron in 1979. This is a computationally intensive method introduced due to the introduction of computers in statistical practice. The method is (as said before) basically based on random sampling of dataset with replacement – in our case residual values of claims paid triangles, where every element of the sample has same probability to be in a new generated sample. This procedure creates a large number of new samples with sample size as the fist sample (n) that the method is based on. The main goal of this procedure is to estimate the parameters of the population distribution. For every sample we can we can do estimation of those parameters.

The distribution generated is empirical and does not require any strong assumptions, but it can be valuable in estimating confidence intervals for the variable that we are interested in. The only assumption is that the first sample is representative for the population.

Example of bootstrapping procedure will be given here:

Here we will give a brief example of the basic bootstrapping statistical concept. If we have one sample with sample size of ten elements – X = (35, 34, 13, 33, 27, 30, 19, 31, 10, 33) then the mean for this sample is m = 26,5 and standard deviation is sd = 9,168182. Bootstrapping this sample X is random sampling elements of the sample X with replacement. By that we obtain bootstrapped sample X_1^* = (30, 27 , 35, 35, 13, 35, 33, 34, 35, 33) and the mean for this bootstrapped sample is m_1^* = 31,0 and standard deviation is sd_1^* = 6,847546. You can see from the bootstrapped sample that elements from the first sample X can belong more than once in the bootstrapped sample. This procedure of sampling with replacement is done about 10000 times and values m_1^*, m_2^*, … , m_{10000}^* and sd_1^*, sd_2^*, … , sd_{10000}^* provide empirical distribution for the mean and standard deviation.

This method is an easy understandable and applicable statistical concept that will be important in understanding the idea of bootstrapping Over Dispersed Poison model for Chain ladder and Mack model for Chain ladder.

Bootstrapping can be done directly on the observation and on the residual values of the observations as we will see later in this work.

Applying bootstrapping in claims reserving process starts with the claims triangle. Various models are developed for incremental and cumulative paid claims triangles. The reserved claims calculated from the first triangle can be denoted as R_0. After that, residual triangle is obtained as the base triangle for the bootstrapping application. One resampled triangle of the residuals represents one base triangle for obtaining pseudo random triangle of claims and pseudo random reserved claims calculation. Results of reserved claims calculated for all iterations can be denoted as R_a, R_s, R_d, …, R_b where b is the number of iterations. These values represent empirical distribution of reserved claims using chain ladder method. Two mentioned models (ODP and Mack) for estimating reserves and variability of those reserves will be further explained in the following chapters of this work.

1.1. Bootstrapping the Chain Ladder - Over dispersed Poisson model

Model that will be presented in this chapter is Over Dispersed Poisson (ODP) model for Bootstrapping the Chain ladder triangles of paid claims. The model is presented by Renshaw & Verrall (1998) and developed there on. In this work main assumptions and the brief example will be given.

The ODP model is a generalization of the Poisson model and it overcomes many of the limitations while retaining the same structure and the desirable feature that the reserve estimates are identical to those obtained using the basic Chain Ladder method. The over-dispersed Poisson distribution allows the variance to be different from the mean (in Poison distribution mean and the variance are the same), and permits non-integer values. Overdispersion is measured with parameter φ.

Some of the characteristics of the model are: it is a model of incremental amounts, it is not suitable when development factors are less than 1, when forecasting using a distribution forecast of incremental values will be positive, simulated cumulative amounts will be strictly increasing, simulated reserves cannot be negative, the ultimate claims will be at least as big as the observed cumulative paid for each accident year. The ODP model was also developed by England & Verrall (2002) (Appendix 3) where assumptions and other explanations are given.

Let`s start with the triangle of incremental paid claims that is usually denoted as:

P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	. . .	P_{1n}
P_{21}	P_{22}	P_{23}	P_{24}	P_{25}	. . .	P_{2n}	
P_{31}	P_{32}	P_{33}	P_{34}	. . .	P_{3n}		
P_{41}	P_{42}	P_{43}	. . .	P_{4n}			
P_{51}	P_{52}	. . .	P_{5n}				
P_{61}	. . .	. . .					
. . .	$P_{n-1,n}$						
P_{n1}							

In this triangle n is the number of development years for full development of claims so tail factor is not considered in this work.

Assumptions for the ODP model are:

$E[P_{ij}] = \mu_{ij} = x_i * y_j$,

$$\text{where} \sum_{j=1}^{n} y_j = 1$$

P_{ij} is the amount of incremental paid claims for accident year i and development year j, $E[P_{ij}]$ (or μ_{ij}) is the expected value of incremental paid claims, x_i represents expected ultimate claims for accident year i, and y_j may be interpreted as the expected incremental development proportion for the development year j, the parameters x_i and y_j can be estimated using the Chain Ladder method (with main diagonal values and mean average development factors going backward).

$Var[P_{ij}] = \varphi_j * E[P_{ij}]$ or simplified $Var[P_{ij}] = \varphi * E[P_{ij}]$

φ_j is a scale parameter that depends of the development year. It can also be the same for all development years – constant φ is estimated using following formula:

$$\varphi = \frac{1}{d} \sum_{i=1}^{n} \sum_{j=1}^{n-i+1} \frac{\left(P_{ij} - E[P_{ij}]\right)^2}{E[P_{ij}]}, \quad \text{(England and Verrall 2002 – Appendix 3)}$$

Value d denotes the degrees of freedom of the chi squared distributed variable, and is calculated as the number of observations minus number of parameters fitted. Number of observations is the number of P_{ij} in the triangle $n*(n+1)/2$, and the number of parameters is number of x_i plus number of y_j minus 1, since the condition that sum of all y_j must be equal to1.

Model will be presented in steps as follows:

1) Fit chain ladder model and obtain fitted incremental values

In this step Chain Ladder development factors are calculated, according to cumulative claims development triangle (for example mean average for every development year). Then, those development factors are used to get so called “ideal triangle” of increment payments using the main diagonal of the triangle of cumulative payments and going backward by dividing with corresponding development factor. Increment claims of the “ideal triangle” will be noticed as μ_{ij}(for accident year i and development year j).

2) Obtain (scaled) Pearson residuals: $r_{ij} = (P_{ij} - \mu_{ij})/\sqrt{\varphi_j \mu_{ij}}$

Residuals are calculated for every increment of the triangle according to formula above. In the formula value φ_j is scaled parameter, and it is calculated for every development year. It also can be constant scale parameter φ (shown in example in the next chapter).

3) Resample residuals

Obtain new residual triangle by resampling residual values with substitution. This is the bootstrapping application in ODP model for chain ladder reserved claims calculation.

4) Obtain pseudo data, given $P_{ij}^* = r_{ij} \sqrt{\varphi \mu_{ij}} + \mu_{ij}$

After this step the pseudo triangle of the increment paid claims will be completed by calculating all values in the pseudo triangle of the increment paid claims by formula above. Formula is just a reversed formula for obtaining Pearson scaled residuals.

5) Use chain ladder to re-fit model, and estimate future incremental payments

Use Chain Ladder method for calculating reserves for obtained pseudo data (incremental paid claims) triangle.

6) Repeat many times, storing the reserve estimates (this gives the predictive empirical distribution)

Stored values of the reserve estimates will create empirical distribution that will be useful for estimating confidence interval for that variable. Mean of the stored values should be compared to a basic Chain ladder calculation.

7) Prediction error is then decomposed into two components: parameter uncertainty and process uncertainty (England and Verrall 2002)

For the underlying model, parameter uncertainty is estimated by re-sampling through the bootstrapping method (standard deviation of the stored reserve estimates of the bootstrapping) and the process uncertainty is estimated by simulating the future development from the estimated ODP distribution (estimated as the multiplication of the scale parameter and mean of the stored reserve claims values from bootstrap procedure). According to that prediction error has two terms for calculation given in a formula:

$$\text{prediction error} = \sqrt{(\text{process uncertainty})^2 + (\text{parameter uncertainty})^2}$$

More accurate formula for estimating prediction error is given by:

$$\text{prediction error} = \sqrt{\varphi \hat{R} + \frac{N}{N-p}\left(SE(\hat{R})\right)^2}$$

Prediction error refers to a process of claim reserve estimation, which can be used in later estimation of value at risk of the reserved claims. Constant scale parameter φ is discussed above, and $\hat{R}$ is the estimate of reserved claims derived from bootstrap simulations. Multiplication of these two terms gives the process variance.

The second term in the right part of the equation is biased standard error given by a formula:

$$SE(\hat{R}) = \sqrt{\frac{1}{B}\sum_{k=1}^{B}(R_k^* - \hat{R})^2}$$

Where B is the number of bootstrap simulations, R_k^* is the bootstrap estimate of reserved claims for k-th simulation, and $\hat{R}$ is the overal mean of bootstrap reserve claims estimation.

Some formulas and explanations of estimation for statistics of interest are given in previous chapter. In the next part of the chapter numerical example will be given according to Taylor and Ashe (1983) claims triangle data.

Numerical example for Bootstrapping method of Chain ladder - Over disperzed Poisson model

Numerical example of ODP model with constant scale parameter will be given according to the steps explained above. Example will be based on the ten years of development of claims paid data. The chain ladder has no tail factor since this is a full development period.

Table 1. Cumulative claims triangle

Acc.	Triangle of Cumulative Loss Payments									
Year	1	2	3	4	5	6	7	8	9	10
1	357.848	1.124.788	1.735.330	2.218.270	2.745.596	3.319.994	3.466.336	3.606.286	3.833.515	3.901.463
2	352.118	1.236.139	2.170.033	3.353.322	3.799.067	4.120.063	4.647.867	4.914.039	5.339.085	
3	290.507	1.292.306	2.218.525	3.235.179	3.985.995	4.132.918	4.628.910	4.909.315		
4	310.608	1.418.858	2.195.047	3.757.447	4.029.929	4.381.982	4.588.268			
5	443.160	1.136.350	2.128.333	2.897.821	3.402.672	3.873.311				
6	396.132	1.333.217	2.180.715	2.985.752	3.691.712					
7	440.832	1.288.463	2.419.861	3.483.130						
8	359.480	1.421.128	2.864.498							
9	376.686	1.363.294								
10	344.014									

Source of the data: Taylor & Ashe (1983)

First three tables are referred to the step 1 of the model - Fit chain ladder model and obtain fitted triangle values of claims. In table 2 development factors are obtained using mean average (or average) and by dividing the main diagonal values of cumulative claims triangle with corresponding development factors the fitted triangle is obtained.

Table 2. Development factors

	Age-to-Age Factors								
1	3,1432	1,5428	1,2783	1,2377	1,2092	1,0441	1,0404	1,0630	1,0177
2	3,5106	1,7555	1,5453	1,1329	1,0845	1,1281	1,0573	1,0865	
3	4,4485	1,7167	1,4583	1,2321	1,0369	1,1200	1,0606		
4	4,5680	1,5471	1,7118	1,0725	1,0874	1,0471			
5	2,5642	1,8730	1,3615	1,1742	1,1383				
6	3,3656	1,6357	1,3692	1,2364					
7	2,9228	1,8781	1,4394						
8	3,9533	2,0157							
9	3,6192								

The next step is to obtain scale parameter φ according to formula given above. The value of estimated constant scale parameter φ is 229,3.

After obtaining constant scale parameter φ, the triangle of scaled residuals can be calculated and it's given in Table 4.

Table 3. Fitted cumulative triangle

Acc.				**Fitted Cumulative Loss Payments - Ideal triangle**						
Year	1	2	3	4	5	6	7	8	9	10
1	270.061	942.678	1.647.172	2.400.610	2.817.960	3.110.531	3.378.874	3.560.909	3.833.515	3.901.463
2	376.125	1.312.904	2.294.081	3.343.423	3.924.682	4.332.157	4.705.889	4.959.416	5.339.085	
3	372.325	1.299.641	2.270.905	3.309.647	3.885.035	4.288.393	4.658.349	4.909.315		
4	366.724	1.280.089	2.236.741	3.259.856	3.826.587	4.223.877	4.588.268			
5	336.287	1.173.846	2.051.100	2.989.300	3.508.995	3.873.311				
6	353.798	1.234.970	2.157.903	3.144.956	3.691.712					
7	391.842	1.367.765	2.389.941	3.483.130						
8	469.648	1.639.355	2.864.498							
9	390.561	1.363.294								
10	344.014									

Table 4. Residuals with constant scale parameter

Acc.				**Residuals with constant scale parameter**						
Year	1	2	3	4	5	6	7	8	9	10
1	0,737	0,501	-0,488	-1,359	0,742	2,272	-1,027	-0,430	-0,379	0,000
2	-0,171	-0,238	-0,208	0,570	-0,775	-0,591	1,099	0,110	0,321	
3	-0,585	0,337	-0,199	-0,094	1,008	-1,760	0,903	0,256		
4	-0,404	0,889	-0,804	2,325	-1,704	-0,313	-1,142			
5	0,804	-0,688	0,534	-0,759	-0,090	0,768				
6	0,310	0,260	-0,342	-0,799	0,939					
7	0,341	-0,566	0,471	-0,125						
8	-0,701	-0,436	0,860							
9	-0,097	0,061								
10	0,000									

Table 5. Pseudo random incremental claims triangle (according to sampled scaled residuals)

Acc.				**Pseudo random incremental paid claims triangle**						
Year	1	2	3	4	5	6	7	8	9	10
1	365.834	1.228.123	1.797.688	2.551.126	2.984.700	3.227.148	3.607.025	3.835.151	4.379.799	4.463.066
2	446.659	1.252.317	2.186.211	3.456.107	4.037.367	4.562.483	4.983.501	5.225.849	5.591.838	
3	260.536	1.033.048	1.965.734	3.137.744	3.846.751	4.225.248	4.638.495	5.005.318		
4	473.397	1.334.668	2.411.129	3.247.616	3.773.312	4.100.048	4.472.931			
5	278.347	1.284.569	2.185.345	3.294.167	4.198.216	4.451.951				
6	340.592	1.458.341	2.005.773	2.591.680	3.324.790					
7	277.160	1.266.981	2.109.450	3.020.524						
8	642.362	1.638.206	3.081.576							
9	520.058	1.562.986								
10	236.559									

Table 6. Development factors of the pseudo random claims triangle

Age-to-Age Factors

1	3,3570	1,4638	1,4191	1,1700	1,0812	1,1177	1,0632	1,1420	1,0190
2	2,8037	1,7457	1,5809	1,1682	1,1301	1,0923	1,0486	1,0700	
3	3,9651	1,9028	1,5962	1,2260	1,0984	1,0978	1,0791		
4	2,8193	1,8065	1,3469	1,1619	1,0866	1,0909			
5	4,6150	1,7012	1,5074	1,2744	1,0604				
6	4,2818	1,3754	1,2921	1,2829					
7	4,5713	1,6649	1,4319						
8	2,5503	1,8811							
9	3,0054								

After bootstrapping (random sampling of scaled residuals with replacement) from the triangle in Table 4, pseudo triangle of paid claims (Table 5) can be obtained according to formula in step 4 (Obtain pseudo data). On the basis of that pseudo triangle development factors are calculated (Table 6) and also the amount of reserved claims for pseudo triangle data with Chain ladder method.

Calculation of reserved claims based on the pseudo random triangle is the one iteration in the process. Every random sampling of scaled residuals represents the one iteration and one base triangle for reserved claims calculation. Results for reserved claims for all iterations should be recorded and those values represent predictive empirical distribution for reserved claims. Standard deviation of those values is the variability measure and a standard error of the reserved claims for ultimate development period of these claims (Table 7).

Prediction error for reserved claims by accident years is calculated after 10.000 random sampling iterations and results are given in Table 7. Prediction error in percent is given in relation to a reserved claims calculated according to a claims development triangle in Table 1. Reserved claims calculated according to a claims development triangle in Table 1 are Chain ladder reserved claims with mean average development factor, and the value of these reserves is 18.680.856.

Table 7. Prediction error for reserved claims based on 10000 simulations

ACC yr	Prediction Error	Prediction Error %
1	0	0,00%
2	114.503	121,00%
3	214.160	45,61%
4	261.711	36,88%
5	310.628	31,54%
6	388.578	27,38%
7	507.656	23,31%
8	766.969	19,56%
9	1.074.267	25,11%
10	2.160.827	46,71%
Total	3.168.717	16,96%

Example shown here is based on the constant scale parameter φ. Scale parameter can be estimated for all development years j, φ_j. This way of estimating the overdispersion will reduce the process error.

This prediction error was calculated according to a given formula above. Multiplying the residuals (Table 4) with $\sqrt{\frac{N}{N-p}}$ for ODP bootstrapping model automatically takes into account degrees of freedom and this increases the variance and eliminates the adjustment of the prediction error after bootstrapping. By this we will get the full empirical distribution of all cash flows and the prediction error will simply be standard deviation of the results.

We stated earlier in the text that this is a method of incremental payments, and it can only be applied on the triangle with development factors greater or equal to 1. In the next part of the chapter the Mack model will be presented. This model overcomes this and it's a model for cumulative paid claims triangle.

1.2. Bootstrapping the Chain Ladder – Mack model

The model that can be applied in a triangle with negative incremental values is the Mack model. The model is presented in Mack (1993) - Distribution-free calculation of the standard error of chain-ladder reserve estimates.

Since it is a model of cumulative claims triangle, let us give some basic notation before the model explanation.

The triangle of cumulative claims paid will be denoted as following:

$$
\begin{array}{llllllll}
C_{11} & C_{12} & C_{13} & C_{14} & C_{15} & C_{16} & \ldots & C_{1n} \\
C_{21} & C_{22} & C_{23} & C_{24} & C_{25} & \ldots & C_{2n} & \\
C_{31} & C_{32} & C_{33} & C_{34} & \ldots & C_{3n} & & \\
C_{41} & C_{42} & C_{43} & \ldots & C_{4n} & & & \\
C_{51} & C_{52} & \ldots & C_{5n} & & & & \\
C_{61} & \ldots & \ldots & & & & & \\
\ldots & C_{n-1,n} & & & & & & \\
C_{n1} & & & & & & &
\end{array}
$$

$C_{i,j}$ is the cumulative amount of claims for accident year i up to a development year j.

Here we have to make two other notations: $w_{ij} = C_{i,j-1}$ and $f_{ij} = C_{ij}/C_{i,j-1}$ for the following simplified notation of formulas.

Assumptions for the Mack model are:

- $E(C_{ij}) = \lambda_j * C_{i,j-1}$

  This term means that the expected value of the cumulative claims is proportional to the previous development year cumulative paid amount. λ_j is basically representing the development factor.

- $V(C_{ij}) = \sigma^2_j * C_{i,j-1}$

  This term means that the variance of the cumulative claims is proportional to the previous development year cumulative paid amount.

Parameters λ_j and σ^2_j need to be estimated, and according to Mack`s model the estimates for these parameters are given with formulas:

$$\widehat{\lambda_j} = \sum_{i-1}^{n-j-1} w_{ij} f_{ij} \,/\, \sum_{i-1}^{n-j-1} w_{ij}$$

and

$$\widehat{\sigma_j^2} = \frac{1}{n-1} \sum_{i=1}^{n-j-1} w_{ij}(f_{ij} - \widehat{\lambda_j})^2$$

The model will be, as the ODP model was in previous chapter, presented in the following steps:

1. Fit the chain ladder model to the observed link ratios

In this step we calculate development factors for the cumulative claims paid triangle. Development factors are previously denoted as f_{ij}. Applying mean average formula we can estimate parameters λ_j for all development years. They represent the estimates of how will claims develop over development years.

2. Obtain scaled Pearson residuals

$$r_{ij} = \frac{\sqrt{w_{ij}}(f_{ij} + \lambda_j)}{\hat{\sigma}_j}$$

Residuals are calculated for every increment of the triangle according to formula above. In the formula value σ_j is sigma squared (which scales residuals), and it is calculated for every development year. This parameter is given in the model assumptions and the formula for the calculation of $\hat{\sigma}_j$ is given above.

3. Resample residuals

Obtain new residual triangle by resampling residual values with substitution. This is the bootstrapping application in Mack model for chain ladder reserved claims calculation.

4. Obtain pseudo data, given r_{ij}^* , λ_j

$$f_{ij}^* = \frac{r_{ij}^* \sigma_j}{\sqrt{w_{ij}}} + \lambda_j$$

After this step the pseudo triangle development factors will be completed by calculating all values in the pseudo triangle of development factors by formula above. Formula is just a reversed formula for obtaining scaled Pearson residuals.

5. Use chain ladder model to re-estimate the development factors (as a mean average of the pseudo-development factors)

Use mean average formula to obtain the average development factors for all development years and all pseudo triangles of development factors from step 4.

6. Obtain pseudo cumulative claims triangle move 1 period ahead by multiplying the previous cumulative claims by the appropriate simulated development factor obtained at Step 5

Move one year ahead by multiplying the previous cumulative claims by the appropriate simulated development factor obtained at Step 5. By that step you will obtain full development amounts of claims for all accident years. Reserved claims are the difference between the full development amount of claims and the main diagonal value of cumulative paid claims triangle for all accident years.

7. Repeat many times, storing the reserve estimates (this gives the predictive distribution)

Stored values of the reserve estimates will create empirical distribution, as it was in ODP model steps and that will be useful for estimating confidence interval for that variable. Mean of the stored values should be compared to a basic Chain ladder calculation.

8. Prediction error estimation

For the underlying model as it was in ODP model, prediction error of reserved claims is divided in two parts parameter uncertainty and the process uncertainty. According to that prediction error of reserved claims has two terms for calculation given in a formula:

$$\text{prediction error} = \sqrt{(\text{process uncertainty})^2 + (\text{parameter uncertainty})^2}$$

Formula for process uncertainty for the accident year i is:

$$\mathrm{Var}[R_i] = \hat{C}_{i,n}^2 * \sum_{k=n-i+1}^{n-1} \frac{\hat{\sigma}_{k+1}^2}{\hat{\lambda}_{k+1}^2 \hat{C}_{ik}}$$

And the parameter uncertainty is given with the formula for the accident year i:

$$\mathrm{Var}[\hat{R}_i] = \hat{C}_{i,n}^2 * \sum_{k=n-i+1}^{n-1} \frac{\hat{\sigma}_{k+1}^2}{\hat{\lambda}_{k+1}^2 \sum_{k=n-i+1}^{n-k} C_{qk}}$$

In the previous formulas $C_{i,n}$ is the value of the cumulative development triangle for the accident year i and last development year n. Other parameters in the formulas are given above.

The two formulas above combined give the prediction error of the reserved claims Mack model for accident year i, or in other words mean square error of prediction (MSEP):

$$\mathrm{MSEP}[\hat{R}_i] = \hat{C}_{i,n}^2 * \sum_{k=n-i+1}^{n-1} \frac{\hat{\sigma}_{k+1}^2}{\hat{\lambda}_{k+1}^2} \left(\frac{1}{\hat{C}_{ik}} + \frac{1}{\sum_{j=1}^{n-k} C_{jk}}\right)$$

The prediction error (MSEP as stated previously) for overall reserve can be estimated by following formula:

$$MSEP[\hat{R}] = \sum_{i=2}^{n} (MSEP[\hat{R}_i] + C_{in} \left(\sum_{q=i+1}^{n} C_{qn}\right) * \sum_{k=n-i+1}^{n-1} \frac{2\hat{\sigma}_{k+1}^2}{\hat{\lambda}_{k+1}^2 \sum_{k=n-i+1}^{n-k} C_{qk}}$$

Prediction error or MSEP is the measure of the variability of the process and is the measure of importance for further analysis of reserved claims.

Formulas and explanations of estimation for statistics of interest are given in previous chapter. In the next chapter of the work numerical example will be given according to Taylor and Ashe (1983) claims triangle data as it was for ODP chain ladder bootstrap.

Numerical example for Bootstrapping method of Chain ladder - Mack model

Numerical example of Mack will be presented, as it was for the ODP model, according to the steps explained above. Example will be based on the ten years of development of claims paid data. The chain ladder has no tail factor since this is a full development period.

Table 8. Cumulative claims triangle

Acc.	**Triangle of Cumulative Loss Payments**									
Year	1	2	3	4	5	6	7	8	9	10
1	357.848	1.124.788	1.735.330	2.218.270	2.745.596	3.319.994	3.466.336	3.606.286	3.833.515	3.901.463
2	352.118	1.236.139	2.170.033	3.353.322	3.799.067	4.120.063	4.647.867	4.914.039	5.339.085	
3	290.507	1.292.306	2.218.525	3.235.179	3.985.995	4.132.918	4.628.910	4.909.315		
4	310.608	1.418.858	2.195.047	3.757.447	4.029.929	4.381.982	4.588.268			
5	443.160	1.136.350	2.128.333	2.897.821	3.402.672	3.873.311				
6	396.132	1.333.217	2.180.715	2.985.752	3.691.712					
7	440.832	1.288.463	2.419.861	3.483.130						
8	359.480	1.421.128	2.864.498							
9	376.686	1.363.294								
10	344.014									

Source of the data: Taylor & Ashe (1983)

Table 9. Development factors

Acc.	**Age-to-Age Factors**								
Year	1	2	3	4	5	6	7	8	9
1	3,1432	1,5428	1,2783	1,2377	1,2092	1,0441	1,0404	1,0630	1,0177
2	3,5106	1,7555	1,5453	1,1329	1,0845	1,1281	1,0573	1,0865	
3	4,4485	1,7167	1,4583	1,2321	1,0369	1,1200	1,0606		
4	4,5680	1,5471	1,7118	1,0725	1,0874	1,0471			
5	2,5642	1,8730	1,3615	1,1742	1,1383				
6	3,3656	1,6357	1,3692	1,2364					
7	2,9228	1,8781	1,4394						
8	3,9533	2,0157							
9	3,6192								

First two tables show cumulative triangle of paid claims and the calculated development factors for the triangle. Mean average calculation of average factors is used for obtaining parameters λ_j for all development years.

Table 10. Scaled residuals

Acc. Year	Pearson scaled residuals								
	1	2	3	4	5	6	7	8	9
1	-0,519	-1,117	-1,152	0,772	1,490	-0,850	-1,189	-0,759	0,000
2	0,030	0,047	0,632	-0,608	-0,322	0,939	0,346	0,651	
3	1,290	-0,179	0,006	0,850	-1,141	0,758	0,682		
4	1,500	-1,228	1,840	-1,594	-0,282	-0,907			
5	-1,540	0,689	-0,683	0,005	0,543				
6	-0,197	-0,664	-0,636	0,878					
7	-0,942	0,764	-0,137						
8	0,693	1,647							
9	0,197								

Table 3 represents scaled residuals calculated according to formula given in step 2 of the Mack model.

Table 11. Pseudo random development factors triangle (according to sampled scaled residuals)

Acc. Year	Pseudo random obtained Age-to-Age Factors								
	1	2	3	4	5	6	7	8	9
1	3,495	1,756	1,354	1,174	1,091	1,133	1,054	1,100	1,038
2	2,737	2,008	1,576	1,261	1,160	1,035	1,048	1,099	
3	2,927	1,618	1,364	1,227	1,010	1,088	1,060		
4	4,039	1,752	1,430	1,130	1,096	1,166			
5	3,699	1,539	1,549	1,199	1,152				
6	3,086	2,000	1,458	1,160					
7	4,483	2,004	1,464						
8	2,885	1,636							
9	3,716								

After bootstrapping (random sampling of scaled residuals with replacement) from the triangle in Table 10, pseudo triangle of development factors (Table 11) can be obtained according to formula in step 4 (Obtain pseudo data).

On the basis of the random development factors (Table 11) and cumulative triangle of paid claims (Table 8) we can calculate reserved claims for as many iterations (let`s say 10000) using mean average development factors in reserved claims calculations.

Mean and prediction error of reserves is then calculated, for all accident years and for total reserves according to formulas given in step 8 of the Mack model (Prediction error estimation). Next table shows prediction error (MSEP).

Table 12. Prediction error for reserved claims based on 10000 simulations

ACC yr	Prediction Error	Prediction Error %
1	0	0,00%
2	77.009	81,38%
3	126.616	26,97%
4	138.506	19,52%
5	275.053	27,93%
6	436.399	30,74%
7	615.902	28,28%
8	990.597	25,27%
9	1.052.691	24,60%
10	1.453.573	31,42%
Total	2.312.279	12,38%

This prediction error was calculated according to a given formula above. You can incorporate standard error in step 6 of the Mack model by obtaining the next value after main diagonal (C_{ij}) in the triangle as the random variable with normal distribution with mean $\lambda_j * C_{i,j-1}$ and standard deviation $\sigma^2_j * C_{i,j-1}$ or noted as $N(\lambda_j * C_{i,j-1}, \sigma^2_j * C_{i,j-1})$. This was done according to model assumptions that are given previously. This way process error can be explicitly calculated from the standard deviations of claim reserves estimates and you don't have to use the formulas for prediction error

2. IMPLEMENTATION IN STATISTICAL SOFTWARE R

Numerical examples that are explained here for ODP model and Mack model can be done in an excel spreadsheet with all functions implemented in Microsoft office excel. Statistical software R has these functions in library called ChainLadder. In this software results can be obtained and checked with the results from the spreadsheet that are presented by steps of the both models.

First thing we have to do in R implementation for these models (ODP and Mack) is to install Chain Ladder package with the following command:

```
install.packages('ChainLadder')
```

This package allows statistical software R to use all functions that we need for our calculations according to these models. After that we need to put the triangles and use installed functions. Example will be done for the Mack model. Import of triangle of cumulative claims can be done using the following command:

```
triangle<-matrix(c(
+
357848,1124788,1735330,2218270,2745596,3319994,3466336,3606286,3833515,
3901463,
+
352118,1236139,2170033,3353322,3799067,4120063,4647867,4914039,5339085,
NA,
+ 290507,1292306,2218525,3235179,3985995,4132918,4628910,4909315,NA,NA,
+ 310608,1418858,2195047,3757447,4029929,4381982,4588268,NA,NA,NA,
+ 443160,1136350,2128333,2897821,3402672,3873311,NA,NA,NA,NA,
+ 396132,1333217,2180715,2985752,3691712,NA,NA,NA,NA,NA,
+ 440832,1288463,2419861,3483130,NA,NA,NA,NA,NA,NA,
+ 359480,1421128,2864498,NA,NA,NA,NA,NA,NA,NA,
+ 376686,1363294,NA,NA,NA,NA,NA,NA,NA,NA,
+ 344014,NA,NA,NA,NA,NA,NA,NA,NA,NA),
+nrow=10,byrow=TRUE)
```

The matrix represents the data from Table 8 and this is the way to import it into R. The command c(…) creates a vector of values of cumulative paid claims, and NA stands for the null value in this vector. Function matrix will generate a matrix with defined number of rows of ten.

All commands are inserted in a Console window of the software. Function MackChainLadder creates an object and output of that object will be the results – the average reserved claims according to Mack model and prediction error according to a same model for bootstrapping chain ladder. This can be done by inserting the following function i R Console window:

```
mackCL<- MackChainLadder(triangle,est.sigma=”Mack”)
```

The first argument of the MackChainLadder is the imported triangle of cumulative claims paid named triangle, and the estimation of process error is defined in the second parameter of the function.

R software will estimate parameters of importance very fast and results of this function are easy to interpret. R also provides a full development triangle according to Mack model by calling the following function:

```
mack$FullTriangle
```

As we have seen from this chapter R software is making easier using the model without making difficult formulas presented for estimating parameter of empirical distribution obtained with bootstrapping procedure. It is also a good way to check all results that we have got from excel spreadsheet calculations. Package ChainLadder also has implemented functions for the ODP model. Those functions are mostly the same as for Mack model but they will not be presented in this work.

3. ONE YEAR RESERVE RISK

Reserve risk is risk given by definition of Solvency II regime as the risk that the current reserves are insufficient to cover their run off over a 12 month horizon of time. The risk is included in the category underwriting risk (in insurance risk). The Solvency capital requirement (SCR) for this risk is based on a value-at-risk (VaR) measure calibrated to a 99,5 percent confidence level over a one-year time horizon. In other words one in two hundred years adverse event should be covered.

The risk is calculated around the current reserves - the current reserves have been set using the data available today. This is not a measure of the volatility of the past reserving process; it is a prospective measure of the risk around the current reserves over the next 12 months.

In ORSA one year horizon is taken requiring a distribution of the expected value of the liabilities for reserved claims after 1 year. Practically run off of reserved claims (referred before as CDR) after one year is the variable that we are interested in. The 1 year-ahead reserve risk standard deviation is the standard deviation of the distribution of profit/loss influence of reserved claims after one year.

For a particular year let:

The opening reserve estimate be - R_0

The reserve estimate after one year be – R_1

The payments in the year be - C_1

The run-off result (claims development result) be CDR_1

Then $CDR_1 = R_0 - C_1 - R_1$.

The three steps below present the obtaining of a distribution of one-year future payments and best estimate starting from a loss development triangle:

1) Calculation of best estimate at time 0. This best estimate is regarded as determinist (Chain ladder…) since calculated on realized data, known at time 0.

2) Simulation of the one-year payments between time 0 and time 1: they are the incremental payments in the sub-diagonal of the loss development triangle. In this step sub-diagonal can be obtained with bootstrapping method described above.

3) On the basis of step 2, calculation of the best estimate of reserves at time 1.

These three steps will provide empirical distribution of CDR and variation measures for the variable (standard deviation of simulated empirical values). It also provides a way to estimate a 99,5 percentile.

This chapter provides some examples of stohastic procedure used in insurance claims reserving. Examples and the results that are shown is this chapter explain some of the ways of implementing bootstrap technique in reserving risk calculation process. It is a work based less on theoretical but more on a practical view of this problem. Background of statistical models applied relies mostly on the bootstrapping procedure, which is dependent on the only sample that we have at the start point which is the cumulative triangle of paid claims in our example. All of the following calculations are based only on this triangle.

ODP model is given for calculation based on incremental claims triangle with positive incremental values and the Mack model overcomes these limitations and is done on cumulative claims development triangle. For both models the triangle that is used has to be representative and should not contain influences from the past that are overcomes during the company`s work because it is used to represent the future development of claims. In those influences we can put company`s policy for settling claims, change in number of employees in claims department and all other big changes that could affect the claims triangle. For the small companies those influences can produce higher prediction error if some of the developing factors is much higher than the others in one development year. Residuals will be higher and bootstrap procedure will generate higher standard error and 99,5 percentile.

Models that are presented in this chapter are two of the models for claims variability estimation that are developed lately and are still developing. There is no ideal statistical model and all these models produce some errors, but they can be used for making conclusions about your claims data. If these models are applied properly on company triangle of claims they can produce very good estimates of the statistics of interest – reserve risk calculations and parameters that describe this risk.

Chapter 18.

INVESTMENT MANAGEMENT - RISK AND CHALLENGES

The ultimate objective of any investor is to maximize return, while minimizing risk. However, it is a goal difficult to achieve, given that risk and return are conditioned upon each other, which is usually measured by the Sharpe ratio (see e.g. Njegomir, 2011, Kapil, 2011, Brigham and Houston, 2012). The Nobel Memorial Prize winning economist, Markowitz (1952) was the first to demonstrate theoretically, that, contrary to selecting single attractive stocks, creating a portfolio may better reduce the risk of investment and he was the first to point out that it is essential to make a compromise between risk and return in the portfolio. Owing to his works and some subsequent works of other authors, the investors seek to create investment portfolios as "baskets" of different investments, aimed at the diversification of return and risk. Optimization in investments presents the investor's endeavour to create investment portfolios that will enable maximizing return with a given level of investment risk and minimizing risks by constraints, which enables to achieve the expected level of return respectively (se for example: Jones 2010, Anderson at al., 2012). After Markowitz's work, the problem of selecting the optimum portfolio moves towards relaxing initial assumptions.

The two basic groups of methods for solving the problem of optimization are probabilistic and possibilistic (fuzzy) programming. Problems are still presented as single-criterion (minimizing risk at fix rates of return and creating an efficient limit) or as multi-criteria (minimizing risk while maximizing return, maximizing dividend payments etc.). This chapter will apply the multi-criteria programming fuzzy method in solving the problem of selecting the optimum portfolio. We are interested in the opportunities and constraints of investing in companies from Vojvodina, when there is an option of investing these assets into risk-free bonds. The list of companies was taken from the website of the Serbian Business Register Agency, while stock prices of individual companies were taken from the website of the Belgrade Stock Exchange. The International Association of Insurance Supervisors, IAIS, issued in October 2003 its core principles, which provide guidelines for the appointment of an actuary within the insurance supervision. These guidelines especially emphasize the role of actuary, who should point out all irregularities in the insurer's operation and inform about it both the managing board and the competent state authorities (Vojinovic et al, 2011).

The research covered 140 companies from Vojvodina active in the period from 2008 through 2015, whose stocks were traded at the Belgrade Stock Exchange: 42 companies from the field of agriculture, forestry and fishery, one company dealing with mining, 56 companies from the field of processing industry, six companies from the field of building and construction, 15 wholesale and retail trading companies, five companies dealing with accommodation and catering services, five companies from the field of transport and warehousing, five companies from the sector of scientific, professional, innovation and technical activities, two companies dealing with administrative and supporting services and one company from the sector of financial and insurance activities. Those companies (58 companies), who recorded a drop in the price of their stocks in each of the observed years, likewise the ones who failed to have any trade with their stocks in the period from 2008 to 2013 (149 companies) were preliminary excluded from the research. A total of 205 securities owned by companies from Vojvodina were delisted from the Stock Exchange in the period between 2009 and 2015 (196 by 2013 and 36 between 2013 and 2015). The list of companies covered by the research is given in Appendix 1. Essentially, the notion of insurance has not changed through history. Its objectives and tasks have remained the same, while the mechanism of implementing insurances has been subject to changes. Protection, or the state of being insured, has always presented the basis for the existence and implementation of insurance. It is an economic protection against harmful effects and economic disorders bringing about risks in all stages of social reproduction and in the daily life of people (Avdalovic et al, 2009).

1. INVESTMENT ACTIVITIES OF INSURANCE COMPANIES UNDER CONDITIONS OF SOLVENCY II

The basic role of insurance companies is the indirect economic protection against damages, which may incur as consequences of the realization of the insured perils. Insurance companies are also exceptionally important financial mediators. Namely, they collect premiums and accumulate these as reserves and later market the accumulated assets on the financial market as institutional investors. Despite the fact, that in average in Europe [277] the total value of the insurance companies' investment portfolios has dropped, owing to the performance of the financial crisis from 7200 billion euros to 6900 billion euros, insurance companies have a significant share in the financial market with respect to their investments during 2007 making 54% of the GDP. The total

[277] CEA (2009). European Insurance in Figures. *CEA Statistics No 37,* Brussels: Comité Européen des Assurances, pp. 20-22.

value of market placements by the insurance companies exceeding 3 trillion euros includes placements in state and corporate bonds. All estimates indicate that the profit, generated by investment funds in developed countries exceeds the interest on savings deposits in banks (Lakic et al, 2008).

When calculating capital requirements using a standard formula, more types of investment risks are considered: 1) interest rate changes risk (It is especially important for life insurance companies offering insurance services containing built-in options or guarantees for the policyholder.); 2) stock price changes risk (It is important for insurance companies offering life insurance with the policyholder's participation in risk and insurances related to investments in investment funds.); 3) Currency /exchange rate risk (For insurers outside the Eurozone there is a significant impact of the foreign exchange risk, in the form of additional capital requirements or the need of additional reduction due to the lack of access opportunities to liquid/solvent financial markets.); 4) the risk of the negative changes in property prices; 5) spread changes risk (The risk which reflects changes in the value of the net assets, which occur as a consequence in the change of yield on that asset in relation to the risk-free bond. This risk refers to changes in the level and variability of the spread and is applied to bonds, mortgage loan, credit derivatives and structured credit instruments, such as products of securitization of outstanding and collaterized debt obligations.) and 6) the risk of concentration (This risk is higher in case of wrongly diversified investment portfolios with regard to the well diversified ones).

By setting up an efficacious risk management process, the company's management have at disposal all inputs necessary for making decisions concerning the acceptance of certain risks (which, by their nature, represent chances, usually linked to the advantage of making the first move and to preferential data disposal), reduction of some risks (and, seldom, their elimination), adoption of more appropriate, but different strategies for risk distribution, and the optimization of strategic planning and decision-making processes on re-distribution, i.e. re-allocation of funds (Vojinovic et al, 2016). Solvency II demands higher solvency capital for higher investment risk exposures, which will influence the insurers to channel most of their investments towards safer placements. The direction of changes depends on the current structure of the insurer's investment portfolio and from the financial markets' level of development. The need of reducing investment risk sets the condition of higher demand of securities with fix return, and, primarily, for state bonds respectively, which causes the rise of their prices, but also the drop of interest rates. On the other hand, the decrease in the demand of stocks is reflected as follows: first, the most liquid ones will be jeopardized, but the long-term effects are greater for smaller liquid bonds, given that a relatively small change in the trading volume has significantly greater impact on the price. Additional price variability of bonds forms a condition for an even smaller demand of such securities.

Finally, the non-conformity between the supply of and demand for state bonds potentially will create a space for high rated corporate bonds. Insurance companies may be interested in investing in high rated corporate bonds since these securities enable investors, though with slightly higher risk, to have higher rates of return and the opportunity of additional diversification of the investment portfolio, thereby an additional investment risk reduction. The increased demand for corporate bonds would condition lower capital costs for their emitters and the consequential investment volume increase, which ultimately may affect a faster economic progress. Insurers earn their assets in two ways:

- founders' shares at founding an insurance company, and similarly, they collect funds during their operation by issuing shares, stocks,
- from their current operations, i.e. insurance premiums paid by the insured, incomes from investments of funds and other (Vojinovic et al, 2016).

2. PORTFOLIO OPTIMIZATION BY USING POSSIBILISTIC PROGRAMMING - LITERATURE OVERVIEW

Although the probability theory is the main tool in analysing random phenomena in the field of finances, market is also influenced by factors, which are not stochastic by their nature. These are linguistic descriptions of financial variables, which are characterized by two types of indefiniteness: ambiguity, e.g. “approximately 12% return” and vagueness in a sense of division by clear limits, e.g. “high risk”. The fuzzy mathematical programming was developed from the need to solve optimization problems adequately, which in their setting includes the above mentioned indeterminacies. Further on, the author provides an overview of literature which used fuzzy methodologies in solving the problem of portfolio optimization.

Wei Guo Zhang et al. (2007) consider the portfolio selection problem by means which are defined by upper and lower possibilistic means and variances. The authors transform the MV model into a linear one using possibilistic distributions, so their approach is convenient for solving the selection problem of “large” portfolios. The authors suggest two portfolio selection models and introduce the notion of lower and upper possibilistic efficient portfolio. An algorithm was presented in the paper by which the possibilistic efficient frontier for the observed portfolios can explicitly be calculated. The authors presented simple, linear models for portfolio selection under the assumption that the returns are modelled by trapezoidal fuzzy numbers.

X. Zhang et al. (2010) use the credibility theory in developing a model for adjusting an existing portfolio by the amount of transaction costs. Returns are modelled by triangular fuzzy numbers, while in obtaining the optimum strategy sequential quadratic programming was used. X. Zhang et al. (2011) further develop the problem determined in their former work, now from the aspect of possibilistic MV theory. They suggest a portfolio optimization model by using a V-shape transaction cost function in order to move from the current portfolio to the adjusted one. The same sequential programming method was used for calculating the optimum strategy for adjusting the portfolio. Huang (2008) approaches the portfolio selection problem by using a semivariance (SV) as a fuzzy variable and demonstrates certain features of the fuzzy semivariance. Bhattacharyya et al. (2011) suggests two MSV models, yet these authors use interval estimations and the impact of transaction costs in MV model with skewness. The model incorporates additional criteria: short- and long-term returns, liquidity, dividends, number of assets in the portfolio and the permitted minimum and maximum amount of money, which can be invested into the stocks of selected companies. They analysed scenarios covering future optimistic, pessimistic and fuzzy mean semivariance and developed a GA based on semivariance in order to solve the problem for the most general case. The results of numeric experiment show, that the suggested algorithm is efficient in solving fuzzy MSV models. Lin and Hsieh (2004) also dealt with the project portfolio selection problem and they pointed out the multitude of conflicting criteria, which must be considered: economic criteria, human resource development and corporate image. Damghani et al. (2011) were inspired by the work of their forerunners and the developed a decision support system (DSS) under the presence of uncertainty, in order to select the optimum portfolio under multiple investment opportunities. Investments are considered as projects, so initial costs, profit, necessary resources, likewise all available assets were considered uncertain. That uncertainty is modelled by concepts which are fuzzy.

3. PORTFOLIO SELECTION MODEL SCHEME

The justification of the use of multiple criteria portfolio selection model lies in the fact, that the expected return and risk do not cover all information necessary to make a decision about an investment. By incorporating additional criteria, it is possible to modify decisions relating to portfolio selection, which is not dominating in an MV environment, but compensates it by excellent performances under other criteria, thus it is dominant in a multiple criteria scheme. Guided by the work of Gupta and others (2008), the criteria we use are the following: short-term return, long-term return, risk, dividend, liquidity, intellectual capital efficiency and physical capital efficiency. The last two criteria use fundamental indicators from the financial statements of observed companies and it is rather interesting how these additional criteria impact the adjustment of the optimum selection. All the above mentioned works examine investments in risky assets only. In setting up the problem in this chapter, investments in risk-free assets are also permitted. [278] The following notations are used:

r_f – return on risk-free instrument,
r_i – return on the stock of the i^{th} company, i = 1, 2, ..., n,
x_i – share of total assets invested in i^{th} stock,
y_i – portfolio membership indicator of the i^{th} stock, its value is 1 if it belongs to the portfolio, otherwise it is 0,
d_i – annual dividend on the i^{th} stock.

Now, objectives (criteria) and constraints can be formulated:

Returns on risky assets are modelled by trapezoidal fuzzy numbers, thus emphasizing the uncertainty of the financial market and that the available data are inaccurate and incomplete. For details about the theory of fuzzy sets see the fundamental works of Zadeh (1965), Dubois and Prade (1980, 1987). Fuzzy number A (figure 1) = (a, b, α, β) is a trapezoidal fuzzy number if its membership function is given as:

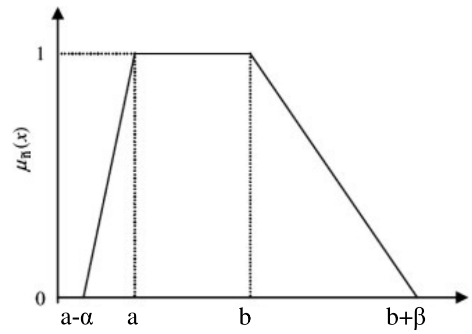
$$\mu_A(x) = \begin{cases} 1 - \dfrac{a-x}{\alpha}, a - \alpha \le x \le \alpha \\ 1 \qquad\qquad\quad , a \le x \le b \\ 1 - \dfrac{x-b}{\beta}, b \le x \le b + \beta \end{cases}.$$

Other domains for fuzzy sets are possible: lattices and partially ordered sets. For more detailed insight see e.g. Seselja et. al (2010) Denoted by $r_i = (a_i, b_i, \alpha_i, \beta_i)$ return on the i^{th} stock in the portfolio. For a portfolio with n risky and one risk-free asset $\mathbf{x} = (x_f, x_1, ..., x_n)$, fuzzy return is given as:

[278] As an equivalent for risk-free assets, securities of the Republic of Serbia were taken with a maturity of 3 months, with an average annual rate of 4,68% (during 2015).

$\Pi_s(\mathbf{x}) = r_f x_f + r_1 x_1 + ... + r_n x_n = (\Sigma a_j x_j, \Sigma b_j x_j, \Sigma\alpha_j x_j \Sigma\beta_j x_j)$[279] $= (A(\mathbf{x}), B(\mathbf{x}), \alpha(\mathbf{x}), \beta(\mathbf{x}))$.

Figure 1. Membership function of a trapezoidal fuzzy number



The expected rate of return on portfolio Π given by trapezoidal fuzzy number was defined by Dubois and Prade (1987) as an interval $[E_*, E^*] = [A(\mathbf{x}) - \alpha(\mathbf{x})/2, B(\mathbf{x}) + \beta(\mathbf{x})/2]$. By defuzzification we get the arithmetic mean of this interval, $E(\Pi) = \Sigma\frac{1}{2}[a_i + b_i + \frac{1}{2}(\beta_i - \alpha_i)]x_i$, as an estimation of the expected return on portfolio Π , which is maximized. The selection of the specific values of a, b, α and β, likewise the form of the fuzzy number's membership function used to describe the return on each stock, are rather arbitrary. Following the work of Vercher (2007) relating to core [a, b], we use 40th and 60th percentile of the return distribution, obtained from historical data, while for ranges α and β we use the differences of the fortieth and the fifth and the ninety-fifth and the sixtieth percentile. Other selections are possible and for details see Klir and Yuan (1995).

The annual dividend on portfolio is calculated as:

$D(\mathbf{x}) = d_1 x_1 + d_2 x_2 + ... + d_n x_n$.

As an approximation for the amount of the dividend, we use relative earnings per share (EPS). Portfolio risk is measured by the semi-absolute deviation of returns on portfolio **x** below the expected return. It is considered, that deviations above the expected return cannot be treated as risky, but as desirable, thus it has no impact on the level of risk. The measure of "low risk" describes investor preferences in a more realistic manner, since it penalizes only negative deviances from the expected return. Stevenson (2001) points out the appropriateness of using the "low risk" measure in case of developing markets, where returns are not distributed normally. The mean semi-absolute deviation

[279] The risk-free return rate can be presented as a trapezoidal fuzzy number in a trivial manner: $r_f = (r_f, r_f, 0, 0)$.

of return on portfolio **x** was proposed by Speranza (1993) in the following formula:

$$E\left(\left|\min\left\{0, \sum r_j x_j - E\left(\sum r_j x_j\right)\right\}\right|\right).$$

For working with trapezoidal fuzzy returns, the following formula for the semi-deviation of portfolio returns, analogous with Speranza's formula, is more appropriate:

$\sigma'(\Pi) = E(\max\{0, E(\Pi) - \Pi\})$.

It can be readily seen, that the interval containing semi-deviation, has the following form:

$\sigma'(\Pi) = [0, B(\mathbf{x}) - A(\mathbf{x}) + ½(\alpha(\mathbf{x}) + \beta(\mathbf{x}))]$, and after defuzzyfication:

$\sigma'(\Pi) = \Sigma½[b_i - a_i + ½(\beta_i + \alpha_i)]x_i$.

Liquidity is an opportunity to sell/exchange a financial asset for cash, without any significant loss of its value. Most frequently, it is measured by the turnover rate/rate of trading, which is the percentage of shares being effectively traded. Given that the trade of most of the shares owned by companies from Vojvodina is done according to the prevailing price method and that trades are infrequent, the liquidity coefficient for a single share is measured by the share of the number of days on which trading was made in the whole observed period, $l(a_i)$ $l_i = t_i/T$, while portfolio liquidity is a linear combination of single liquidities:

$L(x) = x_f + l_1x_1 + ... + l_nx_n$.

Constraints:
Budget constraints: $x_f + x_1 + ... + x_n = 1$.
Maximum (minimum) share of capital invested in a single stock: $l_i \le x_i \le u_i$, $i = 1, 2, ..., n$. Minimum share of capital invested in risk-free asset: $x_f \ge l_f$. The maximum and minimum share of capital depend on a number of fundamental factors, for example: trend in industry, minimum number of shares to be bought, capitalization of small companies etc.

The intellectual capital efficiency is a fundamental indicator, which is calculated as a sum of human capital efficiency (HCE) and structural capital efficiency (SCE). HCE measures the created value added (VA)[280] on each

[280] The company's added value is calculated according to the formula: PBT+GS+A+D, where PBT is the profit before tax, GS is the amount of gross salaries and fringe benefits, A is amortization and D is depreciation.

monetary unit invested in the employees. Structural capital (SC) [281]is the result of the work of the human capital in the past. Its efficiency is reflected in its share in the created value added:

$ICE_i = VA_i/GS_i + SC_i/VA_i$.

It is expected, that highly effective companies (ICE > 2,5) generate additional yield more easily (Pulic (2003)). The effectiveness of the intellectual capital portfolio x is given as:

$ICE(x) = ICE_1x_1 + ICE_2x_2 + ... + ICE_nx_n$.

Intellectual capital produces value in an interaction with the physical and financial capital. The effectiveness of using physical capital, CEE represents the share of value added in the total assets (TA) of the company: CEE = VA/TA. CEE shows how much value added has been generated per each monetary unit invested in the physical capital. The efficiency of the physical capital in portfolio x is given as:

$CEE(x) = CEE_1x_1 + CEE_2x_2 + ... + CEE_nx_n$.

Short sale is not permitted, $x_i \geq 0$ for all i = 1, 2,...,n.

The Optimization Problem

Based on the above presented objectives and limitations, the optimum portfolio selection problem can be formulated as follows:

$\text{Max } \Pi_s(\mathbf{x}) = r_fx_f + r_1x_1 + ... + r_nx_n$

$\text{Min } \sigma'(\Pi) = \Sigma\frac{1}{2}[b_i - a_i + \frac{1}{2}(\beta_i + \alpha_i)]x_i$

$\text{Max } D(\mathbf{x}) = d_1x_1 + d_2x_2 + ... + d_nx_n$

$\text{Max } L(\mathbf{x}) = x_f + l_1x_1 + ... + l_nx_n$

thus, the following is valid:

$x_f + x_1 + ... + x_n = 1,$

$l_i \leq x_i \leq u_i,\ i = 1, 2,..., n,$

$x_f \geq l_f,$

$ICE(\mathbf{x}) = ICE_1x_1 + ICE_2x_2 + ... + ICE_nx_n \geq ice_{min},$

$CEE(\mathbf{x}) = CEE_1x_1 + CEE_2x_2 + ... + CEE_nx_n \geq cee_{min},$

$x_i \geq 0,\ i = 1, 2,...,n.$

---

[281] SC = VA – HC

4. RESULTS

In solving the optimization problem, *Lingo 13.0* application was used. The programme script is attached in Appendix 2. Tables 1 and 2 show optimum portfolios for different levels of risk. Companies, whose stocks were selected, are denoted by numbers from 1 to 140, which coincide with the serial number of companies in the table from Appendix 1. The optimization problem was solved by the maximum limitation of investments in risky assets to 25% (Table 1) and to 10% (Table 2). In both cases, investments in risk-free, state bonds were limited to 25%. The tables contain relative shares in the stocks of companies from Vojvodina, while the share, which was invested in bonds has been left out, since, for all levels of risk and for different investments in risky assets, it is always 25%. Only the two last observed risk amounts, 69% and 70%, make an exception in Table 1, when the share of bonds falls below 24.47% and 23.73% respectively.

Tables 3 and 4 present the optimum values of dividends and liquidity. Optimum solutions at different levels of investment in risky assets were analysed in detail. Noticeably, investments in agriculture vary between 12% and 30% and these were implemented by investments in two companies during the whole spread of the risk. The first company is characterized by lower expected return and semi-deviation, while the second one had exceptionally high expected return with proportionally higher level of risk. Detailed descriptive data about each company are given in *Lingo* script in Appendix 2. The percentage invested in agriculture grows with the increase of risk-tolerance, independent of the limitation of investment in risky assets. Investments in agriculture should be limited to about 10% for markedly risk-averse investors. The mining sector is represented by a single company from Vojvodina (43) and it was presented in all optimum portfolios with a maximum share of 25% and 10% respectively. The time series, based on which the expected return and semivariance were calculated, is short, thus it is not possible to make any long-term conclusions. The company has been operating steadily since it has started trading on the Stock Exchange, so the amount of the semivariance is relatively low. On the other hand, the expected returns are high and so are the potential earnings on stocks and the liquidity, which is the maximum compared with the rest of the observed companies. The sector of processing industry is represented in both types of optimum portfolios. The post-crisis situation in Serbia's industry is explained in more detail in Adzic and Stojic (2016). In the less restrictive model, the processing industry is represented by two companies (70 and 85) with emphasized polarized values of return and semi-deviance. When investment is limited to 10%, portfolios contain about 40% of assets invested in processing industry at all levels of risk, which is a significantly different arrangement compared to highly concentrated investments. Investment in processing industry is locally diversified - besides the mentioned areas- by investments in stocks of veterinary institutes (65), bakeries (66) and chemical industry (79). Adzic and Stojic (2014a) investigated portfolio selection for processing industry and came to similar results when applying fuzzy methodology. The wholesale trade sector is the only sector, where no companies were delisted from the Stock Exchange during the last two years and it includes the largest percentage of companies, whose stock prices have been rising since the emergence of the 2008 crisis. According to the researches made by Vojvodina CESS, investments in the trading sector increased faster than in any other sector in Vojvodina in the period from 2001 till 2007 with average growth rate of about 200%.[282] In a less concentrated portfolio, trade is only represented in the motor vehicle parts trade subsector (106) with about 5%, exclusively in low-risk portfolio. The transportation sector is represented in both types of portfolios with one company only (130), (out of the 5 companies, whose stocks are being traded on the Stock Exchange), with a maximum 25% in the first type and 10% in the second type of portfolios respectively. The building sector is fully absent from both types of portfolios. Companies from this sector are featured by trading with losses (101) or modest yields and exceptionally high risks (100). Operations with real estates, with less than 2%, are represented in lower risk, non-concentrated portfolios. Interestingly, the company dealing with the rental of real estates (131) is the only one, whose stocks are traded on the Stock Exchange.

Finally, the sector of administrative and supportive services is represented in all portfolios by one company (139), which had positive performances during the observed period. We will present below a solution of the optimum portfolio selection problem in the case of investing with high level of risk aversion. All portfolios have the same level of intellectual capital efficiency in the amount of 2.143. State bonds were left out from the formula for calculating the portfolio's intellectual capital efficiency, thus the value was obtained by normalization[283]. For industrial sectors, the results show the following properties: Investment in agriculture is realized with the minimum 5% regardless the risk level. General problems of agricultural enterprises are explained in e.g. Adzic and Stojic (2014b, 2015). Most frequently, the number of represented companies is three, whereby companies (9) and (27) are permanently present with their maximum of 2% in investments. Low liquidity is the feature of all companies from the

[282] This data should be taken with reserve, because the most significant investments were implemented in 2004.

[283] The value was obtained by normalizing the required lower limit of 1,5, by dividing it with the weight sum of 0,7 from the arithmetical mean of each efficiency.

sector of agriculture, forestry and fishery. Buy and sale is realized, even in the most frequent case, once in 5 days, and very often it is less than once in 100 days. The selected companies are featured by high intellectual (2.03 – 7.8) and physical capital (0.2 – 0.23) efficiency[284] and positive dividend. Investment in the mining sector is realized by the investment of the maximum 10% in NIS (Petroleum Industry of Serbia), as the sole representative of this sector. The required low risk level fully excludes food industry from investments in the sector of processing industry. Food industry is featured by high expected return at high levels of risk, caused by large fluctuations in stock prices in the period of 2008-2015, thus companies like Sojaprotein, Dijamant, Vital, Sunce etc. were absent from the portfolio, while advantage was given to smaller companies producing and processing chemicals, plastic mass, glass, ceramics, brick, energy machines etc. Company (50), the oil factory from Nova Crnja is an exception, since it is present in risk portfolios with more than 5,5%. Companies (82), (84) and (85) are included in low risk portfolios with a maximum of 2%, 10% and 10% respectively. The wholesale and retail trade sectors is represented by companies (107), (111) and (112) in which the suggested investment is maximum 2%, 2% and 10%. Company (106) shows no oscillations in the price of its stocks, yet has an exceptional human potential and also a positive return on stocks. For the same reason, company (123), from the sector of accommodation services, was included in optimum portfolios. The proposed investment rate in the sector of transportation is 2% in company (130). The expected stock price growth is 30% with a relatively low risk. The intellectual capital efficiency coefficient is above 3, while the potential payment of dividend amounts to 30% of the stock price. The limitation to merely 2% is because of the low liquidity. Investment in professional, innovative and scientific activities amounts to 5% in company (134). The stocks of this company are desirable in all low risk portfolios. For portfolios with semi-absolute deviation in the interval of 5%-7%, the expected return is between 9.6% and 12.5%. At the first sight, investment in low risk portfolio generates lower return than an investment in risk-free bonds. However, the return on the stock price growth is the only profit generated by the portfolio. Dividends, which are (potentially) paid, are approximated in the amount of net profit per stock, which can increase the return of optimum portfolios for an additional 26-33% (Table 1 and Table 2). By maximizing the left range (minimum returns shaped a-α) by maximizing the right range as well (i.e. maximum returns shaped b+β), we enable to construct a portfolio with return asymmetrical to the right.

[284] The mean value of the intellectual capital efficiency coefficient in agriculture was merely 1.38 in the period of 2005-2009.

The function of the objective, first maximized, is given as follows:

$LS(\Pi) = r_f x_f + (a_1 - \alpha_1)x_1 + ... + (a_n - \alpha_n)x_n$

$RS(\Pi)$[285] $= r_f x_f + (b_1 + \beta_1)x_1 + ... + (b_n + \beta_n)x_n$

while the other functions of the objective and constraints are unchanged. The results are shown in Table 3.

Table 1. Overview of Pareto optimum solutions at limiting investments in certain assets to 10%

Risk	**Company**										
	Share of each asset in the portfolio										
0.20	**9**	**43**	**45**	**50**	**66**	**71**	**85**	**92**	**131**	**139**	
	0.10	0.10	0.10	0.019	0.095	0.01	0.10	0.10	0.025	0.10	
0.25	**9**	**43**	**45**	**50**	**66**	**85**	**92**	**107**	**131**	**139**	
	0.10	0.10	0.02	0.058	0.100	0.10	0.100	0.053	0.019	0.10	
0.30	**9**	**43**	**50**	**79**	**85**	**92**	**107**	**129**	**131**	**139**	
	0.10	0.10	0.073	0.10	0.10	0.10	0.10	0.052	0.003	0.022	
0.35	**9**	**43**	**50**	**58**	**79**	**85**	**92**	**129**	**131**	**139**	
	0.10	0.10	0.079	0.079	0.10	0.10	0.089	0.10	0.003	0.001	
0.40	**9**	**43**	**50**	**58**	**79**	**85**	**92**	**129**	**135**		
	0.10	0.10	0.099	0.098	0.084	0.10	0.047	0.10	0.022		
0.45	**9**	**43**	**50**	**58**	**65**	**79**	**85**	**92**	**129**	**135**	
	0.10	0.10	0.084	0.10	0.039	0.084	0.10	0.009	0.10	0.033	
0.50	**9**	**36**	**43**	**50**	**58**	**65**	**79**	**85**	**129**	**139**	
	0.10	0.030	0.10	0.094	0.10	0.034	0.087	0.10	0.10	0.005	
0.55	**9**	**36**	**43**	**50**	**62**	**65**	**70**	**79**	**85**	**120**	**139**
	0.10	0.074	0.10	0.10	0.041	0.027	0.004	0.10	0.10	0.10	0.005
0.60	**9**	**36**	**43**	**50**	**62**	**65**	**70**	**79**	**85**	**129**	**139**
	0.10	0.095	0.10	0.10	0.004	0.027	0.021	0.10	0.10	0.10	0.004
0.65	**9**	**36**	**43**	**50**	**65**	**70**	**79**	**85**	**129**	**139**	
	0.10	0.092	0.10	0.100	0.026	0.052	0.076	0.10	0.100	0.004	
0.70	**9**	**36**	**43**	**50**	**65**	**70**	**79**	**85**	**129**	**139**	
	0.10	0.086	0.10	0.100	0.026	0.084	0.049	0.10	0.100	0.005	

[285] The function of mean right range is maximized instead of the function of mean return. Some other functions are also possible, for example: the skewness function $S(\xi) = E(\xi-E(\xi))^3$.

Table 2. Pareto optimum solutions in the case of limitations of investment in risky assets to 10%

Risk	Return	Dividend	Liquidity
0.20	0.1806	0.2870	0.50
0.25	0.2846	0.2838	0.50
0.30	0.3574	0.1540	0.50
0.35	0.4153	0.1430	0.50
0.40	0.4725	0.1590	0.50
0.45	0.5289	0.1650	0.50
0.50	0.5840	0.1260	0.50
0.55	0.6383	0.1230	0.50
0.60	0.6924	0.1210	0.50
0.65	0.7462	0.1230	0.50
0.70	0.8000	0.1240	0.50

Noticeably, the obtained portfolios are very close to same-risk portfolios obtained by the maximization of the expected returns. A better diversification incurs, especially in the sector of agriculture, forestry and fishery, because the stocks of companies (30) and (37) have been present in maxmin portfolios for a longer period of time. Other sectors are represented with the same number of stocks in both portfolio types.

Comparing values from Table 2 and Table 4, it is discernible, that portfolios obtained by maximizing the expected return, have superior characteristics. Dividends for these portfolio grow parallel with the increase of risk up to 33%, while portfolios obtained by maximizing the minimum and maximum return, have a relatively constant value of about 24.5%. Returns on assets and the efficiency of the physical capital respectively, diverge from the initially same value at a risk of 5%. With the increase of risk, the growth of efficiency is discernible at the first type of portfolio and the drop of efficiency at the second type. Human capital efficiency is the only constraint of the second problem which achieves higher values then in the first problem. Human capital efficiency was constant and amounts to 2.143, which, by maximizing the end of returns, moves in the interval from 2.327 up to 2.272 and drops with the decrease of risk.

Table 3. Portfolios obtained by maximizing minimum and maximum returns

Risk	13	27	31	36	43	58	79	82	84	85	107
0.050	0.02		0.02	0.02	0.10	0.02	0.02	0.011	0.10	0.10	0.02
0.055	0.020	0.02	0.02	0.02	0.10	0.02	0.02	0.02	0.10	0.10	0.02
0.060	0.070	0.02	0.02	0.02	0.10	0.02	0.02	0.02	0.10	0.10	0.02
0.065	0.100	0.02		0.02	0.10	0.02	0.02	0.02	0.02	0.10	0.02
0.070	0.100	0.02		0.02	0.10	0.02	0.02	0.02	0.02	0.10	0.02
Risk	**110**	**111**	**112**	**123**	**129**	**134**	**139**	Min. return		Max. return	
0.050	0.02	0.02	0.02	0.02		0.09	0.10	0.0208		0.2001	
0.055	0.02	0.02	0.02	0.02		0.076	0.10	0.027		0.2253	
0.060	0.02	0.02	0.02	0.02		0.031	0.10	0.032		0.2494	
0.065		0.02	0.02	0.02	0.0003	0.02	0.10	0.0358		0.2727	
0.070		0.02	0.02	0.02	0.02	0.004	0.10	0.0373		0.2941	

Table 4. Values of other objective and constraint functions at maximizing minimum and maximum returns

Risk	Dividend	Liquidity	Return on assets	Human capital
0.050	0.2480	0.4243	0.2065	1.6292
0.055	0.2409	0.4242	0.2036	1.6249
0.060	0.2489	0.4236	0.1837	1.6149
0.065	0.2460	0.4253	0.1811	1.5844
0.070	0.2443	0.4232	0.1727	1.5909

Fuzzy methodology is an adequate method for modelling events which, in addition to their stochastic nature, possess a subjective character as well in a form of the investors' expectations, who with their activities on the market can affect the values and states of events in question. The chapter presented a model for measuring the competitiveness of companies in all fields of market activity in the province of Vojvodina and attempted to solve the problem of multiple criteria portfolio selection. Research in the possibilities of investment portfolio optimization is essential from both global, scientific and local, practical aspects. Namely, as far as the author knows, no similar research has been made with such a number of companies from Vojvodina. Intellectual and physical capital efficiencies of the companies were included for the first time among functions of constraints. Given that the research primarily used data from the Serbian market, the research bears significance for investors interested in investing in Serbia, especially institutional investors, but also domestic companies seeking to create value for their shareholders and - with a risk level of their business activities - make investors with a certain tolerance to risk interested. The above mentioned implies the importance of research for domestic institutional investors and state institutions as well.

Appendix 1: List of companies included in the research

A – Agriculture, forestry and fishing

1. Đuro Strugar a.d. Kula (excluded)*
2. PP Elan Izbište*
3. Mitrosrem a.d. Sremska Mitrovica (Market cap 1.478.840.000)
4. Kozara a.d. Banatsko Veliko Selo (Market cap 150.453.000)
5. Agroseme a.d. Kikinda*
6. Jedinstvo a.d. Kikinda**
7. Lučić Prigrevica a.d. Novi Sad (Market cap 358.984.000)
8. PP Miletić a.d. Srpski Miletić (Market cap 175.068.108)
9. PP Zlatica a.d. Lazarevo (Market cap 553.431.060)
10. Banatski Despotovac a.d. Banatski Despotovac (Market cap 39.669.091)
11. Kačarevo a.d. Kačarevo (Market cap 69.276.800)
12. Omoljica a.d. Omoljica*
13. Stari Tamiš a.d. pančevo (Market cap 514.559.500)
14. Ravnica a.d. Bajmok (Market cap 459.278.000)
15. Pionir PP a.d. Srbobran (Market cap 535.125.000)
16. Aik Bačka Topola a.d Bačka Topola**
17. Agrobačka a.d. Bačka Topola (Market cap 137.358.300)
18. Doža Đerđ a.d. Bačka Topola (Market cap 195.471.000)
19. Zobnatica a.d. Bačka Topola**
20. Ratar a.d. Jaša Tomić*
21. Graničar a.d. Konak**
22. Pobeda a.d. Boka*
23. Bratstvo jedinstvo a.d. Neuzina*
24. Labudnjača a.d. Vajska*
25. Kolut a.d. Kolut (Market cap 74.704.500)
26. PP Sombor a.d. Sombor **
27. Sava Kovačević a.d. Vrbas (Market cap 1.058.008.130)
28. 1. Oktobar a.d. Sombor**
29. Agros a.d. Opovo **
30. Jedinstvo a.d. Apatin*
31. Poljoprivreda Novo Selo a.d. Orom (Market cap 34.175.013)
32. Kelebija a.d. Kelebija**
33. PP Bezdan a.d. Bezdan (Market cap 488.473.040)
34. Sloga a.d. Kać (Market cap 123.050.500)
35. Podunavlje a.d. Čelarevo (Market cap 581.712.300)
36. Bačka a.d. Bačka Palanka (Market cap 196.241.500)
37. Agrovršac a.d. Vršac**
38. VP Dunav a.d. Bačka Palanka (Market cap 40864000)
39. Ribar a.d. Novi Kneževac*
40. Ribarstvo a.d. Baranda (Market cap 43.190.280)
41. Ribnjak Sutjeska a.d. Zrenjanin (Market cap 86.877.900)
42. Sloboda A. D. Zrenjanin (Market cap 43.603.200)

B – Mining
43. NIS a.d. Novi Sad (Market cap 136.318.494.400)

C – Manufacturing
44. IM Topola a.d. Bačka Topola**
45. Neoplanta a.d. Novi Sad (Market cap 1.275.291.805)
46. Higlo hladnjača a.d. Horgoš**
47. Hladnjača Apatin a.d. Apatin**
48. Soja protein a.d. Bečej (Market cap 11.916.419.200)
49. Dijamant a.d. Zrenjanin (Market cap 2.432.746.080)
50. Banat fabrika ulja a.d. Nova Crnja (Market cap 629.449.100)
51. Vital a.d. Vrbas (Market cap 993.118.100)
52. Sunce a.d. Sombor (Market cap 541.103.220)
53. Mlekara a.d. Subotica**
54. Ratar a.d. Pančevo (Market cap 110.362.500)
55. Žitosrem a.d. Inđija (Market cap 194.291.073)
56. Žitopromet Mlinpek a.d. Stara pazova**
57. Kikindski mlin a.d. Kikinda (Market cap 949.985.757)
58. Žitko a.d. Bačka Topola (Market cap 401.483.700)
59. Žitobanat a.d. Vršac (Market cap 75.515.550)
60. Danubius a.d. Novi sad** (Market cap 1.264.682.100)
61. Bečejska pekara a.d. Bečej (Market cap 45.416.500)
62. Superprotein a.d. Zrenjanin**
63. Fabrika stočne hrane a.d. Crvenka**
64. Jabuka a.d. Pančevo (Market cap 927.603.000)
65. Veterinarski zavod Subotica a.d. Subotica (Market cap 2.194.000.940)
66. Pekara 1. maj a.d. Vršac (Market cap 16.272.960)
67. Hleb a.d. Novi Sad (Market cap 252.269.000)
68. Trivit Pek a.d. Vrbas (Market cap 15.555.310)
69. Jaffa a.d. Crvenka*
70. Medela a.d. Vrbas (Market cap 517.959.519)
71. Crvenka fabrika šećera a.d. Crvenka (Market cap 5.451.304.000)
72. Šajkaška fabrika šećera a.d. Žabalj (Market cap 4.190.125.000)
73. TE-TO a.d. Senta (Market cap 2.722.815.200)
74. BB Minaqua a.d. Novi Sad**
75. Čoka duvanska industrija a.d. Čoka (Market cap 79.260.000)
76. Niva a.d. Novi Sad**
77. Ruma fabrika kože a.d. Ruma (Market cap 98.716.800)
78. Stolarija a.d. Titel**
79. Linde gas Srbija a.d. Bečej (Market cap 733.107.570)
80. Albus a.d. Novi Sad (Market cap 45.198.600)
81. Rumaplast a.d. Ruma**
82. Izolir a.d. Zrenjanin (Market cap 24.669.906)
83. Chemos a.d. palić (Market cap 58.401.920)
84. Elektroporcelan a.d. Novi Sad (Market cap 65.374.584)
85. Polet IGK a.d. Novi Bečej (Market cap 3.337.530.000)

86. Integral betonirci a.d. Subotica**
87. Čelik a.d. Bački Jarak (Market cap 25.963.200)
88. Utva silosi a.d. Kovin (Market cap 1.009.686.600)
89. Radijator a.d. Zrenjanin (Market cap 155.452.534)
90. Vagar a.d. Novi Sad (Market cap 16.930.960)
91. Sila a.d. Stara Moravica**
92. FKL a.d. Temerin (Market cap 191.591.400)
93. Šipad Srbobran a.d. Srbobran**
94. Žitopromet-mlin a.d. Senta (Market cap 715.158.150)
95. Utva – Milan premasunac a.d. Kačarevo (Market cap 76.120.000)
96. Prerada drveta a.d. Ada (Market cap 4.479.500)
97. Naša sloga a.d. Kovin (Market cap 386.246.400)
98. Granexport a.d. Pančevo (Market cap 1.169.570.000)
99. Budućnost a.d. Subotica (Market cap 43.625.000)

F – Construction

100. Vojvodinaput a.d. Novi Sad*
101. Sremput a.d. Ruma (Market cap 135.399.260)
102. ZGOP a.d. Novi Sad (Market cap 3.954.937.000)
103. Vig vodovod i grejanje a.d. Novi Sad (Market cap 25.809.300)
104. Radnik a.d. Bačka Palanka (Market cap 39.348.000)
105. Elektromont a.d. Novi Sad (Market cap 1.788.000)

G – Wholesale and retail trade

106. Interservis a.d. Futog (Market cap 79.448.200)
107. Poljopromet a.d. Ruma (Market cap 5.246.600)
108. Agrovojvodina komercservis a.d. Novi Sad (Market cap 182.004.000)
109. LTH Shipons a.d. Novi Sad (Market cap 103.338.000)
110. Univerzal a.d. Kanjiža (Market cap 57.714.500)
111. BB Trade a.d. Žitište (Market cap 31.605.840)
112. Trgopromet a.d. Subotica (Market cap 570.679.884)
113. Podunavlje a.d. Bačka Palanka (Market cap 44.269.940)
114. Podunavlje a.d. Beočin (Market cap 32.529.236)
115. Senta-promet a.d. Senta (Market cap 88.931.700)
116. Vojvodina sport a.d. Novi Sad (Market cap 17.782.560)
117. Ogrev a.d. Zrenjanin (Market cap 36.812.556)
118. Peščara a.d. Subotica (Market cap 43.569.000)
119. Metalac – Metalurgija a.d. Novi Sad (Market cap 191.713.000)
120. BMK & Zanatprodukt a.d. Stara Pazova (Market cap 7.368.960)

I – Accomodation and food service activities

121. Hotel park a.d. Novi Sad (Market cap 215.280.000)
122. Hotel Narvik a.d. Kikinda**
123. Putnik a.d. Novi Sad (Market cap 42.776.832)
124. Tisa a.d. Senta**
125. UTP Bela Crkva a.d. Bela Crkva

H – Transportation and storage
126.STUP Vršac a.d. Vršac (Market cap 562.464.000)
127.Dunavprevoz a.d. Bačka Palanka**
128.Luka Leget a.d. Sremska Mitrovica (Market cap 472.374.045)
129.Luka Dunav a.d. Pančevo (Market cap 282.728.268)
130.Luka Bačka Palanka a.d. Bačka Palanka*

L – Poslovanje nekretninama
131.Tekstilpromet a.d. Zrenjanin*
132.Venac a.d. Ruma (Market cap 83.985.300)

M – Professional, scientific and technical activities
133. Urbisprojekt a.d. Novi Sad (Market cap 14.998.800)
134. SP Laboratorija a.d. Bečej (Market cap 276.462.000)
135. Veterinarska stanica a.d. Pančevo**
136. Sacen a.d. Novi Sad (Market cap 91.474.000)
137. Interšped a.d. Subotica (Market cap 75.957.670)

N – Administrative and supportive service
138.Revnost a.d. Novi Sad (Market cap 12.016.800)
139.Novosadski sajam a.d. Novi Sad (Market cap 240.718.410)

K – Financial and insurance activities
140.Pobeda holding a.d. Petrovaradin**

* Stocks excluded from the Stock exchange during year 2012.
** Stocks excluded from the Stock exchange during 2013-2015 period.

Appendix 2: The LINGO code

```
sets:
asset/1..30/:rate, eps, ice, cee, liq, alfa, beta, a, b, x;
endsets
data:
rate= 0.3545    0.7203  0.2066  0.2124  0.1370  1.3164  -0.0636 0.3994  0.4833
        2.8306  2.0762  3.4833  1.6897  0.1914  2.5072  0.0000  1.9947  1.2586
        0.0973  0.2600  -0.0247 0.1105  0.0040  -0.0101 0.1000  0.5260  0.4625
        0.0690  0.0000  0.1137;
eps=  0.4489    0.1774  0.3063  0.1821  0.0593  0.0076  0.0797  0.1561  0.1927
        0.0952  0.3246  0.1349  0.3952  0.0696  0.0838  0.5249  0.1011  0.3609
        0.0742  0.7208  0.0485  0.0015  0.2890  0.3522  1.0110  0.3470  0.2621
        0.4590  1.2719  0.9425;
ice=  7.8166    2.8146  2.3562  2.8170  2.0323  1.2632  1.9753  2.5215  1.7983
        4.0502  2.7547  2.9711  3.6210  2.0128  2.1094  1.3936  2.9428  3.6937
        3.2906  2.5795  2.2855  1.8336  1.3411  1.7850  3.1171  3.0023  21.4697
        2.5763  2.0323  1.0407;
cee=  0.2386    0.3697  0.2437  0.0847  0.2062  0.0954  0.1727  0.2190  0.1203
        0.0708  0.1142  0.1034  0.0959  0.0812  0.1304  0.4648  0.1953  0.2505
```

```
          0.2500  0.1732  0.0578  0.1316  0.3300  0.2881  0.0856  0.1373  0.1726
          0.6794  0.7232  4.4742;
liq=  0.1079      0.0515  0.0109  0.0287  0.0010  0.0010  0.0065  1.0000  0.0010
          0.9941  0.1733  0.0277  0.5743  0.0020  0.8406  0.0317  0.0129  0.5683
          0.0010  0.0030  0.0129  0.1683  0.4901  0.0020  0.0069  0.0000  0.0218
          0.0257  0.0317  0.0248;
alfa= 0.0000      0.4887  0.0000  0.1316  0.0000  0.0000  0.1115  0.0901  0.0709
          0.0000  0.0728  0.0000  0.9971  0.0000  0.1856  0.0000  0.0000  0.5677
          0.0000  0.0000  0.0882  0.0000  0.1258  0.0464  0.0533  0.0387  0.7141
          0.2055  0.0000  0.1779;
beta= 1.1848      1.8264  0.7931  0.7071  0.4065  3.7772  0.1168  0.2796  1.3636
          8.7954  6.2171  10.6660 5.5255  0.5058  7.5232  0.0000  5.8993  3.9863
          0.2760  0.8222  0.0000  0.2146  0.2066  0.0377  0.2779  1.4335  1.8141
          0.2309  0.0000  0.3718;
a=   -0.0192      0.2412  -0.0422 0.0161  0.0100  0.136           -0.0792 0.3289
          0.0705  0.0820  0.1470  0.1501  0.1500  0.0313  0.1910  0.0000  0.1512
          0.1193  0.0110  0.0031  -0.0082 0.0434  -0.0370 -0.0131 0.0232  0.0852
          0.0295  0.0354  0.0000  0.0309;
b=    0.1266      0.5306  0.0562  0.1209  0.0608  0.6082
-0.0507   0.3752  0.2498  1.1815  0.9333  1.4834  0.9653  0.0931  1.1546  0.0000
          0.8886  0.6885  0.0455  0.1059  0.0028  0.0702  0.0046  -0.0026 0.0646
          0.2693  0.3455  0.0900  0.0000  0.0996;
ub= 0.1;
rizik=0.05;
div=0.05;
ikap=1.5;
fkap=0.1;
likv=0.2;
ksi=0.9;
enddata
min=(@sum(asset:((a+b)*0.5+(alfa+beta)*(1/3))*x))*(@sum(asset:((a+b)*0.5+(alfa+be
ta)*(1/3))*x)) + 1/72*(@sum(asset:(alfa+beta)*x))*(@sum(asset:(alfa+beta)*x));
@sum(asset:x)+rf=1;
@sum(asset:rate*x)>0.1;
@for(asset:@bnd(0,x,ub));
@sum(asset:x*eps)>div;
@sum(asset:x*ice)>ikap;
@sum(asset:x*cee)>fkap;
@sum(asset:x*liq)+rf>likv;
@sum(asset(i)|i#le#41 :x(i))>0.05;
@sum(asset(i)|i#le#92 :x(i))-@sum(asset(i)|i#le#42 :x(i))>0.05;
@for(asset(i)|liq(i)#le#0.01:@bnd(0,x(i),0.02));
@for(asset(i)|ice(i)#le#1.6:@bnd(0,x(i),0));
rf>0;
rf<0.3;
end
```

Chapter 19.

PORTFOLIO OPTIMIZATION WITH REALISTIC CONSTRAINTS

Financial institutions and individual investors face a variety of constraints when making portfolio asset allocation decisions. These constraints, in general, reduce the set of feasible solutions. On the other hand, they are often crucial to take into the account if we want to model situations corresponding to the real investment practice. In this chapter we study how such constraints can be incorporated into the optimization problem, how such constrained optimization problem can be solved as well as what are implications of these constraints.

1. STANDARD MARKOWITZ PROBLEM AND ITS ALTERNATIVE FORMULATION

Modern portfolio theory has begun with the seminal paper by H. Markowitz (1952). There he proposed the following simple method for determining optimal portfolio allocation. Namely, an investor is supposed to find optimal trade-off between expected portfolio return and risk, typically measured using standard deviation of portfolio returns. Note that this problem is an optimization problem with multiple objectives (in fact, two objectives), i.e. we would simultaneously like to reduce portfolio risk and to increase expected portfolio returns. The set of portfolios that solves such a problem is called efficient frontier or Pareto optimal frontier. If a portfolio is Pareto optimal, we cannot reduce its risk without reducing its expected return and, conversely, we cannot improve its expected return without simultaneously increasing its risk. It is in this particular sense that these portfolios are optimal.

Importantly, this problem can be mapped into a series of quadratic optimization problems with a single objective function. Indeed, consider first the basic ingredients of the standard Markowitz optimization problem:

$$
\begin{aligned}
r_p &= \sum_{j=1}^{N} w_j r_j \\
E\left(r_p\right) &= \sum_{j=1}^{N} w_j \mu_j = w.\mu \qquad (1)\\
V\left(r_p\right) &= \sum_{j,k=1}^{N} w_j w_k \Sigma_{jk} = w.\Sigma.w
\end{aligned}
$$

Here, in the first line we define portfolio returns as the weighted average of individual asset returns, with the weights given as a ratio of market capitalization of an invidiual asset (obtained as a product of the number of shares n in that asset and the corresponding asset price p) in the total portfolio capitalization (value):

$$
w_j = \frac{n_j p_j}{\sum_{k=1}^{N} n_k p_k} \qquad (2)
$$

The second line in (1) defines the expected return on a given portfolio, provided that expected returns on individual assets are known. This relationship follows directly from the first expression in (1) and linearity of the expectation operator. Finally, the third equation in (1) is portfolio variance, the square of the standard deviation of portfolio returns. As one can see, portfolio variance is a quadratic form in the vector of portfolio weights w. Its defining matrix is variance-covariance matrix of portfolio returns Σ. In our notation, a.b is scalar product (or matrix multiplication) of quantities a and b.

Standard Markowitz optimization problem, in its minimalistic formulation, can be posed as solving the following problem for all possible values of the target expected returns:

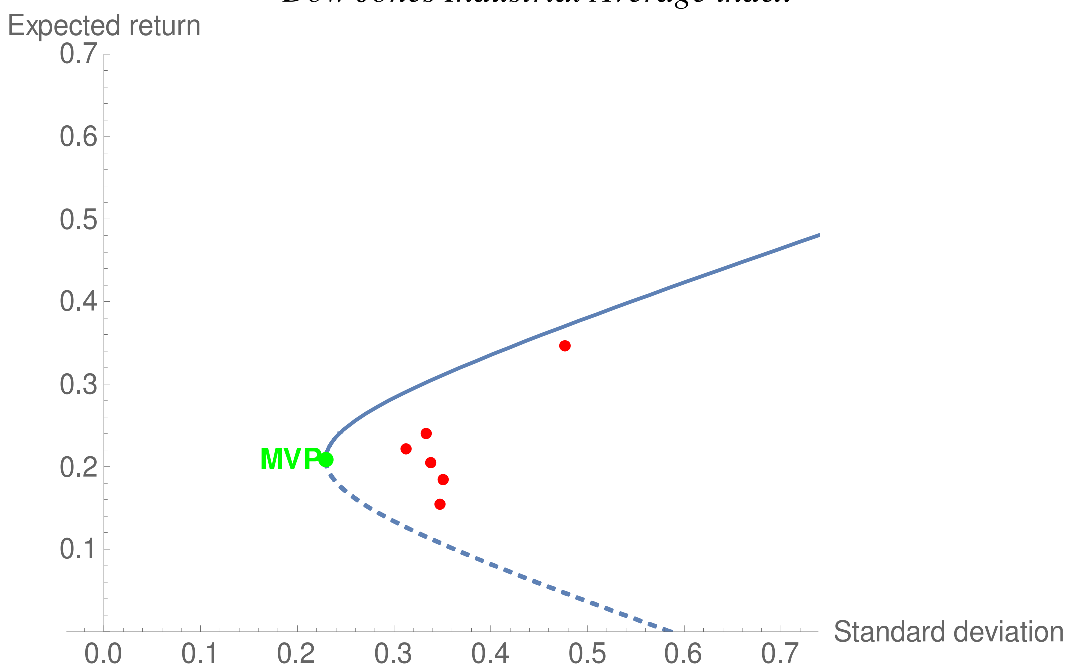
$$
\begin{aligned}
&\mathrm{Min}_w \;\; \mathrm{w}.\Sigma.\mathrm{w} \\
&\text{s.t.} \\
&\mathrm{w}.\mu \geq \mu_{\text{target}} \qquad (3)\\
&\sum_{j}^{N} w_j = w.1 = 1
\end{aligned}
$$

Note that in order to solve the original two-objective optimization problem we map it into a one-objective problem with the second objective restated as a constraint. Importantly, in order to derive the enitre efficient frontier, we need to solve problem (3) repeatedly, i.e. for all possble values of the target expected return. In the last line in (3) we see the first example of a constraint, namely the budget constraint.[286] The sum of all weights has to be equal to one (here we introduce for later convenience 1 as a vector consisting of ones). This constraint simply says that we need to investment our money somewhere and that we leave no money on the table. As we have mentioned above, this is a minimalistic formulation of the standard Markowitz problem. Any more realistic portfolio optimization problem typically adds a variety of additional constraints.

Because the objective function is a quadratic form and the constraints are linear, optimization problem (3) is known in mathematics as quadratic optimization problem. Most currently available software can solve it with ease.

In Figure 1 we present an example of an efficient frontier constructed from weekly data for the period 1995-2005 on 6 large US stocks belonging to the Dow Jones Industrial Average index. Sample mean and sample variance-covariance matrix is used for estimating portfolio inputs.

Figure 1. An example of the efficient frontier with 6 US stocks belonging to the Dow Jones Industrial Average index



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[286] Note that it is actually never optimal to provide the investor with an expected return great than the minimal required return. Thus, we can, without loss of generality, replace inequality in (3) with equality.

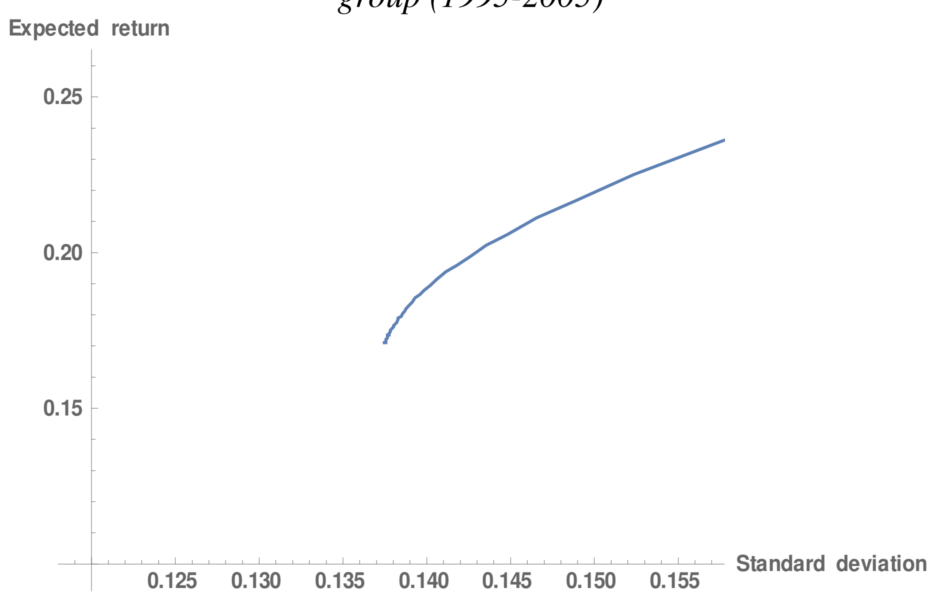
Several things are worth observing. First, individual assets are (almost) never on the efficient frontier (the red points on Figure 1). Second, the part of the frontier at or above the minimum variance portfolio (MVP) is Pareto optimal. On the other hand, portfolios below MVP (the dashed line) are inefficient. Third, without knowledge of an investor's utility function one cannot decide on a particular portfolio on the frontier. Only once we know our risk apetite, one can optimally determine a particular portfolio.

There is, also, an alternative formulation to the Markowitz problem. In this case, we maximize the expected return on the portfolio but penalize that objective with the cost function proportional to the portfolio variance. In this case, the minimal problem that we need to solve is:

$$\begin{aligned}&\mathrm{Max}_w \;\; w.\mu - \frac{k}{2} w.\Sigma.w \\ &s.t \\ &w.1 = 1\end{aligned} \tag{4}$$

Notice that optimization problem (4) is, again, a quadratic optimization problem. Here, constant k parametrizes an investor's attitude towards risk. If k is fixed to a particular value, solving (4) we obtain a unique optimal portfolio. On other hand, if we vary k, we obtain an alternative Pareto frontier (see Figure 2).

Figure 2. Optimal risk-return tradeoff using alternative formulation for different values of k, for the 30 stocks of the Dow Jones Industrial Average group (1995-2005)



2. SHORT SALES AND HOLDING CONSTRAINTS

In many emerging markets such as Serbia, no assets can be sold short on the financial market. In most advanced economies short sales are broadly allowed. However, particular market players such as mutual funds or pension funds are prohibited by regulators from taking short positions. How does one take into the account the prohibition of short sales? This is simple. Namely, we need to require that all components of the vector of weights w are greater or equal to zero. A simple example demonstrates that imposing short sales prohibition actually may increase the risk that we are forced to take, for the same expected return.

Namely, consider 4 stocks belonging to the same sample of Dow Jones Industrial Average stocks. Suppose that we are interested in achieving the expected return of at least 23 percent on the annual basis with the minimal risk (variance). We now compare the solution to the standard Markowitz problem (3) with the problem with added prohibition on short sales

$$
\begin{aligned}
&\mathrm{Min}_{w}\ \ \mathrm{w}.\Sigma.\mathrm{w} \\
&\text{s.t.} \\
&\mathrm{w}.\mu \geq \mu_{\text{target}} \\
&\sum_{j}^{N} w_j = w.1 = 1 \\
&w \geq 0
\end{aligned}
\tag{5}
$$

In both cases target return is 23 percent annually. In contrast to problems (3) and (4), problem (5) cannot be solved analytically but is still easy to solve numerically. Namely, (5) is still a quadratic optimization problem. Table 1 provides a comparison of the results of problems (3) and (5).

Note that without introducing the restriction on short sales, it would be optimal to sell short the third stock (thus the negative weight in the left column). With the prohibition on short sales, for the third stock the short sales constraint is binding. Thus, the smallest allowed weight that we can put there is 0. Also, with prohibition we would invest less money in the first and fourth stock and even more money in the second stock. The resulting portfolio is, therefore, less diversified than the one obtained without the additional constraint.

Table 1. The effect of adding short sales prohibition into the standard Markowitz approach for the 4 stocks belonging to the Dow Jones Industrial Average

Standard Markowitz weights (%)	With short sales constraints (%)
16.7	7.4
50.3	56.1
–6.9	0
39.9	36.5
Optimal standard deviation using standard Markowitz	Optimal standard deviation with short sales constraints
27.72	27.97

This is reflected, also, in the fact that optimal standard deviation with short sales prohibition is slightly higher than without that additional constraint. The difference in optimal level of risk is 25 basis points, or quarter of a percent.

It is important to note that imposing short sales constraints improves stability of the portfolio optimization problem. In order to understand the reason for that note that high crosssectional correlation between different portfolio assets lead to potential instability of the optimization problem since matrix inversion, necessary to solve the optimization problem, becomes problematic. On the other hand, adding short sale constraint has similar effect as a reduction in asset correlations (Jagannathan and Ma (2003)). Thus, adding such constraint potentially improves stability of the optimization process.

One can think of the short sales constraints as a special case of holding constraints which can be, generically, presented in the form:

$$L_j \leq w_j \leq U_j \tag{6}$$

Here, L and U are lower and upper bounds of asset exposures. Thus, when U is arbitrarily large and L is equal to 0 we obtain short sales constraints as a special case. Holding constraints (6) are common in regulation of pension and investment funds. They often limit the maximum exposure of a fund in any particular asset with the rational that this would force some diversification. Let us consider previous example and observe how would the introduction of an upper bound change the solution of the optimization process. Namely, let us assume that we still have prohibition of short sales (i.e. L=0 for all assets) but add the constraint (6) such that U=0.5 for all assets. That means that we are not allowed to hold more than 50 percent of our portfolio in any single asset. Table 2 summarizes the results.

Table 2. The effect of adding upper limit on holding constraints

Weights when L=0 (%)	Weights when L=0, U=0.5 (%)
7.4	4.5
56.1	50
0	0
36.5	45.5
Optimal standard deviation when L=0	Optimal standard deviation when L=0, U=0.5
27.97	28.08

The upper limit on holdings binds for the second asset while the lower limit binds the third asset holdings. Also, notice that while the intention of the „regulator“ has been to force more diversification by imposing the upper limit on invidual asset holdings, in reality holdings of asset 1 is further reduced with respect to the situation when only L=0 is imposed. Thus, we can observe that when the universe of avaiable investment assets is very limited like in this example, constraints of this type can very seriously limit diversification of a portfolio. In this case, we are forced, mostly, to invest just in 2 out of 4 assets. For this reason, in emerging markets with underdeveloped financial markets such as Serbia, constraints of this type should be avoided if possible.

3. CONSTRAINTS ON ASSET CLASSES OR SECTORS

Another common type of constraints are limitations on the total exposure towards a particular group of assets. For example, we may be allowed to invest only a certain fraction of total portfolio wealth into high tech stocks, or in an asset class such as foreign equities. How can we model such situation? Let us introduce holding matrix H which has the same number of columns as the total number of asset N. The number of rows is equal to the number of different sectors (limitations) that we want to impose. Matrix H has elements that are either 1 or 0. They are 1 only if a particular sector contains such a stock. In that case, in general, we can write down sectoral constrains in the following matrix form:

$$L \leq H.w \leq U \tag{7}$$

Suppose that in our previous example, stocks 1 and 2 belong to the first sector while stocks 3 and 4 belong to the second sector. Suppose, further, that we are not allowed to invest more than 60 percent of our money in either of the two sectors of the economy. In that case, matrix H has elements (1, 1, 0,0) in the first row and (0,0,1,1) in the second row. Constrain (7), thus, reads:

$$w_1 + w_2 \le 0.6$$
$$w_3 + w_4 \le 0.6$$

Table 3 compares portfolio optimization with short sales constraints with the one in which these sectoral constraints are added.

Table 3. The effect of sectoral constraints

Weights with short sales constraints (%)	Weights with additional sectoral constraints (%)
7.4	6.3
56.1	53.7
0	0
36.5	40.0
Optimal standard deviation with just short sales constraints	Optimal standard deviation with additional sectoral constraints
27.97	27.99

Notice that sectoral constraints are, in general, less stringent than holding constraints on individual assets. This is natural since they do not constrain each invidual weight separately but, rather, linear combinations of weights. They leave more room for optimization and are, for this reason, less potentially dangerous to impose by regulators than constraints on individual asset holdings.

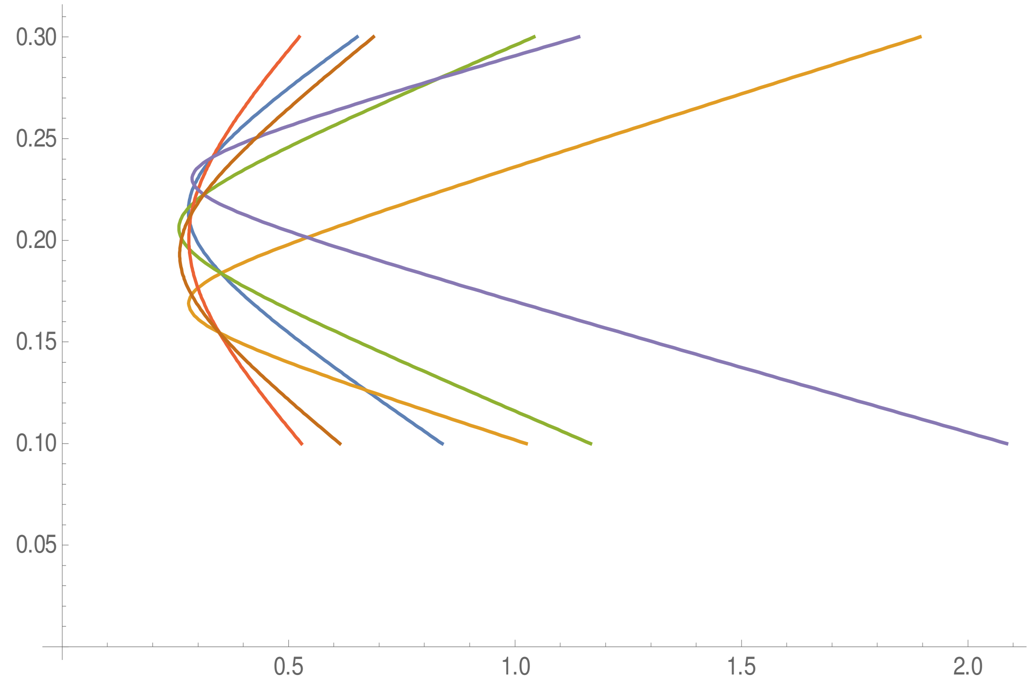
4. CARDINALITY CONSTRAINTS

A portfolio manager might want to restrict the number of assets allowed in a portfolio. This could be the case when, for example, he is attempting to construct a portfolio tracking a benchmark using a limited set of assets (cardinality constraints are discussed, among other papers, in Chang et al. (2000)). The cardinality constraint takes the form:

$$\sum_{i=1}^{N} \delta_i = K \tag{8}$$

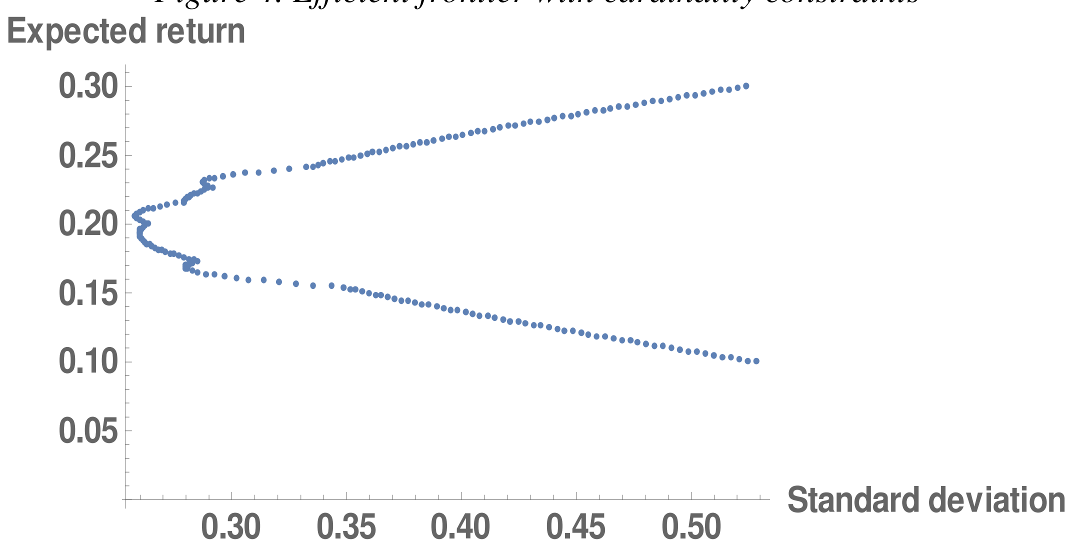
Here, delta is equal to 1 if an asset is included into the portfolio and is 0 otherwise. Suppose that, for simplicity, we need to construct an efficient frontier that corresponds to K=2 and N=4. The main issue is that for different levels of the expected return different pairs of stocks need to be included into the efficient frontier, in principle. So, how does one solve such an optimization problem? We begin by constructing efficient frontiers corresponding to each possible pair of stocks: (1,2), (1,3)..., (3,4). Clearly, there is a total of 6 pairs (the number of ways in which we can pick two out of four elements without replacement). Efficient frontiers look like this:

Figure 3. Efficient frontiers for each possible pair of stocks in a universe of 4 stocks



Suppose that now for each value of the expected return we find minimum risk among the 6 curves above. We would obtain the locus of points that satisfy cardinality constraint and provides the best mean-risk tradeoff. That is the efficient frontier with cardinality constraint (see Figure 4).

Figure 4. Efficient frontier with cardinality constraints



Notice that when cardinality constraints are imposed, efficient frontier is obtained as a result of a two-stage optimization process. Also, its shape is, in general, not convex. As N and K grow, however, cardinality constraints are less binding and the resulting efficient frontier gets more convex in shape.

5. INTEGER AND MIXED INTEGER PROGRAMMING AND ROUND LOT CONSTRAINTS

In investment practice, much more often than we typically appreciate, one needs to deal with integer or mixed integer programming. Consider, for example, the following situation. Suppose we need to select some investment projects but have a limited budget. Due to that, we cannot take all of the projects but only some of them. Projects cannot be repeated (i.e. the maximum quantity of each project is 1) and cannot be divided (we cannot do 1/3 of a project, e.g.). Thus, we can either select a project (in that case the decision variable is equal to 1) or discard it (in that case decision variable is 0). This is an example of a integer programming problem (in fact, a binary programming problem).

Let us now come back to the issue of portfolio optimization. Usually, Markowitz portfolio optimization has as the output a set of optimal portfolio weights. These weights, generically, imply that the number of stocks that we need to hold is fractional. In reality, we cannot hold a non-integer number of stocks. Moreover, usually stocks are purchased in round lots, i.e. in multiples of 100 (purchasing individual stocks may be theoretically possible but is very rarely done in practice due to cost consideration). The question is: how should we amend the optimization problem in order to take into the account the fact that we trade only in round lots? Mathematically, the problem is something called mixed-integer programming problem. Only more advanced software packages are able to successfully tackle such problems. Below we describe one way to do it. The procedure below is adapted from Fabozzi et al (2007).

For each stock type i, we start by determining a fraction of portfolio wealth equal to the value of one trading lot. We denote that quantity as f_i. For example, if the total portfolio wealth is \$10 million and stock i trades at \$86 in round lots of 100, then:

$$f_i = \frac{86*100}{10000000} = 0.00086$$

Suppose, further, that the number of round lots for asset i is z_i. Then, portfolio weight of asset i is $w_i = z_i f_i$. However, because z is an integer, there is no guarantee that the sum of w's will be exactly equal to 1. It will be either slightly above or slightly below 1. As a result, we introduce two corrective variables, $\varepsilon_+, \varepsilon_- \geq 0$ such that:

$$\sum_{i=1}^{N} z_i f_i + \varepsilon_- - \varepsilon_+ = 1$$

These are called under and overshooting variables. Introducing matrix Λ as a diagonal matrix with elements f, position vector z and a vector consisting of ones, 1, we can rewrite the budget constraint as follows:

$$z.\Lambda.1 + \varepsilon_- - \varepsilon_+ = 1 \tag{9}$$

The undershooting and overshooting variables need to be as small as possible at the optimal point and, therefore, they are penalized in the objective function. Thus, we are supposed to solve the following optimization problem (we use the alternative Markowitz formulation):

$$\begin{aligned} &\max_{z,\varepsilon_-,\varepsilon_+} z.\Lambda.\mu - \frac{k}{2} z.\Lambda.\Sigma.\Lambda.z - \gamma(\varepsilon_- - \varepsilon_+) \\ &s.t \\ &z.\Lambda.1 + \varepsilon_- - \varepsilon_+ = 1 \end{aligned} \tag{10}$$

for nonnegative epsilon and all other constraints that we may deem appropriate. Notice that epsilons are real variables while z's are integer. It is for this reason that the problem (10) is mixed integer programming problem, i.e. a problem in which some decision variables are integer while others are not.
In order to solve such a problem in practice, it is important that the solver is given a good initial starting point. It is natural try the following. Namely, we could solve the alternative Markowitz problem without invoking the round lot constraints first. This would give us some values of w's. We can use this information to find approximate values of round lots correspoding to this solution. These approximate values of round lots can then serve as a good initial guess for the solver.

6. TAKING INTO THE ACCOUNT TRANSACTION COSTS

Standard asset-allocation models generally ignore transaction costs and other costs related to portfolio and allocation revisions. However, the effect of transaction costs is far from insignificant. On the contrary, if transaction costs are not taken into consideration, they can eat into a significant part of the returns. In this section we show how to take into the account transaction costs. It is convenient to use the alternative formulation of the Markowitz problem as the framework within which we do this. Namely, we simply add another penalty related to the transaction cost in addition to the risk penalty (see Fabozzi et al. (2007, Chapter 4).

$$\begin{aligned}&\text{Max}_w \;\; w.\mu - \frac{k}{2} w.\Sigma.w - k_{trans} TC\\&s.t\\&w.1 = 1\end{aligned} \tag{11}$$

In other words, the objective is to maximize the expected return less the cost of risk and transaction costs. The transaction costs term in the utility function introduces resistance or friction in the rebalancing process that makes it costly to reach the mean-variance portfolio, which would have been the result had transaction costs not been taken into account. We can imagine that as we increase the transaction costs, at some point it will be optimal to keep the current portfolio.

Transaction costs models may involve complicated nonlinear functions. Although there is software for general nonlinear optimization problems, the computational time required for solving such problems is often too long for realistic investment management applications, and the quality of the solution is frequently not guaranteed. In case of linear and quadratic transaction costs, the problem maps back into the quadratic optimization problem. As we know from before, such problems are easy to solve.

Let us assume that TC is a separable function (by assets) dependent only on the portfolio weights w, or more specifically on the portion to be traded $x = w - w_0$, where w_0 is the original portfolio allocation and w is the new portfolio after rebalancing. For simplicity we assume that there are no fixed charges and that trading cost is simply proportional to the traded amount:

$$TC(x) = \sum_{i=1}^{N} TC_i(x_i)$$

where (12)

$$TC_i(x_i) = \beta_i abs(x_i) = \beta_i abs(w_i - w_{i0})$$

Note that transaction costs contain term with absolute value of trade. This is because we acquire costs whether we buy or sell stocks. But, that means that the objective function is a non-differentiable function of w.

It turns out that a simple trick can help us get rid of such non-differentiability. Namely, let us introduce auxiliary variables y (one for each asset) and set $y_i = abs(w_i - w_{i0})$. It is easy to check that this implies, equivalently, that

$$y_i \geq (w_i - w_{i0})$$

and (13)

$$y_i \geq -(w_i - w_{i0})$$

Thus, the optimizaiton problem can be presented alternatively as follows:

$$\text{Max}_{w,y} \;\; w.\mu - \frac{k}{2} w.\Sigma.w - k_{trans}\beta.y$$

$$s.t$$

$$w.1 = 1 \tag{14}$$

$$y \geq (w - w_0)$$

and

$$y \geq -(w - w_0)$$

This allows us to map the problem into a quadratic optimization problem, albeit with some extra variables.

Linear transaction costs are economically quite meaningful and correspond to some of the standard ways in which transaction costs are assessed in practice. Let us now consider a simple example in order to illustrate the method. Suppose that we have 4 stocks as before and that the initial position was given by the following vector of portfolio weights:

$$w_0 = \begin{pmatrix} 0.1 & 0.5 & 0.1 & 0.3 \end{pmatrix} \tag{15}$$

Suppose, further, that k=4 (corresponding to moderate risk aversion). One can solve the optimization problem (4) without transaction costs as a benchmark. We, then, solve (14) by setting $k_{trans} = 0.01$. Thus, we assume that in each trade a one percent transaction cost is assessed. Table 4 compares the optimal weights without and with transaction costs:

Table 4. The effect of transaction costs on optimal portfolio selection

Weights (no transaction costs) (%)	Weights (with transaction costs) (%)
23.0	21.5
26.3	34.0
13.3	11.6
37.4	32.8

Note that taking into the account transaction costs leads to less trading, i.e. to an allocation that is closer to the original allocation (15) than would be the case if we did not take these costs into the account (left column in Table 4).

In this chapter we have briefly outlined some of the important constraints related to building more realistic portfolio optimization problems. In most cases, inclusion of these additional constraints does not change the basic mathematical structure of the problem, i.e. we stay within quadratic optimization problem. One important exception are round lot constraints which lead to a mixed integer programming problem. Several other interesting cases are not discussed, for the sake of brevity (for example, inclusion of taxes or more complicated transaction costs). For details, one can consult Fabozzi et al. (2007), perhaps the best resource on practical portfolio optimization issues available at present.

Chapter 20.

THE IMPORTANCE OF MARKETING METRICS FOR RISK MANAGEMENT OF BUSINESS PERFORMANCE OF INSURANCE COMPANIES

The subject of this chapter is the contribution of the measurement of marketing activities to risk management performance of insurance companies. This problem has not been given sufficient attention, both in theory as well as in practice. Marketing metrics, which aims a completely different approach to measuring marketing activities compared to the traditional one, makes it possible to access these activities as a necessary condition for growth and development of the insurance company. The assessment of efficiency of conducting marketing activities and their impact on the financial performance represents a sufficiently complex problem, which cannot be limited only to monitoring the company's profits and requires consideration of many interrelated factors. According to P. Kotler, without financial thinking marketer cannot be raised to a higher level of organization. He must understand the financial statements, profit and loss accounts, liquidity movements, net cash flow, added value, market capitalization, the cost of capital, return on investments (ROI), return on assets (ROA). In addition, researchers suggest a number of other indicators for assessing the effectiveness of marketing activities that are not based on financial results (Lehmann, 2004; O'Sullivan & Abel, 2007; Chendall & Langfield-Smith, 2007). Below we will first emphasize the importance of marketing in insurance companies and then we will analyze the concept of marketing metrics in this area. Using concrete data from one insurance company we will investigate the impact of marketing expenses to total insurance premium.

1. MARKETING IN INSURANCE

Insurance companies use marketing as a way to explore the insurance market and possibilities of influence on it in order to maximize profits. Marketing concept in insurance is of recent date. In the beginning, marketing was seen as a sales function of insurance, aimed at realization of insurance services. But today's marketing has assumed a new meaning and is viewed as a complex approach to organization and management of the entire activities of insurance company, focused on providing the specific services of insurance and in extent consistent with the demand. Demand is formed by insurance company investing in accordance with its capabilities to satisfy it. Marketing department of insurance company is seen as a source of reliable information and recommendations on many issues of current and future business of insurance company. Insured becomes the most important participant of the insurance market, whose interests and needs for insurance protection determine the activity of the insurer.

Business Analysis of the largest insurers in the world shows that a series of directions and marketing functions is identical for all of them. It refers to orientation of the insurer on market conjuncture, enabling maximum for certain new forms of insurance that should satisfy the potential interests for insurance. Marketing process involves a series of activities in order to create demand for insurance products and satisfy the interests for security.

The formation of the demand is oriented on potential policyholders in order to attract their attention on insurance products offered by the specific insurer. In this process tools and methods of persuasion are widely applied by using advertisements, a complex of organizational measures concerning the conclusion of the insurance contract are carried out, differentiation of tariffs for individual insurance products is performed, etc.

The satisfaction of interests in insurance is achieved through a high level of insurance culture, as well as the quality of insurance services, which is a condition for stable demand for insurance products. The insurance companies have large insurance acquisition costs, costs of improved customers service and costs of building brand image in the market.

Concluded insurance contract represents the beginning of a formal relationship between the insured and the insurer. It presents evidence that insurance policy was purchased. It precedes the great activity of insurers in order to sell insurance policies because there are other competitors in the insurance market that offer the same products. From the way that the insured is welcomed in an insurance company or at the representative agency, what kind of impression the appearance of the office will leave on him, kindness of staff of the insurer, often depends on whether the potential customer will become insured of given insurance company or he will go to the competitors. Therefore, insurance companies assume that potential client is everyone who comes into the insurance company or was visited by an insurance agent. It is necessary to provide him with detailed information, expert advice and assistance to quickly obtain the necessary documentation. Serving clients is one of the main factors to satisfy the interests for insurance. Relationship with customers, potential policyholders, is the key factor that directly affects demand for insurance products. Therefore, the higher the level of services by the insurer, the greater the demand for their services. However, the increase in the level of demand requires increased costs. Therefore, the management of the insurance company is trying to find the optimal relationship between the level or quality of insurance services provided to the insured and costs, which are necessary for their realization. The main tasks of marketing services include collection, processing and analysis of information on the insurance market in order to detect market niches that can be conquered, or market segments where there is a demand for certain insurance products as well as researching the presence of competitors. Marketing department analyzes, monitors and forecasts the market conjuncture including separate regional markets, their segments in certain geographic areas, in terms of socio-demographic composition of potential insureds and their purchasing power. It is also important to study the perspectives of competitors in the insurance market. Data of insurance companies, data from National Bank of Serbia, data of the Association of Insurers as well as data of the Republic Institute for Statistics are used for this purpose. At the end, the task of marketing department is developing its own business strategy and behavior in accordance with the state of market conditions. Based on a detailed analysis of the insurance market, estimation of the unmet demand size for insurance products in volume and species, and also based on an analysis of its own technical and financial capacities, insurance company develops business strategy to conquer the market, which is being explored. In doing so, plans are made, deadlines are determined, controls are implemented of the plan fulfillment and during its practical realization the corrections are made.

The role of marketing is also important in the price formation for insurance products. The most important role in the formation of these prices have actuaries. Based on the probability theory, they predict the frequency and intensity of the risks which are the subject of insurance in order to determine their value as probable, planned size. Risk price is actually a key element which determines the tariff of insurance and that should cover the expected insurance benefits. Thus, the tariff represents the putative price, formed as a result of scientific and technical assessment. In this sense, the tariff represents the base price of insurance products. However, the base price may be corrected on the market. If, for example, the demand for certain insurance products exceeds supply, insurer has the opportunity to increase its market price as long as they are not equate. If the offer surpass demand the insurer is forced to lower the price until the buyers start to buy that product. Mismatch of tariff as calculated price and market price can have a negative impact on business of insurance companies. Tariff as a calculated price contains the net technical premium that is a source of technical reserves (unearned premium, reserves for incurred reported claims, reserves for incurred but not reported claims and, if necessary, reserves for unexpired risks). Tariff also contains allowance for prevention as a source of funds for prevention, which is intended for preventing the realization of risk and for the reduction of the harmful effects of risks whose implementation began. A significant element of the tariff is the expense loading which should cover the costs of insurance. If the costs of insurance exceed expense loading, it impairs the technical premium which is the source of reserves for claims and unearned premiums, and in the long run it can jeopardize the safety of policyholders' compensations. Also, too high insurance costs pose a significant risk to the profitability of insurers. From the above we can conclude that insurance tariffs as the calculated category does not serve as a source of technical reserves. Reserves are formed from insurance premiums, which represent the realization price by selling insurance products, which in fact represents the amount actually paid by the insured to the insurer. Thereby, two situations may occur. First, when premiums exceed tariff in which case the insurer form more reserves than it is estimated by actuaries. The second variant, when the amount of the premium is actually lower than the tariff, results in reserves established lower than those predicted by actuaries when they determined the tariff. Thereby the insurance premium retains constituent elements of tariff, only their amounts can be changed.

2. THE CONCEPT OF MARKETING METRICS IN THE INSURANCE

Marketing is business philosophy and important business function. It is the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large.[287] The company financial success a lot depends on marketing ability. Successful marketing builds demand for products and services; and introduce new or enhanced products or services that ease people`s lives. Performance marketing, an element of holistic marketing, requires understanding the financial and nonfinancial returns to business and society from marketing activities and programs.

Financial consequences of marketing effort concerned the issue of customer satisfaction. We need to understand what it costs to improve levels of customer satisfaction and what it is worth to a company to have highly

[287] www.marketingpower.com/AboutAMA/Pages/DefinitionofMarkeitng.aspx; Kotler,P., Keller, K.L. (2015). *Marketing Management.* Boston: Pearson, p.27.

satisfied customers. It is possible to have paradoxical results: customer satisfaction can go up, yet profits and market share go down.

The keys to marketing success have become measurable performance and accountability. Marketing managers must quantify market opportunities and environment threats. They must quantify the value of products, customers, and distribution channels under various pricing and communicational scenarios. They must justify the financial risk and benefits of their decisions. Must assess plans, explain variances, judge performance, and identify leverage points of improvements in numeric expressions.

Marketing metrics is a tool that allows measurement of the influence of marketing activities on the profit and market assets of the company. Furthermore, this is a tool for deciding on the amount, type and structure of marketing investments. In today's hyper-competitive business landscape, most insurance companies constrained to take successes metrics. To gather and analyze basic market data, measure the core factors that drive their business models, analyze the profitability of individual customer accounts, and optimize resource allocation among increasingly fragmented media.

A metric is a measuring system that quantifies trends, dynamic or characteristic. We use metrics to explain phenomena, diagnose causes, share findings, and project the results of future events.[288] Marketing metrics offer high-value metrics for every aspect of marketing: market share, competitors` power, margins and pricing, products and portfolios, sales forces and channels, promotional strategy, customer profitability, customer perceptions and more.

In the early stages of the implementation of marketing metrics, insurance companies track the number of insurance contracts concluded (for insurance products, region, market and sales channels), test and explore the market, then monitor the effectiveness of campaigns and marketing programs and assess return on investment.[289]

[288] Farris, P.W., Bendle, N.T., Pfeifer, P.E., Reibtein, D.J. (2012). *Marketing Metrics: The Definitive Guide to Measuring Marketing Performance.* New Jersey: Pearson Education, p.1

[289] Stojanović, Ž., Gligorijević, M., Rakonjac Antić, T. (2012). The Role of The Marketing Mix in The Improvement of Agricultural Insurance. *Economics of Agriculture*, 4/2012, p. 776.

In the developed insurance markets, they consider optimal allocation of marketing resources and asset value of the insurance company. Best results are achieved if the insurance company integrates the above measurements on the short-term and long-term levels, where the objectives are measured quantitatively and qualitatively. The marketing metrics should be a part of the planning process and presented daily, at all management levels in the insurance companies.[290]

Two authors, Mintz and Currim made a literature review and they are grouped scientific papers in the field of metrics into three groups of papers. The first is in the development of marketing metrics, the second in the linking marketing mix efforts to financial metrics, based on financial ratios; and the third linking metric use to firm performance, profit and shareholder value. [291]

Justify marketing costs is possible only if we establish a correlation with financial performance, using metrics that will reliably predict future events. The ratio of the financial implications of marketing activities and marketing is crucial, as recent research suggests that the marketing leaders are expected to reduce costs and increase contributions to the growth of the company, or demonstrate: the contribution of marketing for other sectors, the effectiveness of the activities, the establishment of appropriate relations between corporate and marketing objectives.

It is essential that the financial metrics related to profit, sales, cash flow, is supplemented by non-financial indicators such as market share, quality of products and services, customer satisfaction, customer loyalty, brand value etc. It is very important to choose the right metrics that will indicate the existence of an optimal allocation of resources to be used in the marketing of insurance companies.

Ultimately, marketing costs are justified if there is a corresponding correlation with the financial performance of the insurers. Through a system of evaluation, marketing performance management leads to a proactive governing of processes which result in reduced costs and increased efficiency.

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[290] LaPointe, P. (2007). *Marketing by the Dashboard Light*. New York: Marketing NPV in cooperation with the Association of National Advertisers, p.29.

[291] Mintz, O., Currim, I.S. (2013). What Drives Managerial Use of Marketing and Financial Metrics and Does Metric Use Affect Performance of Marketing-Mix Activities? *Journal of Marketing* 2013, Vol. 77, Issue 2, pp. 17-18.

Marketing performance metrics is in correlation with the financial ratios. Marketing managers concerned about the overall financial ratios of a company for two reasons: 1) marketing contributes to the financial performance of a company and 2) financial performance can constrain or permit marketing strategies and activities. Marketing performance metrics measure the factors which actually drive performance of a company.

3. MEASURING THE IMPACT OF MARKETING COSTS ON THE TOTAL INSURANCE PREMIUM

Due to the significant reduction in the volume of production and services of many businesses, caused by the global economic crisis, optimization of marketing costs is very important, and in accordance with this timely evaluation of the effects and appropriate audit of marketing for correcting marketing activities undertaken. Quantitative assessment of the performance of one or another marketing strategy will enable the company to use resources in the most efficient way. Insurance companies in developed countries are already actively working on the implementation of the analysis of marketing activities efficiency, and their contribution to raising financial performance. The aim of the implementation of marketing activities is to increase market share and profits in the short and long term, in other words, these activities should contribute to the growth of the value of the insurance company.

Marketing activities often require significant and unjustified high costs in relation to the effects achieved. Without observing financial effects of marketing activities, there is no serious scientific approach to this problem. The specific nature of insurance services, in the form of promises given to the insured that if the risk is realized, he will be compensated, causes marketing special role in this activity. Since the primary purpose of insurance is reflected in ensuring the protection of insured from risks, insurance premiums, as the price of the insurer service, should be sufficient to settle the damage claims, for the formation of appropriate reserves and covering the costs of conducting insurance. Too high costs of marketing activities threaten the sufficiency of premiums, which indicates the importance of proper management of these costs in insurance. For the foregoing reasons, the main research question of this chapter is how to determine the effects of marketing activities on the financial performance of insurance companies observed primarily through realized insurance premiums and marketing costs, i.e. investments in marketing activities. The focus will therefore be on the management of marketing costs and its effects on paid insurance premiums and thus the profitability of insurance companies, which will be supported by analysis on concrete data. The measurement of those effects requires a completely different approach, which emphasizes the quantitative and qualitative aspects of the analysis. Marketing metrics, as a new theory, offer an opportunity for this modern and fundamentally changed approach to measuring effects of marketing.

3.1. The relationship between marketing costs and gross premiums

We have data on gross premiums and total costs of marketing for one insurance company in Serbia for the period 2007-2015. It is a short series of data, so any conclusions should be taken with a grain of salt, which is a limitation of this part of the work.

Table 1. Data on gross premiums and marketing expenses (in 000 dinars)

Year	Gross premium	Total marketing costs
2007	13,698,366	363,051
2008	14,495,896	427,132
2009	14,583,150	730,747
2010	14,655,673	1,079,019
2011	15,435,121	1,395,023
2012	17,873,280	1,534,885
2013	17,528,367	1,378,889
2014	17,551,842	1,188,562
2015	21,461,336	1,348,473

Source: Domestic Serbian insurance company

We are interested in the correlation coefficient between these two series, or whether there is a correlation between them. To do this, it is best to eliminate the trend component of the observed series to avoid confusing and erroneous conclusions. Emphasized trends, if not removed, will not lead to accurate conclusions.[292]

Consider first data on the total cost of marketing. Cubic trend function best approximates the data. Its equation is:

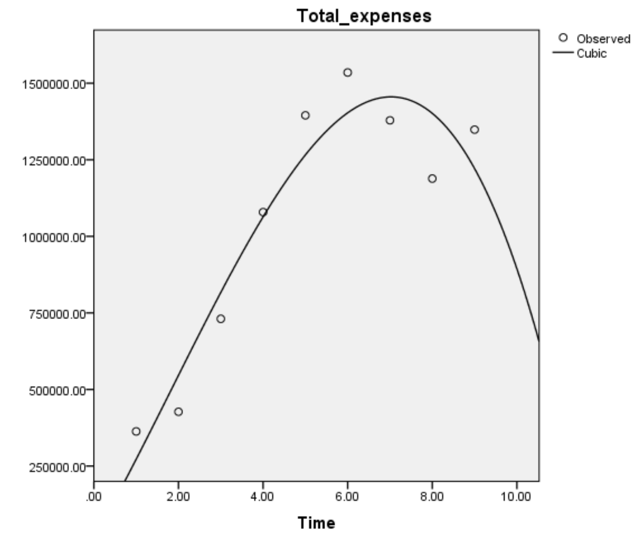
$$\hat{y}_t = 15526.341 + 241310.272t + 18849.860t^2 - 3419.816t^3,\ t=1,\ldots,9.$$

The coefficient of determination is 0.914, which indicates a high percentage of the explained variability. The value of F test statistic used to test the null

[292] Žižić, M., Lovrić, M., Pavličić, D. (2003). *Metodi statističke analize.* Belgrade: Faculty of Economics, University of Belgrade.

hypothesis that all the coefficients of the model equals 0 is 17.774, p-value is 0.004, which means that we reject H_0.

Figure 1. Cubic trend of total costs from 2007 to 2015

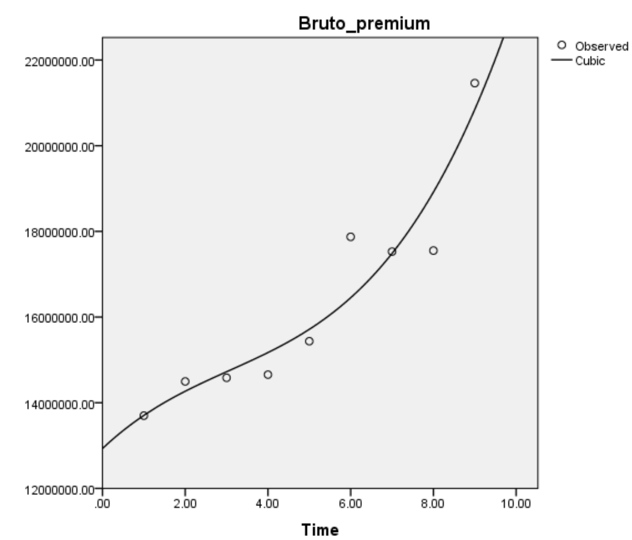


Cubic trend also best approximates the data on gross premiums. Its equation is:

$$\hat{y}_t = 12930658.01 + 912028.971t - 155437.011t^2 + 16871.779t^3, \; t=1,\ldots,9.$$

The coefficient of determination is 0.904, which indicates a high percentage of the explained variability. The value of the test statistic F is 15.634, p- value is 0.006, which means that we reject H_0

Figure 2. Cubic trend in gross premiums from 2007 to 2015



If we eliminate the trend components from the original series (using a formula $(y_t / \hat{y}_t)100$)), we can consider the interdependence between the total cost and gross premiums. On the basis of Table 2 we see that Spearman's correlation coefficient is 0.235, indicating that there is a weak positive correlation between the observed values. This further means that, taking into account the small number of data, the growth of total marketing costs has little impact on the growth of gross premiums.

Table 2. Spearman's correlation coefficient

			gross pr.	total cost
Spearman's rho	gross pr.	Correlation Coefficient	1.000	.235
		N	9	9
	total costs	Correlation Coefficient	.235	1.000
		N	9	9

Source: Output from SPSS

3.2. Estimation of marketing costs and gross premiums using bootstrap methods

For the statistical estimation of the average marketing costs and the average value of gross premiums we can use bootstrap methods[293]. It is a method whose basic ideas are as follows. Let $X=(X_1, ..., X_n)$ is a random sample. From this sample we generate a large number of samples with repetition, also called *bootstrap* samples. Distribution of the statistics (which we are examining) in all possible *bootstrap* causes is called *bootstrap* distribution. It gives us information about the distribution of sample statistics.

It is possible to construct several confidence intervals for an unknown parameter using bootstrap methods. The most important are: percentile, BCa, bootstrap-*t* and ABC interval. We will keep on the first two.

The percentile interval is constructed as follows. Let $X=(X_1, ..., X_n)$ is a random sample and based on it calculated estimator of unknown parameters θ , denote by $\hat{\theta} = S(X)$. Based on the original sample, the *B bootstrap* samples X^{*1},

[293] The basic idea of this method can be found in: Efron, B., Tibshirani, R.J. (1993). *An introduction to the bootstrap.* London: Chapman & Hall and Rajic, V. (2007). Statistički metodi ponovljenih uzoraka - analiza i primena u imovinskom osiguranju. *Doctoral thesis,* Belgrade: Faculty of Economics, University of Belgrade.

$X^{*2}, \ldots, X^{*B}$ are generated and in each of them is calculated the value of statistics $\hat{\theta}^{*}(b) = S(X^{*b})$, b = 1, 2, ..., B. Percentile confidence interval with coverage probability (1-2α)·100% is:

$$I_{perc} \approx [\hat{\theta}_B^{*(\alpha)}, \hat{\theta}_B^{*(1-\alpha)}],$$ [294]

where $\hat{\theta}_B^{*(\alpha)}$ is the estimated value of the α- percentile of the distribution of random variable $\hat{\theta}^{*}(b)$, which is determined by the formula $\#\{T^{*}(b) \leq \hat{t}^{(\alpha)}\}/B = \alpha$.

BCa interval is constructed in the following manner[295]. From the original sample X=(X_1, ..., X_n) is generated B *bootstrap* samples X^{*1}, $X^{*2}, \ldots, X^{*B}$ and in each of them calculates the value of statistics $\hat{\theta}^{*}(b) = S(X^{*b})$, b= 1, 2, ..., B. BCa confidence interval with coverage probability (1-2α)·100% is:

$$I_{BCa} = (\hat{\theta}^{*(\alpha_1)}, \hat{\theta}^{*(\alpha_2)}),$$

wherein:

$$\alpha_1 = \Phi\left(\hat{z}_0 + \frac{\hat{z}_0 + z_\alpha}{1 - \hat{a}(\hat{z}_0 + z_\alpha)}\right),$$

$$\alpha_2 = \Phi\left(\hat{z}_0 + \frac{\hat{z}_0 + z_{1-\alpha}}{1 - \hat{a}(\hat{z}_0 + z_{1-\alpha})}\right).$$

$\Phi(\cdot)$ is a distribution function of the standardized normal distribution, z_α is α percentil of the standardized normal distribution. The parameter $\hat{z}_0$ is called a bias correction and is calculated according to the formula:

$$\hat{z}_0 = \Phi^{-1}\left(\frac{\#\{\hat{\theta}^{*}(b) < \hat{\theta}\}}{B}\right).$$

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[294] Efron, B., Tibshirani, R.J. (1993). *An introduction to the bootstrap.* London: Chapman & Hall.

[295] See for details: Efron, B., Tibshirani, R.J. (1993), *op. cit.*

Therefore, this parameter depends on the number of replicas $\hat{\theta}^*(b),\ b = 1, 2, ..., B$, which are less than the estimate $\hat{\theta}$. The parameter $\hat{a}$ is called acceleration and is calculated using the jackknife method[296]:

$$\hat{a} = \frac{\sum_{i=1}^{n}\left(\hat{\theta}_{(\cdot)} - \hat{\theta}_{(i)}\right)^3}{6\left\{\sum_{i=1}^{n}\left(\hat{\theta}_{(\cdot)} - \hat{\theta}_{(i)}\right)^2\right\}^{3/2}}$$

wherein $X_{(i)}$ is a sample of the form $\left(X_1, X_2, ..., X_{i-1}, X_{i+1}, ..., X_n\right)$, $\hat{\theta}_{(i)} = S(X_{(i)})$ and $\hat{\theta}_{(\cdot)} = \sum_{i=1}^{n} \hat{\theta}_{(\cdot)} / n$.

First we evaluate the total marketing expenses by observing the sampling period. So, we have information on the total marketing expenses for the period 2007-2015. Based on the observed sample period, we can evaluate the average marketing expenses, as well as the standard deviation of these expenses. Thus, taking into account that there is a small amount of data, we construct the following intervals shown in Table 3.

Table 3. The percentile and BCa interval for the average marketing expenses and standard deviation of these costs

			95% Confidence Interval	
		Statistic	Lower	Upper
Total costs	N	9		
	Mean	1049531.2220	763095.6300	1312163.8310
	Std. Deviation	437783.32890	166689.20760	524038.01320

			BCa 95% Confidence Interval	
		Statistic	Lower	Upper
Total costs	N	9		
	Mean	1049531.2220	735307.7226	1333138.2240
	Std. Deviation	437783.32890	284107.69660	490636.68530

**Bootstrap results are based on 1000 bootstrap samples*
Source: Output from SPSS

296 Jackknife method is one of the statistical methods of repeated samples. Read more about him in Efron, B., Tibshirani, R.J. (1993), *op cit.*

We can see that for the average marketing expenses the percentile interval has smaller interval lenght, while for the standard deviation BCa interval has smaller lenght . We will be managed by the fact that the shorter interval is more accurate. We conclude that the average marketing expenses of the observed insurance company is in the interval:

$763095.63 \leq \mu \leq 1312163.831,$

while the standard deviation of these costs is:

$284107.697 \leq \sigma \leq 490636.685.$

These intervals were obtained by using data from a relatively short sample period, so they should be viewed with reserve.

Now we will estimate the value of gross premiums based on the observed sample period. So, we have information on gross premiums for the period 2007-2015, based on which we can evaluate the average value of gross premiums, as well as its standard deviation. Thus, taking into consideration that it is a small amount of data, we have constructed the following intervals shown in Table 4.

Table 4. The percentile and BCa interval for mean value and standard deviation of gross premiums

			95% Confidence Interval	
		Statistic	Lower	Upper
gross_premium	N	9		
	Mean	16364781.2200	15041090.1300	17982155.2000
	Std. Deviation	2464130.55900	1187874.03600	3241306.00300

			BCa 95% Confidence Interval	
		Statistic	Lower	Upper
gross_premium	N	9		
	Mean	16364781.2200	15236391.9300	17764525.0000
	Std. Deviation	2464130.55900	1462710.98500	3011741.61800

**Bootstrap results are based on 1000 bootstrap samples*
Source: Output from SPSS

We can see that BCa intervals have smaller length for the average value and for the standard deviation. We conclude that the average gross premium of the observed insurance company is in the interval:

$$15236391.93 \leq \mu \leq 17764525.00,$$

while the standard deviation is:

$$1462710.985 \leq \sigma \leq 3011741.618.$$

These intervals were obtained by using data from a relatively short sample period, so they should be viewed with reserve.

If we compare the interval estimates of the average marketing expenses and the average gross premium, we see that the average marketing costs represent roughly 5% to 7% of gross premiums.

It is noted that each year the effects of marketing were significantly different. The largest increase in gross premiums was achieved in 2012 (15.8%) and 2015 (22.3%). Certain marketing processes and activities of these years should be further analyzed and applied in the future. Also, the problem of inconsistent effects of marketing in the reporting period was the frequent changes at the head of the marketing department, so it was not possible to implement a long-term marketing strategy.

Chapter 21.

INFLATION RISK MANAGEMENT WHEN ASSESSING THE SIZE OF TECHNICAL RESERVES

Insurance sector is traditionally considered a stabile part of the financial system. However, as the result of a wide spectrum of social, technological and global economic forces, changes within the insurance sector are unavoidable, which makes connections between insurance companies and other parts of the financial system continuously stronger. If the adequate risk management system is absent, higher level of these connections can increase the vulnerability of insurance companies and compromise their stability. In case that risk management is not successful enough, an insurance company must have access to additional resources in order to cover the potential losses.

Unlike other financial institutions, insurance operations are characterized by time incompatibility of cash flow within ‘the production cycle’, i.e., incompatibility between the collection of premiums and the payment of compensations to policy-holders, so that an insurance company needs to form technical reserves. In order to secure compensation payments to policy-holders and long-term solvency, technical reserves are established by complex actuary based risk assessments. Oversights in risk management in connection with establishing of the reserves, can have far-reaching effect, since it is impossible to compensate claims covered by insurance policies from personal sources of policy-holders. When established reserves are not sufficient to cover the claims, insurance company is still obliged to settle the claims according to the insurance policies. In order to neutralize these and other adverse events, insurance company must possess the adequate risk management system and the available resources dependent on risk profile.

Dynamic approach to risk management of forming the technical reserves is crucial for preserving the solvency of an insurance company. Such approach involves identification of major risk sources, quantification and monitoring the level of risk exposure, and continuous improvement of the reserves formation methodology. In order to keep insurance company risks within acceptable limits, different models of risk management need to be skillfully employed.

Each method of technical reserves assessment in non-life (general) insurance, either traditional deterministic, or stochastic, requires both skill and expertise in its use; because very complex claim processes tend to be described in a relatively simple way. While assessing technical reserves, an actuary meets with the problems of delays in claim reporting, difficulties in obtaining claim development histories, projecting claim development, treatment of reinsurance indemnity, etc. Thus, the use of wrong assessment model and data can lead to inadequate calculation of technical reserves[297].

The model's risk and unreliable data are connected with errors in the model and/or data, or with their inadequacy with real demands of the assessment. The general demand of the model making is the balance between the ease of use and its adaptability to previous empirical data. The model should be as simple as possible, but it must not neglect the basic parameters used in projecting. The model is deemed inadequate when it contains irregularly distributed expected claims, or when it incorrectly recognizes connections between some of the basic factors influencing the risk. The risk of model's inadequacy is in connection with the calculation of technical reserves by numerous subjective estimations, limited number of observations carried out when choosing the model, and during a short observing period when certain important events are excluded. Mistakes in assessment of the technical reserves may occur also due to inadequate data, i.e., because adequate and comparable date are not in use[298]. Unfortunately, in the practice of assessing the reserves, the inflation risk management is often ignored in domestic practice, despite the fact that it could influence the value of the reserves. Applying the methods for reserves assessment that ignore the effect of inflation practically means that an insurance company uses the model and data that are not enough precise. Despite the fact that a substantial body of literature about different approaches to the incertitude of technical reserves modeling is readily available, there are not many papers dealing with the effect of inflation on the assessment of outstanding claims taking into account practical implementation. This chapter aims at proposing the possible model for assessment of outstanding claims using the effect of inflation in a simple and applicable way, which is to contribute to the more realistic calculation of technical reserves.

The chapter presents data needed for the assessment of outstanding claims using the effect of inflation (Part 1), as well as the assessment procedure (Part 2) and practical example which shows the effect of inflation on the estimated amount

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[297] Kočović, J. (2011). Reserves in insurance-practical aspects, *III Course for Continuing actuarial education and education of financial experts,* Belgrade: Institute of Insurance and Serbian Actuarial Association, slides 6-8.

[298] Doganjić, J. (2015). Upravljanje finansijskim i aktuarskim rizicima formiranja i ulaganja rezervi u neživotnom osiguranju. *Doctoral thesis,* Kragujevac: Faculty of Economics, University of Kragujevac, pp. 85,86.

of reserves (Part 3). It also indicates the potential problems in connection with the assessment, as well as possible solutions (Part 4).

1. DATA REQUIRED FOR THE ASSESSMENT

Outstanding claims modeling using inflation factor requires data on the value of claims, historical inflation rates, as well as projected inflation rates. These data are presented in Table 1 - The incremental values of settled claims, in Table 2 - Historical inflation rates and inflation coefficients, and in Table 3 - Projected values of annual inflation rates and inflation coefficients.

Table 1. The incremental values of settled claims

Accident year	**Period of claim development (in years)**				
	0	**1**	**…**	***n*-1**	***n***
t-n	$X_{t-n,0}$	$X_{t-n,1}$	…	$X_{t-n,n-1}$	$X_{t-n,n}$
t-n+1	$X_{t-n+1,0}$	$X_{t-n+1,1}$	…	$X_{t-n+1,n-1}$	
…	…	…	…		
t-1	$X_{t-1,0}$	$X_{t-1,1}$			
t	$X_{t,0}$				

Wherein:

$X_{t,0}$ - The value of claims occurred and settled in year *t*,
$X_{t-1,0}$ - The value of claims occurred and settled in year *t*-1, etc.

The following tables contain data on inflation rates, both historical and projected.

Table 2. Historical inflation rates and inflation coefficients

Year	***t-n***	***t-n*+1**	**…**	***t*-1**	***t***
Annual inflation rate *	c_{t-n}	c_{t-n+1}	…	c_{t-1}	c_t
Annual inflation coeffic.	$i_{t-n} = 1 + c_{t-n}$	$i_{t-n+1} = 1 + c_{t-n+1}$	…	$i_{t-1} = 1 + c_{t-1}$	$i_t = 1 + c_t$

*shown as a decimal (CPI/100)

Wherein:

c_{t-n} - Annual inflation rate in year *t-n*,
c_{t-n+1} - Annual inflation rate in year *t-n*+1, etc.,

and

i_{t-n} - Annual inflation coefficient in year *t-n*,
i_{t-n+1} - Annual inflation coefficient in year *t-n*+1, etc.

Table 3. Projected values of annual inflation rates and inflation coefficients

Year	***t*+1**	***t*+2**	**…**	***t*+*n*-1**	***t* + *n***
Annual inflation rate*	c_{t+1}	c_{t+2}	…	c_{t+n-1}	c_{t+n}
Annual inflation coeffic.	$i_{t+1} = 1 + c_{t+1}$	$i_{t+2} = 1 + c_{t+2}$	…	$i_{t+n-1} = 1 + c_{t+n-1}$	$i_{t+n} = 1 + c_{t+n}$

* shown as a decimal (CPI/100)

Wherein:

c_{t+1} - Projected value of annual inflation rate in year *t*+1,
c_{t+2} - Projected value of annual inflation rate in year *t*+2, etc.

and

i_{t+1} - Projected annual inflation coefficient in year *t*+1,
i_{t+2} - Projected annual inflation coefficient in year *t*+2, etc.

There is a common assumption in practice that all claims are settled during the middle of the calendar year, so that semiannual inflation rates are calculated using annual inflation rates data (from Table 2 and 3). These calculations are given in Table 4.

Table 4. Calculation of semiannual and cumulative inflation coefficients for historical inflation rates

Year	***t-n***	***t-n*+1**	**…**	***t*-1**	***t***
Annual inflation coefficient	i_{t-n}	i_{t-n+1}	…	i_{t-1}	i_t
Semi-annual inflation coefficient	$\sqrt{i_{t-n}}$	$\sqrt{i_{t-n+1}}$	…	$\sqrt{i_{t-1}}$	$\sqrt{i_t}$
Cumulat. inflation coefficient	$I_{t-n} = I_{t-n+1} \cdot \sqrt{i_{t-n+1}} \cdot \sqrt{i_{t-1}}$	$I_{t-n+1} = I_{t-n+2} \cdot \sqrt{i_{t-n+2}} \cdot \sqrt{i_{t-n+1}}$	…	$I_{t-1} = I_t \cdot \sqrt{i_t} \cdot \sqrt{i_{t-1}}$	$I_t = \sqrt{i_t}$

Wherein:

I_t - Inflation coefficient for half a year, which is used to level claims from 30 June, year t with those from 31 December 31, of the same year,

I_{t-1} - Cumulative inflation coefficient for the period from 30 June, year *t*-1 till 31 December, year *t*, etc.

Using the data on semiannual inflation coefficients, it is possible to calculate cumulative inflation coefficients, that are further used in projecting the outstanding claims.

Table 5. Calculation of semiannual and cumulative inflation coefficients for projected inflation rates

Year	***t*+1**	***t*+2**	**…**	***t*+*n*-1**	***t*+*n***
Annual inflation coefficient	i_{t+1}	i_{t+2}	…	i_{t+n-1}	i_{t+n}
Semiannual inflation coeffic.	$\sqrt{i_{t+1}}$	$\sqrt{i_{t+2}}$	…	$\sqrt{i_{t+n-1}}$	$\sqrt{i_{t+n}}$
Cumulative inflation coefficient	$I_{t+1} = \sqrt{i_{t+1}}$	$I_{t+2} = I_{t+1} \cdot \sqrt{i_{t+1}} \cdot \sqrt{i_{t+2}}$	…	$I_{t+n-1} = I_{t+n-2} \cdot \sqrt{i_{t+n-2}} \cdot \sqrt{i_{t+n-1}}$	$I_{t+n} = I_{t+n-1} \cdot \sqrt{i_{t+n-1}} \cdot \sqrt{i_{t+n}}$

Wherein:

I_{t+1} - Inflation coefficient for half a year, which is used to level claims from 31 December, year t with those from 30 June, year *t*+1,

I_{t+2} - Inflation coefficient for the period from 31 December, year t till 30 June, year *t*+2, etc.

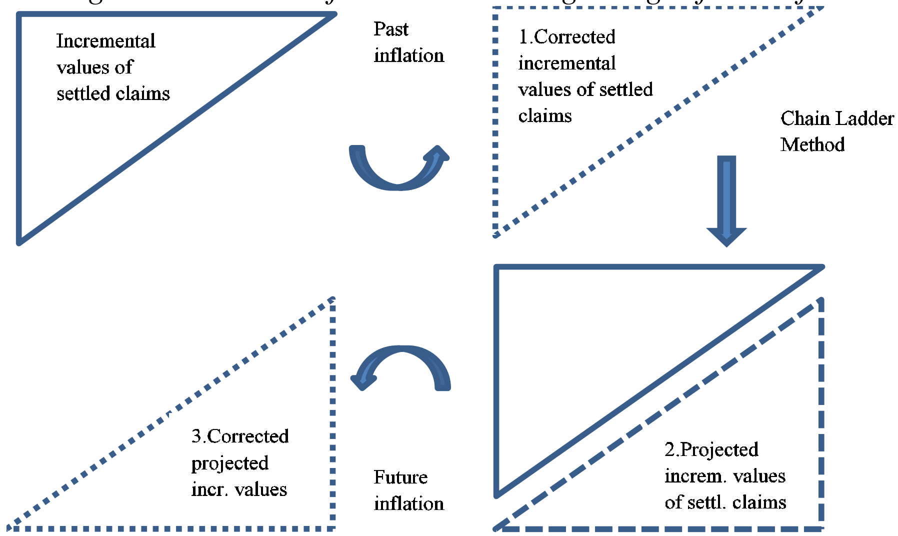
2. PROJECTION OF OUTSTANDING CLAIMS INCLUDING THE EFFECT OF INFLATION

The method for projection of outstanding claims including the effect of inflation is developed in three major phases:

1) Adjustment of incremental values of settled claims from the previous period for the previous inflation
2) Calculation of projected values of incremental claims, corrected for the previous inflation, and
3) Adjustment of projected values of incremental claims for the expected inflation

In Figure 1 all three phases of the calculation are represented.

Figure 1. Model of claims reserving using inflation factor



Source: Lipovec, R.. (2011). Practically aspects of the non-life insurance IBNR formation, I Course for Continuing actuarial education, Belgrade: Institute of Insurance and Serbian Actuarial Association, slide 37.

2.1. Correction of incremental values of settled claims from the previous period for the previous inflation

Incremental values of claims corrected for historical inflation rates (Table 6) are established as the product of incremental values of claims settled in a certain year and a corresponding cumulative inflation coefficient.

Table 6. Incremental values of settled claims, corrected for the previous inflation

Accident year	Period of claim development (in years)				
	0	**1**	**…**	***n*-1**	***n***
t-n	$X^*_{t-n,0} = X_{t-n,0} I_{t-n}$	$X^*_{t-n,1} = X_{t-n,1} I_{t-n+1}$	…	$X^*_{t-n,n-1} = X_{t-n,n-1} I_{t-1}$	$X_{t-n,n} I_t$
t-n+1	$X^*_{t-n+1,0} = X_{t-n+1,0} I_{t-n+1}$	$X^*_{t-n+1,1} = X_{t-n+1,1} I_{t-n+2}$	…	$X^*_{t-n+1,n-1} = X_{t-n+1,n-1} I_t$	
…	…	…			
t-1	$X^*_{t-1,0} = X_{t-1,0} . I_{t-1}$	$X^*_{t-1,1} = X_{t-1,1} . I_t$			
t	$X^*_{t,0} = X_{t,0} . I_t$				

Source: William, F.R. (1981). Evaluating the Impact of Inflation on Loss Reserves, Casualty Actuarial Society Discussion Paper Program, Arlington: Casualty Actuarial Society, p. 392.

Wherein:

$X^*_{t,0}$	-	Values of claims occurred and settled in year *t*, adjusted for inflation coefficient which levels the claims from 30 June of that year with those from 31 December, of the same year.
$X^*_{t-1,0}$	-	Values of claims occurred and settled in year *t*-1, cumulative inflation coefficient for the period form 30 June, year *t*-1 till 31 December, year *t*, etc.

2.2. Calculation of projected values of incremental claims, adjusted for the previous inflation

Based on the data from Table 6, and with standard *Chain ladder* method cumulative values of claims can be determined (corrected for the previous inflation). These coefficients are represented in Table 7.

Table 7. Cumulative values of settled claims adjusted for the previous inflation

Accident year	**Period of claim development (in years)**				
	0	**1**	**…**	***n*-1**	***n***
t-n	$X^*_{t-n,0}$	$\sum_{i=0}^{1} X^*_{t-n,i}$	…	$\sum_{i=0}^{n-1} X^*_{t-n,i}$	$\sum_{i=0}^{n} X^*_{t-n,i}$
t-n+1	$X^*_{t-n+1,0}$	$\sum_{i=0}^{1} X^*_{t-n+1,i}$	…	$\sum_{i=0}^{n-1} X^*_{t-n+1,i}$	
…	…	…			
t-1	$X^*_{t-1,0}$	$\sum_{i=0}^{1} X^*_{t-1,i}$			
t	$X^*_{t-n,0}$				

The next step is to establish the development factor of settled claims cumulative values, adjusted for the previous inflation in the way represented in Table 8.

For each stage of development, development factors can be calculated as the average of all development factor values per accident year for that stage of development, or by other recognized actuary methods (excluding the development factor of extreme values, mean value method of all development factors, etc.).

Table 8. Development factors of settled claims cumulative values (per accident year) adjusted for the previous inflation

Accident year	Stage of claim development		
	1/0	**…**	**n/(n-1)**
t-n	$\frac{\sum_{i=0}^{1} X^*_{t-n,i}}{X^*_{t-n,0}}$	…	$\frac{\sum_{i=0}^{n} X^*_{t-n,i}}{\sum_{i=0}^{n-1} X^*_{t-n,i}}$
t-n+1	$\frac{\sum_{i=0}^{1} X^*_{t-n+1,i}}{X^*_{t-n+1,0}}$	…	
…	…		
t-1	$\frac{\sum_{i=0}^{1} X^*_{t-1,i}}{X^*_{t-1,0}}$		

Development factors, previously described, are represented in Table 9.

Table 9. Development factors of cumulative values of settled claims, adjusted for the previous inflation

	Stage of claim development				
	1/0	**2/1**	**…**	**(n-1)/(n-2)**	**n/(n-1)**
Development factor	${f'_{1/0}}^*$	${f'_{2/1}}^*$	…	${f'_{(n-1)/(n-2)}}^*$	${f'_{n/(n-1)}}^*$

Using the represented factors, cumulative 'lower triangular matrix' values can be established, adjusted for the previous inflation, and then also the incremental values of the triangular matrix, adjusted for the previous inflation. The calculation is represented in Tables 10 and 11.

Table 10. Cumulative projected values of settled claims adjusted for the previous inflation

Accident year	Period of the claim development (in years)				
	1	**2**	**…**	**n-1**	**n**
t-n+1					$\sum_{i=0}^{n} X_{t-n+1,i}{}^*$
…			…	…	…
t-1		$\sum_{i=0}^{2} X_{t-1,i}{}^*$	…	$\sum_{i=0}^{n-1} X_{t-1,i}{}^*$	$\sum_{i=0}^{n} X_{t-1,i}{}^*$
t	$\sum_{i=0}^{1} X_{t,i}{}^*$	$\sum_{i=0}^{2} X_{t,i}{}^*$	…	$\sum_{i=0}^{n-1} X_{t,i}{}^*$	$\sum_{i=0}^{n} X_{t,i}{}^*$

Wherein:

- For the period of development 1

$$\sum_{i=0}^{1} X_{t,i}^{\ *} = X_{t,0}^{\ *} \cdot f'_{1/0}{}^{*},$$

- For the period of development 2

$$\sum_{i=0}^{2} X_{t,i}^{\ *} = \sum_{i=0}^{1} X_{t,i}^{\ *} \cdot f'_{2/1}{}^{*},$$
$$\sum_{i=0}^{2} X_{t-1,i}^{\ *} = \sum_{i=0}^{1} X_{t-1,i}^{\ *} \cdot f'_{2/1}{}^{*}, \text{ etc.}$$

...

- For the period of development n-1

$$\sum_{i=0}^{n-1} X_{t,i}^{\ *} = \sum_{i=0}^{n-2} X_{t,i}^{\ *} \cdot f'_{(n-1)/(n-2)}{}^{*},$$
$$\sum_{i=0}^{n-1} X_{t-1,i}^{\ *} = \sum_{i=0}^{n-2} X_{t-1,i}^{\ *} \cdot f'_{(n-1)/(n-2)}{}^{*},$$

…

- For the period of development n

$$\sum_{i=0}^{n} X_{t,i}^{\ *} = \sum_{i=0}^{n-1} X_{t,i}^{\ *} \cdot f'_{n/(n-1)}{}^{*},$$
$$\sum_{i=0}^{n} X_{t-1,i}^{\ *} = \sum_{i=0}^{n-1} X_{t-1,i}^{\ *} \cdot f'_{n/(n-1)}{}^{*},$$
…
$$\sum_{i=0}^{n} X_{t-n+1,i}^{\ *} = \sum_{i=0}^{n-1} X_{t-n+1,i}^{\ *} \cdot f'_{n/(n-1)}{}^{*}.$$

Incremental projected values of settled claims, adjusted for the previous inflation are calculated as the difference of consecutive cumulative values in a certain accidental year. Their values are represented in Table 11.

Table 11. Incremental projected values of settled claims indexed by the previous inflation

Accident year	Period of claim development (in years)				
	1	**2**	**…**	***n*-1**	***n***
t-n+1					$X_{t-n+1,n}^{\ *}$
…			…	…	…
t-1		$X_{t-1,2}^{\ *}$	…	$X_{t-1,n-1}^{\ *}$	$X_{t-1,n}^{\ *}$
t	$X_{t,1}^{\ *}$	$X_{t,2}^{\ *}$	…	$X_{t,n-1}^{\ *}$	$X_{t,n}^{\ *}$

Wherein:

- For the period of development 1

$$X_{t,1}^{*} = \sum_{i=0}^{1} X_{t,i}^{\ *} - X_{t,0}^{\ *},$$

- For the period of development 2

$$X_{t,2}^* = \sum_{i=0}^{2} X_{t,i}^* - \sum_{i=0}^{1} X_{t,i}^*,$$

...

$$X_{t-1,2}^* = \sum_{i=0}^{2} X_{t-1,i}^* - \sum_{i=0}^{1} X_{t-1,i}^*, \text{ etc.}$$

...

- For the period of development n-1

$$X_{t,n-1}^* = \sum_{i=0}^{n-1} X_{t,i}^* - \sum_{i=0}^{n-2} X_{t,i}^*,$$

$$X_{t-1,n-1}^* = \sum_{i=0}^{n} X_{t-1,i}^* - \sum_{i=0}^{n-1} X_{t-1,i}^*,$$

…

- For the period of development n

$$X_{t,n}^* = \sum_{i=0}^{n} X_{t,i}^* - \sum_{i=0}^{n-1} X_{t,i}^*,$$

$$X_{t-1,n}^* = \sum_{i=0}^{n} X_{t-1,i}^* - \sum_{i=0}^{n-1} X_{t-1,i}^*,$$

…

and $X_{t-n+1,n}^* = \sum_{i=0}^{n} X_{t-n+1,i}^* - \sum_{i=0}^{n-1} X_{t-n+1,i}^*$.

2.3. Calculation of projected incremental values, adjusted for the future inflation

Projected incremental values of settled claims are determined as the product of incremental projected values of claims settled in a certain year, and with corresponding cumulative coefficient of projected inflation. The calculation is represented in Table 12.

Table 12. Incremental projected values of settled claims adjusted for the future inflation

Accident year	Period of claim development (in years)					
	0	1	2	…	n-1	n
t-n+1						$X_{t-n+1,n}^* \cdot I_{t+1}$
…				…	…	…
t-1			$X_{t-1,2}^* \cdot I_{t+1}$	…	$X_{t-1,n-1}^* \cdot I_{t+n-2}$	$X_{t-1,n-1}^* \cdot I_{t+n-1}$
t		$X_{t,1}^* \cdot I_{t+1}$	$X_{t,2}^* \cdot I_{t+2}$	…	$X_{t,n-1}^* \cdot I_{t+n-1}$	$X_{t,n}^* \cdot I_{t+n}$

The sum of all incremental values of settled claims, adjusted by the factor of future inflation, presents the total amount of outstanding claims adjusted by the inflation factor:

$$Y_T \_ X_{t,1}{}^* \cdot I_{t+1} + X_{t,2}{}^* \cdot I_{t+2} + X_{t-1,2}{}^* \cdot I_{t+1} + \cdots + X_{t,n-1}{}^* \cdot I_{t+n-1} + X_{t-1,n-1}{}^* \cdot I_{t+n-2} + \dots + X_{t,n}{}^* \cdot I_{t+n} + X_{t-1,n-1}{}^* \cdot I_{t+n-1} + \cdots X_{t-n+1,n}{}^* \cdot I_{t+1}$$

3. PRACTICAL EXAMPLES

The presented model is tested on a hypothetical example of projection of insurance company's outstanding claims modeling by using inflation factor. As it is said before, this modeling requires data on the value of claims, historical inflation rates, as well as projected inflation rates. These data are presented in Table 13 – The incremental values of settled claims, in Table 14 – Historical rates of annual inflation coefficients, and in Table 15 – Projected rates of inflation coefficients.

Table 13. The incremental values of settled claims (in RSD)

Accident year	Period of claim development (in years)					
	0	**1**	**2**	**3**	**4**	**5**
2010	184.039.440	110.681.943	34.062.693	34.542.204	16.655.732	**7.596.978**
2011	219.546.510	140.725.778	51.183.641	29.295.307	**20.269.388**	
2012	287.330.429	154.477.401	40.099.156	**35.391.981**		
2013	339.742.487	208.833.475	**44.055.833**			
2014	380.339.527	**179.496.386**				
2015	**518.971.196**					

The following tables contain MMF consumer price indexes (CPI) for the Republic of Serbia, both historical and projected.

Table 14. Historical annual CPI for the Republic of Serbia

Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
CPI	10,2	7,0	12,2	2,2	1,8	2,5

Source: http://www.imf.org

Table 15 represent MMF projected values of CPI for the Republic of Serbia.

Table 15. Projected values of CPI for the Republic of Serbia

Year	**2016**	**2017**	**2018**	**2019**	**2020**
CPI	4,1	4,0	4,0	4,0	4,0

Source: http://www.imf.org

As the result of modeling by using inflation factor (explained in Chapter 1 of this chapter), outstanding claims with the amount of RSD 367,47 million were obtained. If the inflation factor was not used in the calculation, projected outstanding claims would be RSD 385,95 million. It could be seen that outstanding claims with the inflation effect are around 95% of outstanding claims without inflation effect. From the first look to tables 14 and 15, it could be concluded that this effect is due to higher inflation rates in previous period, than inflation rates for the future period (CPI in years 2010 to 2012 are much higher than CPIs from future periods).

Also, the model has been tested on a hypothetical case when the inflation rate from the previous period is higher than the estimated future inflation rate, as well as in the opposite case, when the inflation rate in the previous period is lower than the estimated future inflation rate. For example, applying the rate of 5% in the previous period and the rate of 1% in the future, resulted in outstanding claims with the amount of RSD 367,43 million, while reverse case resulted in outstanding claims with the amount of RSD 406,87 million.

Based on the conducted testing, it could be concluded that in the case when the inflation rates in the previous period are higher than future inflation rates, outstanding claims with inflation effect are lower than basic outstanding claims (without the inflation effect). Conversely, when the inflation rates in the previous period are lower than future inflation rates, outstanding claims with inflation effect are higher than basic outstanding claims (without the inflation effect).

4. PROBLEMS IN CONNECTION WITH THE CALCULATION OF TECHNICAL RESERVES USING INFLATION, AND POSSIBLE SOLUTIONS

There is not a special statistics of price increases of repairs, construction, equipment and spare parts, services (transport, medical, therapy, etc.), the amount of lost profit, etc., that would take into account only the prices that affect the value of the insured claims, and therefore technical reserves. The data about the index of consumer prices for a certain country or a region can be used as the possible solution for the purpose of evaluating technical reserves.

Data on inflation in the future are particularly problematic. In countries with a stabile consumer price index, it would not be a problem to consider the inflation in projecting outstanding claims. However, in the developing insurance markets estimation of inflation is difficult and carries a high level of uncertainty. The IMF (International Monetary Fund) could be the possible source of data for projected inflation values, since it gives the midterm inflation projections. For the types of insurance for which the claim development over longer period of time is expected it is necessary to model the assumed future inflation rates on the basis of known values, using a stochastic method recognized by actuaries. Also, there are examples in the international practice, of regulators giving the recommended inflation rates that can be used in a projection.

Significant differences between levels of previous and expected inflation also represent a special problem. Because of that, it is necessary to fully consider the relationship between previous and future inflation rates while assessing the reserves for claims using the effect of inflation. In case that their effect negatively affects the amount of the assessed reserves, it is possible to limit the use of low inflation rates expected in the future out of prudential reasons.

Domestic legislation does not explicitly permit, but also does not prohibit the application of the effects of inflation in the assessment of outstanding claims in statutory balance sheet. Regardless of the final decision concerning its application in statutory balance sheet, presented model can be applied in the practice of insurance companies, as a risk management mechanism. The relationship between the amount of outstanding claims without the effect of inflation and amount of outstanding claims that include the effects of inflation can be a useful control tool in the assessment of the sufficiency of insurers technical provision. This indicator helps to providing risk and solvency assessment of insurance company, and also provides additional information of potential free resources or lack of those resources, to the management of the insurance company.

Chapter 22.

RISK MANAGEMENT IN INSURANCE PREMIUM FORMATION

At the end of the Q3 2015, there were 24 insurance companies operating in Serbia. Among them, 20 companies provide insurance services only, while the other 4 are focused on reinsurance services. Among those companies that provide only insurance services, five companies provide only life insurance services; nine provide only non-life insurance services; and 6 provide both life and non-life insurance services. If we look at the ownership structure of those 24 companies, we can see that 18 companies are foreign owned, while only 6 are domestically owned.[299]

The main subject of this analysis is risk management in the insurance business sector. Since the insurance premium, as the price of an insurance policy, should ensure that insurer is able to make payouts for claims being made against the policy, we start with explaining actuarial methods for insurance premium calculation.

Next, we focus on risks in providing insurance services. This is particularly important because insurers cannot know whether the insured damage will happen or not. Moreover, the timing and the amount of damage are also uncertain. For that reason insurance companies are exposed to various risks. Among them the most important is the premium risk. This risk realizes if the expectations are based on inadequate knowledge of loss distribution or if the losses exceed their expected values simply because they fluctuate around their mean. Some of the reasons why the total amount of net premium could be insufficient for covering underwriting losses could be the risk of using wrong models, the risk of catastrophic events, the risk of legislation change and the risk associated with selling insurance premiums at discount. In addition to premium risk, there is also the risk that insurer's operating costs will exceed their projected values. Insurance companies are also exposed to risk that the value of their assets and liabilities will change as a result of broad economic factors.

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[299] All data used in this analysis are taken from National Bank of Serbia (2015). *Sektor osiguranja u Srbiji - izveštaj za treće tromesečje 2015. godine*. Belgrade: National Bank of Serbia.

Further, we explain the profitability measures for insurance companies such as the loss ratio, the expense ratio and the combined ratio. These three ratios represent the most common measures of premium adequacy in non-life insurance and they are all based on three variables: earned premiums, incurred claim amount and insurer's operating costs.

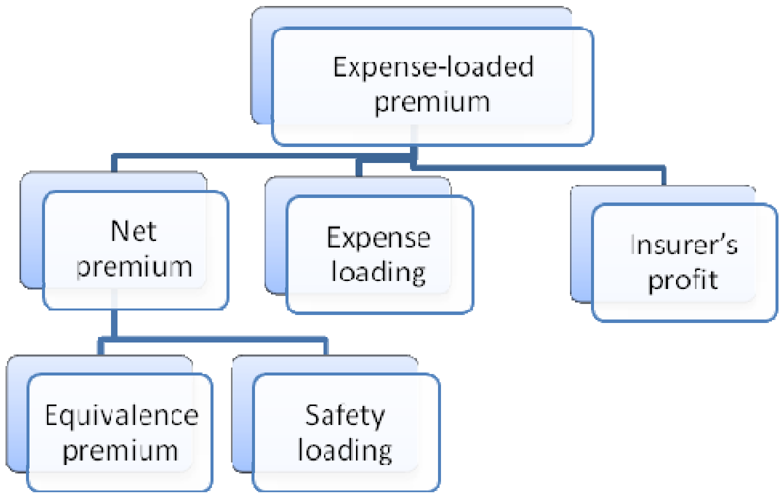
Finally, we focus on how risks in providing insurance services are managed. We argue that the major economic reasons why insurance companies manage risks are managerial self interest, the non-linearity of taxes, the cost of financial distress and the existence of capital market imperfections. Insurance companies should manage only those risks that cannot be eliminated or transferred to other parties. That happens in two cases. The first case is when the complexity of risks makes them difficult to transfer and communicate to other parties or when transferring these risks to other insurance companies might reveal information about certain customers, giving an undue advantage to competitors. The second case relates to those risks that are central to insurer's business. They are the reason for firm's existence and the insurer has competitive advantage in managing them. At the end, we explain several techniques for risk management and control including standard setting and financial reporting, setting limits in risk taking and offering incentive compatible contracts.

1. ACTUARIAL METHODS FOR INSURANCE PREMIUM CALCULATION

The main problem with premium calculation is that premiums need to be determined in the present time so that they can cover all damage claims as well as insurer's costs in the future predetermined period, usually one year. This means that premium calculation involves making certain forecasts, which represent the assessment of the future events that influence the amount of damage that will happen in the future. This assessment is based on the data that are available in the present time. It should be also noted that this assessment is related to certain risk. Because of that, mathematical and statistical methods are the most appropriate for solving these kinds of problems. They rely on various assumptions and have some limitations, but nonetheless they are scientifically founded and provide best results.

Insurance premium, as the price that an individual or business pays to insurance company for an insurance policy, should ensure that insurer is able to make payouts for claims being made against the policy. Since there is a risk of those claims being higher than predicted, insurance premium includes the safety loading as well. Finally, insurance premium should cover insurer's operating costs (expense loading) and enable insurer to make profit. In sum, expense-loaded premium or gross premium consists of: net premium, expense loading and insurer's profit. Net premium includes: equivalence premium and safety loading. Equivalence premium is the expected present value of the insurer's payout.

Figure 1. Insurance premium



Source: Prepared according to Kočović, J. (2010). Upravljanje aktuarskim rizicima u osiguravajućoj kompaniji. In: Problemi poslovanja osiguravajućih kompanija u uslovima krize, Kočović, J., Hanić, H. (eds.), Belgrade: Serbian Actuarial Association, Institute for Insurance and Actuarial, pp. 11-24.

In order to calculate the gross (expense-loaded) premium, an insurance company can add a fixed amount of expenses and profit to the net premium, add a percentage of the premium, or add a combination of a fixed amount and a percentage of the premium. Insurer's operating costs include: commissions paid to agents who sell the policies, legal expenses associated with settlements, salaries, taxes, clerical expenses, and other general expenses.

Equivalence premium in the period t, denoted by EP_t, represents the expected present value of the insurer's payout and can be written mathematically as follows:

$$EP_t = E[S_t]$$

where $E[S_t]$ represents the expected present value of the insurer's payout in period t.

Since an insurance company cannot determine with certainty the exact amount of its payout, i.e. there is always a risk that the amount of damage will be greater than expected, safety loading must be added to equivalence premium. The assessment of the safety loading as well as the equivalence premium is based on insurer's experience using the statistical data on previous claims, usually for the last five or ten years. Safety loading is determined using the rule called premium principle, which also represents a formula for net premium calculation. Mathematically net premium can be represented as follows:

$$NP_t = (1 + \lambda)E[S_t]$$

where NP_t represents the net premium in period t, λ represents coefficient of safety ($\lambda > 0$) and $E[S_t]$ represents the expected present value of the insurer's payout in period t. Safety loading in period t, denoted with SL_t, is equal to $\lambda E[S_t]$ and it is proportional to the total expected insurer's payout.

$$SL_t = \lambda E[S_t]$$

An alternative way to calculate the net premium is as follows:

$$NP_t = E[S_t] + kNP_t$$

where the safety loading in period t is expressed as a percentage k of the net premium $(SL_t = kNP_t)$.

After arranging the previous expression we get:

$$NP_t = E[S_t] \times \frac{1}{1 - k}$$

And the coefficient of safety λ is equal to:

$$\lambda = \frac{k}{1 - k}$$

A limitation of the premium principle is that it does to take into account the variation of insurer's payouts. The expected value only locates the center of the distribution of the insurer's payouts, but it does not provide an adequate description of a set of measurements. Two sets of measurements could have equal expected values, but significantly different frequency distributions. For that reason, standard deviation principle is often used for net premium calculation, since it takes into account the dispersion of total insurer's payouts.

According to standard deviation principle, a net premium in period t, NP_t, can be written as follows:

$$NP_t = E[S_t] + \alpha\sqrt{Var[S_t]}$$

where coefficient α is a proportion calculated using the data on past events ($\alpha > 0$). In this case, the safety loading in period t is proportional to the standard deviation of the total insurer's payout in period t:

$$SL_t = \alpha\sqrt{Var[S_t]}$$

As can be seen from this expression, in the case of two insured events, the safety loading and subsequently the net premium is higher for the event where the standard deviation of the insurer's payout is higher. This event is also riskier from insurer's point of view and thus requires a higher net premium.

The coefficient α can be calculated using the data on net premiums and accepted claims from previous periods. These data are available on insurance statistics database. The coefficient α is calculated as follows:

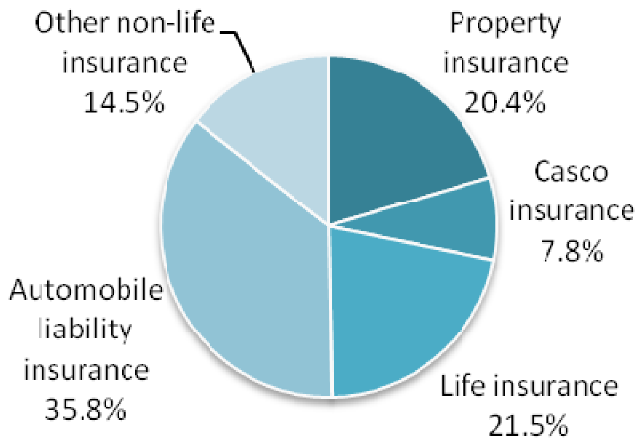
$$\alpha = \frac{NP - E[S]}{\sqrt{Var[S]}}$$

where NP denotes the total net premium for the past period (t-1 or any other period in the past), $E[S]$ is the mean of the total insurer's payout for the past period and $\sqrt{Var[S]}$ is the standard deviation of the total insurer's payout for the past period. In that way, the coefficient α can be calculated for the t-1, t-2 or any other period in the past. When calculating the net premium for period t, an insurance company can use the coefficient α for one of the past periods (e.g. for period t-1 or t-2), or the weighted average of the coefficients for several past periods, e.g. for three years.

In that way, using the data for previous periods and applying appropriate mathematical and statistical methods, an insurance company can calculate the premium for the current year. An insurance premium calculated in that way is compared with insurance premiums for previous years and after the repeated analysis of insured damages, especially those with high potential payouts, an insurance company can decide whether to accept the premium for the current year or to make certain adjustments.

The total insurance premium of all insurers operating in Serbia equaled 60.6 billion RSD (or 506 million EUR) in Q3 2015, which is 18% higher compared with the same period a year before.

Figure 2. Insurance premium in Q3 2015



Source: National Bank of Serbia (2015). Sektor osiguranja u Srbiji - izveštaj za treće tromesečje 2015. godine. Belgrade: National Bank of Serbia.

As it can be seen from the Figure 2, the non-life insurance premium accounted for 78.5% of the total insurance premium in Q3 2015, while life insurance premium accounted for 21.5%. The highest proportion in the total insurance premium has automobile liability insurance premium with 35.8%. In Q3 2015, the total non-life insurance premium increased by 17.1% compared with the same period a year before.

2. RISKS IN PROVIDING INSURANCE SERVICES

As we mentioned earlier, the insurance premium should cover underwriting losses, operating costs and enable insurer to make profit. On the other hand, the price of an insurance policy, like the price of any other product or service, depends on the supply and demand. Because of that, in practice, the conflict between marketing and actuary department within an insurance company is quite common. Marketing department endeavors to lower the prices of insurance policies in order to increase sales and stay competitive on the market. On the other side, actuary department must ensure that the price of insurance policy is sufficiently high so that the insurer is able to make payouts for claims being made against the policy. This problem becomes severe in case of tenders where the lowest price is the most important factor in choosing an insurer.[300] It

[300] Kočović, J. (2010) Upravljanje aktuarskim rizicima u osiguravajućoj kompaniji. In: *Problemi poslovanja osiguravajućih kompanija u uslovima krize*, Kočović, J., Hanić, H. (eds.), Belgrade: Serbian Actuarial Association, Institute for Insurance and Actuarial, p. 12.

often happens in practice that insurance companies, in order to get a job on tender, offer insurance policies for the price which is below the expected present value of the insurer's payout. In that way insurance companies can endanger their business and ability to cover underwriting losses.

When selling insurance policies, insurance companies cannot know whether the insured damage will happen or not. Moreover, the timing and the amount of damage are also uncertain. For that reason insurance companies are exposed to various risks. Among them the most important is certainly the premium risk.

Premium risk is the risk that the funds collected through the sales of insurance policies are not sufficient for covering underwriting losses. This risk realizes when the insurer is paying too much for the funds it receives, or, put in another way, when the insurer receives too little for the risks it has agreed to absorb. If this is the case, in any given period, the underwriting losses will be higher than projected. This can happen if the expectations are based on inadequate knowledge of loss distribution or if the losses exceed their expected values simply because they fluctuate around their mean.

If underwriting losses are higher than the total amount of equivalence premium, the company will be able to pay for damage claims only to α clients.[301] Because a rational client knows that he could be the $\alpha + 1$ client, he or she will be willing to pay a higher amount than the equivalence premium for insurance policy in order to minimize the possibility that the company will not pay for his claim. In that way insurance companies form the safety loading in case the underwriting losses are higher than their expected values.

Some of the reasons why the total amount of net premium could be insufficient for covering underwriting losses could be the risk of using wrong models, the risk of catastrophic events, the risk of legislation change and the risk associated with selling insurance premiums at discount.[302]

When calculating the amount of net premium, an insurance company can use wrong models. In that case the loss distribution or the expected value of damage claims could be wrong. This can happen if the company has insufficient amount of data about the past events or if the data are not reliable. For that reason the company should have an adequate database for the past period of at least ten years.

[301] *Ibid,* p. 18.

[302] *Ibid,* p. 18.

Catastrophic events happen rarely, but if they happen, insurer's payouts can be so high that they can endanger its business. For that reason, the company should maintain sufficient liquidity to easily handle any demand for cash. Otherwise, an insurer would have to sell off illiquid assets at prices lower than normal. This will lead to large losses and potential insolvency.

The change in legislation can put previously well established transactions into contention even when all parties have previously performed adequately and are fully able to perform in the future.[303] Furthermore, some countries in transition liberalized the regulations for determining the minimum amount of net premium, which led to some insurance companies charging the prices below the expected value of their payouts. In that way, those companies not only endangered their solvency, but also the solvency of the whole insurance market.

Insurance companies usually offer discounts to clients which did not have damage claims in the last few years. In that way insurers encourage their clients to take care of their insured property and avoid risks of having damage. Sometimes it happens that discounts are so high that the price of the policy is below the expected value of underwriting loss. This practice can negatively influence insurer's loss ratio and lead to potential insolvency.

In addition to premium risk, there is also the risk that insurer's operating costs will exceed their projected values. If that happens, one part of the net premium will be used for covering insurer's operating costs instead of for covering underwriting losses. This can impede company's ability to make payouts for claims being made against the policy.

Insurance companies are also exposed to risk that the value of their assets and liabilities will change as a result of broad economic factors. This type of risk is called systematic or market risk and it impacts the insurance market as a whole. Because of that systematic risk cannot be diversified. Systematic risk comes in a variety of forms, but for the insurance sector the most important systematic risks are interest rate risk, basis risk and inflation risk.[304]

Insurance companies also earn interest from investing the funds which they collected through the sales of insurance policies. Interest rate risk relates to the possibility that the market value of company's investment assets may decline

[303] Babbel, D.F., Santomero, A.M. (1996). Risk Management by Insurers: An Analysis of the Process. *Wharton working paper*, No. 96-16, Financial Institutions Centre, The Warton School, University of Pennsylvania, p. 12.

[304] *Ibid*, p. 11.

over time or that borrowers of insurer funds may default on their obligation to the company.

Basis risk arises from an imperfect hedge and it relates to the possibility that two investments in a hedging strategy will not experience price changes in opposite directions from each other. The imperfect correlation between two investments adds risk to the company by creating the potential for excess gains or losses.

Inflation increases the cost of future claims on current policies. For example, in most of the cases, the values of the insured property are based on the cost to repair or replace the item at the time of loss with very few contracts providing a pre-specified fixed value. [305] Because of that, the cost of claims increases as inflation increases the value of the property.

During the periods of high inflation automobile manufacturers tend to keep the prices of new cars unchanged while increasing the prices of replacement parts above the inflation level. In that way, they compensate the losses caused by inflation from the sale of new cars by making high profits from the sale of replacement parts. However, most of the car repairs are covered not by consumers, but by insurance companies. For that reason, many insurance companies engaged in disputes with car manufacturers over the need to use original manufacturer's replacement parts when a car is damaged in a traffic accident.

At the end of the Q3 2015, there were 11 insurance companies offering automobile liability insurance in Serbia. The total automobile liability insurance premium increased by 38.3% compared with the same period a year before.

The solvency margin represents the amount by which the fair value of insurer's assets exceeds the fair value of insurer's liabilities. At the end of the Q3 2015, the solvency margin of all insurance companies operating in Serbia equaled 17.3 billion RSD, which is encouraging since the solvency margin functions as a buffer against the risks related to investment activities. Moreover, the guarantee reserves equaled 31.5 billion RSD and the ratio of the guarantee reserve to the solvency margin equaled 181.2% for non-life insurance companies in Serbia.

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[305] Ahlgrim, K., D'Arcy, S. (2012). *The Effect of Deflation or High Inflation on the Insurance Industry.* Casualty Actuarial Society, Canadian Institute of Actuaries, and Society of Actuaries, p. 11.

If we analyze the structure of liabilities in the balance sheet of insurance companies operating in Serbia at the end of Q3 2015, we can see that technical reserves accounted for 73.8%, while equity and other reserves accounted for 19.7%.

Besides the adequate amounts of technical reserves, insurance companies are required to invest their funds depending of the type of insurance they provide, the maturity of their obligations and the profitability of their investments. At the end of the Q3 2015, in non-life insurance, the coverage of technical reserves by prescribed assets was 102.6%. Technical reserves were covered by government securities (59.4%), deposits with banks and cash holdings (19.8%), real estate for investment (7.9%) and insurance premium receivables (6.8%).

3. THE MEASUREMENT OF PREMIUM RISK USING THE PROFITABILITY RATIOS

Profitability measures for insurance companies are based on three variables: earned premiums, incurred claim amount and insurer's operating costs.[306] In practice, insurance policies enter at different times during the calendar year, so the total amount of premiums cashed in year t does not contribute entirely to the profit of that year. For that reason, this amount has to be reduced by the amount of premiums cashed in that year (t) that will contribute to profit in the next year (t+1) and increased by the amount of premiums cashed in the previous year (t-1) that will contribute to profit in this year (t).

Mathematically earned premiums in year t can be written as follows:

$$\tilde{P}_t = P_t + PR_{t-1} - PR_t$$

where $\tilde{P}_t$ represents earned premiums in year t, P_t represents the total amount of premiums cashed in year t, also called written premiums, PR_t represents the amount of premiums cashed in that year (t) that will contribute to profit in the next year (t+1), also called premium reserve at time t and PR_{t-1} represents the amount of premiums cashed in the previous year (t-1) that will contribute to profit in this year (t), also called premium reserve at time t-1.

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306 Jovović, M. (2012). Primena pokazatelja profitabilnosti u svrhe merenja rizika dovoljnosti premije osiguranja. In: *Ekonomska politika i razvoj*, Jovanović Gavrilović, B., Rakonjac Antić, T., Stojanović, Ž. (eds.), Belgrade: Faculty of Economics, University of Belgrade, p 240.

The incurred claim amount in period t is not the same as the claim settled in period t because one part of the claim settled in period t refers to claims incurred in previous periods. Moreover, one part of the claim incurred in period t in not settled in that period and it will be settled in the following periods. The claim reserve at time t-1 includes the estimate of the claim incurred in the previous period and the claim reserve at time t includes the estimate of the claims incurred in year t, but not settled yet. Thus, the incurred claim amount in period t equals the claim settled in period t plus the claim reserve at time t minus the claim reserve at time t-1. Mathematically the incurred claim amount can be written as follows:

$$\widetilde{S_t} = S_t + R_t - R_{t-1}$$

Where $\widetilde{S_t}$ represents the incurred claim amount in period t, S_t represents the claim settled in period t, R_t represents the claim reserve at time t and R_{t-1} represents the claim reserve at time t-1.

Now, if we know the amount of earned premiums in year t, the incurred claim amount in year t and insurer's operating costs in year t, we can calculate the annual profit (or loss) in year t, as follows:

$$\Pi_t = \widetilde{P_t} - \widetilde{S_t} - E_t$$

where Π_t represents the insurer's annual profit (or loss) in year t and E_t represents insurer's operating costs in year t.

The loss ratio in year t represents the ratio of the incurred claim amount in year t to the earned premiums in year t. Mathematically it is written as follows:

$$LR_t = \frac{S_t + R_t - R_{t-1}}{P_t + PR_{t-1} - PR_t} = \frac{\widetilde{S_t}}{\widetilde{P_t}}$$

where LR_t represents the loss ratio in year t. If the loss ratio is lower than one, the amount of earned premiums is sufficiently high to cover the claim costs in that year. Loss ratio represents the most basic measure of premium adequacy in non-life insurance.

The expense ratio in year t represents the ratio of the insurer's operating costs in year t to the earned premiums in year t. Mathematically it is written as follows:

$$ER_t = \frac{E_t}{P_t + PR_{t-1} - PR_t} = \frac{E_t}{\widetilde{P_t}}$$

where ER_t represents the expense ratio in year t. This ratio shows how much of the earned premiums in year t has to be used to cover insurer's operating costs in that year.

The combined ratio represents the sum of the loss and expense ratio and it is the ratio of the incurred claim amount and insurer's operating costs in year t to the earned premiums in year t. Mathematically it is written as follows:

$$CR_t = LR_t + ER_t = \frac{\tilde{S}_t + E_t}{\tilde{P}_t}$$

If the combined ratio is lower than one, an insurance company earns a positive profit. Since the combined ration does not take into account the interest earned by investing one part of earned premiums, in some cases, it is possible that a company earns a positive profit even in the combined ratio is slightly greater than one.[307] These three ratios represent the most common measures of premium adequacy in non-life insurance.

4. HOW ARE RISKS IN PROVIDING INSURANCE SERVICES MANAGED?

There are at least four major economic reasons why insurance companies should manage risks: managerial self interest, the non-linearity of taxes, the cost of financial distress and the existence of capital market imperfections.[308]

The argument about managerial self interest can be traced back to the agency theory. Managers are tied to one company where they work and they have limited opportunities to diversify their own wealth. For that reason, managers prefer stability over volatility and it is in their best interest to manage and lower the risk since in that way they keep their jobs safe.

In addition to managerial self interest, insurance companies have incentive to manage risk because tax code is highly non-linear. When tax structure in not proportional, the income smoothing reduces the effective tax rate, which further means that the company pays less tax. In that way, activities which reduce the volatility in earnings will positively affect shareholder value.

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[307] *Ibid*, p. 241.

[308] Babbel, Santomero, *op. cit*., p. 2.

The costs of financial distress are the costs that a company, which has difficulty paying off its financial obligations, faces beyond the costs of doing business. The chance of financial distress increases when an insurance company has high volatility in earnings. Companies with increasing costs of financial distress not only face potential bankruptcy, but also a loss of profitability. This is because firm's clients search for healthier companies to buy their insurance products. Furthermore, in case of financial distress, managers become preoccupied with the treat of bankruptcy and employees become less productive as they worry about their jobs.

In the capital market imperfection argument, the external financing is more costly than internal financing because high transaction costs are associated with external financing. Insurance companies whose earnings are highly volatile have to search for external finance to exploit investment opportunities during the periods when their profits are low. For that reason, volatility in earnings increases the cost of capital and reduces the amount of optimal investments.

Insurance companies should manage only those risks that cannot be eliminated or transferred to other parties. Those risks insurers can manage more efficiently than the market. With this in mind, the risks in providing insurance services can be classified into risks that can be eliminated or avoided by standard business practices, risks that can be transferred to other participants and risks that must be actively managed at the firm level.[309]

Business practices for avoiding risks include the standardization of contracts, procedures and business processes as well as the standardization of insurance policies. In that way inefficient or adverse business decisions can be prevented. In addition, a company can implement incentive compatible contracts to increase goal congruence between employees and shareholders and motivate employees to make best decisions for the company.

There are also risks that can be successfully transferred to other participants. For example, interest rate risk can be transferred through swaps, futures or other derivative products, while actuarial risk can be transferred to reinsurers. Furthermore, an insurance company can diversity its risks by buying and selling its financial claims. For this strategy, it is important that the efficient market exists, so the company can sell its financial claims for their fair value or for the price which is close to fair value.

[309] *Ibid*, p. 6.

There are two cases when risks should be actively managed at the firm level. The first case is when the complexity of risks makes them difficult to transfer and communicate to other parties or when transferring these risks to other insurance companies might reveal information about certain customers, giving an undue advantage to competitors. The second case relates to those risks that are central to insurer's business. They are the reason for firm's existence and the insurer has competitive advantage in managing them.

There are several techniques for risk management and control. The first technique relates to standard setting and financial reporting. The firm needs to set underwriting standards, risk classification standards and standards for rating risk exposures in order to ensure that accepted risks comply with the parameters that the company is ready and capable to accept. Moreover, apart from standard accounting reports, the management of the company needs special reports which contain information on actuarial risk, asset quality and overall risk posture. These reports also need to be standardized and created on regular basis.

The next technique pertains to setting limits in risk taking. For example, an insurance company may accept only those customers that pass some pre specified quality standards or it can restrict the activities of its sales agents and portfolio managers by setting some pre defined limits.

Finally, the company can lower the costs of control by offering incentive compatible contracts to its employees. In that way, sales agents and managers will be paid according to the risks born by them, but the contracts must be aligned with insurer's financial goals. Otherwise, the salaries dependent solely on sales can lead to dangerous growth and mispricing of risks.

An insurance company should have its tariff policy which needs to be monitored and examined on the regular basis. If the premium is set to low, it will not be sufficient for covering damage claims causing underwriting profit to be negative. In that case, recapitalization might have to be undertaken. On the other side, if the premium is set to high, an insurer will not be competitive on the market which will cause the number of its clients to decrease over time. For that reason, setting the adequate price for insurance policy is the most important problem on which the main goal of the insurance company depends and that is to protect its clients from possible damages.

Chapter 23.

UNDERWRITING RISKS ASSESSMENT IN MARINE CARGO INSURANCE: CASE IN SERBIAN INSURANCE MARKET

The unreliability of all complex systems or processes is mainly caused by the numerous of different activities, presence of sub-systems and interactions between the subsystems and different external or internal impacts, which may be constant or occasional. Any complex system, including the system of insurance business, is not fully foreseeable and is exposed to potential risks, which can be considerable. In their operations, the underwriters are facing the requests for cover of different types of risks. Underwriting in cargo insurance involves the analysis, selection and classification of insurance applications, assessment of clients' exposure to certain risks and definition of appropriate price of insurance coverage. Thus, the underwriting in cargo insurance tends to be a very risky process. In the insurance business, due to the complexity of business systems and the number of external influences, the different types of risk assessment is often done intuitively, based on experience or knowledge of individuals. The aim of this research is to present an approach to risk assessment in underwriting process on the marine cargo insurance market in Serbia. When had in mind the complexity of the analysed issue and the numerous of risks and risk parameters in underwriting on the one hand and faults of the representative statistical data on risks in underwriting process on the other hand, Fuzzy Analytic Hierarchy Process (FAHP) method can provide acceptable quantitative data. These data can be used for the development of appropriate measures and strategies at the national level, which can minimise or eliminate the identified risks.

1. NON- LIFE UNDERWRITING RISK MODULE

The standard formula for Solvency Capital Requirement (SCR) aims to capture the material quantifiable risks that most undertakings are exposed to. The standard formula might however not cover all material risks a specific undertaking is exposed to. A standard formula is a standardized calculation method, and is therefore not tailored to the individual risk profile of a specific undertaking. For this reason, in some cases, the standard formula might not reflect the risk profile of a specific undertaking and consequently the level of own funds it needs. EIOPA documents covers all risk modules of the standard formula, addressing the assumptions related to the risks covered by the respective modules as well as the assumptions for the correlation between the modules. It does not address why some risks are not explicitly formulated in the standard formula. However, this does not mean that these risks do not need to be considered for the purpose of the assessment of the significance of the deviation. The SCR covers all quantifiable risk for existing business and also new business expected to be written in the following 12 months. The SCR is calibrated using the Value at Risk (VaR) of the basic own funds to a confidence level of 99.5 % over a one-year period. This calibration objective is applied to each individual risk module and sub-module. The SCR standard formula follows a modular approach where the overall risk which the insurance undertakings exposed to, is divided into sub-risks and in some risk modules also into sub- sub risks.

Guidelines on own risk and solvency assessment imply that the undertaking should develop for the ORSA (Own Risk and Solvency Assessment) its own processes with appropriate and adequate techniques, to fit into its risk-management system. Also, they need to take into consideration the nature, scale and complexity of the risks inherent to the business. Article 45 of Solvency II requires the undertaking to perform a regular ORSA as part of the risk-management system. The main purpose of the ORSA is to ensure that the undertaking engages in the process of assessing all the risks inherent to its business and determines the corresponding capital needs. To achieve this, an undertaking needs adequate and robust processes to assess, monitor and measure its risks and overall solvency needs, and also to ensure to take the output in decision making processes of the undertaking. The methods employed may range from simple stress tests to more or less sophisticated economic capital models.

Non - Life underwriting risk module consists 3 sub modules: Premium and reserve risk, Lapse and CAT. The underlying assumptions for the non-life premium and reserve risk sub-module can be summarized as follows:

- The underlying risk follows a lognormal distribution.
- Complex relationships between different risks that could give rise to dependencies in the risk profile are implicitly taken into account in the correlation parameters between the segments, LoBs and between premium and reserve risk for each LoB.
- The final factors are reflective of the average size and performance of the portfolios of insurers in the European market.
- Net earned premium can be used as a proxy for premium risk exposure.

- Net provisions for claims outstanding can be used as a proxy for reserve risk exposure.
- Expenses are not evolving independently or in an opposite way from the underlying risk over time.
- Non-proportional reinsurance reduces the premium risk volatility by 20%
- it is assumed that the segmentation of insurance obligations by captives can be considered materially less diversified in terms of LoB compared to the portfolio used in the calibration of the standard formula.
- it is assumed that geographically diversified portfolios are diversified in respect of size and timing of losses which an insurance undertaking faces.

Complex relationships between different risks could also give rise to dependencies in the risk profile. The most obvious of these is the relationship between non-life underwriting risk and contingent credit risk. The circumstances that cause increased insurance losses, and therefore an increase in reinsurance recoveries, could in turn have a negative effect on the creditworthiness of the reinsurer. However, such complex relationships between premium and reserve risk and counterparty default risk or market risks have not been considered in the premium and reserve risk module. They are implicitly taken up in the correlation parameters between the risk modules, $3 \cdot \sigma\ V$.

σ denotes the combined standard deviation for premium and reserve risk and V denotes the total volume measure for premium and reserve risk. The volume measure V is equal to the sum of all volume measures for the different segments the undertaking is exposed to. For non-life lapse risk it is assumed that either relevant option exercise rates are not used in the calculation of technical provisions for non-life obligations or, where they are used in the calculation, changes of the relevant option exercise rates used in the calculation of technical provisions would not have a material impact on the value of technical provisions. The non-life catastrophe risk sub-module is essentially split into three separate and independent sub-sub-modules that cover catastrophe risk related to natural perils, risk related to man-made events and other catastrophe events. The final recommended calibration for premium and reserve risk factors for Marine, aviation and transport LoB are as follows:

	QIS5	Recommended
Premium risk - gross	17%	14.9%
Reserve risk - net	14%	11.0%

Mathematically speaking, the entries in the table above represent standard deviations for premium and reserve risk, respectively.

2. MARINE CARGO INSURANCE

Marine cargo insurance represents the oldest form of insurance and its development is considered to be the foundation of all other insurance types. This insurance includes the insurance of various material interests of numerous participants included in the process of physical distribution of goods. Cargo insurance provides the protection for the policyholders that are exposed to many risks that might be actualized during the transport, storage, goods handling and the like, i.e. it indemnifies the potential claim sustained by the policyholder if such risks actuate. The goal of cargo insurance is to provide protection to the policyholders exposed to various perils and unwanted events regarding the goods or their own interests during transport. This insurance is flexible and cover is usually adjusted to the specific needs of the client whereas scope of cover may be determined according to the policyholder's wishes.

2.1. Underwriting in marine cargo insurance

The main assumption of underwriter's successful business is optimal management of complex business system of an insurance company. Underwriters constantly deal with requests to cover various types of risks. However, in particular situations, the market requires from the underwriters to cover the risks with which they are not sufficiently familiar and thus, they can either refuse to provide the cover or accept it by attaching particular limits or exclusions. Many risks are out of reach for the underwriter or underwriter's influence might be limited. On that ground, insurance companies have to carry out systematic approach to risk management and they have to apply modern actuarial, underwriting, financial, legal, engineering and other mechanisms, with the aim of protecting themselves as well as their clients.

Underwriting involves the process of analysis, selection and classification of insurance applications, assessment of clients' exposure to certain risks and definition of appropriate terms and price of insurance coverage (Macedo, 2009). The application of actuarial principles in the transport insurance is often limited by the fact that it includes almost unlimited set of different insurance objects. The large number of different circumstances surrounding particular processes of physical distribution of goods, coupled with permanent market volatility, seasonal impacts on the risk and numerous other factors. However, due to the fact that it is very difficult to provide a representative statistical sample in marine cargo insurance, actuarial science is commonly based on rough assessment of the most important risk indicators of homogenous insurance subjects. Rough statistical assessment of risk parameters often represents just the foundation for the definition of main quantitative risk indicators. This helps to define the adjustments based on subjective perception of a particular insurance risk, with the aim to determine premium rates or insurance premiums for any specific insurance cover.

Marine cargo insurance requires a multidisciplinary approach involving necessary knowledge in various fields such as foreign trade operations, forwarding, transport technologies and organization, technological knowledge of goods, storage, overloading, cargo weighing technologies, traffic laws etc. Underwriting is a dynamic and cyclic process involving the coordination of numerous activities and subjects within insurance companies, and external subjects, in order to make optimal decisions regarding conditions of insurance cover and adequate insurance premium. In general, risk assessment in insurance includes the evaluation of influences of numerous elements of risk including initial hazardous events, indirect events, causes, influencing factors etc. as well as the overall risk assessment, i.e. the assessment of the operating risk of a business system. Various types of risk and specific features of cargo insurance require the application of appropriate underwriting methods, techniques, procedures or strategies. In the insurance industry, the assessment of various risks is often intuitive, based on experience and knowledge of experts, because of the complexity of business systems and numerous external influences.

The risk characteristics of the logistics processes are that they often act simultaneously on both the goods and the environment. Analysis of physical risk is performed by collecting relevant information on risks based on available statistical data, experience and knowledge of individuals or otherwise, usually using formalized methods and techniques. The main problem that occurs in the process of underwriting in the marine cargo insurance represents the subjectivity of the assessment of risk, and consists in the fact that different persons have different perceptions of risk, depending on the expertise and qualifications, experience, personal characteristics, preferences towards acceptance and other risks. Risk identification serves as the basis for qualification of risk, and understanding their characteristics and peculiarities. Qualification of risk entails the process of establishing the basic elements or risk factors, such as the basic factors that affect the amount of total risk. Marine cargo insurance characterized by an almost unlimited number of cases of insurance, a large number of options to provide insurance coverage as well as a number of risk elements (some of which are variable in time and space). In other words, almost every cargo insurance represents single specific case, which implies the necessity of holding multidisciplinary experience and knowledge in risk assessment and ways of contracting insurance.

3. THE BASIC PARAMETERS OF THE UNDERWRITING PROCESS IN MARINE CARGO INSURANCE

There are many risk elements that both independently and in mutual interaction affect the total level of risk associated with goods-in-transport. Having in mind huge number of risks in cargo insurance, it is very difficult to analyse and assess all risk elements at the same time, especially if we want to have high reliability rate. For that reason, in the risk assessment practice the selection of dominant elements that need to be assessed, i.e. the elements that affect the total risk the most is done. In this research the underwriting process parameters in marine cargo insurance (depends on the premium amount) are divided into two groups and to risk parameters logistic processes and risk parameters related to the characteristics and peculiarities of insurance coverage.

3.1. Risk parameters of logistics processes

In this research, the total risk in logistics processes is divided into five elements, i.e. five basic risk factors. Each of the defined risk elements can be divided into several sub-elements which both independently and in interaction with other sub-elements determine the total risk of a concrete process of physical distribution covered under marine cargo insurance.

Risk level associated with transport of goods

There is a countless number of goods that are being transported, all with different characteristics and specificities, which affect the level of risk involved in logistics processes. For the purpose of risk analysis and quantification, it is necessary to establish the classes of homogenous groups of goods (or risks) similar in characteristics, i.e. probability of loss occurrence and expected consequences. For example, homogenous groups of goods can be bulk cargo, liquid cargo, dangerous substances, construction materials, insured parcels, different foodstuffs, oversized cargo, heavy mechanization, motor vehicles, spare parts and numerous other types of goods. Also, within each homogenous group of goods many subgroups that can have specific risk level parameters can be defined. Even in case of the same type of goods, the total assessed risk level of a logistics process can only be relatively reliable, if there are specificities that can significantly affect the reliability of physical distribution from a consignor to a consignee. Subgroups of goods can be observed as a segment of a unique homogenous group in relation to which it is possible to determine an individual level of risk. Technological and transport characteristics of goods most often predetermine the possibility of physical damage, theft, no delivery, loss of a characteristic of goods during transport etc.

Risk levels associated with goods packaging and security

Closely connected to technological and transport characteristics of goods, the risk level is highly affected by goods protection (packaging, palletization, containerization, etc) as well as security during transport, storage etc. Packaging is an integral part of goods, and the selection of optimal packaging may minimize the risk and form one part of preventive actions. Same type of goods can be packed in different types of commercial packaging that may be of different material and different protection in respect of external conditions, which significantly affects the risk in transport. Goods palletization implies bringing packaging units together onto a pallete what makes for additional protection of goods. Apart from optimal packaging, the risk is highly affected by transport containerization. One of many advantages of goods containerization is the fact that the exposure to external, static and dynamic conditions, weather conditions, theft risk etc is significantly minimized. The basic role of optimal security is protection of goods from damages that most often occur due to different dynamic influences during transport and handling.

Risk levels associated with the type and organization of transport

Type of transport (marine, river, combined, rail, road, air, postal, pipeline and the like), level of transport and traffic infrastructure and communications as well as conditions and limits of itinerary are very important risk factors. Each type of transport generates specific risks characteristic of the given transport. For example, marine transport is characterized by numerous risks occurring only in this type of transport, such as: sinking of ship, effects of sea water on goods, effects of high waves etc. Also, particular types of transport last significantly longer than some other, what has a considerable influence on the risk exposure duration. By rule, risks in combined transport are increased due to the fact that the goods are several times reloaded, withheld, warehoused at intermediate points etc. In case transport is organized by forwarders or agents, there are certain limitations on risk control but also a possibility of indemnity of possible losses based on legal and contractual liabilities towards carriers or forwarders for damages to goods. Also, Full Container Load transport is less risky than Less than Container Load transport because LCL principle implies extended period of transport, opening of containers during transport for the purpose of loading and unloading, what generates different risks such as handling risks, increased risks of theft or no delivery etc.

Risk level associated with transport route

Efficacy and reliability of logistics processes directly depends on itinerary, i.e. on the characteristics of a transport chain or structure of transport network. Duration of transport which depends on physical distance between a consignor and a consignee is important but not essential component of risk. More significant risk factor is the level of transport and traffic, navigation area and distance (in river and marine transport), characteristics of transshipment points or junctions as well as terms and limitations of transport. Depending on the type and natural characteristics of goods, occurrence of transport risks on some sections can be closely connected to climate factors in areas through which goods are transported. Also, certain administrative and political limitations as well as some national regulations may affect the total amount of risk. The choice of adequate structure of transport chain or network should enable fulfillment of all consignor's requests and depends on the interaction of transport subsystems and most often, the correlation between defined speed of goods transport, quality and reliability of delivery and expenses.

Risk level associated with other logistics parameters

There are numerous logistics parameters that affect the occurrence of risks associated with logistics processes. Handling risks for example, to which the goods are exposed during loading, unloading and reloading from one means of transport onto another. In certain cases, as in the case of goods sensitive to dynamic influences, breakable goods, heavy goods, goods of large sizes and goods of specific shapes and so on, handling risks can be more dominant than other transport risks. Goods handling technology is tightly connected to goods qualities (bulk cargo, containers, liquid cargo, general cargo, road and railroad vehicles, heavy and oversized objects etc). During transport, goods can be reloaded several times, which increases the total transport risk. Important risk parameter is a level of technology and quality of reloading services as well as duration thereof. Also, every transport interruption (reloading, waiting time, intermediate warehousing, storage at the place of dispatch or delivery of goods etc.) increases the transport risk. Storage risks depend on many factors such as type of goods, type of warehouse, warehousing technology, security of goods in warehouse and so on. Transport risk also depends on the characteristics of storage process, i.e. type and technology of storage, number of storages during transport, duration of storage, storage limitations and other parameters. Also, storage risk is connected to duration of storage, technology, specific characteristics of local environment, technological principles of storage (FIFO or LIFO) and so on.

3.2. Risk parameters connected to characteristics and specificities of insurance cover

There are many parameters which affect the risk level of insurance cover and depend on clients' specific requests and terms of insurance cover. Insurance cover means protection of an insured object against certain types of risks defined in insurance contract, based on which premium is established. Different modalities of contracting insurance, acceptance and exclusion of certain risks from insurance cover, agreed deductibles, different characteristics of insureds, various internal or external influences can be of essential importance when determining premium amount in marine cargo insurance.

Characteristics of insurance cover. In cargo insurance in the Republic of Serbia various domestic and international insurance terms and conditions are used (at first place *Institute Cargo Clauses*), which most often provide coverage against standardized groups of risks. However, as insurance terms are often tailored to special needs and requirements of the policyholders, cargo insurance often covers individual, specific risks that are not covered under standardized sets of clauses. Also, practice shows that different limitations of cover, different modalities of exclusions from cover, different limitations or assumption of certain specific risks and different types and amounts of deductible etc. are concluded. Scope of cover is the basis for determining insurance premium.

Reinsurance. Reinsurance premiums directly affects formation of the gross insurance premiums. Determination of the reinsurance premiums depends on the type of reinsurance and specificity of insurance coverage and includes the use of complex mathematical and actuarial methods and models.

Deductible. By contracting a deductible, the underwriter transfers a portion of risk to the policyholder and results in decrease in risk covered by the underwriter and concurrently it stimulates the policyholder to undertake activities in order to minimise loss. The type and amount of deductible greatly impacts the amount of risk covered by the underwriter.

Types of insurance contracts. As regards duration, transport insurance contracts can be concluded on voyage or time charter basis. According to the insurance contract type, cargo insurance can be concluded by individual or general contracts. The most common types of general contracts in insurance of goods in transport are *Open Cover contract, Floating policy* etc.

Bonus-malus. Underwriting activities relating to bonus-malus system are usually based on the determination of optimum bonus-malus criteria, so that a policyholder is encouraged to take measures to prevent the occurrences and minimize risk.

Utility theory. Utility denotes the measure of relative certainty of persons or systems regarding the desirability of a specific value, object or service. Utility theory is broadly applied in risk management and insurance because it realistically describes the behaviour of an entity when deciding on the level of risk and its acceptability, and takes into account certain subjective factors.

The market factor. Competition affecting the reduction of premiums, insurers flexibility at the conclusion of insurance contracts, expanding the range of insurance products, flexibility regarding modalities of payment of insurance premiums and others.

Corporate objectives. The objective of every insurance company is to generate maxim profit from insurance business. Insurance companies may have different policies and strategies of risk acceptance implying readiness, appetite and tolerance in respect of risk acceptance.

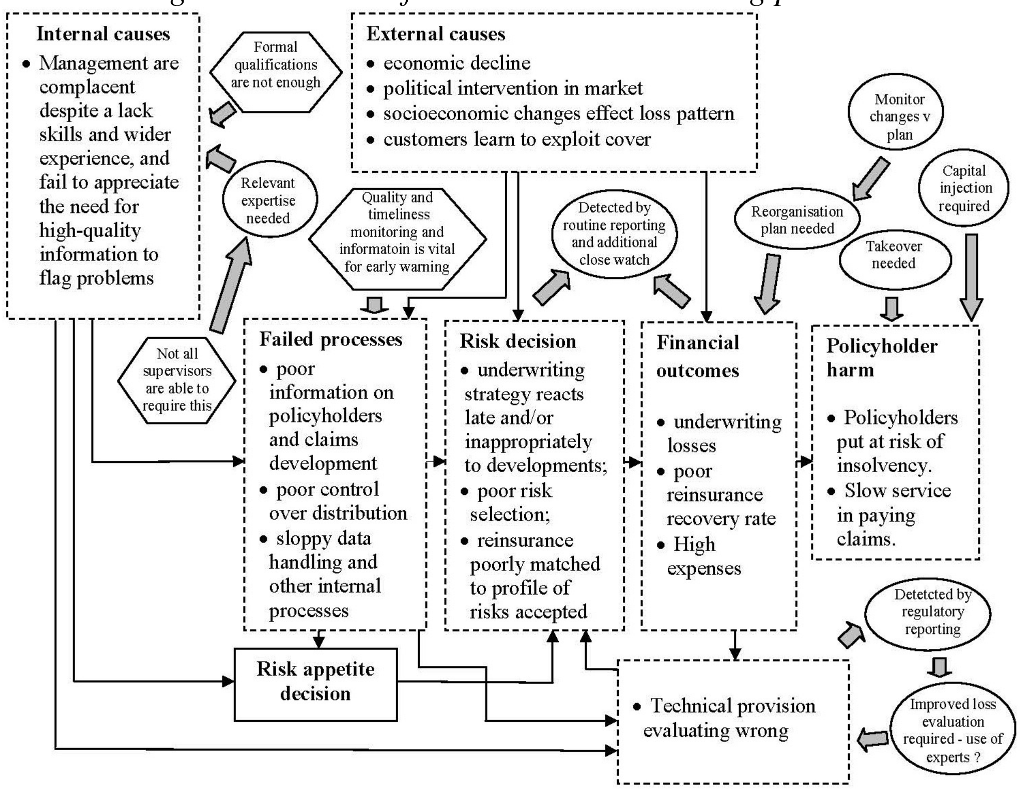
Characteristics of the insured. The insurer analyses available information on policyholder and insured, their solvency, business reputation, practising appropriate standards of business operation, considers his own experience as well as experience of other insurers, based on which he makes decisions on the scope and price of cover, possible limitations and in certain though rare cases, rejection of insurance application. In certain cases, these factors may have crucial importance in the assessment of risk and the amount of the premium.

4. ASSESSMENT OF RISK OF THE UNDERWRITING PROCESS IN MARINE CARGO INSURANCE IN SERBIA

The risk map is one of the instruments in the systematic approach of risk management. The risk map makes it possible to identify, classify and assess the importance of operational risks to which the system is exposed. The risk map should show all risks in a clear and systematic fashion so that their impact on the overall risk could be best evaluated and the best risk management method could be chosen. This research analyses the risk map in the underwriting process of an insurance company developed by Sharma (2002).(Figure 1)

Many authors have researched operational risks in insurance industry (Tripp et.al, 2004; Leadbetter and Stodolak, 2009). It is very difficult to clearly distinguish and classify risks and causes of risk related to the underwriting process in the insurance business, because the underwriting risks are closely connected and one element of risk may, directly or indirectly, greatly impact several other risks. Also, certain risks or risk causes may fall into several categories depending on the various angles from which a problem may be considered and different causal links that predetermine risks. In this research, the causes of risks of underwriting in marine cargo insurance are classified in five categories:

Figure 1. Causes of risks in the underwriting process



Source: Adapted from Sharma, P. et al. (2002). Prudential Supervision of Insurance Undertakings. Conference of Insurance Supervisory Services of the Member States of the European Union. Brussels: European Commission, p.101.

I. Internal causes of risk

Internal causes of risk may occur as a consequence of insufficient formal education or lack of experience of underwriters, inappropriate risk management methods, inadequate level of reliability and availability of information within the system, as well as of other management and organizational errors incurred due to inexperienced and insufficiently educated underwriters.

II. External or initial causes of risk

There are numerous operating risks on which insurance companies have little or no influence at all. External risk may lead to various negative scenarios, worsening of operating conditions, which in extraordinary cases may have destructive effects on underwriters. These risks often represent the initial cause of or initiate other types of risk. External risks are widely present on the market in Serbia as a result of a relatively slow economic growth, disloyal competition, political instability, social and economic features of the market etc.

III. Causes of risk associated with the failed work processes

Risks in the failed work processes are incurred as a consequence of deficiencies in the technological processes and in the organization and structure of the business system. This includes information available to underwriters on portfolio related risks which is poor and unreliable, inadequate monitoring of underwriting result and claim development in respect of the policyholder, data validity risks etc. The underlying principle of the work process risk management is the defining and formalizing of internal business procedures and processes, enhancement of the information and communication technology of the business system, optimal allocation of activities and resources, periodic control of all processes and activities etc.

IV. Causes of risk related to decision making

Risks related to decision making are an essentially important segment which implies the taking of underwriting decisions on the manner, modality and price for risk acceptance. Wrong decisions by underwriters may cause important consequences and generate numerous direct and indirect risks. In Serbia there is a pronounced problem related to the expertise and experience of underwriters which is closely associated with the risk in decision making.

V. Other causes of risk

Other causes of risk may include financial outcomes (underwriting losses, poor reinsurance recovery rate, high expenses etc.), policyholders harm risks, technical provision evaluation risks, litigations, loss of the underwriters business reputation etc. The occurrence of these risks is closely related to internal and external risk and risks related to decision making. In the practice of marine cargo insurance in Serbia the risk appetite decision is a very pronounced cause of risk. In general, in Serbia as in other countries, insurance companies apply different policies and strategies resulting from the readiness, appetite and tolerance in accepting risk.

4.1. Model of underwriting risk assessment based on FAHP

There are numerous researches in the area of risk management and there are different methods and models that solve a great variety of problems connected to risk management. AHP enables the decision makers to structurize a complex problem into a simple hierarchy and to sistematically assess a large number of quantity and quality factors (Saaty 1977, 1980). The main idea of the AHP is to encompass and apply knowledge and experience of professionals on the problem that is analyzed. This method makes possible to decompose and partially solve a particular problem, after which partial solutions are put together again in order to obtain the solution to the initial problem. AHP is a multy-criteria method based on the hierarchy decomposition of a particular problem into hierarchy elements with level structure. The AHP method includes identification of goals and critera to be compared and assesssed, assessment based on pairwise comparison of elements at each chierarchy level and sinthesis of results based on comparison of criteria at all levels. The goal is at the top of the hierarchy structure, and criteria that may be decomposed into subcriteria i.e. into new hierarchy levels are at the next level. A pairwise comparison of elements is done at each level of the hierachy structure by way of the scale of importance, and criteria, subcriteria and alternatives are measured and evalutated and finally the total values of alternatives are synthesized. The last level denotes the alternatives representing the final result of the problem analysis, i.e. the corresponding weights against the defined goal. In several papers Saaty (2006, 2008) applies the AHP method when evaluating uncertainty and risk.

Fuzzy Analytic Hierarchy Process (FAHP) extends the AHP method by combining it with the fuzzy set theory. In some cases, although simple and easy to use, the traditional AHP method is not able to present human cognitive processes. That is specific for situations when problems are not completely defined, their solution includes uncertain data or there are no exact and reliable data on realization of a certain problem. Although Saaty's (1980) discrete scale (from 1 to 9) has an advantage in terms of simplicity and easy use, it does not take into account the uncertainty connected to perception of a decision-maker. Application of fuzzy numbers in the basic scale can improve accuracy of evaluations, so, the FAHP method is often applied. The FAHP method was proposed by van Laarhoven and Pedrycz (1983). Today, there are different modalities of the FAHP method proposed by various authors. In this research, we used Chang's (1996) extent analysis method developed on the basis of the classical AHP method. The FAHP can be described as follows (Wang et al. 2008; Radivojevic and Gajovic 2014):

- Comparison of pairs of elements i and j at every level of the hierarchy in relation to the elements at the higher level, by applying the fuzzy numbers that correspond to the Saaty scale from 1 to 9. The decision maker determines the value b_{ij}, for elements i and j, where b_{ij} is a triangular fuzzy number (l_{ij}, m_{ij}, u_{ij}).

- Summing of rows of the matrix $B = (b_{ij})_{n\times n}$ so that one gets the values:

$$RS_i = \sum_{j=1}^{n} b_{ij} = \left(\sum_{j=1}^{n} l_{ij}, \sum_{j=1}^{n} m_{ij}, \sum_{j=1}^{n} u_{ij} \right),\ i = 1,...,n$$

The normalization of values RS_i according to relation:

$$S_i = \frac{RS_i}{\sum_{j=1}^{n} RS_j} = \left(\frac{\sum_{j=1}^{n} l_{ij}}{\sum_{k=1}^{n} \sum_{j=1}^{n} u_{kj}}, \frac{\sum_{j=1}^{n} m_{ij}}{\sum_{k=1}^{n} \sum_{j=1}^{n} m_{kj}}, \frac{\sum_{j=1}^{n} u_{ij}}{\sum_{k=1}^{n} \sum_{j=1}^{n} l_{kj}} \right), i = 1,\ldots,n$$

Determining the degree of possibility of $S_i \geq S_j$ according to relation:

$$V(S_i \geq S_j) = \begin{cases} 1, & \text{if } m_i \geq m_j \\ \dfrac{u_i - l_j}{(u_i - m_i) + (m_j - l_j)}, & \text{if } l_j \leq u_i, \quad i, j = 1,\ldots,n;\ j \neq i \\ 0, & \text{otherwise} \end{cases}$$

where $S_i = (l_i, m_i, u_i)$ and $S_j = (l_j, m_j, u_j)$. Calculate the degree of possibility of S_i over all the other fuzzy numbers by:

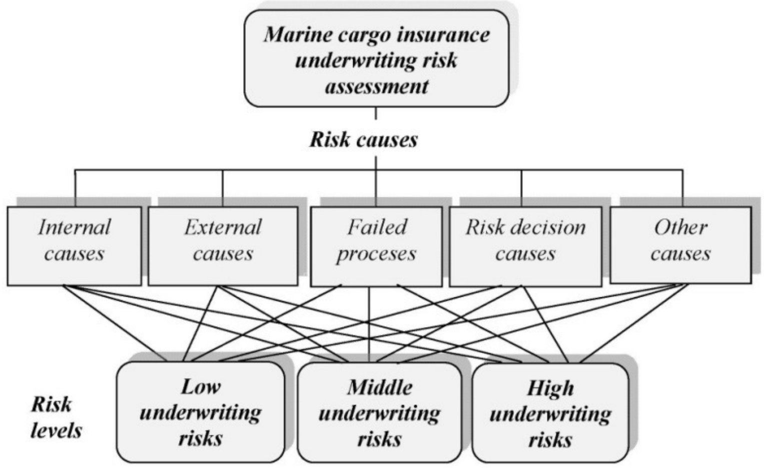
$$V(S_i \geq S_j \mid j = 1,\ldots,n;\ j \neq i) = \min_{j \in \{1,\ldots,n\},\, j \neq i} V(S_i \geq S_j),\ i = 1,\ldots,n$$

- Define the priority vector $W = (w_1,\ldots,w_n)^T$ of the fuzzy comparison matrix B as:

$$w_i = \frac{V(S_i \geq S_j \mid j = 1,\ldots,n;\ j \neq i)}{\sum_{k=1}^{n} V(S_k \geq S_j \mid j = 1,\ldots,n;\ j \neq k)}, \quad i = 1,\ldots,n$$

Figure 2 shows the hierarchy structure according to AHP method applied to an example of underwriting risk assessment in marine cargo insurance. The hierachy structure is made of a goal (*Marine cargo insurance underwriting risk assessment),*criteria (*Risk causes*) and alternatives (*Risk levels*).

Figure 2. Hierarchy structure of risk



More detailed description and mathematical formulation of the FAHP can be found in Chang (1996).

4.2. Underwriting process risk assessment on the cargo insurance market in Serbia

There is a large number of different methods to analyse and assess risk, ranging from simple to very complex ones. Their application depends on the size and characteristics of the insurance company, time available for analysis, cost of implementation, available staff, limitations etc. The research shows an approach to underwriting process risk assessment in cargo insurance in Serbia. In view of the complexity of the observed problem, the number of risks, risk parameters, risk causes and the insufficiency of representative statistics on numerous risks in the underwriting process of cargo insurance, the FAHP method can provide acceptable quantitative data. Input data for FAHP method have been obtained by survey among experts in the transport insurance, from various insurance companies in Serbia. The output results show the categories of risk with the greatest impact on the total underwriting risk in cargo insurance.

The research shows an approach to underwriting process risk assessment in cargo insurance in Serbia. In view of the complexity of the observed problem, the number of risks and risk parameters and the insufficiency of representative statistics on numerous risks in the underwriting process of cargo insurance, the FAHP method can provide acceptable quantitative data. Input data for FAHP method have been obtained by survey among experts in the transport insurance, from various insurance companies in Serbia. The output results show the categories of risk with the greatest impact on the total underwriting risk in cargo insurance. Table 1 shows the matrix of comparison of risk categories according to FAHP method. Table 2 shown local and global priorities according to FAHP method.

Table 1. The matrix of comparison of risk categories according to FAHP method

Causes of risk	Internal causes	External causes	Failed process	Risk decision	Other UW risks	*W*
Internal causes	(1, 1, 1)	(1, 1 ,3)	(1, 3, 5)	(1/5, 1/3, 1)	(1, 1, 3)	0.224
External causes	(1/3, 1, 1)	(1, 1, 1)	(1, 1, 3)	(1/5, 1/3, 1)	(1/5, 1/3, 1)	0.135
Failed processes	(1/5, 1/3, 1)	(1/3, 1, 1)	(1, 1, 1)	(1/7, 1/5, 1/3)	(1/5, 1/3, 1)	0.068
Risk decision	(1, 3, 5)	(1, 3, 5)	(3, 5, 7)	(1, 1, 1)	(1, 3, 5)	0.331
Other UW risks	(1/3, 1, 1)	(1, 3, 5)	(1, 3, 5)	(1/5, 1/3, 1)	(1, 1, 1)	0.242

Table 2. Local and global priorities according to FAHP method

Risk elements →	Internal causes	External causes	Failed processes	Risk decision	Other causes	Final priority vector *W*
Risk level ↓	0.224	0.135	0.068	0.331	0.242	
Low UW risks	0.011	0.045	0.020	0.053	0.081	0.210
Midle UW risks	0.084	0.045	0.014	0.120	0.081	0.344
High UWrisks	0.129	0.045	0.034	0.158	0.081	0.446

Based on risk analysis results for several insurance companies in Serbia obtained through the AHP method it has been concluded that risk decision causes in marine cargo insurance are predominant with a share of 33.1% when compared to all other underwriting risks. The experts' assessment is logic if we consider the complexity of the underwriting profession in marine cargo insurance, numerous parameters influencing the forming of the insurance premium and the generally limited experience of underwriters, in particular in smaller insurance companies. *Internal causes* are associated with *risk decision causes* with a relative share of 13.5% compared to other underwriting risks. Other causes have also been assessed as having high degree of risk, with relative share of 24.2% in comparison to other underwriting risks. According to the analysis, *failed processes* are the least pronounced with a relative share of 6.8%, which can be accounted for by the existence of internal business procedures and processes in insurance companies, and of appropriate information and communication technologies alongside appropriate control of all processes and activities in the majority of insurance companies. The analysis has showed that the predominant opinion among experts is that the underwriting risks in marine cargo insurances in Serbia are huge with relative importance of 44.6%. In other words, on the basis of comparison of defined criteria of underwriting risk in marine cargo insurance in relation to the specified alternatives *low, middle and high underwriting risk*, experts have assessed the alternative *high underwriting risk* as the most probable risk. Available statistical data show a huge fluctuation of premiums and claims in all insurance companies whereas in Serbia marine cargo insurance has an overall positive result although some insurance companies record a negative result. The insurance experts have taken into account that in the reported period there have been no catastrophic losses in this line of insurance which could have disturbed the ratio of premiums and claims at the level of insurance companies but also at the level of the Republic of Serbia. The assumption of the expert's assessment on high underwriting risk stems from the fact that marine cargo insurance is a very complex line of insurance, entailing many decision-making related risks, and that there are very few competent and experienced cargo insurance underwriters and a comparatively large number of underwriters on a rather small market together with rather high internal, external and other insurance risks.

In the insurance industry, the assessment of various risks is often intuitive, based on experience and knowledge of experts, because of the complexity of business systems and numerous external influences. The FAHP method can provide satisfactory solutions in cases of different elements of risk affecting the overall underwriting risk and where there are no representative statistical parameters for accurate risk quantification. Conditions for reducing risk in the cargo underwriting process, as regards the Republic of Serbia, are efficient education of underwriters, improvement of technological processes in insurance companies, application and control of business supervision standards in insurance companies, implementation of measures to reduce external risks etc.

Chapter 24.

RISK ANALYSIS IN LIFE INSURANCE POLICY SELECTION BY APPLYING OPTIMIZATION CRITERIA

Criteria decision making is one of the most popular sectors in decision-making with a wide application in solving real problems. The mathematical basis of the algorithm method of criteria analysis can be described as a selection of one from the final series m alternative $A_i\left(i=1,...,m\right)$ based on n criteria $X_j\left(j=1,...,n\right)$. Each of the alternatives is the vector $A_i=\left(x_{i1},...,x_{ij},...,x_{in}\right)$ where x_{ij} is a value of j attribute for i alternative. In order to formulate mathematically the model of multi-criteria decision-making we need the information on all the alternative embodiments of the process for which the decision is made, and on the goals that the decision maker wants to achieve. Also, it is necessary to identify how each alternative contributes to achieving the set goal. Depending on the decision maker, the solution model may not be unique. Models of multi-criteria decision making facilitate decision-makers the adoption of optimal decisions in situations where there are a large number of diverse criteria, which can often be conflicting. Hence it is the actuality of research the application of multi-criteria decision making method, in such an important decision for each individual, such as selection of the best life insurance policy is incontestable.[310]

1. METHODOLOGICAL ASSUMPTIONS OF AHP METHOD FOR MULTICRITERIA DECISION MAKING

Analytic Hierarchy Process – AHP is one of the most popular methods for decision making, which is most often used in cases where there is a possibility of hierarchical structuring relevant criteria. The method was invented by Thomas Saaty[311] even in the 70s of the last century.

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[310] Harrington, S.E., Niehaus, G. R. (2003). *Risk Management and Insurance*. New York: McGraw Hill.

[311] Saaty, T. (1980). *The Analytic Hierarchy Process*. New York: McGrow-Hill.

Algorithm of AHP method can be described as an analysis of the structure of a complex decision problems, which can contain several criteria, several alternatives, and even to be more decision-makers (group decision), determining the relative weight of criteria and alternatives by levels and the formation of the final order of the alternatives (rank alternative). Phases of AHP method can present as follows:

1. Decomposition of the problem;
2. Data collection and comparison of pairs of alternatives;
3. Determining the relative importance of the criteria;
4. Synthesis and determining solutions.

The first phase, decomposition of the problem, involves creating a hierarchical structure, which is aimed at the top, while on the lower levels of the hierarchy there are the criteria with possible sub-criteria. At the lowest level are the alternatives that need to be evaluated.

The second phase, in addition to collecting data includes the comparison of pairs hierarchical structure formed in the first stage. Comparison of pairs of alternatives is carried out primarily at a given level of the hierarchy, and in relation to the criterion of the immediately higher level. Preferences of the decision maker are expressed using the Saaty-ratio HP 9-point scale. Preferential level 1 shows that the two alternatives are completely identical, while the absolute preference of one over another alternative is presented by assigning to a pair number 9.

In the third phase it is formed a matrix A of dimensions $n \times n$ at the level of criteria or $m \times m$ at the level of alternatives, where there are the elements $a_{ii} = 1$ (matrix elements on the main diagonal are the units), and a_{ji} elements are reciprocal of a_{ij}, $i \neq j,\ i, j = 1, 2, ..., n$

$$A = \begin{bmatrix} 1 & a_{12} & ... & a_{1n} \\ \frac{1}{a_{12}} & 1 & ... & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \cdots & 1 \end{bmatrix} \tag{1}$$

In the first column of the matrix A are the coefficients of the relative importance of the criteria $2, 3, \cdots, n$ in relation to a criterion 1. In the case that the assessment of decision-makers is completely consistent, the remaining columns of the matrix would be calculated automatically. However, AHP method does not imply consistency, and the process of comparison is repeated for each column of the matrix, making independent assessments by the decision-maker. At the end of the comparison it is formed the matrix A which multiplied by the vector of relative weights of $w=(w_1,w_2,\cdots,w_n)$ is:

$$A\cdot w=n\cdot w \,\text{or}\, (A-n\cdot I)\cdot w=0 \tag{2}$$

Nontrivial solution of this system of linear equations exists if $(A-n\cdot I)=0$, which implies that the n is the own value of the matrix A. It is evident that the matrix has a rank n. Each column represents a constant multiple of the first, and therefore, all the eigenvalues of the lines, except one, are equal to 0. Ideally, when there is an exact measurement, the matrix A is consistent and all its elements satisfy the condition of transitivity, $a_{jk}=\frac{a_{ji}}{a_{ki}}$. However, in real cases it is not possible to accurately determine the value of w_i/w_j, so the decision maker can only assess their value. In this case, the weight vector w can be obtained by solving the equations $A\cdot w=\lambda_{\max}\cdot w$, provided that $\sum_{i=1}^{n} w_i=1$ and $\lambda_{\max}$ is the largest eigenvalue of the matrix A (due to the properties of the matrix $\lambda_{\max}\geq n$).

Consistency index - CI is a measure of deviation n from $\lambda_{\max}$ and can be represented by the following formula:

$$CI=\frac{\lambda_{\max}-n}{n-1} \tag{3}$$

For values of the index $CI<0{,}1$, the estimated value of the coefficient a_{ij} is considered to be consistent, and the deviation $\lambda_{\max}$ from n as negligible. In other words, the AHP method accepts the consistency which is less than 10%. Also, by using the index of the consistency it can be calculated the ratio of consistency $CR=CI/RI$, wherein RI is a random code.

And the last, the fourth phase of AHP method involves finding the so-called composite normalized vector, or the determination of solutions. In the previous, the third stage, it is determined the vector sequence of activities of criteria in the model. Now it's a determination of the importance of alternatives in the model. At the end we get a ranking list of alternatives, i.e. overall synthesis problem. The ranking list of alternatives is got if the participation of each alternative is multiplied by the relative weight of the observed criterion, then all these values are added together for each alternative separately. The fact that such we get is the weight of observed alternative in the model. After receiving the ranking list of alternatives it is carried out the sensitivity analysis of results.

The method manifests lacks only when, in the matrix of decision-making there are two identical alternatives. Then it is necessary to standardize the decision-making matrix in such a way that each column is divided with its highest coefficient. In this way the two authors, Belton and Gear have set a revised AHP method.

2. DEFINING THE OBJECTIVE AND SELECTION OF MODEL CRITERIA OF MULTI-CRITERIA ANALYSIS FOR SELECTION OF INSURANCE COMPANY WITH THE MOST FAVORABLE LIFE INSURANCE POLICY

Defining the objective of the model is one of the most important steps in decision making problem. The aim of this model is to rank insurance companies according to selected criteria, in order to select the best insurer for life insurance.

When choosing criteria of the model, we followed the experiences of developed countries in the field of life insurance, but we were guided by the specifics of Serbian life insurance market. In developed markets of life insurance, for example, what is the US market, the choice of the insurer with the most favourable terms of life insurance policies is not simple, since there are a large number of insurance companies that sell life insurance. There are many criteria that should be taken into consideration in order to make the right choice. In the Serbian market, choosing the best insurer of life insurance is from that side, much easier than in developed markets, because we have a smaller number of alternatives to compare. However, due to the underdevelopment of the life insurance market, the best while choosing is to follow experiences of developed countries.

One of the most important criteria, which each individual would consider well before the conclusion of a life insurance policy, is the ratio of the premiums and the sum insured, i.e. the ratio of its total payments to the insurance company and the total amount that the company will pay him or beneficiary when the insured event occurs.

Also, one of the important criteria, especially in developed life insurance markets, certainly is financial strength and stability of insurers, primarily because of the long, which is a basic feature of life insurance. The biggest role in the presentation of the financial performance of insurance companies should play a supervisory authority, in our case, the National Bank of Serbia. Another aspect that is very important when choosing the best life insurance policy is the ability of the sales agent who is responsible for selling life insurance.

2.1. AHP model for ranking and comparing insurance companies engaged in life insurance business

As stated above, the objective is to rank insurance companies engaged in life insurance business in order to select the best company for the contracting of life insurance. The criteria were selected based on the experiences of many authors competent for life insurance[312], but also based on the specifics of Serbian life insurance market. In the model it is considered the six largest insurance companies of life insurance, which participate with over 80% of the total premium of life insurance.

As the most important criterion in the model it was elected the ratio of premium and sum insured. There were established the same assumptions for contracting a life insurance policy for all insurance companies, in order to alternatives could be comparable. Namely, it is assumed that a mixed policy of life insurance contracts females, with the access age of 30 years, for a period of 25 years and with an annual premium of EUR 1,200. In this way, comparative data were obtained, which can be used in the model.

Variety of insurance company expressed by the number of product variants that are offered, has a favourable effect on the attractiveness of life insurance policies. The higher is the number of goods, the greater is the possibility that the insured find the right product.

As one of the most important indicators that was also chosen as a criterion in the model is the net financial result of insurance companies which shows the performance of the insurance market in Serbia. Among the criteria that show

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[312] Belth, J.M. (1985). *Life Insurance - A Consumer's Handbook*. Indiana University Press; Vaughan, E. J., Vaughan, T. M. (2000). *Osnove osiguranja: upravljanje rizicima*. Zagreb: Mate.

the performance of insurance companies, which were used in the model, there are also total premium life insurance, mathematical reserves for life insurance and number of insurance contracts.

The total life insurance premium indicates the position that the insurance company takes on the life insurance market. Mathematical reserve, on the other hand, is the most important position in the financial report of each insurance company that deals with life insurance, because it indicates the ability of the insurance company to settle all obligations from the insurance contract. The mathematical reserve can be most simply defined as the difference between the obligations of insurers and policyholder liabilities reduced by the value on the moment when the mathematical reserve is calculated. The mathematical reserve is taken for the criterion for the reason that this item in their balance sheets has only insurance companies which are engaged in life insurance business. Considering that among the insurance companies in the model there are composite companies, i.e. companies engaged in both life and non-life insurance, the introduction of mathematical reserve for life insurance as a criterion was aimed to show the real volume of life insurance business, by which a composite society included in the model deal with.

As one of the criteria we used the number of the insurance contract which insurance company concluded with policyholders, and which indicates the performance of an insurance company. Another of the criteria based on which alternatives were evaluated in the model, is the length of operating insurance company. From the ability of the sales agent it depends largely on whether the life insurance policy of an insurance company will be sold successfully. Competence, commitment and education of sales agent will affect higher sales of life insurance policies. The ability of an agent is a quantitative indicator that is qualified with the help of scale which was given in the following table.

Table 1. Scale for quantification criteria

Qualitative assessment	**Bad**	**Low**	**Average**	**High**	**Very high**	**Type criteria**
Quantitative assessment	1	3	5	7	9	max
	9	7	5	3	1	min

Alternatives in the model are insurance companies that operate in the life insurance market in Serbia, but instead of real names, there were used marks of Insurance company 1, Insurance company 2, and so on.

Structure of AHP model for ranking and comparing insurance companies in Serbia, was performed by using the software Super Decisions.

3. EMPIRICAL VERIFICATION

The data used for the formation of models, which relate to the operations of insurance companies have been gathered from financial statements, as well as from regular annual and quarterly reports of the National Bank of Serbia. The data related to the conditions of life insurance policies, have been collected from insurance companies that were considered in the model. In order to insurance companies could be ranked according to the criteria that we determined, it is necessary to determine the weight of criteria, and then for each of the criteria we need to determine the intensity for evaluating the respective performance of insurance companies. Weights of criteria were determined by using the specialist software Super Decisions, based on the assessments in the couples of relative importance of criteria. For evaluation of pairs it was used Saaty's Premium scale, given in the following table.

Table 2.Saaty's table for comparing pairs of alternatives

Intensity of importance	Definition	Explanation
1	Equally important	Two alternatives equally contribute to the objective
2	Low importance	
3	Moderately important	Based on the experience and judgment it is given moderate preference for one alternative over another.
4	Moderately important +	
5	Strictly more important	Based on the experience and judgment it is strictly favored one alternative over another.
6	Strictly +	
7	Very strict, demonstrated importance	One alternative is strongly favored over the other; its domination is proved in practice.
8	Very strict	
9	The extreme importance	The evidence based on which it is favored one alternative over another, have been confirmed with the greatest plausibility.
2,4,6,8	Subtotals	When a compromise is necessary.
The reciprocal of the upper nonzeros	If alternatives i has some of the listed values from the scale, when it is compared to the alternative j, thenjtakes the reciprocal value when it is compared to the alternative i.	

Source: Saaty, T. (1980). The Analytic Hierarchy Process. New York, McGraw-Hill, p. 54.

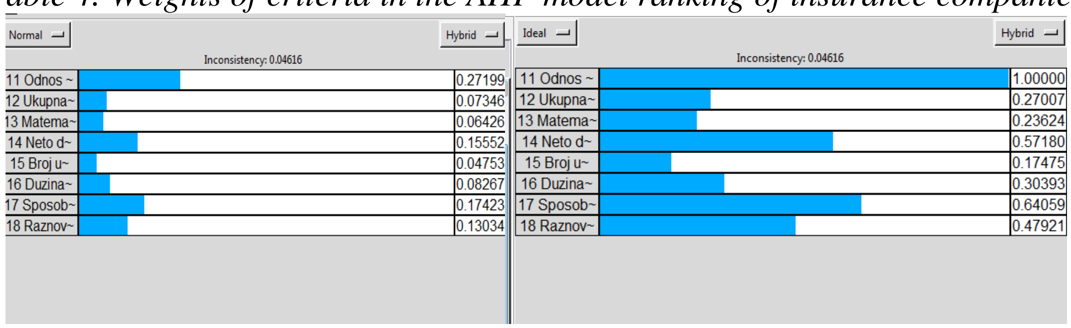
Relations between the criteria in our model are given in Table 3.By using the software Super Decisions there were calculated relative weights of criteria in the model. Graphical representation of weight of criteria of AHP model for ranking of insurance companies dealing with life insurance business is presented in Table 4.

Table 3. Evaluation of criteria pairs according to Saaty's Premium scale

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
The ratio of the premiums and the sum insured	1	4	4	2	3	5	2	2
Life insurance premiums		1	1	0,5	0,5	2	0,5	0,333
Mathematical reserve			1	0,5	0,5	2	0,5	0,333
Financial result				1	2	3	4	0,5
Diversity of offer					1	3	2	1
Number of insurance contracts						1	0,5	0,333
Longitude of business							1	0,5
The ability of an agent								1

The criteria defined by columns in Table 3:
(a) The ratio of premium and sum insured; (b) Life insurance premium; (c) Mathematical reserve; (d) Financial result; (e) Diversity of offer; (e) Number of insurance contracts; (g) Longitude of the business; (h) The ability of an agent.

Table 4. Weights of criteria in the AHP model ranking of insurance companies



By using the software Super Decisions it is determined priority of criteria in order of importance in the model. On the graph in Table 4 we see that the criterion of the ratio of total premiums and the sum insured is the most important criterion when deciding to purchase a life insurance policy, with priority of 0.27199 and it dominates over all criteria. Second-ranked criterion is the ability of the agent sales, whose priority is 0.17423. Looking at the final ranking of priorities, we see that the criterion of the financial results of the insurance company is the third, by relevance, with the priority of 0.15552.These three criteria dominate in the model with a total priority of 60%, which means that those are the criteria that need the most attention when buying life insurance policy from an insurance company.Fourth place, by priority of criteria, occupies diversity of the offer, more precisely, the number of products which insurance company offers, and after that, there are the next criteria: mathematical reserve, longitude of business, the amount of total life insurance premiums and eventually the number of contracts of insurance.

In models of multi-criteria decision-making is very important to pay attention to the index of consistency in the model, which must be less than 0.1.In the model of ranking of insurance companies it is satisfied this condition, because the inconsistency is 0.04616, which means that there is no error in the model.

The values of indicators of insurance companies and life insurance policy conditions are given in Table 5.Based on a range of criteria values, there were calculated intensity values, i.e. limit values of quantitative criteria that separate the different estimates.Intensities of the quantitative criteria are defined by using the scale of five levels (excellent, very good, good, fair and poor).Table 6 shows the values of intensity according to the criteria, and in Table 7 are given normalized value of the criteria.

Table 5. The values of criteria in the AHP model ranking of insurance companies for life insurance

(a)	(b)	(c)	(d)	(e)
Insurance company 1	0,81	435.155	1.722.211	224.763
Insurance company 2	0,85	2.267.937	9.656.023	522.622
Insurance company 3	0,86	1.476.783	9.212.392	169.525
Insurance company 4	0,91	389.514	783.661	-49.964
Insurance company 5	0,89	686.543	3.110.948	-57.228
Insurance company 6	0,85	1.903.424	10.301.464	170.362
Criteria	min	max	max	max
The highest value	0,91	2.267.937	10.301.464	522.622
The lowest value	0,81	389.514	783.661	-57.228

(a)	(f)	(g)*	(h)	(i)
Insurance company 1	4	642.980	31	5
Insurance company 2	6	669.876	14	9
Insurance company 3	7	103.788	16	3
Insurance company 4	3	17.666	5	5
Insurance company 5	6	60.856	6	7
Insurance company 6	9	272.276	9	7
Criteria	max	max	max	max
The highest value	9	669.876	31	9
The lowest value	3	17.666	5	3

**Number of insurance contracts in composite companies (in our model the insurance company 1, the insurance company 2, the insurance company 3 and the insurance company 6) besides a life insurance contract includes a non-life insurance.*

The criteria defined by columns in Table 5:

(a) Insurance companies engaged in life insurance; (b) The ratio of the premium and the sum insured (30 years of entry age, the duration of insurance of 25 years, a person of the female sex); (c) The amount of total insurance premiums of life (in 000 RSD); (d) Mathematical reserve for life insurance (in 000 RSD); (e) Net result (in 000 RSD); (f) Diversity of offer (number of life insurance products); (g) Number of insurance contracts; (h) Longitude of doing business in Serbia; (i) The ability of an agent / Score of the sales process

Table 6. The values of intensity of criteria

Criteria	(a)	(b)	(c)	(d)
Type of criteria	min	max	max	max
Excellent	[0,8 - 0,81]	[2.100.000-2.300.000]	[10.000.000-11.000.000]	[500.000-550.000]
Very good	[0,82-0,84]	[1.600.000-2.099.999]	[7.500.000-9.999.999]	[400.000-499.999]
Good	[0,85-0,87]	[1.100.000-1.599.999]	[5.000.000-7.499.999]	[250.000-399.999]
Fair	[0,88-0,90]	[600.000-1.099.999]	[2.000.000-4.999.999]	[100.000-249.999]
Poor	[0,90-0,91]	[380.000-599.999]	[700.000-1.999.999]	< 0

Criteria	(e)	(f)	(g)	(h)
Type of criteria	max	max	max	max
Excellent	[8-9]	[650.000-700.000]	>35	[8-9]
Very good	[6-7]	[450.000-649.999]	[26-35]	[6-7]

Good	[4-5]	[250.000-449.999]	[16-25]	[4-5]
Fair	[3-4]	[50.000-249.999]	[6-15]	[3-4]
Poor	< 3	[15.000-49.999]	[0-5]	< 3

The criteria defined by columns in Table 6:

(a) The ratio of premium and sum insured; (b) Life insurance premium; (c) Mathematical reserve; (d) The financial result; (e) Diversity of offer; (e) Number of insurance contracts; (g) Longitude of the business; (h) The ability of an agent

Table 7. Normalized values of criteria

The weights of criteria	**0,26391**	**0,06686**	**0,10308**	**0,19015**
	(a)	(b)	(c)	(d)
IC1	1	0,191873	0,167181	0,430068
IC2	0,955716	1	0,937345	1
IC3	0,934114	0,651157	0,894280	0,324374
IC4	0,886668	0,171748	0,076073	-0,095603
IC5	0,903130	0,302717	0,301991	-0,109502
IC6	0,947270	0,839276	1	0,32597556

The weights of criteria	**0,10982**	**0,05794**	**0,06524**	**0,143**
	(e)	(f)	(g)	(h)
IC1	0,444444	0,959849	1	0,555556
IC2	0,666667	1	0,451613	1
IC3	0,777778	0,154936	0,516129	0,333333
IC4	0,333333	0,026372	0,161290	0,555556
IC5	0,666667	0,090847	0,451613	0,777778
IC6	1	0,406457	0,290323	0,777778

The criteria defined by columns in Table 7:

(a) The ratio of premium and sum insured; (b) Life insurance premium; (c) Mathematical reserve; (d) The financial result; (e) Diversity of offer; (e) Number of insurance contracts; (g) Longitude of the business; (h) The ability of an agent

After we determined the weights of all criteria and entered the intensity in the rating model, we can synthesize model and determine the final ranking of insurance companies. The best insurance company is exactly the one with which we will enter into a contract of life insurance.

Table 8. Graphical representation of ranking of insurance companies according to the selected alternatives

Graphic	Ratings Alternatives	Total	Ideal	Normal	Ranking
	IC1	0.4713	0.5506	0.1417	5
	IC2	0.8560	1.0000	0.2573	1
	IC3	0.4860	0.5678	0.1461	4
	IC4	0.3362	0.3927	0.1011	6
	IC5	0.5156	0.6024	0.1550	3
	IC6	0.6614	0.7726	0.1988	2

According to our model, the life insurance policy is best to buy from the insurance company 2, which is ranked as first, taking into account all the criteria, with priority of 0.2573. It is followed by the insurance company 6, the insurance company 5, the insurance company 3, while the insurance company 1 is in the second to last place, and the insurance company 4 is in the last place.
Ideal column shows the results divided by the maximum value, so that the highest ranking has priority 1. The others are in the same proportion as in the Normal column, and interpretation of other results is as follows: the insurance company 6 is 77.26% rating of the insurance company 2, while the insurance company 5 is 60.24% rating of the insurance company 2, etc.

Insurance companies could be ranked according to each criterion individually, taking into account the normalized values and the relative weight of criteria. Rank of insurance companies by any criteria separately, indicates how much our decision would be distinguished if we did not take all criteria into account simultaneously.

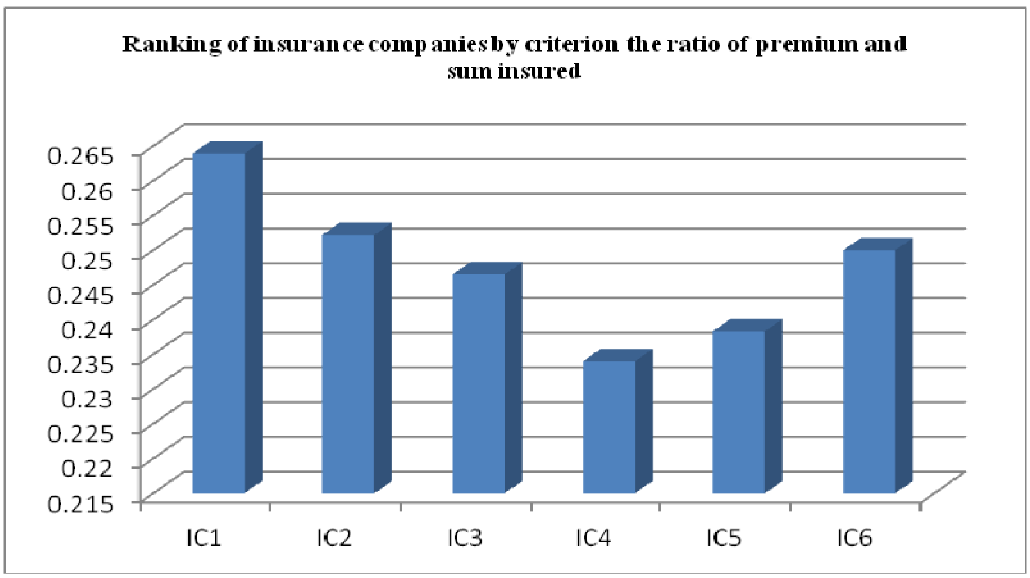
We will observe first how to modify the ranking if we want to rank insurance companies according to the most important criterion - the ratio of premium and sum insured; the order is as in Table 9.

Looking at the graphic representation of ranking alternatives according to the criteria the ratio of premiums and insured sums, we can see that the alternatives are ranked entirely different compared to the result of multi-criteria analysis. If we decide to have the most favourable life insurance policy only according to this criterion, our choice would be the insurance company 1, for which we would, taking into account the overall synthesis models, decide only after four better ranked companies.

Table 9. Insurance companies according to the criteria - the ratio of premium and sum insured

The relative weight of criteria 0,26391			
	The ratio of premium and sum insured	**Total**	**Rank**
IC1	1	0,26391	1
IC2	0,95571567	0,252223	2
IC3	0,934114163	0,246522	4
IC4	0,886668013	0,234001	6
IC5	0,903130318	0,238345	5
IC6	0,94726979	0,249994	3

Graph 1. The graph rank alternatives by the most important parameters in the model



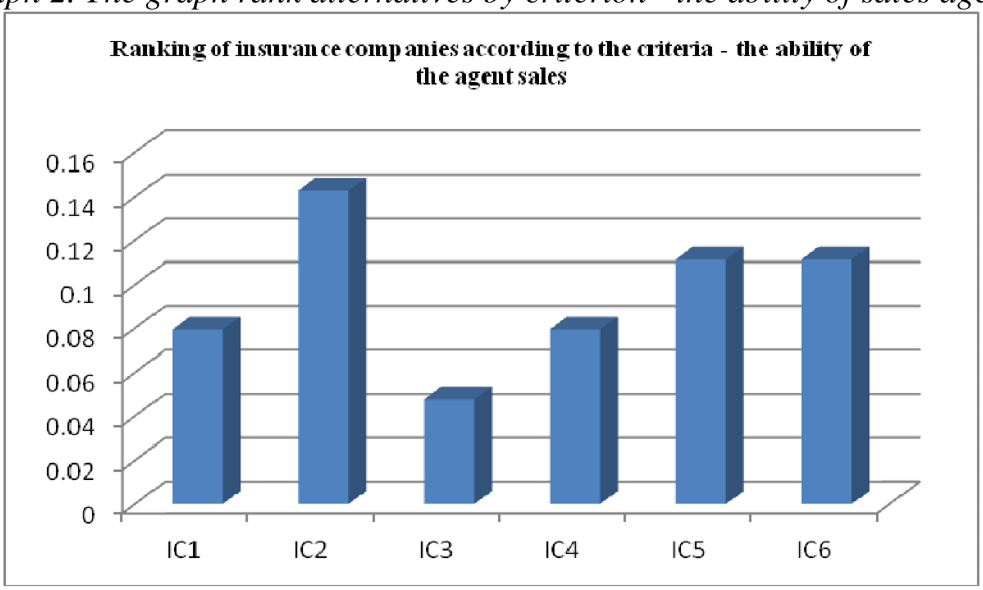
The model provides numerous possibilities, so that alternatives can be ranked according to each criterion individually, depending on what is the most interesting to decision maker. There can be changed the priorities of certain criteria and then observe the changes that occur in range of alternatives. We will show the ranking of insurance companies towards the most important criteria, which are, in addition to the relationship of premium and sum insured, also the ability of the agent sales and net result of the insurance company. As already mentioned, the three criteria in the model have a priority of 60%, while the other five criteria have a priority of 40%. Also, we will show the ranking of insurance companies according to the mathematical reserve[313], which is the most important item in the financial statements of each insurance company, which is engaged in life insurance business.

The ability of the agent sales is of great importance to the process of selling a life insurance policy. Rank of insurance companies by this criterion is given in Table 10, and a graphical representation is given in Graph 2. The best insurance company, according to this criterion, is the insurance company 2.

Table 10. Ranking of insurance companies according to the criteria - the ability of the agent sales

The relative weight of criteria 0,143			
	The ability of the agent	**Total**	**Rank**
IC1	0,555555556	0,079444	3
IC2	1	0,143	1
IC3	0,333333333	0,047667	4
IC4	0,555555556	0,079444	3
IC5	0,777777778	0,111222	2
IC6	0,777777778	0,111222	2

Graph 2. The graph rank alternatives by criterion - the ability of sales agents



[313] Kočović, J., Šulejić, P., Rakonjac-Antić, T. (2010). *Osiguranje*. Belgrade: Faculty of Economics, University of Belgrade.

If we compare the insurance companies according to the criteria of the financial result, we recognize that even according to this criterion, the insurance company 2 is the best. Rank of insurance companies according to the criteria of the financial result is shown in Table 11, while the graphical representation of rank is given in Graph 3.

Table 11. Insurance companies according to the criteria of the financial result

The relative weight of criteria 0,19015			
	The financial result	**Total**	**Rank**
IC1	0,430068003	0,081777	2
IC2	1	0,19015	1
IC3	0,324374022	0,06168	4
IC4	-0,095602558	-0,01818	5
IC5	-0,109501705	-0,02082	6
IC6	0,325975562	0,061984	3

Graph 3. The graph rank alternatives according to the criteria of the financial result

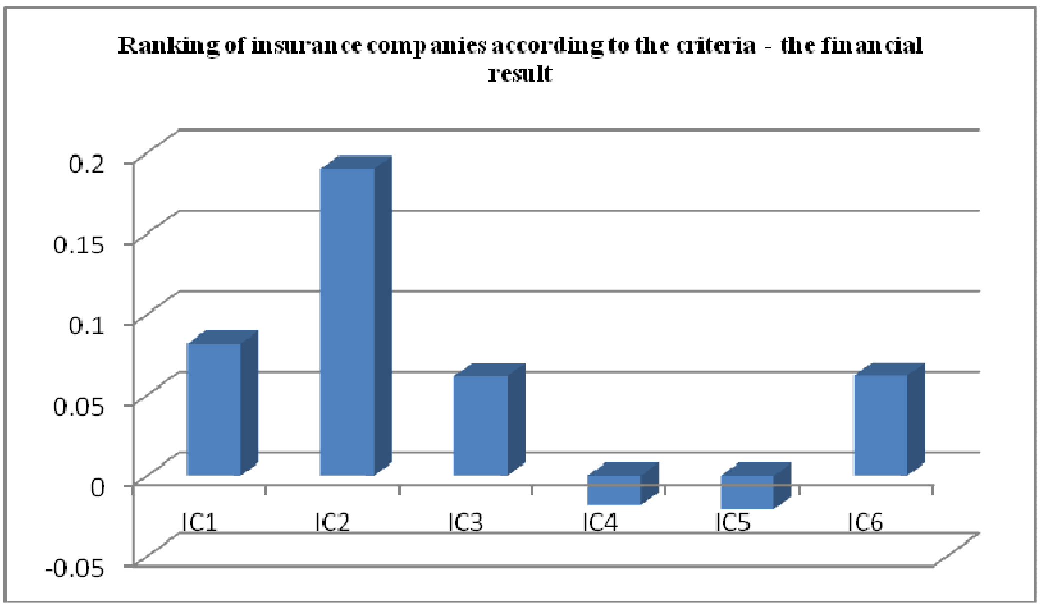
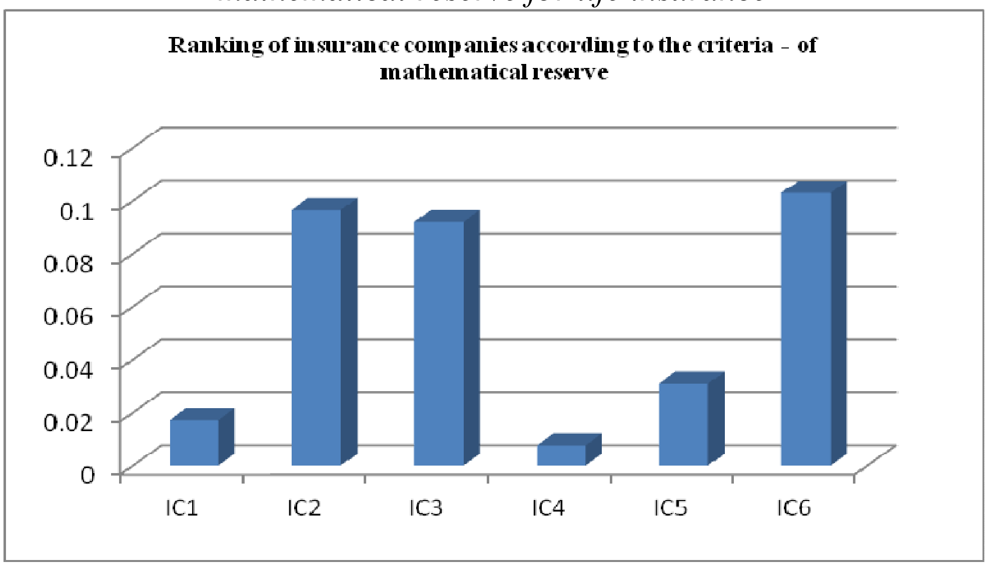


Table 12 shows the ranking of insurance companies according to the criterion of mathematical reserve for life insurance, and in the Graph 4, it is graphically showed the ranking of the alternative according to this criterion. The best alternative, according to the amount of mathematical reserves, is the insurance company 6.

Table 12. Insurance companies according to the criteria of mathematical reserve for life insurance

The relative weight of criteria 0,10308			
	Mathematical reserve for life insurance	**Total**	**Rank**
IC1	0,167181189	0,017233	5
IC2	0,937344731	0,096621	2
IC3	0,894279881	0,092182	3
IC4	0,07607278	0,007842	6
IC5	0,301990863	0,031129	4
IC6	1	0,10308	1

Graph 4. The graph ranking alternatives according to the criteria of mathematical reserve for life insurance



After we ranked the alternatives according to important criteria individually, we see how different is the result when making decisions, taking into account several criteria simultaneously. That is the significance of multi-criteria decision-making, which provides the ability to come to optimal decisions by taking into account the larger number of criteria simultaneously. Also, as we have seen, the criteria may not be expressed in the same units of measurement, since by normalizing the matrix they are reduced to a comparable size. So in the case of our model, we had the criteria expressed in dinars (total life insurance premiums, financial result, mathematical reserve) in years (the longitude of business) and qualitative (the ability of sales agent).

Multi-criteria decision-making has been successfully used in circumstances when there is a large number, often conflicting criteria that should be taken into account when making decisions. Since the modern business environment means making decisions by taking into account the large number of different criteria, multi-criteria decision-making methods are imposed as a perfect instrument for decision-making. Just the reality, in which more complex decisions are made, caused the rapid development of the methods used in solving the most complex problems of multi-criteria analysis.

The chapter presents a theoretical framework of multi-criteria decision-making model, and AHP method of multi-criteria decision-making which is applied to the empirical data from insurance companies. Methods of multi-criteria decision making are classified depending on the existence of the attribute information, with the proviso that the most of complex methods require from decision maker to possess certain information about the attributes that will take into account when making decisions. Methods of multi-criteria decision making which do not require any information about the attributes are very simple to implement, but there is few real situations in which they can be used. More complex multi-criteria decision-making methods require some transformation of data, whether it is a linear or vector normalization of attributes or quantification of qualitative attributes.

The aim of this study was to develop a theoretical model of multi-criteria decision-making, but also to show the practical application of one of multi-criteria decision-making methods when making very important decisions for the individual, such as buying a life insurance policy. It was chosen the method Analytic Hierarchy Process (AHP method) that during the process of decision-making requires precise definition of the objective problems as well as the criteria and alternatives. Starting from the initial assumptions of the study it was confirmed that it is possible to form a multi-criteria analysis model when choosing an insurance company for the purchase of a life insurance policy in such a way where insurance companies were treated as a set of alternatives from which it is needed to select the best alternative by taking into account the available criteria.

In developed markets such as the US, Japan, Germany and France, life insurance has a long tradition and is an essential part of the system of providing financial and social security of individuals. In all developed countries, life insurance policies are almost inevitably being bought, in order to ensure individuals in case of death or longevity, despite the state social insurance, which are the two main risks that are covered by this type of insurance. On our insurance market, life insurance in the total insurance portfolio, there were about 20%.Although the percentage of the share of life insurance is at a relatively satisfactory level compared to other countries in the region, as well as the European and world average, it is important to note that life insurance in Serbia in previous years grew at double-digit rates of growth, which points to the growing importance of the market.

Because of the fact that the life insurance company get on the importance in our market and that individuals will be found before a selection of purchasing a life insurance policy, this study was designed as a sort of exploration of application of multi-criteria analysis in making optimal decision when purchasing a life insurance policy, taking into account all the criteria.

In times of economic crisis, high unemployment, job instability and uncertainty of survival of the state pension system, individuals are forced to think about their own future and to timely provide. A life insurance policy is one of the least risky forms of saving, which provides an extra income in the "third" age, in case that it is concluded insurance on endowment. The fact is that the placement of funds collected from the sale of life insurance policies, is strictly regulated and controlled by the NBS so that the risk of loss of funds is reduced to a minimum. Also, if an individual decides to buy a life insurance policy which covers the risk of death, he will protect his loved ones.

It is chosen AHP method multi-criteria decision-making, by which we formed a multi-criteria analysis model selection of the best life insurance policy. Due to data availability, for the alternatives there are selected six largest insurance companies engaged in life insurance business, which have a share of over 80% of the total life insurance market in Serbia. The criteria were selected mostly on the basis of current literature in the field of life insurance, but also based on the specifics of Serbian life insurance market. It was contemplated the eight criteria that are important in making such an important decision, such as buying a life insurance policy.

The model has proved that the greatest importance, when deciding on purchasing a life insurance policy, have the attitude of our payments to the insurer to its total insured amount, then the ability of and skill of the agent sales during the sales process, as well as the financial result of insurers. When deciding on the most favourable insurer, there are also considered the overall height of the premiums for life insurance, mathematical reserve which the insurers are obliged to form and which is one of the most important items of balance of insurance company which is engaged in life insurance, then the longitude of the business, the total number of contracts insurance and diversity of product offerings for life insurance. All of the above criteria are expressed in different units of measure, and ability of sales agent is qualitative criteria.In order to get, as the ultimate objective of the model, the order of alternatives, i.e.

insurance companies, it was necessary to determine the weight criteria, which are determined using the software Super Decisions, based on the assessment of the relative importance of the criteria in pairs. Then, for the criteria, there are calculated intensity values, which are determined on a scale of five levels (excellent, very good, good, fair and poor).After all the intensity values are inserted in the rating model Super Decisions software, it was obtained complete ranking of alternatives, i.e. insurance companies, which indicates which company should be selected during the conclusion of the life insurance.

The multi-criteria analysis in case of selecting the best a life insurance policy, has unambiguously offered solution to the problem on real data from insurance companies. Model provides a number of options, and so alternatives can be compared by one criterion or several criteria, all depending on the preferences of the decision maker. Also, insurance companies can use model for comparison with the competition, and in order to identify their own weaknesses that need to be improved in order to attract customers.

PART IV

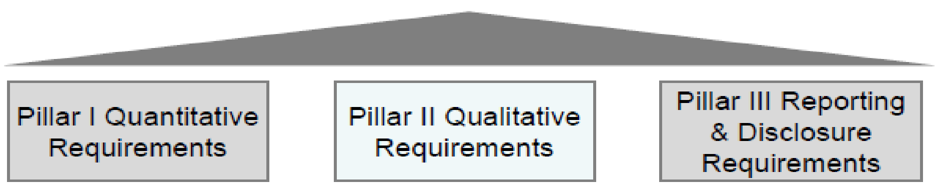
OWN RISK AND SOLVENCY ASSESSMENT - ORSA

Chapter 25.

ORSA - A NEW APPROACH TO ENSURE SOLVENCY

The EU Solvency II - Directive is based on a 3-pillar concept. The first pillar defines the quantitative Solvency Capital Requirements (SCR) that substitute the previous Solvency I concept. The other two pillars are new: Pillar II deals with qualitative requirements for the governance; and pillar III is focussed on the reporting to the public as well as to the regulator. Part of pillar II is the ORSA: “The introduction of the Own Risk and Solvency Assessment (ORSA) process and associated reports is a key part of the risk management framework introduced by Solvency II. It will cover not just the current risk profile and governance arrangements, but how these might change going forward, in the light of the commercial and strategic intentions of the insurer and the nature of the risks being run” - so commented in “Raising the bar on insurance technical expertise”, published by the Actuarial Association of Europe - AAE. Undoubtedly ORSA is an essential part of the governance requirements (see Figure 1).

Figure 1. Structure of pillar II



Art.	Description
Governance System	
41	General Governance Requirements
42	Fit & Proper Requirements
43	Proof of good repute
44	Risk Management
45	Own Risk and Solvency Assessment
46	Internal Control
47	Internal Audit
48	Actuarial Function
49	Outsourcing
...	

A basic motive for ORSA is to complement the SCR requirements defined by the standard formula in pillar I against the background that:

- the SCR requirements take into account only one year as a time horizon,

- the individual risk situation of the company might differ from the assumptions used in the SCR standard formula.

1. TARGETS AND PRINCIPLES OF ORSA

The ORSA is structured by guidelines, published by EIOPA in the "Final Report on Public Consultation No. 14/017 on Guidelines on own risks and solvency assessment". It is focussed on the following main targets in order:

- to assess the overall solvency needs taking into account the specific risk profile, approved risk tolerance limits and business strategy;
- to assess the permanent compliance with the solvency requirements and technical provisions;
- to assess the extent to which the risk profile deviates significantly from assumptions underlying the SCR, calculated with the standard formula or with its partial or full internal model.

ORSA has to follow some basic principles:

- Compulsory: Every company has to perform its own risk and solvency assessment,
- Forward-looking and integrated: ORSA has to be an integral part of the business strategy; plans and results should be used continuously for strategic decisions.
- Regularity and completeness: The assessment should be done on a regular basis and without any delay if the risk profile changed materially due to management decisions. All risks have to be considered.
- Documentation and verification: The ORSA process and its results should be proved accurately and sufficient internally documented.

The following chapters discuss some relevant components of the ORSA process.

2. FORWARD LOOKING

One of the most important components of ORSA is the looking forward to future developments against the background that pillar I requirements only discuss the one-year time horizon. Automatically the projections operated by ORSA are integrated in the business and risk strategy as Figure 2 is illustrating.

Figure 2. Capital management strategy

Source: EAA-seminar "ORSA", Warsaw, 2014.

Projections are used for the market value balance sheet and its assets and liabilities (IFRS, local accounting, solvency balance sheet), for the development of SCR by integrating the business planning and free surplus, that is needed for the capital management. A simple example is illustrated in Figure 3 below. This example indicates the different roles of pillar I (SCR) and pillar II (ORSA) with regard to the time horizon.

Figure 3. Projections

Market value balance sheet	2Q 2012	YE 2012	P1 2013	P2 2014	P3 2015
Total assets	7,367.0	7,514.1	7,664.2	7,816.4	7,971.5
Total technical provisions and other liabilities	4,978.6	5,069.9	5,163.1	5,258.2	5,355.1
Total own funds	2,388.4	2,444.2	2,501.1	2,558.2	2,616.4
Stand-alone SCR	**2Q 2012**	**YE 2012**	**P1 2013**	**P2 2014**	**P3 2015**
Market risk	593.9	605.6	617.6	629.9	642.3
Credit risk	206.8	206.8	206.8	206.8	206.8
P&C risk	200.0	204.0	208.1	212.2	225.5
Life risk	325.2	331.7	338.4	345.1	386.6
Business risk	72.8	74.2	75.7	77.2	80.5
Operational risk	20.0	20.0	20.4	20.8	21.2
Total stand-alone SCR	1,275.4	1,296.8	1,318.9	1,341.4	1,405.0
Diversified SCR	**2Q 2012**	**YE 2012**	**P1 2013**	**P2 2014**	**P3 2015**
Market risk	335.8	342.7	349.8	357.0	354.9
Credit risk	121.4	120.6	119.8	119.0	115.6
P&C risk	61.1	62.3	63.5	64.7	68.7
Life risk	167.0	171.0	175.0	179.1	213.4
Business risk	22.3	22.7	23.1	23.6	25.0
Operational risk	20.0	20.0	20.4	20.8	21.2
Tax	0.0	0.0	0.0	0.0	0.0
Total diversified SCR after tax	654.2	664.7	675.7	686.9	718.2
Solvency ration	**2Q 2012**	**YE 2012**	**P1 2013**	**P2 2014**	**P3 2015**
Base case	365%	368%	370%	372%	364%

Pillar 1 requirement

Pillar 2 requirement

Source: EAA-seminar „ORSA", Prague, 2012.

3. STRESS TESTING

Another relevant component discussed in ORSA is the stress/resilience testing in order to analyse the sensitivity with regard to the solvency position. Guideline 7 (Assessment of the overall solvency needs): "Where appropriate, the undertaking should subject the identified material risks to a sufficiently wide range of stress tests or scenario analyses in order to provide an adequate basis for the assessment of the overall solvency needs."

Different approaches are used:

- Sensitivity stress: Assessment of variability of results when individual economic variables, loss assumptions, risk factors are changed, e.g. models, planning process, etc.

- Stress test: Analysis of the impact that adverse - but possible - change in economic conditions might have on the financial condition of a company; these tests are normally used by regulatory stress tests (EIOPA stress test see Figure 4).

Figure 4. EIOPA Stress Testing

Non-Life Stresses	**Adverse 1**	**Adverse 2**
NatCat / ManCat	1-in-100 year event	1-in-200 year event
Provisions deficiency	1,00%	3,00%
Life Stresses	**Adverse 1**	**Adverse 2**
Longevity	10,00%	18,00%
Mortality	0.6 additional death	2 additional death
Mass Lapse Stress	**Adverse 1**	**Adverse 2**
Mass lapse	20,00%	35,00%

Source: EIOPA, Stress Test, 2014

- Scenario analysis: An integrated scenario defines movements in a number of risk drivers that are logical and realistic relative to one another.

- Reverse stress test: Identification and assessment of scenario/stresses, that would lead to insolvency of the undertaking; an illustration is presented in Figure 5.

Figure 5. Reverse stress test

	Key market risks scenario		
Loss required to breach SCR	**972 m**		
	Contribution	**Loss**	**Stress rate**
Equity	2%	20 m	-41%
Interest Rate	8%	77 m	-0.94%
Real Estate	2%	17 m	-17%
Credit Spread	88%	858 m	2.57%

Source: EAA-seminar „ORSA", Prague, 2013

4. CAPITAL PLANNING

According to Guideline 10 (Continuous compliance with regulatory capital requirements) ORSA has to consider the capital planning. That includes not only projections of capital requirements, but also "the quantity and quality of its own funds over the whole of its business planning period and the composition of own funds across tiers and how this composition may change as a result of redemption, repayment and maturity dates during the business planning period". That should ensure that the ORSA includes processes and procedures in order to allow the company to monitor and manage the quality and loss absorbing capacity of its Own Funds (see Figure 6) over the whole of its business planning period. It can affect the MCR and the SCR if there are changes in the company´s risk profile and therefore need to be reflected in the capital management process and the structure of Own Funds incl. the raise of new funds.

In detail: When considering future Own Fund requirements the company has to consider:

- the capital management including issuance or repayment of capital instruments, dividends and other distributions of income or capital, or calls on ancillary Own Fund items. This has to include both projected changes and contingency plans in the result of a stressed situation;

- the interaction between the capital management and its risk profile and its expected and stressed evolution;

- the ability to raise Own Funds of an appropriate quality and in an appropriate timescale with regard to its own access to the capital markets, with regard to the state of the markets, with regard to its dependence on investors and with regard to the impact of other companies seeking to raise Own Funds at the same time;

- the average duration of Own Fund items whether it relates to the average duration of its insurance liabilities and future Own Funds needs;

- the methods and main assumptions used to calculate net cash flows resulting from the inclusion in technical provisions of premiums on existing business that are expected to be received in the future and how it might respond to any changes in basic Own Funds resulting from changes in those cash flow expectations.

Figure 6. The structure of Own Funds

Note that some items appear across more than one tier. The eligibility criteria then need to be consulted to determine where a particular instrument should appear.

Tier 1	Tier 2	Tier 3
Basic own funds Excess of assets over liabilities comprising: ▸ Paid in ordinary share capital ▸ Paid-in initial funds, members' contributions or equivalent BOF items for mutual and mutual-type undertakings ▸ Share premium account ▸ Paid in subordinated mutual member funds ▸ Surplus funds falling under Article 91 (2) ▸ Paid in preference shares ▸ Reconciliation reserve ▸ Subordinated liabilities valued in accordance with Article 75 of Level 1 directive ▸ EPIFP (Expected profit in future premiums) Reduced by: ▸ Reserves the use of which is restricted ▸ Participations held in financial and credit institutions (now capped at maximum of 10%) ▸ Ring fenced funds	**Basic own funds** Excess of assets over liabilities comprising: ▸ Ordinary share capital ▸ Other paid-in capital instruments (that do not have features required for Tier 1 but meet Tier 2 criteria) including: ▸ Initial funds, members' contributions or equivalent BOF items for mutual and mutual-type undertakings ▸ Share premium account ▸ Preference shares ▸ Subordinated liabilities ▸ Subordinated mutual member accounts **Ancillary own funds** Comprise , for example, the following to the extent are not basic own-fund items: ▸ Unpaid and uncalled share capital or preference shares callable on demand ▸ Letters of credit or guarantee (subject to certain restrictions) ▸ Any other legally binding commitments received	**Basic own funds** Excess of assets over liabilities comprising: ▸ Deferred tax assets ▸ Other capital instruments (that do not have features required for Tier 2 but meet Tier 3 criteria) including: Preference shares ▸ Share premium account ▸ Subordinated liabilities ▸ Subordinated mutual member accounts **Ancillary own funds** No specific list

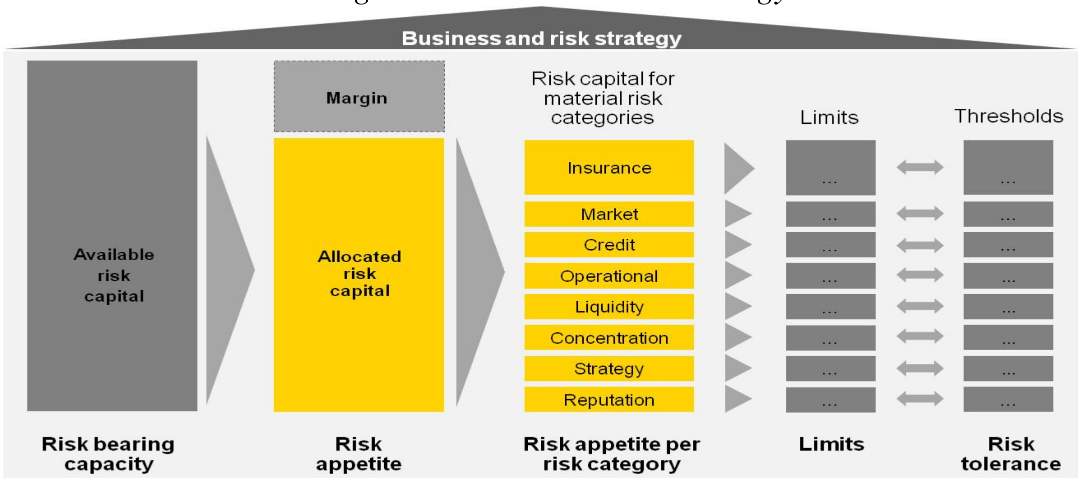
*) ACCORDING TO SOLVENCY II LEVEL 2 DRAFT IMPLEMENTING MEASURES, DATED 31ST OF OCTOBER 2011

Source: EAA-seminar "ORSA", Warsaw, 2013

5. RISK TOLERANCE

ORSA has also to analyse the risk tolerance whether the company has to change its risk tolerance limits derived from the risk capacity and risk appetite. Figure 7 is illustrating the interaction between risk bearing capital and the necessary limits depending on the risk tolerance the company is able or willing to implement.

Figure 7. ORSA and risk strategy



Source: EAA-seminar "ORSA", Prague, 2013.

6. DEVIATION FROM ASSUMPTIONS

Last, but not least Guideline 12 (Deviations from assumptions underlying the SRC calculation) has to be considered: "The undertaking should assess whether its risk profile deviates from the assumptions underlying the SCR calculation and whether these deviations are significant. The undertaking may as a first step perform a qualitative analysis and if that indicates that the deviation is not significant, a quantitative assessment is not required."

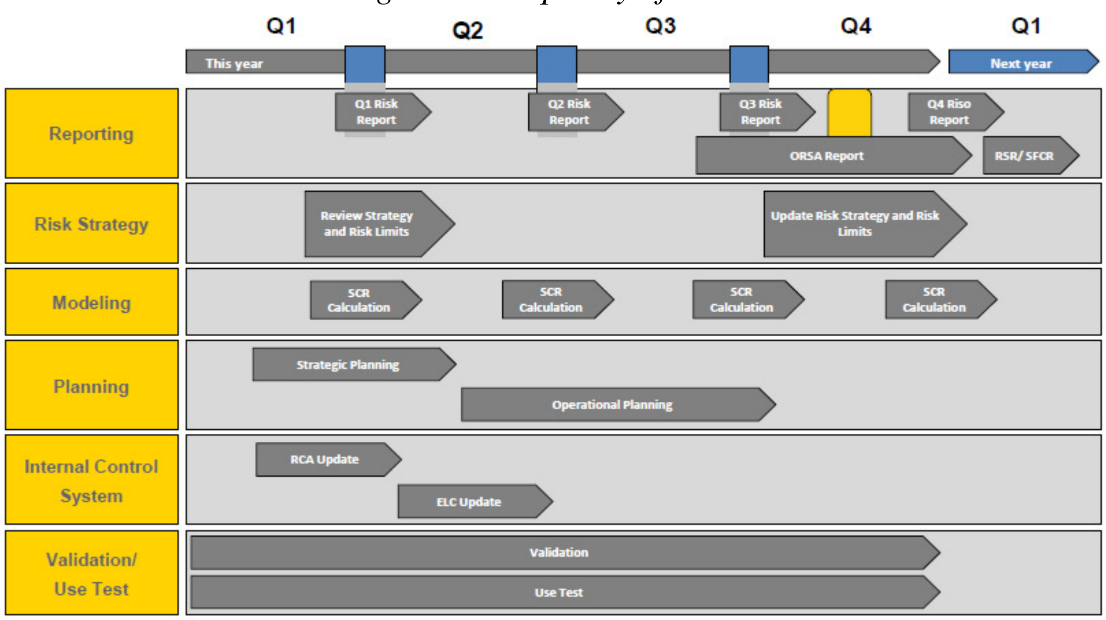
The assessment process is expected to include:

- an analysis of the risk profile and an assessment of the reasons why the standard formula is appropriate, including a ranking of risks;
- an analysis of the sensitivity of the standard formula to changes in the risk profile, including the influence of reinsurance arrangements, diversification effects and the effects of other risk mitigation techniques;
- an assessment of the sensitivities of the SCR to the main parameters, including undertaking-specific parameters;
- an elaboration on the appropriateness of the parameters of the standard formula or of undertaking-specific parameters;
- an explanation why the nature, scale and complexity of the risks justify any simplifications used;
- an analysis of how the results of the standard formula are used in the decision making process.

7. THE FREQUENCY AND REPORTING OF ORSA

ORSA has to be implemented by the company with much freedom, dependent on and integrated in the risk management process that is already implemented. „The undertaking should perform the ORSA at least annually" (Guideline 14 – Frequency). The ORSA has to be performed on a regular basis and in any case immediately after any significant change in the risk profile of the company. So ORSA does not have completely new invented, but can be established and based on already existing tools if there are. An example of the timing of ORSA is given in Figure 8 below.

Figure 8. Frequency of ORSA



Source: EAA-seminar "ORSA", Prague, 2013

Finally the results have to be documented in an ORSA reporting. „The undertaking should have in place at least the following documentation on the ORSA:…c) internal report on ORSA and d) ORSA supervisory report." (Guideline 3- Documentation). So it should be differed between the internal reporting within the company following the steps of the risk management process during the year and the final reporting to the supervisory authority, preferably but not necessarily at the end of the year (see Figure 9). If needed ad-hoc reporting is required; that can happen when extraordinaire events might influence the solvency position to a great extent. According to Guideline 5 (Record of each ORSA) "the undertaking should evidence and document each ORSA and its outcome". The record of each ORSA has to include especially the individual risk analysis and the links between the risk assessment and the capital allocation process and an explanation of how the approved risk tolerance limits were taken into account.

Figure 9. ORSA reporting as a part of the solvency reporting

	SFCR		RSR				ORSA
	Narrative qualitative and quantitative report	QRTs*	Narrative qualitative and quantitative report		QRTs*		ORSA supervisory report
			Summary	Complete report	Annual	Quar -terly	
Preparatory phase (2015)	Narrative report (incl. selected QRTs)						Selected sections of future ORSA report
First submission	Narrative Report in 2015 (as at 31.12.2014); thereafter reports have to be submitted in 2017 (as at 31.12.2016)						
Frequency of reporting	Annual	Annual	Annual	Every 3 years	Annual	Quar-terly	At least annual
	Ad-hoc in case of development with high relevance for SFCR						Ad-hoc in case of changes of risk profile
Deadline for Solo reporting (relevant from 1.1.2016, 22 weeks in preparatoy phase, dependent on national regulator)							
First year:	20 weeks	20 weeks		20 weeks	20 w.	8 w.	Two weeks after completion of internal process
Second year:	18 weeks	18 weeks	18 weeks		18 w.	7 w.	
Third year:	16 weeks	16 weeks	16 weeks		16 w.	6 w.	
Later:	14 weeks	14 weeks	14 weeks	14 weeks	14 w.	5 w.	
Deadline for group submission							
Option 1:	Group-SFCR: + 6 weeks		Group-RSR: + 6 weeks				
Option 2:	Single Group SFCR: see Solo		Only 1 Option!				

*Shorter deadlines for submission of certain QRT data relevant for financial stability

Source: EAA-seminar "ORSA", Prague, 2013

The company has to report the results to the regulator as well to the public. But there is no real experience in the countries how to establish an ORSA reporting. The German Actuarial Association has developed a possible way how to report. According to this proposal the ORSA reporting should present the following content:

- TOP 1: Introduction: General informations regarding the ORSA process and its targets incl. the interaction to other components of the risk management process.
- TOP 2: Management Summary: It might be useful to present a concentrated version with the main results, especially with recommendations how to operate.
- TOP 3: Risk Governance: Main content should be a description of the risk policy and risk strategy in the context of a comprehensive risk management in order to explain the fundaments the ORSA is based on. A valuation of the implemented governance could complement this paragraph.

- TOP 4: Risk Profile: Risk identification should be followed by quantitative results of the SCR standard formula or of internal models. The risk assessment should include qualitative and quantitative results and could be presented in a risk map. It is also useful to document and to value the risk mitigation processes as it is for reinsurance needs.
- TOP 5: Risk Bearing Capacity: This chapter should integrate a description of the quantitative risk bearing concept from the economic and regulatory perspective. The assessment should analyse the solvency position also by stress/scenario-testing and should analyse the changes and also compare the solvency quota to risk appetite and risk limits as well as should comment the deviations of the risk profile from the assumption made for the calculation of SCR. Medium-term projections of results of own funds and risk capital as well as the analysis of the quality, volatility and availability of Own Funds should complement the assessment regarding the risk bearing capacity.
- TOP 6: Methods and Assumptions: The use of of quantitative models incl. the used parameters should be complemented by an assessment of model weaknesses, the used stress and scenario tests, the capital planning process and the qualitative risk-identification,
- TOP 7: Non modelled and quantifiable risks: This chapter should discuss all those risks that are not quantified incl. risks that could be of relevance in future years.
- TOP 8: Limits and triggers: This chapter should deal with limits and triggers that have to be controlled, even with regard to the full utilization. New limits/triggers could be identified by the ORSA assessment. The description could integrate the change in the operating as a consequence of the assessment.
- TOP 9: Technical Provision: The technical provisions calculated in the solvency balance sheet influence the solvency situation. So the appropriateness of the valuation has to be valued.
- TOP 10: Comprehensive solvency requirement: The valuation of the comprehensive solvency situation has to integrate the main topics of the assessment – valuation of the solvency needs, the fulfilment of regulatory requirements, the technical provisions and the potential deviations between the SCR-assumptions and the actual risk profile.

ORSA is a new component in the risk management process and governance. As already mentioned above its special support is given to those solvency concepts that are based on the standard formula, because ORSA plus standard formula is able to approximate the use of internal models, but to avoid the burocratic hurdles of implementing an internal model – of course, if there are no other advantages with regard to the amount of the required risk capital.

Chapter 26.

NBS DECISION AND ORSA

For the majority of European insurance and reinsurance undertakings early 2016 meant final enforcement of the long awaited Solvency II insurance regulation. This was the end of a long way, full of lags and smaller or greater modifications of provisions and methods whilst the central idea and purpose have always remained the same – to introduce better risk management in the insurance industry and thus further improve policyholder protection, deepen the European insurance market and increase global competiveness of European insurance undertakings. Thanks to its prudential basis, Solvency II concept started taking hold in many countries, including EU applicant countries and non-EU countries – some fully others partly. The latter group includes the Republic of Serbia, in view of a decision by the NBS on the governance system in insurance undertakings. As a result, this decision has primarily introduced in the Serbian insurance market quality principles of Pillar 2 of Solvency II that deal with risk management systems in insurance undertakings and data quality standards. Moreover, Pillar 2 introduces one of the probably most complex corner stones of Solvency II: Own Risk and Solvency Assessment (ORSA). Since for Serbian insurance undertakings, primarily those that do not make part of multinational groups, this represents a mostly new concept, in this chapter we will try to shortly explain the key requirements of ORSA and how to comply with them in an expedient way.

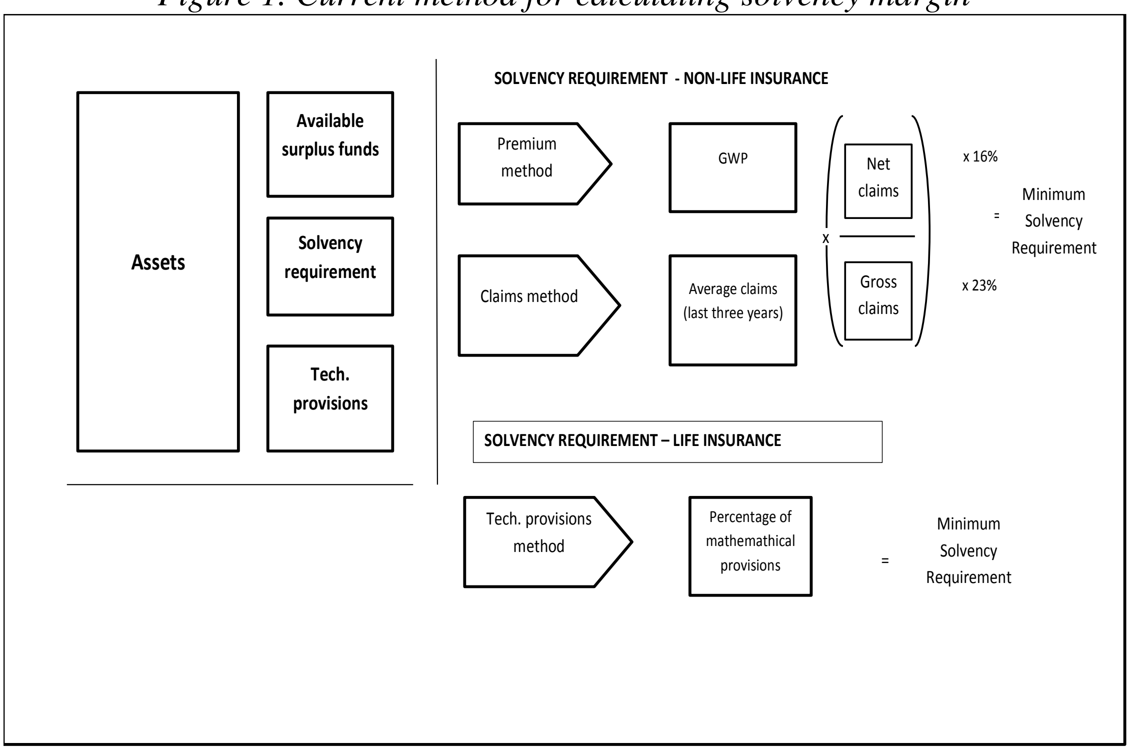
1. WHAT IS SOLVENCY II?

Let us start by asking what solvency means in the first place. In simple terms it can be described as the long-term liquidity of an (re)insurance undertaking or the ability of an undertaking to meet all of its liabilities at any point in time. In poetic terms it is the financial soundness of an undertaking and from the accounting point of view solvency is economic capital that equals the difference between assets and liabilities at fair values. According to one detailed definition, solvency margin is the amount of regulatory capital that insurance undertakings have to keep above the level of their technical provisions for the purpose of covering liabilities. This solvency margin functions as a security buffer against adverse fluctuations in the operations of an insurance undertaking and thereby represents an important element of prudential supervision. Several factors can undermine solvency, such as loss developments, unfavourable developments on financial markets or even a mistaken strategy and realisation of what is known as operational risks, including human error, bad management, intent to cause damage, IT system failures and similar.

To maintain solvency two factors are important: firstly, the insurance undertaking should have both a sound strategy and an effective overall risk management system covering the entire range of risks, and secondly, adequate regulation and supervision of the insurance industry. In Europe and globally the insurance industry is paying utmost attention to policyholder protection. In order to protect its policyholders, i.e. ensure the payment of due indemnification, an insurance undertaking should have sufficient assets at its disposal or, alternatively, sufficient capital.

The present solvency regulation system is based on simple ratios and greatly concentrated on insurance risks, whilst at the same time it neglects most other risks (known to be material risks and mainly market risks). Solvency is calculated as a percentage of technical provisions or mathematical provisions whereas the level of percentage depends on the type of operation. An insurance undertaking is deemed solvent when its capital level is above the capital requirement calculated in this way. In the Republic of Serbia this rationale is used for calculating solvency margin.

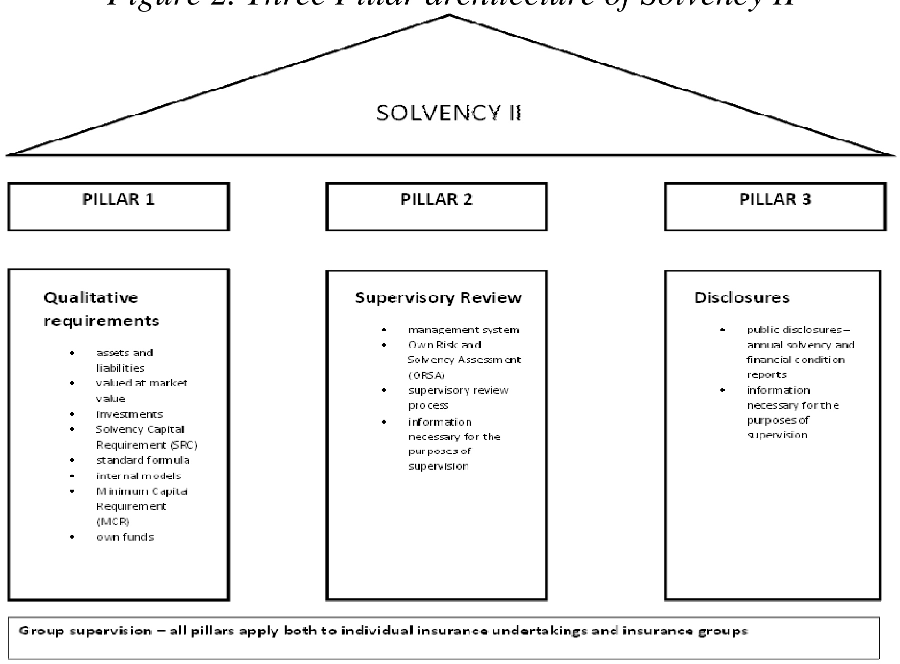
Figure 1. Current method for calculating solvency margin



Source: Own figure

Nowadays, insurance undertakings face a completely changed business environment compared to the 1970s, when the capital adequacy of the insurance sector started being regulated. Since then new risks have arisen, know risks are playing an important role but are neglected, investment policies have changed and the like. As a result, the old formula for calculating solvency could no longer adequately cover the risks to which insurance undertakings were exposed, in terms of capital it did not reward good governance and, at times, it generated inadequate provisioning incentives (as the ratio depended solely on the level of provisions, large insurance undertaking with a prudent provisioning policy automatically had higher capital requirements). What is more, it cannot be said that the capital adequacy calculated according to Solvency I is based on risks, since it does not account for the nature of risks arising from the insurance and investment portfolios of insurance undertakings and, therefore, it does not differentiate between high risk and low risk insurance undertakings[314].

Figure 2. Three Pillar architecture of Solvency II



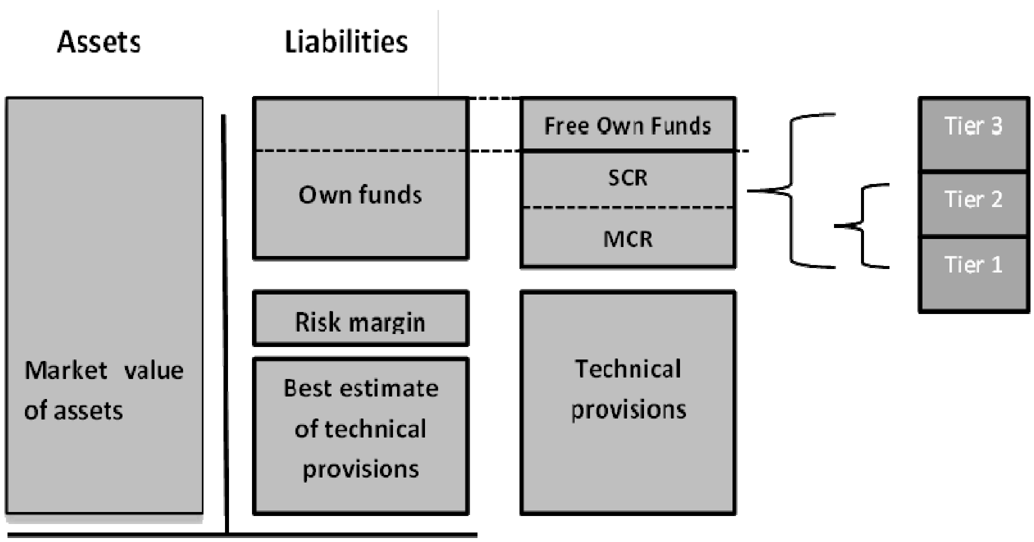
Source: Own figure

The basic requirement under Pillar 1 on insurance undertakings is to estimate both assets and liabilities at market value. So far, in accordance with applicable accounting standards, insurance undertakings have applied this approach only to

[314] Directive 2009/138/EC of the European Parliament and of the Council of 25 November 2009 on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II). *Official Journal of the European Communities,* 2009/138/EC, p. 4.

assets and not to liabilities, particularly not to technical provisions. Consequently, Solvency II introduces rules on the economic or fair assessment of technical provisions, defined as the "best estimate" plus risk margin. The best estimate is calculated as the probability-weighted average of future liability cash-flows, taking account of the time value of money, and the result is then discounted to the present value by applying a risk-free interest rate curve. Precisely thanks to this calculation method of the best estimate, it is very unlikely that any other insurance undertaking would be willing to acquire the provisions assessed in this way. Therefore, the best estimate is increased by a risk margin which equals the price of capital of the insurance undertaking that acquires the portfolio, assuming it keeps the acquired liabilities on its balance sheet. The difference between the market value of assets and liabilities represents own funds or the available capital of the insurance undertaking. According to prescribed criteria own funds are classified into three quality classes and the Directive stipulates which assets and to what percentage can be used to cover regulatory capital[315].

Figure 3. Economic balance sheet



Source: Vandenabeele, T. (2014). Solvency II in a nutshell. Milliman Market Update. Amsterdam: Milliman, p. 5.

On the other hand, Solvency II introduces two levels of capital requirements: the higher "Solvency Capital Requirement" (SRC) which represents the level of capital needed to cover all the materially measurable risks taken into account

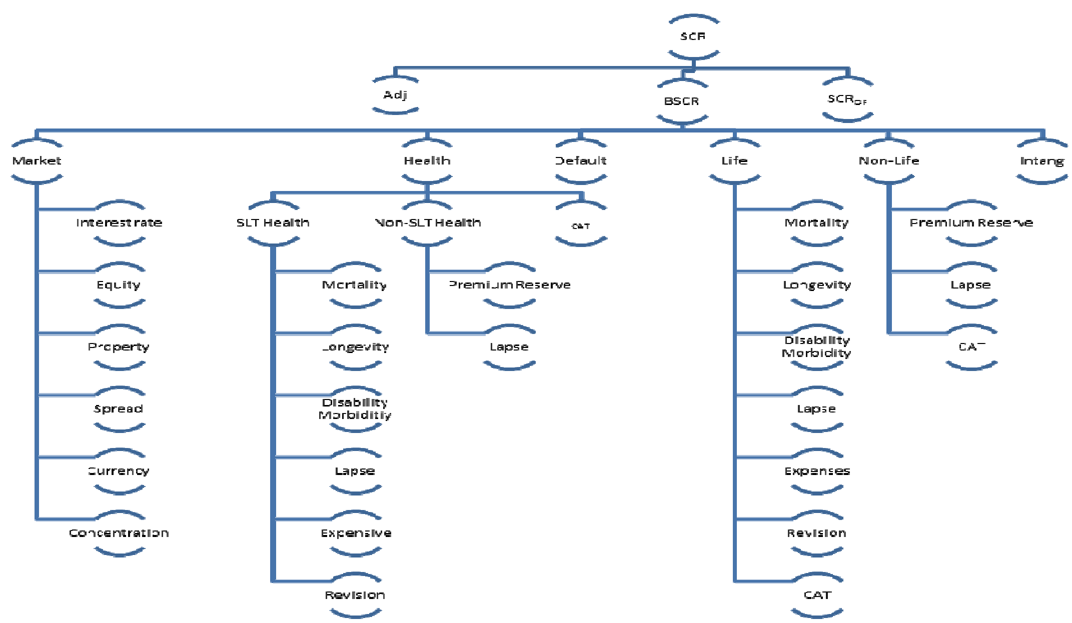
[315] Commission Delegated Regulation (EU) 2015/35 of 10 October 2014 supplementing Directive 2009/138/EC of the European Parliament and of the Council on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II). *Official Journal of the European Communities,* Vol. 58, p. 50.

that an insurance undertaking is exposed to. SRC is calibrated to the target VaR of 99.5%, meaning that assets have to be higher than technical and other provisions at a 99% confidence level over a one-year period.

The lower “Minimum Capital Requirement” (MCR) represents the limit under which an insurance undertaking is exposed to an unacceptable level of risk and under which its capital should not fall, or most rigorous measures will automatically be applied.

SRC and MRC are calculated by applying standard formulas, the same for the entire EU. Capital requirements are calculated separately for each segment of insurance business: non-life insurance risks, life insurance risks, health insurance risks, credit risks, market risks and operational risk. The insurance undertakings that believe that the standard formula does not correctly reflect their risk profile and can prove their belief may submit what is known as an “internal model” in order to be able to decrease capital requirements for individual segments. As a rule, however, internal models involve very demanding, expensive and long procedures.

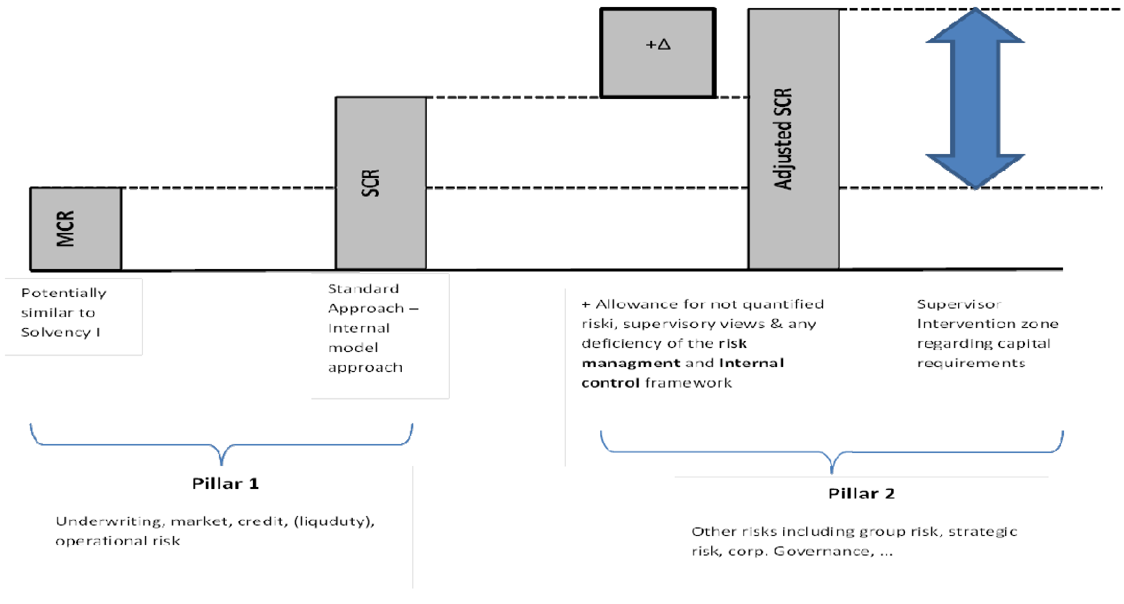
Figure 4. Solvency II standard formula



Source: Own figure

As mentioned before, Pillar 2 introduces quality requirements regarding the management system, risk management, key functions and other internal processes. Pillar 2 also includes ORSA – probably the most demanding requirement of Solvency II.

Figure 5. Assessment of total capital requirements



Source: Vandenabeele, T. (2014). Solvency II in a nutshell. Milliman Market Update. Amsterdam: Milliman, p. 7.

When it comes to "Own Risk and Solvency Assessment" (ORSA) the Directive is rather elementary, since it is defined only in Article 45. According to Solvency II every insurance and reinsurance undertaking has to conduct an own risk and solvency assessment as part of its risk management system. This assessment has to cover at least the overall solvency needs taking into account the specific risk profile, approved risk tolerance limits and the business strategy of the undertaking; the compliance with the capital requirements, and with the requirements regarding technical provisions as laid down in the Directive[316]. In addition, the insurance or reinsurance undertaking has to explain to which extent its risk profile deviates from the assumptions underlying the Solvency Capital Requirement, calculated by applying either the standard formula or the partial or full internal model. The insurance undertaking has to have in place processes which are proportionate to the nature, scale and complexity of the risks inherent in its business and which enable it to properly identify and assess the risks it faces in the short and long term and to which it is or could be

[316] EIOPA (2015). Guidelines on Own Risk and Solvency Assessment. *EIOPA/14/259.* Frankfurt: European Insurance and Occupational Pensions Authority, p. 3.

exposed. The insurance undertaking has to demonstrate the methods used in that assessment. The own-risk and solvency assessment has to be an integral part of the business strategy and needs to be taken into account on an ongoing basis in the strategic decisions of the undertaking. Insurance and reinsurance undertakings are required to perform the assessment referred to in paragraph 1 regularly and without any delay following any significant change in their risk profile. The insurance and reinsurance undertakings have to inform the supervisory authorities of the results of each own-risk and solvency assessment as part of the reported information and their own-risk and solvency assessments must not serve to calculate a capital requirement.

The purpose of Pillar 3 is to improve market discipline through much more overt disclosures and extensive reporting, which will be both quantitative and qualitative and either public or non-public (intended for supervisory bodies). For qualitative reporting purposes insurance undertakings are expected to use “Qualitative Reporting Templates” (QRT) on quarterly and annual basis. For quantitative reporting they have to use “Solvency and Financial Condition Reports” (SFCR) and “Reports to Supervisors” (RSR). These two reports are in writing: SFCR is public and produced annually, whilst RSR is intended only for the supervisory agency, produced every three years and including at least the entire SFCR plus additional information.

2. NBS DECISION - A HYBRID BETWEEN SOLVENCY I AND II

In mid 2015 the Official Gazette of the Republic of Serbia published the Decision on the System of Governance in an Insurance/Reinsurance Undertaking which stipulates the system of governance in an insurance/reinsurance undertaking, types of risks in the insurance industry, detailed conditions and manner of identification, measurement, monitoring and management of these risks, detailed conditions and manner of organising and implementing the internal controls system and conditions for outsourcing[317].
In line with the rationale and targets of Solvency II and taking into consideration the already mentioned deficiencies of the old solvency regulation system, this Decision promotes establishing the risk management function or better risk management as such, stipulates the introduction of internal audit systems, actuary function and compliance function. Moreover, the Decision includes a rather detailed description of the risks that occur in the insurance

[317] Decision on the System of Governance in an Insurance/Reinsurance Undertaking. *Official Gazette of RS,* No. 51/2015, p. 1.

industry, listing many more risks than those actually affecting the solvency margin and used in the formula for its calculation.

Besides, the Decision of the NBS stipulates another very important task for insurance undertakings: an own risk and solvency assessment. As a true translation of EU guidelines, the Decision explicitly requires from Serbian insurance and reinsurance undertakings in the context of risk management to conduct own risk and solvency assessments, which are integral to the business strategy and which are taken into account in making strategic decisions and in managing the undertaking’s capital adequacy. For the purpose of conducting own risk and solvency assessments, undertakings have to establish adequate processes for the identification, assessment, measurement and monitoring of risks that they are or may be exposed to, and for the establishment of the overall solvency needs. Undertakings have to ensure that the results of their own risk and solvency assessment are taken into account in the decision making and planning of their business activities.

The Decision also lays down detailed requirements and instructions on how to conduct own assessments - notably the following: The assessment of deviation of an undertaking’s risk profile from the requirements which relate to capital adequacy and are determined by regulations, shall include the qualitative and quantitative analysis of the significance of the established deviation from the required solvency margin.

This Decision obviously imposes on Serbian insurance undertakings considerable portion of provisions set out in Pillar 2 of Solvency II, but practically omits Pillar 1 and Pillar 3. As only qualitative parts and not the entire Solvency II Directive will be transposed in the legislation of the Republic of Serbia, this can be described as a hybrid between the two regimes. The established reporting and qualitative requirements for calculating solvency margin for regulatory purposes will stay in place and, simultaneously, in the framework of own risk assessment insurance undertakings will have to take account of all other risks as defined by the Decision. This creates an interesting situation where the capital requirements based on a simple, robust ratio formula of the current regulation are confronted with the rather complex requirements ushered in by the NBS Decision. At the same time the Decision fails to prescribe a standard formula that would enable insurance undertakings to calculate their capital requirements by taking into account all or the majority of defined risks.

The following text includes the authors’ thoughts on how insurance undertakings can, in view of the given situation described above, conduct own assessments in practice as well as experience-based practical instructions aimed at facilitating their self assessment process.

3. HOW TO CONDUCT AN ORSA?

The very words *Own Risk and Solvency Assessment* (ORSA) imply a self assessment. “Own” means that there are no precise instructions on how to conduct an ORSA and which formulas to use in this process. Admittedly, the Delegated Regulation and individual pieces of national legislation in principle stipulate the elements that ORSA should include alongside other technical standards, but they do set out neither a calculation method nor an exhaustive list of risks that should be comprised. It is up to insurance undertakings to judge which risks are relevant to them and how they will assess them.

Furthermore, ORSA implies a risk assessment and not precise calculations. EIOPA underlines that all risks should be assessed in the framework of ORSA, including those, whose results are not and cannot be mitigated by means of capital. This means that all risks already included in the calculation of SRC according to the standard formula have to be assessed as well as other risks that are not partially or fully included in the standard formula. The latter can for example include strategic risks, reputation risk, liquidity risk, various business risks and the like.

However, according to the text of a Slovene regulation on own assessment and solvency, insurance undertakings should, as the first step of risk assessment, carry out a qualitative analysis and, if such an analysis shows that the analysed risks are not material or that they do not significantly deviate from the standard formula, then no qualitative analysis of such deviations is necessary. All the risks not included in the formula for the calculation of solvency margin are subject to a qualitative analysis which consists of the descriptions of procedures an insurance undertaking uses to manage individual risks, its individual risk management strategies, risk appetite or existing internal controls– i.e. a disclosure of the risk profile showing exposures to individual risks (e.g. issuer concentration risk, counterparty concentration risk, etc.). The insurance undertaking then enumerates the risks in a catalogue of risks and updates it regularly[318].

[318] Insurance Supervision Agency (2015). *Decision on Own Risk and Solvency Assessment*. Ljubljana: Insurance Supervision Agency, p. 5.

If the qualitative method shows that a certain risk is material for the insurance undertaking, a qualitative analysis should be carried out as well. The insurance companies that are not governed by the Pillar 1 requirements of Solvency II and have not developed any own methods can nevertheless use individual standard formula modules or the entire standard formula. The individual standard formula modules are different in complexity as to how demanding calculations are and what data are needed to perform them. Whilst insurance risk modules may seem very demanding to someone dealing with them for the first time, certain modules of market, credit and operational risks are relatively undemanding, also regarding the necessary data. On top of that on EIOPA website assistance files are available providing simplified calculations for individual modules, previously used in quantitative impact studies (QIS) and past stress tests. According to the NBS Decision insurance undertakings may, if capable, apply for their internal purposes or for ORSA purposes the entire standard formula in order to verify the adequacy of their solvency margin method or quantify any additional material risks not included in the standard formula they apply.

When they evaluate the materiality of risks, both in qualitative and quantitative assessments, insurance undertakings should consider the fact that material risks are defined as having a material impact on their operation. On the other hand Solvency II does not prescribe precise materiality thresholds for the operation of insurance undertakings, and it is therefore up to them to set such thresholds. They can define materiality or significance in several ways: as an impact on profit, as a percentage of total assets or, if a risk affects a single insurance class or investment grade, the materiality of such a risk can be defined as a percentage of provisions for that insurance class in total provisions or as a percentage of investments in total investments, etc.

When they plan to make an own risk and solvency assessment and decide how complex it will be, insurance undertakings can choose valuation methods and frequency rate of assessments in accordance with the principle of proportionality. This means that in the framework of assessment, an insurance undertaking can set up processes and valuation methods that are in line with its organisational structure, risk profile and its complexity as well as risk management system. The complexity of the risk profile of an insurance undertaking is assessed on the basis of its form of incorporation, insurance product portfolio structure, financial investment portfolio structure, business strategy regarding potential new markets and/or the redesigning of existing products or launching of new ones, etc. In practice this means that the smaller the size and complexity of business (few insurance classes, few investment grades) of an insurance undertaking, the less complex own risk and solvency assessment is required. On the other hand, however, insurance undertakings have to understand that their risk profiles may change in time. If as a result these changes affect the adequacy of the processes, methods and frequency of their own risk and solvency assessments, insurance undertakings have to adjust these to their changed risks profiles. An important part of ORSA is future solvency projections made by insurance undertakings, i.e. the use of stress and scenario testing. While it can be said that solvency projections in relation to the business strategy or business model of an undertaking represent a minimum standard, provisions on stress and scenario testing are much more stringent. Most insurance undertakings are already in the habit of making solvency margin projections when they prepare future business plans for periods from three to five years. The provisions on own risk and solvency assessment are more specific in this respect; namely insurance companies are required to make solvency projections for the entire period of their business plans. In this exercise solvency margin projections made according to the prescribed method alone are not enough. On top of that all other risks not covered by the method have to be included if insurance undertakings assess they have a material impact on their operation. If insurance undertakings identify the major risk drivers, factors and/or parameters per insurance class already in the phase of assessing such additional risks and these make part of their business plans (that is usually the case in practice), then for the least complex projection it is enough to linearly extrapolate these factors in accordance with the development factors arising from the underlying business plan. Otherwise, insurance undertakings have to identify these factors in the projection phase. In parallel undertakings have to make projections of available capital and compare the two sets in order to continually comply with capital requirements.

Stress and scenario testing is introduced in the next phase of evaluating the complexity of own risk and solvency assessment. Stress tests are simpler than stress scenarios, as they refer to single parameter changes that affect the value of assets and liabilities and/or own funds of an insurance undertaking or other risk-generated items and are used to identify the impact of a changed parameter on their value. On the other hand, scenario tests are used to identify the impact of the changes of several parameters – e.g. simultaneous changes in several of risk categories that for example affect insurance business, the value of financial investments and interest rate changes.

Insurance undertaking has to select the scope of stress and scenario tests on the basis of its previously identified risk profile and apply the principle of solidarity. In this way it can identify an adequate scope of adverse conditions that may impact its business operations. For the purpose of simplification insurance undertakings may use the parameters of the history of shocks or scenarios that were experienced by themselves, their country or region (devastating floods, earthquakes) or in the broad economic environment (2008 financial crisis).

The insurance undertakings who chose to formulate scenarios and/or shocks on their own have to take into account that they may be subject to adverse conditions for long periods of time as well as experience sudden and major developments, such as great capital market changes, natural disasters or combinations of prolonged adverse conditions and sudden major developments (e.g. a natural disaster followed by a recession period). Any internally planned scenario of an insurance undertaking has to account for the method of risk grouping by business segment, changes in their interdependence under stress and potential new risks or contingent exposures that may arise as consequence of a changed situation. One of the key advantages of historical scenarios lies in the fact that the majority of the above mentioned factors are already known and do not have to be formulated anew.

In parallel insurance undertakings need to take account of the impact of shocks on their available capital or how their solvency ratio could react in an event of one-off or prolonged stress conditions. Once an adverse impact on the state of solvency has been established, insurance undertakings have to include in their own risk and solvency assessments and their solvency projections the impact of risk mitigation techniques (additional reinsurance coverage, temporary suspension of issuing new insurance policies, restructuring of financial investments into safer grades and the like) as well as take measures regarding their future management. The last step includes a comparison between the initial stress scenario and the adjusted scenario that includes risk mitigation effects.

In accordance with the NBS Decision and EU guidelines insurance undertakings have to keep certain records on their own risk and solvency assessment, which includes no less than some internal document (policy) on the performance of each assessment and its results, a report on own risk and solvency assessment, report on own risk assessment and solvency – one for internal use and one for supervisory institutions (NBS). At their discretion insurance undertakings may produce only one report and use it for internal and external purposes.

Such a report has to enumerate the quantitative and qualitative results of a total capital requirement assessment (together with additional risks not included in the prescribed methods) as well as the conclusions arrived at on the basis of these results, information on methods and assumptions used, information on total capital requirements and a comparison between total capital requirements, the legally required solvency margin and available capital – including any deviations from the two methods used, both quantitative and qualitative. In addition, insurance undertakings have to evaluate the impact of planned risk mitigation and management measures.

Any internal document on own risk and solvency assessment of an insurance undertaking has to comprise all the procedures set up for the purpose of assessment performance and the descriptions of methods used, information on the frequency and performance of stress and scenario testing and other analyses, methods of data provision, frequency of assessment performance depending on risk profile and volatility of solvency needs in dependence of available own sources of funds, own assessment timetable and, last but not the least, conditions which require extraordinary performance of an own risk and solvency assessment.

Even though the Solvency II Directive, relevant Delegated Regulation and all the accompanying guidelines and technical standards may easily create the impression that enormous effort is needed to comply with all requirements, luckily enough, Solvency II includes the principle of proportionality, according to which insurance undertakings can adjust their (risk) management systems in proportion to the nature, scale and complexity of the risks inherent in their business. This principle also applies to the performance of own risk and solvency assessments. No precise formula is prescribed for performing ORSA, leaving insurance undertakings with relatively free hands in terms of performance. Nevertheless, certain minimum methods and standards have to be followed according to the Directive. In view of the fact the NBS Decision does not stipulate that capital requirements have to be calculated by using the standard formula from Pillar 1 of Solvency II, the insurance undertakings that do not make part of groups based in an EU member state may "borrow" the standard formula in full or in part for ORSA purposes and use its results to compare them with the legally prescribed solvency margin. No matter what approach insurance undertakings take, they should not be frightened by new requirements. They should understand these new requirements as a useful tool which will enable them to further improve their risk management, and not merely as additional regulatory burden. If well designed they can be very useful at a relatively low investment.

Chapter 27.

SIGNIFICANCE OF ACTUARIAL CONTROL CYCLE IN INTERNAL RISKS MANAGEMENT IN NON-LIFE INSURANCE

In order to survive in a highly competitive environment, non-life insurers must develop an effective system for managing risk and capital, which should enable identification and measurement of the existing and future risks. The goal of managing risk and capital should be increased business efficiency by minimizing the costs of risk-taking, which requires study of the factors that affect the cost of capital and the ways in which insurers can affect these factors. The risk management process allows calculation of the capital requirement in accordance with risk insurance and investment and thereby ensures long-term survival of the insurer.

This chapter shows how actuarial control cycle is used for risk management in non-life insurance. It will present a brief summary of objectives for each element of the actuarial control cycle and describes the role that actuaries play in achieving these goals.

1. DEFINITION OF ACTUARIAL CONTROL CYCLE

Actuaries actively use the concept of a "control cycle", especially when managing long-term risks. This concept implies:

a) modeling expected results;
b) measuring actual results;
c) identifying and explaining differences between expected and actual results; and
d) using these findings for improving the model.

Adequate implementation of this process allows the insurance company to take the necessary steps before the onset of financial problems.[319]

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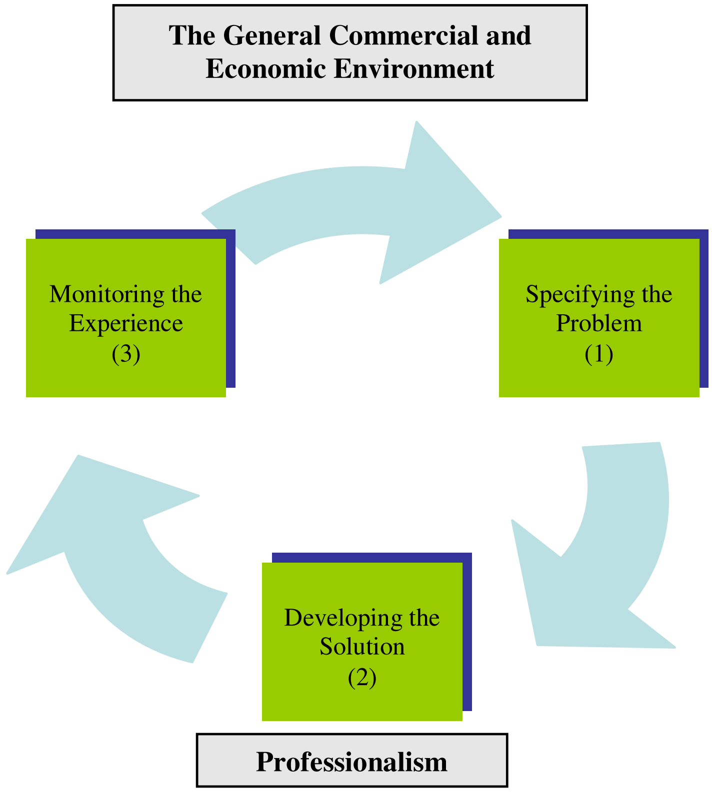
[319] IAA (2009). *Dealing with Predictable Irrationality - Actuarial Ideas to Strengthen Global Financial Risk Management*. Ottawa: International Actuarial Association, (accessed on 4/3/2016 on www.actuaries.org), p. 5.

As is shown in Figure 1, the actuarial control cycle is based on the following three steps:

- defining problems;
- working out solutions to the problems; and
- monitoring results.

Figure 1. Steps in the actuarial control cycle



This process is universal and can be applied for solving any problem.[320]

The Figure 1 shows that the business of an insurer depends on the business environment, as well as on the expertise of its staff. Professionalism of an actuary is of great importance for the successful realization of the cycle.

Control cycle of an insurance company covers the following types of functions:

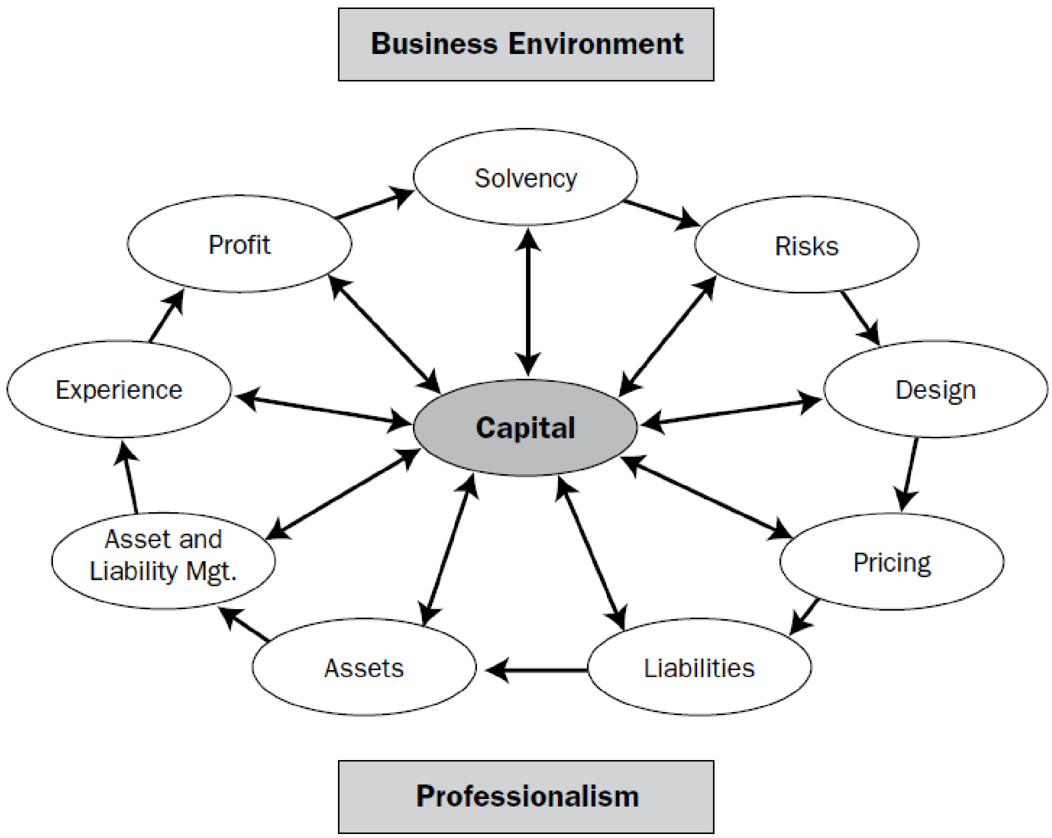
- Design, price, marketing, sales and assessment of the risk associated with the insurance product;
- Assessment of the volume and uncertainty of liabilities in relation to those policies;

[320] Bellis, C. (2010). *Understanding Actuarial Management: the actuarial control cycle*. Sydney: Institute of Actuaries of Australia and the Society of Actuaries, p. 3.

- Choice of the assets that will be used to cover liabilities arising from insurance contracts;
- Calculating capital requirement;
- Managing claims;
- Appropriate communication with key stakeholders (e.g, management, supervisors, insured, and investors);
- Analysis of the future financial circumstances.

The above elements of a control cycle are shown in the Figure 2.

Figure 2. Actuarial Control Cycle



Source:. IAIS (2006). ICP 18A: Risk Management Fundamentals Basic-level Module. Basel: International Association of Insurance Supervisors, p. 3. (accessed on 4/./2016 www.iaisweb.org).

The diagram is circular in shape, because the elements are interdependent and each of them has an impact on the next. The assessment of risks associated with each element of control risk is essential to the business of the insurer.[321]

[321] IAA (2004). *A Global Framework for Insurer Solvency Assessment*. Ottawa: International Actuarial Association, pp. 25 and 26.

As the diagrams above suggests, capital plays a central role. Capital serves as a buffer for unexpected losses, and reduces the impact of any unforeseen adverse fluctuations in operating results, which may impair the ability of an insurance company to fulfil its obligations towards policyholders or to continue its business.

In the process of risk management, capital management plays an important role in harmonising the level of capital and the risks assumed by means of insurance and investment activities.

In the next section, we are briefly defining each element of the actuarial control cycle and emphasising the role of actuaries along the entire cycle.

2. DESIGN AND EVALUATION OF INSURANCE CONTRACTS

The transfer of risk from an individual to the insurer is done based on the contractual relationship under which the insurer, taking into account the premium paid by the insured and contractual provisions, agrees to pay insurance compensation upon occurrence of the insured event. An insurance contract regulates the rights and obligations of both contracting parties i.e. the insurer and the insured[322].

Before starting the evaluation of all potential or existing obligations under an insurance contract, it is necessary to understand the contract and all its characteristics and the risks associated with it. These risks include the possibility of negative selection and adverse effects of certain social, economic, political or natural phenomena.

The acts under which insurance contracts are concluded are the terms and conditions of insurance and insurance premiums. Insurance premiums are an internal act of the insurer that is used for calculation of the amount of the premium for each homogeneous form of insurance.

Terms and conditions of insurance fall into the following categories:

- general insurance terms and conditions, comprise an integral part of an insurance contract, govern the rights and obligations of the parties in the contract, and are common for all types of insurance;

[322] Kočović, J., Šulejić, P., Rakonjac-Antić, T. (2010). *Osiguranje*. Belgrade: Faculty of Economics, University of Belgrade, p. 35.

- terms and conditions for certain types of insurance - comprise an integral part of an insurance contract and regulate individual types of insurance.

Each insurance contract must define: the subject of insurance, the risks the subject is insured against, the duration of insurance and the form of cover for damages.[323]

The subject of insurance must be defined in such a manner that it is unambiguous in terms of its characteristics and identification at the time of contracting the insurance and at the occurrence of the insured event. An insurance contract must define the method of determining damages in the case of realization of the risk or occurrence of the insured event.[324]

Designing an insurance contract requires consideration of a great number of factors in order to make sure that major faults in the design of the contract are noticed before the introduction of a new product to the market.

An insurance company may develop a completely new insurance product or to improve an existing product by allocating it new characteristics that change the risk profile of the existing product in order to meet the needs of the insured. Creating a new insurance product or modifying an existing one consists of three phases.

The first phase includes an analysis of the insurance market. The goal of the first phase is to develop new ideas be based on an analysis of market conditions, which includes an analysis of competition, potential policyholders and sales channels. This stage is used to collect and research information on the needs of clients in order to enable the development of new products. Upon analysis, a decision is made whether to continue with the process. If a decision is made to continue the process, the next phase is product development in which statistical data are used to define the scope of coverage, tariff rates, the conditions of insurance and reinsurance etc. In the last phase, after successful testing of the product concept, is the development of a preliminary strategic plan for the introduction of a new product on the market (the development of marketing strategies). The design and price of the contract should be in accordance with the planned marketing strategy.

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[323] Andrijanić, I., Klasić K. (2002). *Tehnika osiguranja i reosiguranja.* Zagreb: Faculty of Economics, University of Zagreb, p. 23.

[324] Mitrašević, M. (2010). Aktuarska i finansijska analiza adekvatnosti kapitala kompanija za neživotna osiguranja, *Doctoral thesis,* Belgrade: Faculty of Economics, University of Belgrade.

In order to increase sales efficiency of a product, it is crucial to demonstrate its quality, which is reflected in the provision of risk coverage in accordance with clients' needs and with appropriate cost of insurance; providing financial capacity and the timely payment of damages.

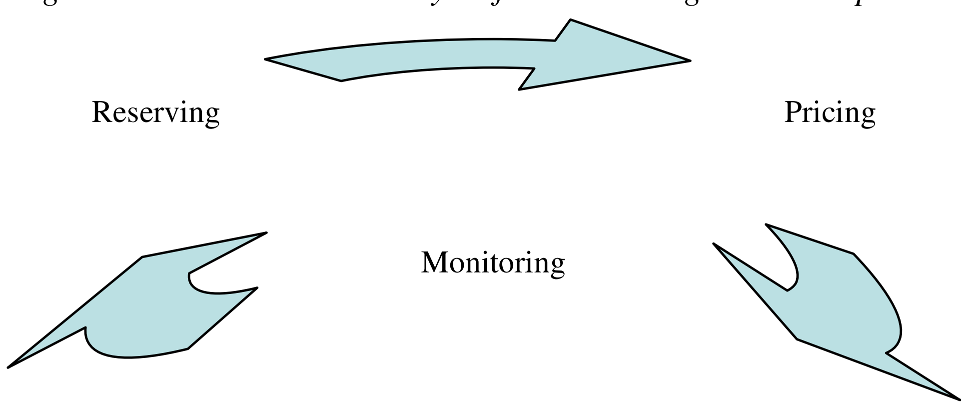
The primary objective of the insurer is to ensure adequate price or premiums of insurance that covers the cost of the product (compensations and costs of insurance) and provides adequate profit margin.

Balancing the volume of insurance premiums with total financial losses to be recovered is a very complex problem. In order to determine the ratio between the amount of compensation from insurance and the amount of the insurance premium, it is necessary to assess the risks, taking into account the probability of occurrence of the insured event and the size of losses[325].

The actuary should consider internal and external factors relevant for the decisions on pricing. External factors include changes in inflation rates, interest rates, market cycles and different regulatory problems. Internal factors which should be considered are changes in insurance programs, changes in the combination of various types of insurance or their classifications, changes in the accounting rules in the department for assessing damage and other.

The actuarial control cycle for calculating insurance premiums can be shown as follows:

Figure 3. Actuarial Control Cycle for calculating insurance premiums



Source: Finnis, D. (2006). The Value of the Actuarial Control Cycle in a Non-Tariff Based Insurance Market. Written for and presented at 8th GCA, Mumbai 10-11 March, (accessed on 4/3/2016 http://www.actuariesindia.org/), p. 9.

325 Корнилов, И.А. (2004). *Основы страховой математики.* Moscow: Юнити, p. 15.

The control cycle should ensure the application of appropriate actuarial methods of projection. Also, this process provides an analysis of the efficiency of the product and identifies the elements that should be improved.

The accuracy of the actuarial calculations is a necessary precondition to ensure the level of the premium, which would be sufficient to cover the cost of providing the insurance product or service and to provide an adequate margin of profit for the insurer. In doing so, actuaries must continuously monitor the dynamics of the changes in risks affecting adequacy of insurance premiums and react by adjusting risk evaluations accordingly and thus actively manage such risk.[326]

3. VALUATION OF INSURANCE LIABILITIES

The realization of insured events in non-life insurance includes compensation for specific types of costs the amounts of which are not known in advance and therefore insurance companies must use special techniques and methods for their calculations. Assessment of future liabilities and calculation of adequate insurance reserves is one of the most important roles of an actuary in an insurance company.

One of the most significant items of liabilities in the balance sheet of an insurer is provision for claims reserve and the expenses associated with compensations for damages. An insurer makes these reserves to ensure payment of claims that are covered by insurance. Another significant portion of liabilities is unearned premium reserve.

In the context of reserves, a control cycle involves the identification, testing, and validation of all the elements in the process of calculating the liabilities arising from compensation claims.

Control cycle is crucial for risk management of reserves. Furthermore, this process provides an analysis of the efficiency of the product and identifies ways to improve it. As part of a control cycle, the actuary should identify the areas with highest exposure to errors in valuations and strive at improving the processes in order to minimise exposure to these errors. This may result in

[326] Kočović, J., Mitrašević, M. (2010). Uloga i značaj aktuara za uređenje tržišta osiguranja. In: *Ekonomska politika i razvoj.* Jovanović Gavrilović, B., Rakonjac-Antić, T. (eds.), Belgrade: Faculty of Economics, University of Belgrade, pp. 127-146.

improving the quality of the data used for valuation, or introducing new actuarial methods for projections.

Outstanding claims reserves are subject to significant variability due to many causes: imprecise forecasts, changes in the law and other internal and external factors, or random variation. Such variability can have a significant impact on the stability of the insurer. In addition to the uncertainty in the overall evaluation of reserves, an actuary faces uncertainty in estimating the time of payment of such liabilities.

The causes of uncertainty in the evaluation of claims reserves can be grouped into several categories, ranging from those that are hardest for an actuary to predict to the predictable ones: *External changes*: changes in the economic, legal, regulatory, or social environments may affect the liabilities for reserves. *Internal changes*: changes in the procedures of the insurance company may affect the indications on the size of outstanding claims (for example, increasing the franchise with general liability policies will cause a reduction in accrued compensation claims and reduce payments compared to previous estimates of net outstanding claims reserves).[327]

Certain factors may have an impact on both sides of the balance sheet, for example, unexpected changes in inflation can affect the expenses for claims and the value of company assets. An actuary should take into account the impacts on the outstanding claims.

Different methods for assessing claims reserve can result in different assessments of outstanding claims reserves. In practice, it is difficult to detect the cause of fluctuations in outstanding claims by quarters, or between one method and the other. Fluctuation may be attributed to uncertainties in the assessment of outstanding claims.[328].

Performance testing is an integral part of the actuarial control cycle associated with the process of reserves assessment. As part of a control cycle, the actuary should identify the areas with highest exposure to errors in valuations and strive at improving the processes in order to minimise exposure to these errors.

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[327] Pinto, E., Gogol, D.F. (1987). An Analysis of Excess Loss Development. *Proceedings of the Casualty Actuarial Society,* Arlington: Casualty Actuarial Society, pp. 227-255.

[328] Berquist, J.R., Sherman, R.E. (1977). Loss Reserve Adequacy Testing: A Comprehensive Approach. *Proceedings of the Casualty Actuarial Society,* Arlington: Casualty Actuarial Society, pp. 123-185.

4. SELECTION OF ASSETS FOR COVERING TECHNICAL PROVISIONS

A significant segment of the actuarial control cycle is a selection of assets for covering technical provisions of the insurer.

Depending on the nature of their obligations, an insurer typically retains, in various proportions and in accordance with the regulations, four basic types of financial assets: bonds and other fixed income instruments; shares; loans, deposits and other rights; real property.

A very important issue in determining optimal investment strategies of insurers is liquidity. Liquidity problem arises when there is a mismatch between the maturity of assets and liabilities. An insurance company must ensure timely payment of liabilities arising from insurance. For this reason, there are restrictions in terms of investment in low liquidity assets, such as real estate, mortgage loans, securities from private investments.

Insurance companies need to invest in the types of assets whose cash flows are matching maturity of their expected liabilities.[329] Good management of assets and liabilities can significantly reduce the liquidity risk.

The investment of technical provisions and guarantee reserves of insurers is subject to strict supervision in order to ensure a high level of protection against the risk.[330]

The actual composition of the investment portfolio, at any given time, should be the product of a structured investment process, characterized by the following steps:[331]

- design and development of the strategic and tactical investment policy;
- examination of economic, political and social environments;
- implementation of the investment policy;
- control, measurement and analysis of realized investment results and the assumed risks.

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[329] Mitrašević, M., Panić, P. (2011). Upravljanje rizikom investicionog portfolija osiguravajućih kompanija. In: *Nadzor i kontrola poslovanja osiguravajućih kompanija,* Kočović, J. (ed.), Belgrade: Serbian Actuarial Association, Faculty of Economics, University of Belgrade, pp. 504-524.

[330] Kočović, J., Mitrašević, M. (2010), *op. cit.,* pp. 127-146.

[331] Reilly, F.K, Brown, K.C. (2002). *Investment Analysis and Portfolio Management*. Oak Brook, IL: The Dryden Press, Harcourt College Publishers, p. 39.

An insurance company should take into account possible significant changes in the correlation between different products and different business lines, on both sides of the balance sheet. For example, increased liabilities arising from the real property insurance can be correlated with the market or credit risks for securities linked to real property, such as mortgage backed securities.

An insurance company should take into account the source, type and amount of risk assumed by all types of insurance. The mutual influence (interaction) between characteristics of the liabilities from insurance and the funds used to cover those liabilities is one of the most important sources of risk for insurers, and therefore one of the most important aspects of risk management.

Insurance companies employ actuaries who specialize in the field of investment in order to manage their investment strategies. By combining their knowledge related to the characteristics of insurance products with the knowledge on investment alternatives, they may recommend types of investment suitable for different kinds of products.

Actuaries assess the level of risk of different investment decisions in order to minimize risk and enable greater stability of the investment portfolio. The role of the actuaries employed in the business of investing is becoming increasingly important with the size of the investment risk.[332]

5. RISK ASSESSMENT

Given the aforementioned, it is evident that there are risks that have adverse effect on the financial position of a company at every step of the control cycle. In order to ensure its stability, an insurance company should investigate the nature and extent of the risks it is exposed to and ensure effective management of these risks. Actuaries are often involved in risk assessment and risk management processes. They identify specific risks and consider the effects of these risks on the operations of the insurance company.

Risk assessment involves determining the probability and size of potential loss. When modelling and measuring risk, for each hazard, actuaries must pay special attention to key components of risk: variability (volatility) of risk, unreliability of input data and extreme events.

[332] Rakonjac-Antić, T., Kočović, J., Mitrašević, M (2011). Upravljanje rizicima solventnosti i adekvatnosti kapitala osiguravajućih kompanija. *Novi Ekonomist,* No. 10, Faculty of Business Economics Bijeljina, University of East Sarajevo, pp: 45-51.

Volatility is the risk of random fluctuations in the frequency or intensity of independent events.[333]

Unreliability of models and input data is a risk that the model used for assessing claims or other relevant processes is not reliable or that the parameters within the model were not evaluated properly. This risk cannot be diversified, because it cannot be relatively mitigated by increasing the size of the portfolio. The risk of unreliability of the model and data includes three key elements: the risk of an incorrectly designed model, the inadequacy of the risk parameters and the risk of changes in the structure of parameters. The model itself may be incorrect or may not be an adequate description of reality. This can happen when inappropriate probability distribution is selected or when the key factors or relations are wrong. Even if the model is set up properly, the parameters should be adequately assessed. The risk of inadequacy of parameter represents the possibility of error in the assessment, which can occur if the amount of data on which the estimate is based is limited or the observed period does not include some devastating events that should also be taken into account when forming the distribution of model parameters. The structure of parameters may change over time, and that should also be considered when assessing risk.

Extreme events are events with low frequency of realisation and high intensity of damage. It is usually difficult to specify the amount of damages for these events and consequently the level of capital requirement. The risk of extreme events, or events that are beyond normal volatility of cash flows, require special attention because the results of fluctuations can be very extreme and require independent management strategies.

Unlike traditional risk management, where individual risk categories are managed separately, Enterprise Risk Management provides an integrated approach to risk management. Enterprise Risk Management is focused on identifying, assessing, monitoring, and reporting on all external and internal sources of risk affecting the operations of an insurance company.[334] Actuaries have the key role in Enterprise Risk Management control cycle.[335]

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[333] IAA (2004), *op. cit.,* p. 27.

[334] IAA (2009). *Note on Enterprise Risk Management for Capital and Solvency Purposes in the Insurance Industry*. Ottawa: International Actuarial Association, p. 5. (accessed on 3/4/2016 www.actuaries.org.uk).

[335] American Academy of Actuaries (2013). *Insurance Enterprise Risk Management Practices*. Washington, DC: American Academy of Actuaries, (accessed on 3/4/2016 www.actuary.org), pp. 5-6.

Solvency II Directive requires that insurance companies focus on managing all the risks they are exposed to in their operations. The new approach is integrated into the framework of the "Own Risk and Solvency Assessment" (ORSA).
ORSA is focused on three main segments:

- Make sure the insurance company meets the capital requirement in accordance with the regulations.
- Assess the amount of capital it requires
- Multi-year projections of the business plan of the insurer on the basis of various financial and business scenarios, including the assessment of the capital required to ensure solvency for each of the scenarios.

One of the objectives of ORSA is to determine whether the individual risk profile of the company deviates from the assumptions of capital requirement calculations in accordance with regulations. [336]

ORSA is a process of internal risk assessments of a company and as such is incorporated in the strategic decisions of the company. In the assessment, it is necessary to take into account the current and expected risk profile of the company with respect to its business strategies and risk appetite.

6. ASSESSMENT AND FORECASTS OF BUSINESS RESULTS OF AN INSURANCE COMPANY

The possibility of insolvency of an insurer creates the need for an independent financial assessment of the insurer, which is focused on the assessment of solvency and profitability of the insurers. Evaluation of solvency and profitability is based on the items of annual financial reports and must rely on basic accounting principles. Given the characteristics of the business of the insurer, assessment should cover a longer time period.

6.1. Profitability and solvency analysis

Profitability of insurance companies implies achievement of a specific rate of return on invested capital.

Profitability of property insurers is determined by insurance performance statistics (damages and expenses related to settlement of claims, which affect

[336] http://ec.europa.eu/

the price of the product, selection of risk, management of claims, and marketing and administrative expenses) and investment performance.

A very important feature of business operations of non-life insurance companies are profit cycles, a phenomenon related to the way periods of high profitability and periods of unprofitability alternate in the insurance market in a given time interval. They reflect the market and macroeconomic conditions and represent one of the most important factors affecting the stability of a non-life insurance company. Therefore, the ability to predict the insurance cycles is very important in order to minimize fluctuations in operating results of insurance companies.[337]

Solvency of an insurance company indicates that the existing cash assets, together with future cash inflows, will cover future cash outflows. Solvency of an insurance company rests on adequate funds for settling liabilities and covering losses. Solvency is based on good management, appropriate pricing and balancing the risks and the appropriate portfolio of insurance contracts and assets.

Solvency rating of an insurance company is very complex. Since inflows and outflows are uncertain, solvency test is based on an estimate of the probability that the cash flows will be sufficient to cover cash outflows.

For insurers offering property insurance, main sources of solvency risk are the risk of deviation from the estimated value of outstanding claims, the assets risk (mainly resulting from investing in stocks), the pricing risk and the credit risk associated with the possibility that the reinsurer will not be able to meet its obligations. From all the above, the risk of deviation from the estimated value of outstanding claims is typically the largest and most difficult to assess. Given that the margin for claims is often greater than the equity, small changes in reserves can have a powerful impact on capital.

The system for ensuring solvency includes: tariff policy, assessing liabilities (including technical provisions), regulations related to investment funds, defining appropriate forms of capital and required solvency margin. These factors, which also comprise the constituent elements of the actuarial control cycle, are explained in the previous section of the chapter.[338]

[337] Mitrašević, M. (2013). Ciklusi profita na tržištu neživotnog osiguranja. *Novi Ekonomist,* No. 14. Faculty of Business Economics Bijeljina, University of East Sarajevo, pp. 92-96.

[338] Kočović, J., Mitrašević, M. (2010), *op. cit.*

6.2. Experience analysis

A very important element of all previous steps of an actuarial control cycle is to define the factors that will affect future performance indicators. In determining these factors, it is important to have information on previous experience in relation to each of the factors and to be aware of the changes in the environment that could lead to different future experiences than those in the past.

The most important part of the experience analysis is the identification of the causes of deviations from the expected results. This means that this phase is useful not only for making initial assumptions, but also to assess to what extent the actual data correspond with previous assumptions.

The results of this phase allow the company to take corrective actions related to product design, cost, investment strategy etc. This stage can help the company to take appropriate steps to fix the problem and helps it to re-examine the strategic decisions. Such assessments are essential for the identification of risks that may affect the business operations.

The experience analysis phase helps in identifying profitable products and markets, as well as efficient investment strategies. It enables actuaries to review the assumptions used in calculating the price and technical provisions in order to adequately assess the liabilities.

Actuaries are often responsible for the implementation experience analysis phase. They develop methods of analysis, identify and prepare the necessary information and perform the necessary analyses. They interpret the results, and, accordingly, propose measures to be taken. [339]

Based on the above, it can be concluded that the actuarial control cycle represents an integrated approach to risk management of an insurance company that takes into account: the design and price of insurance products; management of assets and liabilities; solvency policy and investment policy. The process must be flexible enough to adapt to changing market conditions and to include an assessment of individual categories in accordance with the regulations and rules of the actuarial profession. This dynamic principle of risk management provides information about the possibility that the company experiences potential negative impacts on profitability as well as for early detection of future insolvency of the insurance company.

[339] Hafeman, M. (2009). The Role of the Actuary. *Insurance primer series on insurance,* Issue 4, (accessed on 3/4/2016 www.worldbank.org/nbfi)

Chapter 28.

POSSIBLE APPROACH TO INTERNAL MODELS FOR OPERATIONAL AND STRATEGIC RISK MEASUREMENT: EXPERIENCE FROM THE REAL SECTOR

The rising importance of non-financial risks in financial institutions has started with the adoption of Basel II and Solvency II regulatory documents, and mandatory provisions concerning capital requirements protecting from the occurrence of those risks. Still, the biggest challenges are yet to be met, as contemporary literature abounds with criticism directed towards standard approaches that act almost in a "one size fits all" manner. On the other side, internal models, presumed to be "tailor made", proved to be expensive and not delivering satisfactory results. The other problem refers to not including strategic risk into risk analysis in a serious manner, due to the fact that it cannot be mitigated via capital charges in the same way as financial and operational risks can.

This chapter deals with possible application of a deterministic scenario approach in the process of developing internal models for measuring exposure to operational as well as to strategic risk. The approach does not lack the weak points but represents a credible option providing some important advantages in the risk measurement process.

1. OPERATIONAL AND STRATEGIC RISK: FINANCIAL VS. REAL SECTOR PERSPECTIVE

The identification and measurement of operational risk became an important issue in the financial industry after the introduction of capital charge for this risk (Basel II and Solvency II documents). The Basel Committee defines operational risk as "the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events."[340] Interestingly, such definition of operational risk is broader than the one commonly used in the real sector (includes legal risk, natural catastrophe risk etc.), but is still logical since it includes all the factors (internal as well as external) which might cause

[340] It encompasses errors, infringements, interruptions, damages etc. caused by internal processes, personnel or systems, or caused by external events.

disruption or failure of everyday operational activities of the bank (see Table 1).[341] Practically, it encompasses all factors jeopardizing normal functioning of the bank. When it comes to strategic risk, it seems that it has not been given equal attention in comparison to operational risk. The deviation is even more notable when compared to financial risk (market and credit risks, above all). Moreover, the Basel Committee definition of operational risk assumes that "the definition includes legal risk but excludes reputational and strategic risk", as if strategic risk could be a part of operational risk.

Table 1. Operational risk components

People	Systems	Processes	External events
Fraud, collusion and other criminal activities	IT problems (hardware or software failures, computer hacking or viruses, etc.)	Execution, registration, settlement and documentation errors (transaction risk)	Criminal activities (theft, terrorism or vandalism)
Violation of internal or external rules (unauthorized trading, insider dealing,etc)	Unauthorized access to information and systems security	Errors in models, methodologies and mark to market (model risk). Accounting and taxation errors	Political and military events (wars or international sanctions)
Violation of internal or external rules (unauthorized trading, insider dealing,etc)	Unavailability and questionable integrity of data	Inadequate formalization of internal procedures. Compliance issues	Changes in the political, regulatory and tax environment (political and regulatory)
Breach of mandate	Telecommunications failures	Breach of mandate. Inadequate definition and attribution of responsibilities	Natural events (fire, earthquake, flood, etc.)

Source: Vuksanović, I. (2015). Uticaj upravljanja rizikom na vrednost preduzeća u elektro-energetskom sektoru. Doctoral thesis, Belgrade: Faculty of Economics, University of Belgrade.

The reasons behind the growing importance of operational risk in banking industry, and particularly, for its dominance over strategic risk, refer to obvious

[341] The Basel Committee recognizes that operational risk encompasses a broad range of risk factors and therefore banks are allowed to use their own definitions of operational risk for internal purposes, provided the minimum elements in the Committee's definition are included.

and concrete high probability risk events including, *inter alia*, the following. Firstly, the risk of system failures becomes more important due to significant investments and bigger reliance of businesses on information systems and technology. Secondly, external fraud and system security issues gain in importance with the rising use of electronic dealing. Thirdly, sophisticated financial instruments open the risk of moral hazard; disloyal traders who can create risk positions whose value and risk are not fully understood by the bank's senior management.[342] Sharma (2002) shows that in addition to the insurance risk, notably the greatest cause of failures in insurance companies, the second place belongs to operational risk.[343]

Regardless of the scope of definition (broader in the financial or narrower in the real sector), operational risk factors in all organizations carry some common peculiarities. Unlike the financial risk that is willingly taken by the organization, operational risk is usually not taken, organizations are forced to live with it. In other words, while financial risk holds both the upside and the downside, operational risk implies only losses (sometimes called “pure risks”), and thus is not consistent with an increasing relationship between risk and expected return. Therefore, in real economy, the internally driven operational risk is labelled “preventable risk”.[344] This is only partially true, the problem already observed in the real sector, especially in the case of state-owned companies.[345] Namely, the cases of wilful taking of certain operational risks (environmental pollution, internal processes malfunctioning, etc.) based on cost/benefit analysis of opportunity costs of taking/mitigating operational risk are not rare. The author only imagines similar cases exist in the financial sector as well. The previous notion influences the manner in which operational risk is managed by an organization. To continue further, unlike financial risk which is

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[342] Sironi, A., Resti, A. (2007). *Risk management and shareholders' value in banking: from risk measurement models to capital allocation policies*. John Wiley & Sons, p. 507.

[343] Sharma, P. *et al.* (2002). Prudential Supervision of Insurance Undertakings. *Conference of Insurance Supervisory Services of the Member States of the European Union.* Brussels: European Commission.

[344] These are internal risks, arising from within the organization, that are controllable and ought to be eliminated or avoided. Examples are the risks from employees’ and managers’ unauthorized, illegal, unethical, incorrect, or inappropriate actions and the risks from breakdowns in routine operational processes. Kaplan, R. S., Mikes, A. (2012). Managing risks: a new framework. *Harvard Business Review*, June, 49-58.

[345] Vuksanović, I. (2015). Osetljivost javnih preduzeća u Srbiji na sistematski i nesistematski rizik: Slučaj JP „Elektroprivreda Srbije“. Scientific conference: *Restrukturiranje javnih preduzeća u uslovima institucionalnih ograničenja*, Belgrade: Scientific Society of Economists, pp. 33-59.

fairly understandable and easily captured due to a broad arsenal of methods and measures, operational risk is often hard to identify and understand in terms of measurement. Finally, having only the downside, it makes access to hedging instruments desirable. Yet, unlike in the case of a financial risk, hedging instruments for operational risk are sporadic. In line with the previous, and for the same reason, operational risk is hard to price and transfer. There are exceptions, notably for the risks that can be insured (natural catastrophe risks).

Strategic risk is a consequence of changing (sometimes turbulent) environment and is related to competition, clients/customers, supply chain etc. In the real sector, strategic risk is considered different from operational risk because it is not inherently undesirable. Namely, a strategy with higher expected returns generally requires taking on proportionally high risk. Managing those risks is a key driver in capturing the potential gains.[346] Unlike the real sector companies, financial institutions see strategic risk rather as a source of potential losses due to decisions or radical changes in the business environment, improper implementation of decisions, lack of responsiveness to changes in the business environment (e.g. a turnaround of the economic trend).[347]

Previous divergence is caused rather by different interpretation of the term. Namely, in banking sector, the credit risk is the same as strategic risk in the real sector. Banks take on higher credit risk for higher return just as companies in real sector invest in risky R&D ventures. Still, it is undeniable that "radical changes in the business environment" do not bring only losses but gains as well. Nevertheless, it is the inappropriate reaction to strategic risk factors that causes losses within organizations. Managing strategic risk requires risk-management systems designed to reduce the probability of losses while improving at the same time the organization's ability to contain the risk events in case of their occurrence. In such context, organizations are enabled to take on higher-risk, higher-reward decisions. In banks, however, it is generally accepted that strategic risk "cannot be mitigated via capital charges"[348], and hence, proper strategic risk management systems do not exist. For this purpose, internal risk culture and risk awareness are promoted.

[346] Kaplan, R.S., Mikes, A. (2012). Managing risks: a new framework. *Harvard Business Review*, June, 49-58.

[347] UniCredit Bank. (2015). *DISCLOSURE BY INSTITUTIONS according to Regulation (EU) No. 575/2013*. Milan: UniCredit Group, p.14.

[348] *Ibid.*

2. OPERATIONAL RISK MANAGEMENT SYSTEMS IN FINANCIAL INSTITUTIONS

With the introduction of regulatory requirements with Basel II and Solvency II documents, the financial industry opened the door for different quantitative models as well as qualitative approaches to measuring operational risk. With the notion that full quantitative approach may never be achieved, many argue that measuring of the operational risk still brings numerous issues that have to be resolved.[349]

Under Solvency II, insurance companies are proposed two approaches in measuring operational risk, the use of Standard or Factor-Based Model or the use of internal model of operational risk measurement. When it comes to the Standard Model, doubts remain as to whether this model really captures the operational risk (and, above all, its diverse nature) the insurance companies face.[350]

Besides the Basic Indicator Approach (BIA) and the Standardised Approach (TSA), which represent rather simplified factor-based approaches that are arbitrary up to a certain level, banks are allowed to install internal operating risk measurement system – the Advanced Measurement Approach (AMA). By applying "one size fits all" approach, the BIA and TSA, just as the Standard Factor-Based approach in insurance industry, do not reflect the organization's true risk profile.

The AMA in banking industry and the internal model proposed by Solvency II in insurance industry share many similarities. The operational risk management system is a structured set of processes, functions and resources for calculating the capital requirement based on four quantitative requirements (internal and external data, risk indicators, and scenario analysis, see Figure 1).[351]

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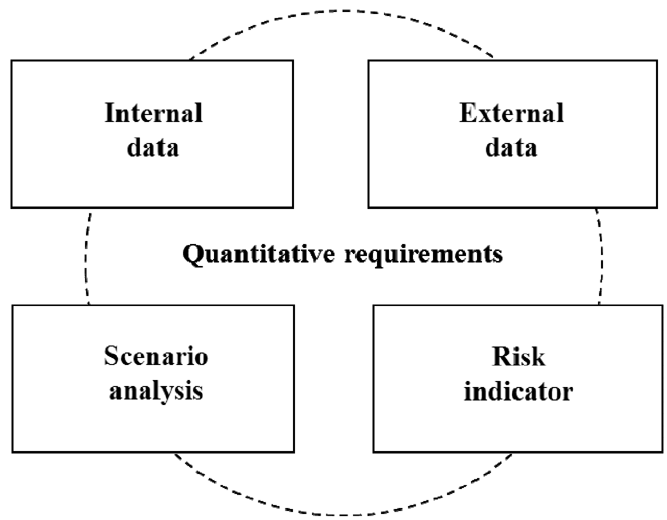
[349] Chavez-Demoulin, V., Embrechts, P., Nešlehová, J. (2006). Quantitative models for operational risk: extremes, dependence and aggregation. *Journal of Banking & Finance*, 30(10), pp. 2635-2658.

[350] Mitrašević, M., Jovović, M. (2012). Measuring non-life insurance risks in the Solvency II concept. *Achieved Results and Prospects of Insurance Market Development in Modern World*, Kočović, J., Jovanović Gavrilović, B., Jakovčević, D. (eds.), Belgrade: Faculty of Economics, University of Belgrade, pp. 331-332; Eling, M., Schmeiser, H., Schmit, J.T. (2007). The Solvency II process: Overview and critical analysis. *Risk Management and Insurance Review*, 10(1), pp. 69-85.

[351] Chernobai, A.S., Rachev, S.T., Fabozzi, F. J. (2008). *Operational risk: a guide to Basel II capital requirements, models, and analysis*. New Jersey: John Wiley & Sons, p. 45.

Internal loss data and external loss data are basically backward looking requirements. As in any other sector, the reliability of measures depends on data quality in terms of completeness, adequacy and accuracy through a correct data classification and loss data collection procedure. On the other hand, due to "lower occurrence frequency-high impact" character of certain operational risk factors, organizations rely on external data (public data or consortia) for operational risk measurement.[352]

Figure 1. Internal operational risk measurement system



Source: Chernobai, A.S., Rachev, S.T., Fabozzi, F.J. (2008). Operational risk: a guide to Basel II capital requirements, models, and analysis. New Jersey: John Wiley & Sons, p. 45

Risk indicators and scenario analysis are forward looking analyses aiming to improve the institution's understanding of its risk profile. By scenario, they assume fictitious operational event (also inspired from an occurred external event).[353] Risk indicators are quantitative metrics reflecting operational risk exposure of specific processes or products; the value of an indicator should be correlated to changes in risk levels.

The internal model approach presupposes the implementation of an internal operational risk measurement model that has to satisfy certain qualitative and quantitative requirements. The Loss Distribution Approach (LDA) and the

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[352] Vuksanović, I. (2015). Uticaj upravljanja rizikom na vrednost preduzeća u elektro-energetskom sektoru. *Doctoral thesis,* Belgrade: Faculty of Economics, University of Belgrade, p. 181.

[353] Events range from an electricity outage, computer viruses entering the company's network to a regulatory authority fines, penalties and lawsuits for unfair employment treatment and so on.

Scenario-Based Approach (SBA) are most commonly used for this purpose. LDA is based on the estimation of the probability distribution of loss data, while SBA is based on expert opinions and judgements. Characteristics of LDA and SBA are provided in the Table 2 and 3, respectively.

Table 2. Loss Distribution Approach characteristics

Characteristic	Description
Specific of Calculation dataset	It is necessary to have a complete and certified loss data collection. Data needs to be filtered and elaborated in respect with the criteria defined by the calculation dataset.
Specification of the granularity of the model	Loss data must be split in homogeneous categories that should respect the hypothesis of independency and identical distribution.
Estimation of the severity loss distribution	For each risk class the probability distribution of loss is calculated. Usually parametric models are used. Parameters are estimated on loss data belonging to risk classes, analyzed throughout the available methodology.
Estimation of the frequency loss distribution	For each risk class the probability distribution of the annual losses frequency (usually Poisson distribution) is calculated.
Risk classes aggregation	The loss distributions of each risk class are aggregated in order to obtain the aggregated distribution of the yearly losses.
Capital at risk calculation	The Capital at risk is calculated considering one year as time horizon and a 99.9% confidence level.

Source: Based on Chernobai, A.S., Rachev, S.T., Fabozzi, F.J. (2008). Operational risk: a guide to Basel II capital requirements, models, and analysis. New Jersey: John Wiley & Sons, p. 45.

A Scenario-Based Approach has a twofold tenet: 1) to highlight top risks, mitigation strategies, and actions for further mitigation; 2) to assess the maximum impact of very extreme and rare events representing the worst case scenarios. Scenario analysis is a durable process consisting of several phases (see Figure 2).[354]

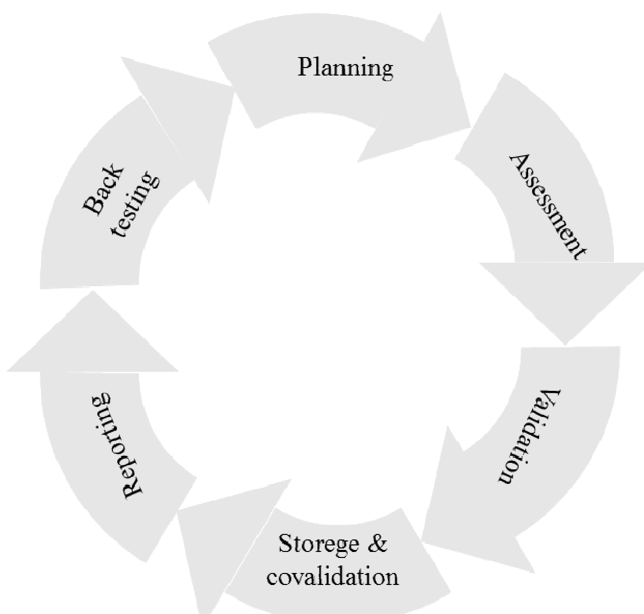
[354] UniCredit Bank. (2015). *DISCLOSURE BY INSTITUTIONS according to Regulation (EU) No. 575/2013*. Milan: UniCredit Group, p. 221; KPMG. (2011). *Preparing for unexpected. Leading practices for operational risk scenarios.* ORX Association, p. 3.

Table 3. Scenario-Based Approach

Characteristic	Description
Scenario generation	It is necessary to have a scenario list, belonging to operational risk, for an expert evaluation. This list must contain all the event types found in the banking activity.
Scenario evaluation	For each scenario, an expert able to provide an evaluation of the probability of the event and its potential impact, starting from yearly average frequency, maximum frequency and severity approximation, is identified.
Data quality control	Scenario evaluations should be verified, for example comparing them with actual losses or with previous evaluations.
Parameter estimation	Scenario evaluations are converted in statistical parameters that are used to evaluate severity and frequency distribution.
Parameterization of the model	Estimated parameters are used as input in the model calculation and obtained distributions are aggregated by Montecarlo methods in order to get the overall annual loss distribution.
Capital at risk calculation	As with LDA models, the capital at risk can be calculated as VaR with a confidence level of 99.9%.

Source: Based on Chernobai, A.S., Rachev, S.T., Fabozzi, F.J. (2008). Operational risk: a guide to Basel II capital requirements, models, and analysis. New Jersey: John Wiley & Sons, p. 47.

Figure 2. Scenario analysis - process flow



It is expected that development of cost-effective but reliable internal models of risk measurement will be a difficult endeavour. Still, it is also expected that in the future, the regulator will encourage financial institutions more to develop their own risk measurement model, given that the standard, factor-based approaches do not fit all.[355]

3. DETERMINISTIC SCENARIO APPROACH - DEVELOPING INTERNAL MODELS BASED ON REAL SECTOR EXPERIENCE

Deterministic scenario approach can be applied to both operational as well as strategic risk management in financial sector. Indeed, deterministic approach offers new perspective to the already existing scenario approach in operational risk management. This is, also, in accordance with the rising expectations from the regulator's side concerning better understanding of the operational risk than currently provided.[356] On the other side, this approach might provide an *ad hoc* but reliable risk management framework for strategic risk management, requiring few additional resources and practically functioning as an upgrade for existing operational risk scenario analyses.

Unlike stochastic scenario analysis[357], designed in a way to generate huge number of random scenarios without human intervenance in the process, deterministic approach presumes the creation of a definite number of scenarios for each risk based on experts' opinion. Such approach is actually most suitable for operational and strategic risk. For example, the risk of inadequate strategy implementation or failed processes cannot be described by probability distribution generated based on an adequate number of historical data.[358]
In deterministic scenario approach, it is most common to present possible range of impacts from extremely optimistic to extremely pessimistic ("worst case") scenario, with the basic scenario in the middle. For the downside risks such as operational risk, only pessimistic scenarios can be determined apart from the

[355] Eling, M., Schmeiser, H., Schmit, J.T. (2007). The Solvency II process: Overview and critical analysis. *Risk Management and Insurance Review*, 10(1), pp. 69-85.

[356] Ernst&Young. (2008). *Measuring operational risk*. EY

[357] Stochastic scenario approach always requires certain automatization. The prerequisites for stochastic analysis is a formula containing inputs and output, probability distribution for each input and random number generator.

[358] Measuring of strategic risks cannot rely on externally (not even internally) available historical data, because strategies are always unique, and even change in the same organization over time.

baseline scenario (e.g. natural catastrophe risk).[359] Creation of these scenarios assumes engagement of the relevant personnel and implementation of various techniques.[360]

FMEA is an example of quite straightforward and useful technique based on numerous interviews with the key persons from the relevant risks' areas (e.g. reporting, IT system etc.).[361] The interviewees provide the input in terms of probable impact and event probability. The majority of strategic and operational risks allow for these estimates:

- The impact on organization's revenues
- The impact on organization's costs
- The impact on organization's risk profile.

The deterministic scenario approach is suitable for measuring operational and strategic risk in a financial organization, especially because financial organizations, as well as regulator, recognize those risks as the amalgams of various risk factors acting sometimes independently, sometimes in concert.
As in the case of a stochastic scenario approach, a deterministic scenario approach requires certain formula containing all the relevant inputs (operational and/or strategic risk factors) and final output, representing certain performance measures across which all risk factors demonstrate their impact. The analysis is usually divided into two stages: individual risk exposure and aggregate risk exposure. Measuring aggregate operational and strategic risk requires automatization and implementation of appropriate simulation programmes.
In the case of a deterministic scenario approach, simulations are not random but carefully chosen. Unlike stochastic scenarios, aggregate risk exposure reflects only those pictures of the future that are reasonably considered plausible. Each simulation can be regarded as a vector of relevant risk factors, where each vector position resembles the chosen scenario (from extremely optimistic to extremely pessimistic) of the relevant risk event:[362]

$Simulation_i=(Risk_1Scen_i, Risk_2Scen_i, \ldots Risk_nScen_i)$.

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[359] For the risks that lack optimistic scenarios, pessimistic scenarios are defined with more nuances.

[360] Segal, S. (2011). *Corporate Value of Enterprise Risk Management - The Next Step in Business Management*. New Jersey: John Wiley & Sons, p. 193.

[361] FMEA could be incorporated into Risk and Control Self-Assessment methodologies in financial institutions.

[362] Segal, S. (2011). *Corporate Value of Enterprise Risk Management - The Next Step in Business Management*. New Jersey: John Wiley & Sons, p. 210.

Where i is the number of simulation, $Risk_xScen_i$ is the scenario for the risk x chosen for the simulation i, and n is the number of relevant risks.

The number of simulations gets big even with a small number of relevant risks. Hence, it is important to chose a set of simulations that provides reliable representation of the risk exposure, which is sufficiently robust as well as stable.[363]

Choosing an appropriate set of simulations assumes the following:[364]

- Defining optimal duration of the risk exposure estimation process (between 6 hours and one day),
- Defining maximum number of simulations (depends on duration, depends on the number of simulations per hour),
- Defining the number of simulations that guarantees achieving stability.

The initial number of simulations can be chosen by using some stochastic technique.[365] Additional set can be chosen to check if the risk exposure results stay within the predetermined tolerance zone, meaning if the stability is attained. In the case of significant deviation of results, the initial number of simulations gets bigger until stability is finally reached.

The probability of each simulation depends on probabilities of individual risk scenarios and correlation between them.[366] Namely, the probability of a simulation is obtained by multiplying the individual scenario probabilities, assuming the absence of correlation in the first stage, and multiplying the attained probability with correlation adjustment factor (CAF) in the second stage:[367]

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[363] It means that the number of simulations is big enough to provide accuracy and reliability, in a way that additional simulations do not change substantially attained risk exposure, which means that stability is reached.

[364] Segal, S. (2011). *Corporate Value of Enterprise Risk Management – The Next Step in Business Management*. New Jersey: John Wiley & Sons, pp. 211-212

[365] We should underline once again that the role of stochastic tools remains in the area of determining the initial set of scenarios representing a single simulation, yet not in the process of generating those scenarios.

[366] Correlation between scenarios can be included in various ways. If the correlation between the risks is directly observable, the impact of a certain risk (its scenarios) is calculated including the impact the other risks that are in correlation with it exert on the chosen performance measure. Yet, the correlation among risks sometimes exists only in the extreme scenario zone.

[367] Calculation of the CAF requires simplicity. In that way, pretentious attempts to entirely describe the relation between the risks, endeavors almost invariably

$P(Simulation_i)=P(Risk_1Scen_i) \cdot P(Risk_2Scen_i) \cdot ... \cdot P(Risk_nScen_i) \cdot CAF.$

CAF represents the product of individual pairwise correlation adjustment factors (IPCAF) between scenarios of the risks among which correlation is identified:[368]

$CAF=IPCAF_{Risk1SceniRisk2Sceni} \cdot IPCAF_{Risk3SceniRisk4Sceni...} \cdot ....$

Where $IPCAF_{RiskxSceni,RiskzSceni}$ represents the individual correlation factor for the emergence of scenario *i* for the risk *x* and scenario *i* for the risk *z*.

IPCAF is determined having in mind the following guidelines:

1) IPCAF > 1 for the positive correlation between scenarios,
2) IPCAF = 1 in case of no correlation,
3) 0 < IPCAF < 1 in case of mild negative correlation,
4) IPCAF = 0 in case of strong negative correlation.

Correlation factors principally serve for incorporating in the model the existing relation between the risk scenarios (tendency or lack of tendency to occur at the same time). It is, however, a highly arbitrary measure. However, regardless its inexactness, the CAF provides certain embodiment of the direction of the interdependency.

A deterministic scenario approach has several advantages in comparison to the stochastic scenario approach:[369]

Firstly, deterministic scenarios can be more robust. Ex post consideration and inclusion of the additional variables leads to higher reliability of the scenarios.

Secondly, deterministic scenarios are more precise. Bigger precision can be attained with elimination of biases and errors, elimination of implausible scenarios, as well as with better prediction of extreme scenarios. Unrealistic scenarios are more common in the stochastic scenario analysis, particularly in case of strategic and operational risks, due to interpolation in the absence of

impossible, are avoided. Segal, S. (2011). *Corporate Value of Enterprise Risk Management – The Next Step in Business Management*. New Jersey: John Wiley and Sons, p. 212.

[368] *Ibid,* p. 213.

[369] Vuksanović, I. (2015). *The impact of risk management on company value in energy sector.* Faculty of Economics, University of Belgrade, doctoral dissertation, pp. 283-285.

enough data for generating probability distribution. In reality, operational and strategic risk events sometimes have only two discrete states (full occurrence or no occurrence). In such cases, interpolation causes unrealistic scenarios. Furthermore, stochastic scenario models received certain unpopularity after 2008 financial crisis, notably due to the failure in predicting extreme scenarios in the tail of a distribution.

Thirdly, a deterministic scenario approach fosters creation of a risk culture because it inolves a bigger number of people, as developing of the risk scenarios requires information and knowledge of the individuals closely tied to risk. People's involvement in the risk measurement process leads to the active thinking about risk in the organization, especially strategic and operational risk.

Fourthly, a deterministic scenario approach provides better decision support. Deterministic scenarios possess higher transparency for managers. In addition, they are more stable since they do not change each time the model is activated again.

Finally, the deterministic scenario approach provides a simple but reliable way of determining an organization’s risk appetite for operational risk management, on aggregate as well as on individual risk factor level. This is of significant importance, since it is expected from the regulators to require the financial institutions to demonstrate clearly their risk appetite (and related tolerance levels) for all operational risk components. The previous approach provides solutions to those requirements.

The experience from the banking industry indicates low satisfaction rate concerning implementation of internal models of risk measurement. The reasons behind are high costs of implementation along with low perceived rate of return on those investments. On the other side, standardized approaches are blamed for not reflecting the true risk profile of an organization applying it. Consequently, while potential benefits from an adequate operational risk management are undisputable, the optimal approach to it remains unclear.

The deterministic scenario approach described previously represents a possible way of capturing true risk profile in a relatively straightforward manner. Industry specifics must be incorporated, of course, but the basic idea remains. The entire process of risk capturing, simulations and risk measurement can be programmed. The experience from the financial industry indicates that creating more rigorous internal models will be significant endeavour given the lack of internal data. Yet, creation of deterministic scenario models represents the first step in a possibly good direction the financial institutions could undertake.

Also, it is in line with the expectations of the regulators about higher understanding of the operational risk regardless of the approach to its measurement.

In the end, we can presume that it is not impossible for regulators to give higher significance to strategic risk in the near future (just in the manner they made operational risk become very important after 2000) regardless of the fact it is currently acknowledged that it cannot be mitigated via capital charge.

Chapter 29.

IMPLEMENTATION OF ORSA REPORT IN SOLVENCY II PREPARATION PHASE

The European Union has been facing outdated and fragmented insurance regulatory and supervisory framework for decades. The Solvency I Directive is not risk-sensitive, it contains a few quality requirements related to risk management and business operation of insurance companies and therefore does not provide the supervisors adequate information about underwriting process. The new European legislative framework is based on risk and strengthens protection of the insurance beneficiary, by using the latest development trends in risk-based supervision, actuarial science and risk management. Solvency II encourages insurance companies to explicitly define their own risk tolerance and risk profile and requires the board members to make their business decisions bearing in mind their consequences to the economic capital.

Solvency II is the new regulatory framework for overall business operations of insurance and reinsurance companies in the European Union, revising the current capital requirements, and introducing new, more strict rules of solvency, risk management and supervision process based on risks and the new method of reporting and disclosing, all for the purpose of protecting policy holders and insurance beneficiaries and preventing disruption of the insurance market. Financial stability and fair and stable markets are the goal of the insurance and reinsurance regulations that also need to be considered.

Under Solvency II capital requirements are set based on insurance or reinsurance companies risk profiles, taking into account the governance method, i.e. the efficiency of insurance and reinsurance companies in managing the risks they are exposed to.

By Serbian Insurance Law from 2014, Solvency II regime will be implemented in the moment Serbia joins European Union. Until Solvency II full implementation, Serbian insurance companies should prepare themselves step by step for transition from Solvency I to Solvency II regime. One of important step is ORSA report. This chapter will have in focus an ORSA report, will give explanation for Forward Looking Assessment of Own Risks based on the ORSA principles and will show practical aspects of writing ORSA report in Solvency II preparation phase.

1. ORSA

The major principles the Solvency II is based on are:

- a requirement of the overall balance sheet and a consistent evaluation of assets and liabilities in order to have realistic basis for risk assessment
- two capital requirements (Minimum Capital Requirement – MCR and Solvency Capital Requirement – SCR) which ensure the risk-based calculation, but also a stronger and simpler foundation for the final action of the supervisory agencies, an updated access to group supervision with specified group solvency requirements and clear responsibilities of the supervisor
- robust business operation system, including the definition of the number of key functions
- Own Risk and Solvency Assessment (ORSA) which is now considered as international best practice for supervisory agencies reporting templates which are in line with the laws of the European Union and enhanced public disclosure.

In contemporary macroeconomic reality the use of risk-based approach and basic principles of Solvency II are necessary drivers of change. European Insurance and Occupational Pensions Authority (EIOPA) shall observe closely any unwanted material consequence of implementing Solvency II, especially a negative impact on insurance beneficiaries.

Solvency II has a three pillar approach. Pillar 1 refers to the insurance of adequate financial resources of insurance and reinsurance companies and includes quantitative requirements which include determining own funds, technical reserves calculation, evaluation of assets and liabilities, and calculation of Solvency Capital Requirement and Minimum Capital Requirement. Pillar 2 refers to the implementation of adequate governance of insurance and reinsurance companies, so that it includes qualitative requirements for establishing efficient governance system, governance system key functions, Own Risk and Solvency Assessment implementation and process of supervision over insurance and reinsurance companies based on forward-looking and risk-based approach. Pillar 3 of Solvency II includes new rules of reporting to the supervisory authority, public disclosure and market discipline.

Own Risk and Solvency Assessment consists of insurers' procedures and processes for identification, assessment, management and reporting about the risk the company may face, in order to set the required funds for providing complete solvency of the company. ORSA must take into account business strategies[370], i.e. how the strategies are set in terms of risk appetite and current risk profile (all the key risks the insurer faces) and to assess the amount of capital required to run business operations during a scheduled timeframe of several years, as well as SCR and the adequacy of own funds. Each insurer is required to implement ORSA on a regular basis. ORSA is not the same as internal model – its scope is wider than that of the internal model. In the process of implementing ORSA each company must set up the ORSA policy, internal documents, and documentation for the supervisor and for the public.

The area that requires special implementation efforts are the qualitative requirements of Solvency II, such as Own Risk and Solvency Assessment. The assumption[371] is that the insurance companies will be focused on capital requirements, whereas ORSA will come second on their list of priorities. That is a big mistake, because when reducing risk it is wrong to consider only required capital. The capital cannot cover deficiency of good management! One of the crucial principles of Solvency II is an integrated consideration of risk and capital. In new legislation Own Risk and Solvency Assessment is important management tool which connects risk management and capital management.

When considering "overall solvency needs" as a part of ORSA, the companies should consider their risk profile, the established risk tolerance limit and business strategy. In addition, ORSA must present the risk mitigation techniques which the companies intend to use in order to manage the risks they are exposed to.

Therefore, the basis of ORSA is not regulatory requirements. On the contrary, Own Risk and Solvency Assessment is based on each company's DNA, i.e. its business strategy. ORSA enables insurers to determine the adequacy of their regulatory capital position, and therefore can help the management to control its liability so they do not accept too much risk, more than their capitals allow. Also, it is expected that determining "overall solvency needs" within ORSA will facilitate a number of important strategic decisions, such as defining risk retention level, capital management optimization methods and setting adequate levels of premium. Effective ORSA can also provide useful insight into the efficiency of capital in management's future business activities and the enable companies to estimate the efficiency of long-term capital of certain products and help creation of new insurance policies.

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[370] Ilić, M. (2014). Uticaj primene direktive Evropske unije „Solventnost II" na sektor osiguranja u Srbiji. *Doctoral thesis.* Niš: Faculty of Economics, University of Niš.

[371] Bernardino, G. (2015). Solventnost II nije savršen regulatorni okvir, ali... *Svijet osiguranja,* No. 9/2015.

ORSA is a shift in management culture which must start from the top. It requires a lot of time, dedication and especially, clear instructions from the top. That is why top management has the crucial role in ORSA implementation. It is their job to establish, communicate and implement a strong risk culture which consistently affects, dictates and adjusts to the business strategy and goals, and thus supports the setup of the framework and process of own risk management. The implementation of ORSA is an excellent opportunity to additionally establish a strong risk culture into insurers' daily business operations, simultaneously allowing time for adequate balance with sales culture. Actually, when establishing a risk culture, an important element is to make sure the analysis of risk and its effects on the capital are explicitly taken into account when strategic decisions of the company are being made. If done properly it brings investment, otherwise it produces costs.

The EU Directive, adopted by the European Parliament in December 2013, set the deadlines for application of Solvency II. The deadline for transposition of provisions of Solvency II Directive into national legislations of the European Union member states was March 31, 2015, and the deadline for implementation of Solvency II to the insurance and reinsurance companies' business operations was January 1, 2016. The Directive 2014/51/EU Omnibus II complements the Solvency II Directive regarding the powers of a new supervisory authority EIOPA.

2. GUIDELINES ON FORWARD LOOKING ASSESSMENT OF OWN RISKS BASED ON THE ORSA PRINCIPLES

EIOPA issues Guidelines (document code EIOPA-CP-13/09) addressed to national insurance regulators on how to proceed in the preparatory phase leading up to the application of Solvency II Directive. During interim phase insurance companies will need to meet the interim Solvency II requirements in addition continuing to comply with existing Solvency I requirements.

In EU this phase is finished and Solvency II full implementation already started, but in Serbia, these interim requirements will be the first next step in implementation of Solvency II regime.

These Guidelines should be seen as preparatory work for Solvency II by fostering preparation with respect to key areas of Solvency II in order to ensure proper management of insurance and reinsurance companies and that supervisors have sufficient information at hand. These areas are the system of governance, including risk management system and a Forward Looking

Assessment of Own Risks based on ORSA principles, pre-application for internal models, and submission of information to insurance supervisor.

Table 1. List of Guidelines on Forward Looking Assessment of Own Risks Based on the ORSA Principles

1.	General provisions for Guidelines
2.	Progress report to EIOPA
3.	Applicability of the threshold for the Forward Looking Assessment of Own Risks
4.	Proportionality
5.	Role of the administrative, management or supervisory body: top-down approach
6.	Documentation
7.	Policy for the Forward Looking Assessment of Own Risks
8.	Record of each Forward Looking Assessment of Own Risks
9.	Internal report on the Forward Looking Assessment of Own Risks
10.	Supervisory Report of the Forward Looking Assessment of Own Risks
11.	Valuation and recognition of the overall solvency needs
12.	Assessment of the overall solvency needs
13.	Forward-looking perspective of the overall solvency needs
14.	Regulatory capital requirements
15.	Technical provisions
16.	Deviations from assumptions underlying the SCR calculation
17.	Link to the strategic management process and decision making framework
18.	Frequency
19.	Scope of group Forward Looking Assessment of Own Risks
20.	Reporting to the supervisory authorities
21.	Assessment of the impact of group specific risks on overall solvency needs
22.	General rule for group Forward Looking Assessment of Own Risks
23.	Specific requirements for a single Forward Looking Assessment of Own Risks' document
24.	Internal model users
25.	Integration of related third-country insurance and reinsurance undertakings

Source: EIOPA (2013). Guidelines on Forward Looking Assessment of Own Risks (based on the ORSA principles). EIOPA/13/09, Frankfurt: European Insurance and Occupational Pensions Authority.

There are 4 chapters in Guidelines:

I: General provisions for preparatory guidelines
II: Forward Looking Assessment of Own Risks
III: Specific features regarding the performance of the Forward Looking Assessment of Own Risks (based on the ORSA principles)
IV: Specificities of the group in the Forward Looking Assessment of Own Risks (based on the ORSA principles)

As part of the preparation for the implementation of Solvency II, national insurance supervisor should put in place from some date, a few years before full Solvency II implementation deadline, the Guidelines as set out in this document so that insurance and reinsurance companies take appropriate steps to full implementation of Solvency II.

In the preparatory phase national insurance regulators are expected to ensure that insurance and reinsurance companies take a forward looking view on the risks to which they are exposed similar to what they will have to do once Solvency II will apply. For this, it is expected that insurance and reinsurance companies actively prepare and begin the implementation of the Forward Looking Assessment of Own Risks (based on the ORSA principles) according to Article 45 of Solvency II Directive.

Since the assessment of the overall solvency needs can be undertaken irrespective of what regulatory quantitative requirements are applicable (Solvency I or II), national insurance regulator are expected to ensure that insurance and reinsurance companies perform such an assessment immediately.

The assessment of the continuous compliance with regulatory capital requirements and the requirements on technical provisions according to Solvency II Directive and the assessment of the significance of the deviation of the risk profile of an undertaking from the assumptions underlying the calculation of the SCR have a strong connection to Solvency II quantitative requirements which are not yet applicable during the preparatory period.

The Guidelines focus on what is to be achieved by this assessment rather than on how it is to be performed. For example, since the assessment of overall solvency needs represents the company's own view of its risk profile, and the capital and other means needed to address these risks, the company should decide for itself how to perform this assessment given the nature, scale and complexity of the risks inherent in its business.

It is crucial that the administrative, management or supervisory body (AMSB) of the company is aware of all material risks the undertaking faces, regardless of whether the risks are captured by the SCR calculation and whether they are quantifiable or not. It is also vital that the AMSB takes an active role in the Forward Looking Assessment of Own Risks by directing the process and challenging the outcome.

The Guidelines apply to both individual company and at the level of the group. Additionally, the Guidelines address issues relevant to the group specificities of the Forward Looking Assessment of Own Risks.

Duties[372] in Forward Looking Assessment of Own Risks Based on the ORSA Principles:

1. Insurance supervisor should:
   - Require insurance companies representing at least 80% of the market share to perform an assessment of whether companies would comply on a continuous basis with the Solvency II regulatory capital requirements and the requirements on the technical provisions;
   - Send to EIOPA, a progress report on the application of these Guidelines.

2. Insurance companies should take the appropriate steps to:
   - Establish a process to develop a Forward Looking Assessment of Own Risks and compile qualitative information supporting the Forward Looking Assessment of Own Risks that will allow insurance supervisor to review and evaluate the quality of the process;
   - Develops own processes with appropriate and adequate techniques, tailored to fit into its organizational structure and risk-management system;
   - Have at least the following documentation:
     - The policy for the Forward Looking Assessment of Own Risks should include at least:
       - A description of the processes and procedures in place to conduct the Forward Looking Assessment of Own Risks;
       - A consideration of the link between the risk profile, the approved risk tolerance limits and the overall solvency needs;
       - Information on how and how often stress tests, sensitivity analyses, reverse stress tests or other relevant analyses are to be performed, data quality standards, the frequency of the assessment itself and the justification of its adequacy particularly taking into account the risk profile and the volatility of its overall solvency needs relative to its capital position and the timing for the performance of the forward looking assessment;
     - Record of each Forward Looking Assessment of Own Risks
     - An internal report on each Forward Looking Assessment of Own Risks

[372] http://www.hanfa.hr

- A supervisory report of the Forward Looking Assessment of Own Risks should present at least the following:
  - The qualitative and quantitative results of the forward looking assessment and the conclusions drawn;
  - The methods and main assumptions used;
- A comparison between the overall solvency need, the regulatory capital requirements and the company's own funds;
  - Explains how the use of different recognition and valuation bases ensures better consideration of the specific risk profile if it uses recognition and valuation bases that are different from the Solvency II bases;
  - Assesses its overall solvency needs and then expresses it in quantitative terms and identify material risks to a sufficiently wide range of stress test or scenario analyses;
  - Assessment of the overall solvency needs is forward-looking, including a medium term or long term perspective;
  - Analyses whether would comply on a continuous basis with the Solvency II regulatory capital requirements;
  - Ensures the actuarial function of the undertaking to provide input as to whether the company would comply continuously with the requirements regarding the calculation of technical provisions and identify potential risks;
  - Assesses whether its risk profile deviates from the assumptions underlying the Solvency II Solvency Capital Requirement calculation;
  - Takes into account the results of the Forward Looking Assessment of Own Risks and the insights gained during the process of this assessment in at its capital management, business planning product development and design;
  - Performs the Forward Looking Assessment of Own Risks at least annually.

3. Group of insurance companies should take the appropriate steps to:
   - Designs the group Forward Looking Assessment of Own Risks to reflect the nature of the group structure and its risk profile;
   - Assesses in the assessment of the group overall solvency needs the risks of the business in third countries in a consistent manner;
   - Adequately assesses the impact of all group specific risks and interdependencies within the group;
   - Includes in the record of the group Forward Looking Assessment of Own Risks at least a description on how the following factors were taken into consideration:
     - The identification of the sources of own funds within the group;

- The assessment of availability, transferability or fungibility of own funds;
- References to any planned transfer of own funds within the group;
- Alignment of individual strategies with the ones established at the level of the group;
- Specific risks the group could be exposed to;

- Provides an explanation of how the subsidiaries are covered;
- Describes which entities within the group do not use the internal model to calculate their SCR and explain why in the case of an internal model pre-application.

4. Insurance group supervisor should form a view whether to allow the group to perform a single Forward Looking Assessment of Own Risks document and decide about language which will be used in ORSA.

As preparation for Solvency II ORSA report, this forward looking process report should contain[373]:

- a description of processes and procedures in place,
- consideration of the link between the risk profile, the approved risk tolerance limits and the overall solvency needs,
- information on frequency of analyses and tests,
- data quality standards,
- justification of its adequacy,
- the frequency of the assessment,
- the timing of the assessment, including the circumstances in which an ad-hoc assessment is required.

All companies are faced with a number of key challenges to prepare that report. Some of the most difficult[374] are: projection of balance sheet and capital requirements, demonstration of continuous compliance and process documentation.

3. ORSA REPORT

Solvency II regulation don't provide structure of ORSA report. Also, there are no rules about obligatory and optional content of report. Idea of EIOPA is to

[373] Munich Re (2013). *EIOPA's view on Forward-Looking Assessment of Own Risks (FLAOR).* München: Münchener Rückversicherungs-Gesellschaft.

[374] Milliman (2013). Key challenges of producing a Forward Looking Assessment of Own Risk. *Solvency II Update,* Amsterdam: Milliman.

allow every company to make report tailored by own needs. This chapter will show one of possible implementation of an ORSA report, which is not fit for any specific company, but should help for better understanding of ORSA requirements. ORSA report should include following: governance statement of risk management system, risk governance and management, including related assessment and improvement areas, business strategy update, risk strategy and verification of its adequacy, risk measurement and models results, including the main risk identification and assessment.

An ORSA report could have following chapters:

1. Prolegomenon
2. Risk management
3. Business strategy
4. Risk strategy
5. Risk measurement
6. Forecast solvency position

3.1. Prolegomenon

Possible content of the first chapters could be confirmation statement, ORSA objectives and scope. Compliance with local solvency regulation and company's risk legislation should be mention here. Here is good place to be quoted appropriate parts of company's risk policy and risk management strategy.

Executive Summary Confirmation Statement[375]

This part should provide an overview of the high level strategy in context of the overall risk profile. Management should be able to confirm that:

- The current risk profile is understood and appropriate for the nature of the business and within the risk appetite of the firm
- Syndicate capital requirements and technical provisions during the reporting period have continuously been met or if not appropriate action was taken
- The syndicate's current point in time capital and solvency position is appropriate
- The dynamics that could likely change the risk profile are understood
- Capital plans to meet the solvency position projected over the required planning period are appropriate including under stressed conditions

[375] Lloyd's (2010). *Solvency II detailed guidance notes, Section 9 - ORSA*. London: Lloyd's, http://www.lloyds.com.

ORSA Objectives

The most important objective of this ORSA Report is to provide company's management with the overall Risk Profile, the Solvency Ratio, results of the main risk assessments, etc.

Company's risk profile and risk assessment methodology is always in scope of this report. Since in Solvency II preparation period there is no standard formula calculation, company's current capital position determined through existing Solvency I model is very important part of ORSA report.

3.2. Risk Management

Company Structure and Corporate Governance

Organizational chart of the company should be disclosed and especially emphasized 4 risk control functions, introduced by Solvency II: Internal audit, Compliance, Actuarial Function and Risk Management. It is good to list risk owners within company and describe of main governance bodies: Management Board, Risk Committee, etc. key activities.

An example of Actuarial Function key activities[376]: "Actuarial function is responsible for the calculation and validation of the technical provisions, for the adequacy of the mathematical provision and other reserves, as well as the adequacy of the tariffs."

Risk Governance and Management

Risk management function is responsible for:

- Managing risk policies and guidelines,
- Defining and coordinating Risk Management activities,
- Implementation of the risk assessment methodologies,
- Measuring, monitoring and reporting the Risk Profile,
- Defining, modifying and managing key decisions within the Risk Management function,
- Supporting the risk owners in measuring and mitigating their risks,
- Reporting, etc.

[376] Generali osiguranje d.d. Zagreb (2015). *Own risk and Solvency assessment (ORSA) report*. Zagreb: Generali osiguranje.

Company should disclose the last material change of the risk profile and actions management has taken to keep within risk appetite.

Management is entitled to provide independent validation of ORSA process.

Risk Profile

Material exposure, concentration, mitigation and sensitivity of risk are parts of the risk profile. Key internal and external risks should be identified and future risks forecasted within planning horizon of a few years. Also summary of all instances of breaches of risk appetite should be disclosed and how the risk strategy changed as a result of it.

Data Quality

Fulfillment of some of following data quality requirements[377] is important to be assessed:

- Embed a system of data quality management across the entity,
- Define and monitor processes for identification, collection, transmission, processing and retention of data,
- Ensure data processing from source to model is transparent and demonstrable,
- Establish a data policy which sets out the entity's approach to managing data quality,
- Perform periodic data quality assessments, and implement a process for identifying and resolving data deficiencies,
- Document instances where data quality may be compromised, including implications and mitigating actions,
- Establish a process to manage changes or data updates which materially impact model outputs, etc.

3.3. Business Strategy

Business Plans

Macroeconomic parameters of the country and development trend of insurance market are basis for a realistic business strategy. Mentioned details together with company's business plans by line of business should be described in this chapter.

[377] EY, *Solvency II and EIOPA requirements in relation to data*, http//:www.ey.com.

The company's long term strategy especially about reinsurance is very important for risk mitigation. Investment strategy also should be disclosed to be able to understand future assets portfolio changes and related risks.

Company Planning Process

Description of planning process from target setting phase to monitoring process with defined responsible company's functions and deadlines should be in this section of ORSA report.

3.4. Risk Strategy

Risk Appetite

Risk appetite represents selection of risks which company prefers to take or to avoid. This section mandatory contain risk appetite statement. Company's risk preferences should be listed and shortly described to support understanding of risk appetite. Risk metrics and targets are also part of this part of ORSA report, e.g. Solvency Ratio target lower than some level.

Risk governance documents

Full internal and external regulation of risk governance should be listed here. List of documents contains international standards, local law and sub-law acts, company's guidelines and procedures, etc.

Link between Risk Profile, Risk Appetite and solvency

Considerations of the link between the Risk Profile, the approved risk tolerance limits and the overall solvency needs should be written in this section.

3.5. Risk Measurement

This section is the most important and has the greatest volume of ORSA report in Solvency II regime. It should contain Solvency II Ratio, Eligible Own Fund, output from Standard Formula calculation, impact of different risks on Standard Formula results, different type of risk analysis, Liability Adequacy Test for life insurance and Best Estimate Liability calculation of technical reserve in non-life insurance, etc. Also result of stress tests and all details about scenarios and their impact of company's results should be here.

Since Serbia is still in Solvency I regime, Standard Formula calculation could not be implemented. This part of report should disclose Solvency I Ratio and other similar calculations, as insurance provision adequacy, checking impact on company's result of some scenarios, etc.

3.6. Forecast Solvency Position

Last chapter is devoted to capital and liquidity plans, including contingency plans under base case and prescribed stress and scenarios. Projected capital and solvency position should be estimated over planning period, e.g. 3 years.

3.7. Future development of ORSA Report in Serbia

After EU joining, Serbia will implement full Solvency II regime and ORSA Report requirements will move to EIOPA Guidelines on Own Risk and Solvency Assessment (document code EIOPA-BoS-14/259). Under new regime, ORSA Report will be more complicated, but much more useful for all stakeholders.

The supervisory authorities' main goal is protecting the users of insurance services. The national legislators are encouraged to strengthen the framework of independence and responsibility. It is crucial in order to ensure the supervisory decisions are made independently from other industries or political influences. If implemented properly, the Solvency II Directive is a solid step towards financial stability, better business transparency and increased user protection.

Chapter 30.

MANAGEMENT OF INTERNAL RISKS IN INSURANCE

Solvency II is the directive regulating capital requirements of insurance companies in European Union. At the heart of the Solvency II directive, the Own Risk and Solvency Assessment (ORSA) is defined as a set of processes constituting a tool for decision - making and strategic analysis. It aims to assess, in a continuous and prospective way, the overall solvency needs related to the specific risk profile of the insurance company.

Supervisory authority prescribes the manner of organising the system of governance in an insurance undertaking, types of risks in the insurance industry, conditions and manner of identification, measurement, monitoring and management of these risks, conditions and manner of organising and implementing the internal controls system, and conditions for outsourcing. The aim of this paper is to shortly describe the governance system, types of risks in insurance industry and possibilities for risk management.

1. THE GOVERNANCE SYSTEM

The governance system in an undertaking includes the following functions:[378] risk management, internal controls system, internal audit and actuarial function. These functions shall be clearly separated in order to prevent the conflict of interest in their performance. Those employees responsible for risk taking or management at the operational level may not at the same time be engaged in the performance of oversight and/or control activities.

Efficient system of governance shall be set up by an undertaking's supervisory board. It shall ensure the management of the undertaking's activities in accordance with the principle of prudent and sound operation. It also shall ensure the oversight of the system, which includes the monitoring and assessment of adequacy of the system and its improvement.

[378] National Bank of Serbia (2015). *Decision on the System of Governance in an Insurance / Reinsurance Undertaking*. Belgrade: National Bank of Serbia, p. 1.

The system of governance shall be set up following the principle of proportionality. This implies proportionality to the nature, scope and complexity of activities performed by the undertaking, its size and organisational structure, scope of operations and types of insurance it provides.

It is crucial that the administrative, management or supervisory body of the undertaking is aware of all material risks the undertaking faces, regardless of whether the risks are captured by the solvency capital requirement or not.[379] It is also vital that this body takes an active role in the ORSA by redirecting the process and challenging the outcome.

2. TYPES OF RISKS IN INSURANCE INDUSTRY

Solvency II implies quantification of risks that confront life nad non-life insurers. The ultimate purpose of this quantification is policyholder protection. From the point of an insurer, the only constraint on underwriting a particular risk is that it must be able to be priced. In other words, if we are able to price risk, then we are able to insure it. We, as individulas, face many risks that are uninsurable due to fundamental uncertainty. For both insurer and insured to benefit from the contract, an insurable risk must be identified, the variability of which is quantifiable in terms of probabilities, as opposed to the uncertainty of an unquantifiable adverse event.

For the insured, insurance contracts provide financial diversification from events that are likely to occur with some probability and are also likely to prove financially ruinous if realized. Many insurance contracts, such as household insurance, satisfy individuals' risk aversion. Insurable risks need to be defined with regard to a specified set of events, occuring within a specified time interval, any claim against which is constrained to a maximum specified severity, for the consideration of an up-front premium. This allows the insurer to maximize the potential efficiency gains from the pooling of risk. The greater the number of participants in a pool, the lower total risk per participant, and hence premium, as risk is spread by diversification across risk objects. It is thus advantageous to an insurer to be large, as economies of scale yield benefits to the insurer in terms of diversification and estimation.

In its operation, an undertaking is or may be exposed particularly to the following risks:[380] insurance risk, market risk, counterparty risk, liquidity risk,

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[379] https://eiopa.europa.eu

[380] National Bank of Serbia (2015), *op. cit.,* p. 2.

operational risk, legal risk and other material risks. These risk categories do not exist independently of one another. These are the risks that attract a regulatory capital charge under the Solvency II framework, whether the standardized or internal models approach is followed. Internal models play an important role in Solvency II. Through them, the same modern developments in risk management and actuarial science, tailored to the risk profile of an individual company, can be used to calculate regulatory capital and make decisions in running a company.[381]

2.1. Insurance risk

Insurance risk is the risk of loss or unfavourable change in the value of liabilities arising from insurance due to the undertaking's inability to absorb the assumed risks that are inherent to the insurance business. This risk includes in particular:[382] risk of inadequately set premium, risk of inadequate formation of the technical provisions, insurance risk arising from disasters, special life and non-life insurance risks (mortality and longevity risks, risk of insurance expiration, morbidity risk, change in the moment of occurrence / frequency / payment of insured events), risk of inadequate assessment of risk assumed in insurance, risk of inadequately set self-retention limit and failure to transfer the excess of risk over the self-retention limit to coinsurance, reinsurance and/or retrocession and other insurance risks.

Uncertain realization in return for a premium implies that all insurance contracts have in common the underwriting of a risk. Underwriting results can be made more predictable if the coverage of similar risk types can be homogenized by means of standardized contracts. Claims volumes are the product of the frequency or probability of claims event occurrence and the severity of a claim, given that an event has occurred. The resulting total claims distribution may be more or less uncertain across a spectrum ranging from unpredictable low-frequency / high-severity events such as earthquakes, to high-frequency / low-severity risks such as motor insurance, which are predictable to a relatively high confidence interval.

The first consideration to be made in the minimization of underwriting risks, and hence potential financial losses, is the criteria by which the risks to be insured are selected and approved. Accepted insurance contracts should be priced with sufficient comfort to support the potential obligations arising from them. Selection and pricing risk can be mitigated significantly through close

[381] Cadoni, P. (2014). *Internal Models and Solvency II*. London: Risk books, p. 1.

[382] National Bank of Serbia (2015). *op. cit.*, p. 2.

attention to product design to preclude unanticipated risk exposures under the terms of insurance contracts.

Insurance risk or underwriting risk is thus the risk of actual claims payments, including the expenses associated with those claims, deviating from expected claims. Underwriting risk stems both from the specific type of peril covered (e.g. fire or theft) and the underwriting process itself.

Risk typology differs between life, non-life, and health insurance, given the nature and horizon of risks underwritten on the life of individuals, or their health, as opposed to risks underwritten on objects, possessions, personal liability, or short-term insurance more generally.[383] Underwriting risk for life insurance includes the total lapse risk, biometric risks (those risks attached to the health or otherwise of policyholders), expense risk for claims, revision risk, and catastrophe risk. Underwriting risk for non-life insurance includes the total for claims risk, consisting of premium and reserve risk, and expense risk for claims. Health risks may contain underwriting features of either life or non-life insurance.

2.2. Life risk

Life insurance risk claims are contingent upon the death or longevity of persons. Life insurance products pledge life and/or death coverage of the insured life in the form of a single lump-sum payment, multiple payments, or regular annuity payments to a beneficiary. Life risk can be thought of as any risk contingent upon human life conditions, whether the risk of early death (mortality), the risk of living too long (longevity), or the risk of disability through incapacity, injury, or illness (morbidity).

Products that insure a beneficiary against the risk of death of the insured life within the policy term are commonly known as traditional life insurance policies, whereas products providing coverage against longevity include pensions, annuities, and endowments. At a high level, life insurance products can be fundamentally categorized as either term life products, which pay a face value upon death, or savings-based products, which may include minimum return investment guarantees. Naturally, these products with embedded investment guarantees create additional risk for the insurer. An annuity is a series of payments, either for a fixed term or until the beneficiar's death.

[383] Buckham, D., Wahl, J., Rose, S. (2011). *Executive's Guide to Solvency II*. Hoboken: John Wiley & Sons, Inc., p. 13.

Endowments pay benefits on death of the insured during the policy term, or at policy term if the insured survives.

Mortality risk, longevity risk, and morbidity risk arise as a result of any uncertainty in biometric trends and parametres that may lead to an increase in technical provisions. Lapse risk comprises changes in the rate of policy lapses, terminations, settlements, and surrender. Lapse risk arises through the potential adverse effect on liabilities of early settlement of contracts or termination of contracts with surrender value, which may be particularly problematic in times of recession.

Life catastrophe risks stem from extreme events such as pandemics. Revision and expense risks arise out of the underwriting process. Revision is that of unanticipated adjustments to annuity cash flows, while expense risk is that of variation in expenses associated with the servicing of contracts. The most important risks to be managed, however, are mortality risk and market risk.

At inception of the life insurance contract, the insurer assumes the risk of the insured dying too soon or dying later than would be expected on the basis of actuarial mortality tables. Since a person may die sooner than expected or later than expected, but not both, it is possible to partially offset mortality and longevity risks within a portfolio by attracting clients with the desired attributes using product design and underwriting policy to set limits / goals for certain types of risk. In general, if the insurer writes sufficiently diversified business, these risks will offset one another. A systematic improvement in life expectancy will improve profitability in the mortality portfolio, offsetting losses in the longevity portfolio. Conversely, a sudden global flu pandemic that will profit from a reduction in annuities payable in the longevity portfolio.

Current life expectancy is measured using mortality tables, which are published by government statistical agencies, or actuarial societies in some countries. Actuarial tables of life expectancy for specific age groups are derived from annual series of death rates. These tables provide a wealth of information on how age, sex, marital status, and lifestyle influence life expectancy. Insurers are also able to use these tables to monitor the mortality characteristics of their portfolios against the deviation of actual from expected mortality outcomes predicted by the standardized population mortality table for their geographic region.

The expected net present value of the life insurance liabilities are estimated on the basis of mortality tables. In developed countries, annual fluctuations of death rates tend to be relativelly small, as life expectancy is quite stable from year to year, with a slight upward trend. Given the extremely long duration of insurance portfolios, some of which can be over 60 years, small cumulative changes in mortality rates over the life of the portfolio can have devastating consequences for economic value.

Mortality risk is subjected to the systematic trend risk. The trend risk can be decomposed into model risk and parameter risk. Model risk results from maximum age attainable being kept at 100, making the probability distribution of life expectancy incorrect. Parameter risk results from the growth rate of life expectancy being underestimated. Mortality risk is also subject to fluctuations in the volatility of mortality experience from period to period and catastrophe risk from epidemics and natural or man-made disasters.

Life insurers are confronted with extreme nature of market risk. Lifelong annuities in particular can pose a great danger to the solvency of an insurer because the technical liabilities are in the form of guaranteed obligations over an extended time period, potentially as long as 70 years. No other financial system participants, not even sovereigns, are willing to assume a liability over such a long horizon. There is thus no way to match the duration of assets and liabilities. Market risk on such a portfolio can be managed in part through conservative interest rate assumptions, but this assumption relies in turn on the assumption that price stability will remain a feature of our economic future.

2.3. Non-life risk

Non-life insurance is variously known as property and liability insurance, property and casualty insurance, and general insurance. Some of the more important risk categories covered by non-life insurers are: motor vehicle, homeowners, fire, marine, aviation, transportation, financial loss, credit loss, general liability, accident and sickness. In the context of Solvency II, the term non-life is commonly used.

Whereas the amounts of life insurance benefits are contractually determined, non-life insurance claims are dependent on the extent or severity of the loss incurred. Because of this, non-life insurance policies need to be highly specific as to the precise nature of the peril covered. So, the key risk to be managed by a non-life insurer is that actual claims volumes experienced are more and/or larger than expected. If claims occur more frequently than expected or are more severe than expected, additional technical provisions will have to be created. Premium risk, reserve risk, and catastrophe risk may all result in the creation of additional technical provisions and deterioration of the capital position.

Premium risk arises in the event that claims in the current year are more frequent and/or more severe than expected. Premium risk is estimated using probability distributions of historical frequency and severity loss data. Separate distributions are sometimes estimated for small and large claims to improve the accuracy of the fitted distributions. The product of these frequency and severity distributions gives the loss distribution per loss event type. The normal distribution is not much used as it fails to capture the timing and size of claims. The probability of there not be a claim on any particular policy is quite high, but given that a claim has been made, there is a small probability that the claim will be enormous. For this reason, the frequency of claims is usually estimated using a Poisson or negative binomial distribution, and claim severity is usually estimated using a log-normal or gamma distribution.

Reserve risk is the risk that additional technical provisions may have to be raised against previous years' claims. At the end of the year, a specific provision called the incurred-but-not-reported provision is raised against claims that have been incurred on events that have already occurred but have not yet been reported. Such long-tail claims are an important feature of liability insurance, where claims can be presented to the insurance company many years after the trigger event. In order to reconcile this discrepancy between policy period and development period, with the latter being the aggregation of claims from the current and previous policy periods, actuaries use a loss triangle to estimate run-off behaviour.

A catastrophe can be defined as a low-frequency, high-impact event causing two or more losses over a short period, usually 72 hours. Catastrophe risk is essentially premium risk in the extreme. Predicting the probability of catastrophes and estimating their losses is highly complex, as these models need to incorporate demographic, meteorological, and seismological information. The extreme nature of catastrophic risk renders it infeasible for most direct insurers to manage it in isolation, hence the need for reinsurance. Loss-sharing arrangements through catastrophe coverage by reinsurers allow insurers and reinsurers to use their capital more efficiently.

2.4. Health risk

Health risk can be difficult to clearly distinguish from either life or non-life insurance. It covers risks and events affecting the physical or mental integrity of the beneficiary, the provision of which by private health insurance schemes differs widely across member states due to differencies in social security systems, which provide health guarantees that may be short term or long term, life or non-life in nature.

The Solvency II Directive distinguishes between health insurance legally classified under non-life activities and under life activities. Non-life activities include accident and sickness insurance and health insurance, which is provided as an alternative to social security in some markets. It is for this reason that the standard formula under Solvency II makes provision for a separate health insurance module to explicitly capture the specificities of health risk.

There is some basis for the legal classification, however, as the capital requirement is calculated according to whether the technical basis for the best estimate of the obligation is similar to that of life or non-life insurance. But from an underwriting point of view, health insurance is broadly differentiated between income insurance cover and medical insurance cover. The former offers protection against the loss income as a result of accident, sickness, or disability, and the latter covers medical expenses incurred as a result of accident, sickness, or disability.

2.5. Market risk

Market risk is the risk of loss or unfavourable change in the undertaking's financial position which directly or indirectly arise from adverse changes in the market, notably in insurance and financial markets. This risk includes in particular:[384] interest rate risk, securities risk, real estate risk, transfer risk, FX risk, competition risk, risk of inadequate response to demands of insurance beneficiaries and other market risks.

Life insurers regard market risk as their most significant risk driver. Non-life insurers also consider it to be important. Increased sensitivity to market risk of life insurers stems from their need to commit funds for durations consistent with the long-term nature of their obligations. Since the actual future payout profile of underwriting liabilities is unknown, the investment portfolio can never precisely mirror the liability profile, with the result that it is subject to price volatility of financial instruments triggered by oscillations in market risk factors.

Interest rates are frequently the predominant risk factors that impact the value of financial instruments of all types, affecting the value of both assets and liabilities. Interest rates are the major risk driver for bonds and other fixed income securities, but also affect the value of insurance liabilities. The risk associated with a change in capital market rates is always present, given discrepancies in the tenor and market values of assets against the profile of

[384] National Bank of Serbia (2015), *op. cit.,* p. 3.

obligations. Life and non-life insurers may experience quite different effects from exposure to this risk at a point in time. Non-life insurers typically hold assets of a longer tenor than their liabilities, hence an increase in interest rates will tend to destroy equity value, all else being equal, because the value of assets will fall farther than the value of liabilities. Life insurers, in contrast, frequently have unmatched portfolios of long-duration liabilities. The net effect will depend on the insurer's particular product set. Fortunately, sophisticated instruments exist with which to hedge interest rate risk, such as swaps, swaptions, forward rate agreements, caps, floors, and collars.

Equity, currency and property risk are the risk of a decrease in value as a result of changes in equity prices, foreign exchange rates, and property prices. Well-developed markets and sophisticated instruments exist for hedging equity and FX exposures, but due to property's heterogeneous nature in general, markets for hedging instruments remain incomplete. In many instances property risk will be regarded as unhedgeable.

Credit spread risk arises from the risk of a change in market value of bonds, structured products, or credit derivatives following a change in the spread between risk-free and credit risk-bearing investments.

Concentration risk arises as a consequence of a lack of investment diversification across geographical areas or economic sectors, or even exposure to large individual investments. On the liability side, concentration refers to a lack of geographical, policy type, or underlying risk coverage diversification of business written.

Reinvestment risk is of particular concern to life insurers, given the long-term nature of their liabilities may require them to consider future reinvestment rates, if a replicating portfolio of assets of sufficient duration is not available in the market.

Market risk collectively is monitored and controlled by the ALM unit. This unit formulates a strategic investment policy that articulates risk appetite, maximum mismatch, and the allocation across bonds, equities, property, alternative investments, and cash. Tactical investment policy is frequently delegated to internal asset managers with the skills to make a call on the fundamentals of an individual investment.

Investments and liabilities can be matched either by cash flow matching or by duration matching. Cash flow matching is often difficult to achieve in practice because underwriting risks create uncertainty in the liability profile. Duration matching identifies assets with similar interest rate sensitivity to the liabilities. A change in the interest rate therefore increases or decreases the value of both assets and liabilities equivalently.

2.6. Counterparty risk

Counterparty risk is the risk of the undertaking's inability to fully or partially collect receivables on various grounds, particularly due to a change in the credit position of the securities issuer and/or other counterparties. This risk arises from the concentration of counterparty exposure, when the potential loss is so high that it jeopardises the undertaking's solvency or financial position - concentration risk. Counterpary risk includes in particular:[385] risk of the inability to collect payment from invested funds of an undertaking, risk of the inability to collect returns on invested funds of an undertaking and/or returns on leased property, risk of the inability to collect receivables from the counterparty in respect of insurance, coinsurance, reinsurance and retrocession and other counterparty risks.

Insurers hold a subsantial proportion of their investment portfolio in bonds. Government debts of developed countries are generally considered to be default free. Sovereign debt of emerging market countries is considered riskier, reflected in the higher yield available on these bonds. The largest portion of an insurer's bond portfolio, however, is likely to consist of corporate bonds on which the risk of default on semiannual coupons and eventual repayment of principal may be substantial. Counterparty deafult risk comprises this risk on the securities in the investment portfolio, debtors such as mortgagors, and any other counterparty to whom the insurer has an exposure in the form of derivatives or reinsurance contracts.

Another important source of credit risk exposure is reinsurance default risk. Because reinsurance default may threaten the solvency of an insurer in the event of a catastrophe, careful consideration is given to reinsurer's financial stability according to credit rating and diversification among reinsurers to establich a maximum level of coverage per reinsurer.

2.7. Liquidity risk

Liquidity risk is the risk of the undertaking's inability to cash in its investment and other assets in order to fully and timely settle its current and future

[385] *Ibid,* p. 3.

liabilities as they fall due. This risk includes in particular:[386] asset-liability management risk, risk of faulty assessment, recording, presentation and disclosure of the undertaking's assets and sources of funding, as well as of its income, expenses and operating results, risk of the failure to sell the undertaking's assets at the book value and to collect payment in respect of such sale, risk of maturity mismatch of assets and sources of funding, risk of the failure to settle obligations in respect of insurance and on other grounds and other liquidity risks.

Liquidity risk is most commonly visualized in terms of a run on the bank with a queue of depositors demanding the return of their deposits, eventually driving the bank to insolvency as it is forced to liquidate increasingly illiquid assets. But liquidity risk is of concern to all financial institutions, whether bank, insurer, pension fund, or mutual fund. There are two types of liquidity risk: funding liquidity risk and asset liquidity risk. Funding liquidity risk stems from the need to redeem deposits or meet claims. Asset liquidity risk arises when an asset that is sold to meet a funding requirement does not realize its expected value because the market is illiquid or distressed.

Non-life insurers typically are not exposed to the asset liquidity risk of life insurers since their policies and assets are of lower duration. However, they will face liquidity strains in the event of a decline in the renewal of policies or even a decline in the sale of new policies, and critically in the occurrence of a catastrophe event.

In contrast to other risks, liquidity risk does not attract a capital charge under Pillar 1 of Solvency II, but requires risk management practice underPillar 2. Liquidity risk is in general highly correlated to one or more risk types, demanding integrated analisys of the potential impact on cash flow patterns due to changes in policyholder behavior, market conditions, and credit conditions under adverse scenarios. Liquidity risk is entirely unsuited to loss absorption via a capital cushion as it is a cash flow-based risk as opposed to a profit and loss-based risk. It is instead managed through contingency planning and risk mitigation.

2.8. Operational risk

Operational risk implies the possibility of occurrence of negative effects on the undertaking's operation due to omissions (non-wilful and wilful) in the work of employees and bodies of the undertaking, inadequate internal procedures and

[386] *Ibid*, p. 4.

processes, inadequate management of information and/or other systems, and unforeseeable external events. This risk includes in particular:[387] risk of faulty and/or inadequate selection of members of the executive and/or supervisory board, and persons to whom the management of some activities of the undertaking was delegated, risk of faulty and/or inadequate selection, classification and appointment of employees in the undertaking (in terms of qualifications and numbers), risk of inadequate organisation of the undertaking's operation, risk of faulty and financially damaging deals, risk of fraud, abuse and other illegal activities of management and employees in the undertaking, risk of concluding, organising and conducting insurance operations contrary to the insurance code of practice, risk of the absence of an adequate internal controls system and work procedures and other operational risks.

Operational risk is defined as the risk of loss resulting from inadequate or failed internal processes, people, systems, or from external events. This definition includes legal risks but excludes strategic risks, reputational risk, and business risk.

From a risk/reward perspective, operational risk is unlike other risks because it is not possible to increase return on equity by assuming more financial risk. Higher operational risk destroys corporate value. Good operational risk management is therefore no different from good management. It is vital to continuously update understanding of the operational risks inherent in products, business processes, and systems. Policies, processes, and procedures should be laid down as part of the risk governance framework to forestall or mitigate as necessary identified material operational risks. Operational risks identified as having the potential to disrupt business severely should have continuity plans in place, while insurance should be considered as a hedge against low-frequency, high-impact events with potentually catastrophic losses.

2.9. Legal risk

Legal risk implies the possibility of occurrence of negative effects on the undertaking's financial result and capital due to the failure to harmonise the undertaking's operation and acts with regulations. This risk includes includes in particular:[388] risk of being ordered measures and/or pronounced a penalty by the National Bank of Serbia and/or sanctions by another competent authority, risk arising from contracts which are not fully or partially executable (e.g. null and void contracts), risk of possible losses arising from disputes, risk arising from

[387] *Ibid,* p. 4.

[388] *Ibid,* p. 5.

the non-establishment of efficient procedures for the prevention of money laundering and terrorism financing and other legal risks.

2.10. Other material risks

Other material risks are other risks which depend on the nature, scope and complexity of the undertaking's operation, which include in particular:[389] reputational risk, arising from diminished public trust in the undertaking's operation, strategic risk, which implies the possibility of negative effects on the undertaking's financial result or capital due to the absence of adequate policies and strategies, and their inadequate implementation, and due to changes in the environment in which the undertaking operates and/or the absence of the undertaking's appropriate response to these changes, risks arising from the introduction of new insurance products, including new activities relating to processes and systems in the undertaking, risks associated with outsourcing and other material risks.

3. RISK MANAGEMENT

An undertaking shall establish comprehensive, reliable and efficient risk management, which is incorporated in all its business activities, in the manner enabling the undertaking to manage the risks, by ensuring sustainable risk exposure at the level which shall not jeopardise the undertaking's assets and operation and/or which shall ensure the protection of rights and interests of insurance beneficiaries.

A wide variety of instruments and techniques are available to insurers for mitigation and transfer of risks. These include reinsurance, asset and liability securitization, hedging, and product design. Risks should be retained in line with core competencies, and all other risks should be transferred or mitigated whenever developed markets exist to do so.

We have seen that the investment portfolio of an insurer is susceptible to market swings as a result of movements in interest rates, equities, and exchange rates. Particularly for life companies, investment performance has a significant impact on profitability and growth. Virtually any market risk imaginable can be hedged, either through exchange traded derivatives or custom bilaterally contracted over-the-counter instruments. Hedging is most commonly employed

[389] *Ibid*, p. 5.

to offset the risks of financial guarantees on liabilities with respect to interest rates and equity values.

It is common practice for insurers to manage risk using reinsurance. Reinsurers play an important role as risk mitigators within the insurance industry, assuming a portion of a risk type from insurers in exchange for a premium, or cession. Diversification, or retrocession, also occurs within the reinsurance industry.

PART V

CATASTROPHE RISK MANAGEMENT

Chapter 31.

GOVERNMENT AS A RISK MANAGER DESIGNED FOR NEW TIMES

Risk management represents one of the most powerful tools that government has and one with a long and successful history in most of the developed countries. The government has a vital role in managing risk because private markets for risk do not always work optimally on their own. Indeed, this is why programs such 88 Baker and Moss as Social Security, Medicare, and federal deposit insurance in the United States are among the most successful and most popular policies ever adopted in this country. Effective government risk management is recognized by the set of four principles: prevention, risk shifting, risk spreading, and loss control[390]. These five principles of effective government risk management are result of extensive historical study focused on linking responsibility and control, managing moral hazard, pooling risk in sound institutions, adopting market conforming approaches to the extent possible, and structuring markets to promote safe products. Risk Management 101 is one of the new promising government risk management ideas that incorporate these principles.

Prevention, risk shifting, risk spreading, and loss control are four basic ways to manage risk. Prevention (or risk reduction) attempts to reduce the frequency and severity of bad things that can happen. Much health and safety regulation falls into this category. Risk shifting transfers the responsibility for bad outcomes, often from the person who suffers the initial loss to the person or entity that caused it (or, in some cases, the person or entity best able to absorb and manage the risk). Liability rules fall into this category. Risk spreading distributes the costs of particular bad outcomes across a large pool of people. Insurance is the standard loss-spreading institution, and many government programs are forms of insurance. Loss control manages or mitigates the consequences after the bad outcome has occurred. Much of the work of fire departments and emergency management agencies, and some of the work of public health and welfare agencies, falls into this category. From the government point of view, successful risk management is based on those core principles.

[390] Baker, T., Moss, D. (2009). *Government as a Risk Manager*. Cambridge, MA: Tobin Project, p. 88.

Prevention, or risk reduction, is a crucial form of risk management. Much government regulation from speed limits to workplace safety rules aims directly at loss prevention. Risk shifting assigns responsibility for a potential future loss to someone other than the person on whom it would initially fall. Risks can be shifted by law, as illustrated by state workers compensation laws in the United States, which make employers responsible for many of the financial consequences of occupational injuries. Risks also can be shifted by contract. For example, contracts among owners, builders, and architects specify who will be responsible for which kinds of losses that may occur in the course of designing and building a structure. These contracts operate within a set of background liability rules that leave some losses with the person who directly suffers them and that shift other losses to the person who caused them or who for some other reason is legally responsible. Making these background liability rules is one of the most important risk management activities of government. Much government risk shifting occurs through liability creating rules (such as medical malpractice law), but some very important risk shifting also occurs through liability limiting rules (such as limited liability or bankruptcy law). For example, bankruptcy limits people's liability for repaying debts in certain circumstances, providing them with the opportunity to get a fresh start, either as a business or individual. Similarly, in the United States there is a federal law that limits consumers' responsibility for unauthorized charges on their credit card accounts. This law facilitated the growth of the credit card market by reducing consumers' fear of credit card fraud. Likewise, corporate law limits the liability of shareholders to the value of their shares, allowing people to invest in businesses without exposing their entire personal net worth. All three of these liability-limiting laws shift risk from borrowers to creditors. Shifting risk can change people's incentives to prevent loss. Being responsible for a bad outcome increases the incentive to prevent it.

Risk shifting can be a flexible, low-cost, and effective government risk management tool, especially in a global economy in which many risks lie beyond the direct reach of government. But it is essential that policymakers manage the incentive effects of risk shifting rules in an effective manner.

Risk spreading differs from other kinds of risk shifting, however, in that the risk of loss shifts to an organization that in turn distributes it broadly, typically by collecting premiums from a large number of people to cover the financial costs of the losses that occur. Insurance is the paradigmatic risk-spreading institution. There are four main kinds of government insurance: social insurance, financial soundness insurance, catastrophe insurance, and a residual category that stands for "market enhancement insurance."

Loss control is directed at severity. There is a distinguish, on one hand, between severity-reduction efforts such as sprinkler systems, storm shutters, and other efforts to protect vulnerable property and, on the other, efforts to reduce severity by actively managing the overall impact of an adverse event after it occurs, such as emergency response. Protection efforts falls into the broader prevention category, while actively managing a loss falls into the narrower loss-control category. In any event, drawing a precise conceptual boundary is much less important than understanding the importance of loss control[391].

To promote the sustainability of the development process, a comprehensive approach by the government is necessary towards the risk management especially the risk associated with financial disasters, natural hazards and climate change. In a fraught world, policymakers cannot allow partisan divides to get in the way of crucial reforms. By drawing on successful strategies employed elsewhere and adopting to current needs, government can-and must-do better[392]. The strategic coordination including the exchange of information, methodologies and tools between experts and institutions working together is essential for diminishing the risk and to improve the continuity of sustainable development.

After the recent wave of storms and disasters - both natural and financial - the need for leadership and a concerted response from national capitals is acute. Adding to the pressure, many governments are managing the implications of an unprecedented degree of fiscal and monetary intervention. They are preoccupied with the urgent tasks of getting banks to lend again and demonstrating fiscal credentials to the bond markets. The crisis mode of the past few years endures in several countries, while in others there is no more than cautious optimism.

Leaders must confront long-term, fundamental questions too: from the size and role of the state to how best to stimulate growth; from profound and surging demographic imbalances to tackling growing unemployment and welfare bills; from deciding on the extent and nature of regulation necessary to protect the public to forging a new relationship between citizens and government services. Thus, many governments confront a daunting paradox: an expanded set of major policy imperatives in a constrained and almost precarious fiscal position.

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[391] Hacker, J., O'Leary, A. (2012). *Shared Responsibility, Shared Risk: Government, Markets and Social Policy in the Twenty-First Century*. Oxford University Press, Inc. p. 183.

[392] Farrell, D. (2012). Government by Design. *McKinsey Quarterly,* No. 1, McKinsey & Company.

In those new times the role of government matters the most, making possible huge strides in addressing critical challenges, even without resolution of the many ideological and policy dilemmas. From government spending to tax collection, education improvement to health outcomes, and welfare reform to job creation, there is a potential for meaningful improvement, to do more and better with less. What is needed is government management by design, built to fit these difficult times: government that identifies the most critical, solvable problems, reorganizes where necessary to deliver the right solutions, and abandons the tools and approaches that no longer work.

In this effort, governments can draw heavily on the mission-driven mind-set of employees - a real comparative advantage for the public sector over the private sector. Leaders can do far more to mine information on what is working elsewhere. International peers, often trying to solve exactly the same problems, provide invaluable road maps and lessons. Unlike the private sector, where companies spend millions of dollars trying to understand secret competitor strategies and replicate them, the public sector is an open environment, and thereby easier to mine for successful practices and lessons learned.

To truly transform government requires fresh thinking and a substantial investment of both resources and political capital: business-as-usual or modest or occasional improvement is inadequate. Those that have achieved sustainable and significantly higher levels of government performance did so by explicitly designing and executing multiyear reforms that push beyond everyday initiatives designed to improve management capability.

1. EFFECTIVE GOVERNMENT RISK MANAGEMENT

Crises are erupting around the globe with increasing frequency. Governments must learn to cope increased risk and complexity are current reality and will be present for a while. Governments that are willing to reform and build crucial capabilities for effective risk management are better able to achieve major breakthroughs in the most fundamental policy areas, even in the absence of new policy or legislation.

The first step is for governments to acknowledge the complexity in their operating environment. There is a real danger of national failure if not collapse when governments ignore complexity and operate as if all problems are amenable to simple policy prescriptions.

Unfortunately, the evidence of the last half-century suggests that many governments will opt to take this path, whether out of political expediency, because of cognitive failures, or simply because they lack the tools to deal with complexity. Avoiding this path requires fundamental changes to the mind-set, capabilities, and organization of government.

Complexity generates “wicked problems” large and intractable challenges with many dimensions and multiple stakeholders that do not necessarily share convergent goals. The most vexing wicked problems today such as climate change, energy security, global pandemics, sustainable development, and cyber threats have causes and influencing factors that are not easily determined ex ante. In increasingly interconnected and globalized world, such wicked problems do not manifest in isolation. Their impact can be felt in multiple dimensions and geographies.

Developing policies and plans to deal with such wicked problems requires the integration of diverse insights, experience, and expertise. People from different organizations, both from within and outside government, have to come together to pool their knowledge in order to discover potential solutions. Mechanisms need to be set up to enable the sharing of information and to strengthen collective action. This is the whole-of-government approach, which injects diversity into the policy process, recognizing that insight and good ideas are not the monopoly of single agencies or of government acting alone[393].

While the whole-of-government approach is an imperative, it is not easily achieved without a basic change of mind-set. Governments, like all large, hierarchical organizations, tend to optimize at the departmental level rather than at the organization level. This is because information flows most efficiently within vertical departmental silos rather than horizontally across departments. Departments tend to reward people for their contributions to the agency, rather than for their contributions to the larger whole-of-government.

Good example is Singapore, where the whole-of-government approach has been most evident in the economic arena. Over some 25 years, a succession of four comprehensive economic reviews has seen the public and private sectors coming together to produce far-reaching policy recommendations for Singapore’s long-term economic competitiveness. But whole-of-government remains a work in progress. It requires emphasis, support, and constant attention

[393] Ho, P. (2012). Coping with Complexity. *McKinsey Quarterly,* No. 2, Mc Kinsey & Company.

from the top. Successive heads of civil service in Singapore have therefore made it their core business to promote the whole-of government mind-set.

Governments must effectively deal with the risk that naturally results from operating in complexity. There will always be threats to national outcomes, policies, and plans. One of the best practices to systematically address or ameliorate these threats is coming from the abovementioned government of Singapore, which developed from the scratch its unique Whole-of-Government Integrated Risk Management (WOG-IRM) framework a governance chain that begins with risk identification and assessment at the strategic level, progresses to monitoring of risk indicators, and finally arrives at resource mobilization and behavioral changes to prepare for each anticipated risk.

After a series of catastrophic events, government bodies that protect the public such as industry regulators, law enforcement, and disaster-preparedness agencies are being more closely scrutinized with regard to their actions, their impact, and their overall effectiveness. But they are not necessarily receiving larger budgets. In stark terms, society is asking whether regulators are most effectively anticipating the next threat and protecting the public. As with unemployment, the policy debate on this issue can become quickly polarized around the trade-off between more protection for the public and consumers and the potentially negative impact of more aggressive regulation for economic growth.

Agencies can make great progress by focusing on optimal resource allocation and redesigning how they organize and plan. They can place more emphasis on outcome-based regulation and on predicting, preparing for, and mitigating “tail risk.” The most significant assaults on the public’s sense of safety and security have come from events that previously seemed unlikely. Tail events are difficult to predict because they often require multiple things to go wrong. Some examples in USA include the attacks of September 11, Hurricane Katrina’s damage to the New Orleans levees, the financial crisis of 2008-09, and the recent earthquake and tsunami in Japan and the nuclear-power-plant meltdown that followed. But better risk-based systems can improve governments’ ability to prevent and respond to such events.

There is a real prize for governments that can make progress even as the policy and fiscal environments threaten to thwart action. But to win, governments must adapt to fit the challenges of today, in part by applying best practices from around the world. In challenging times, government must be deliberately designed and managed to make progress on solvable problems.

2. CORE RISK MANAGEMENT PRINCIPLES

The effective government risk management is based on five core principles[394]: linking responsibility and control, managing moral hazard, pooling risk in sound institutions, adopting market conforming approaches to the extent possible, and structuring markets to promote safe products. The first two principles link responsibility with control and manage moral hazard apply to every government risk management program. The third principle pool risk in sound organizations applies to risk-spreading programs. The final two principles prefer market-conforming approaches and structure markets to promote safe products reflect a preference for market-based solutions and a prescription for helping them succeed. These five principles are not the beginning and end of government risk management, however, that policymakers who ignore these principles especially the first three will be disappointed with the results and may even do more harm than good. The following text is explaining those principles and provide some concrete examples of government risk management programs that successfully apply them.

2.1. Link Responsibility with Control

Link responsibility with control is the first and most important principle. Sound risk management requires placing responsibility on people in a position to do something about the risk In many cases, ideas have evolved over time about who is best positioned to control a particular risk. Nineteenth-century accident law, for example, placed most of the responsibility for workplace accidents on workers, not employers, on the grounds that the workers knew about the potential risks of their work and often were the most immediate cause of workplace accidents. Modern workers compensation, by contrast, recognizes that employers have substantial control over the workplace, especially workplace design, and therefore makes employers partly responsible for workplace accidents. Making employers responsible does not eliminate worker responsibility; it simply shifts some of the financial impact from workers to their employers. As workplace accidents illustrate, control is a relative concept. Rarely does anyone have complete control, at least with respect to a loss that would be significant enough that the government needs to be involved. Instead, people have more or less control. Regarding product safety, consumers have some control over whether a product is used properly, while manufacturers have control over how safe the product is if used properly. Retailers and wholesalers have no direct control over how the product is used or made, but they do have

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[394] Baker, T., Moss, D. (2009), *op. cit.,* p. 96.

control over what products they offer for sale and, compared to consumers, better information about the products and greater ability to influence manufacturers. For this reason, product liability law in the USA assigns responsibility for injuries from defective products not only to manufacturers, but also to retailers and wholesalers. Product liability law also assigns some responsibility to consumers through legal rules that limit liability in cases involving product misuse. As a result, product liability law in the USA represents a good attempt to meet the risk management principle of linking responsibility and control, even if it does not always succeed.

2.2. Manage Moral Hazard

Moral hazard is the term for a threat that arises when responsibility is uncoupled from control. People in control of a loss do not have the same incentive to prevent it when they know that others will be held financially responsible. All forms of insurance and some other forms of risk shifting present this moral hazard problem. For that reason, managing moral hazard is a central concern in the private insurance industry and the primary occupation of many who work in that industry. Government should take its cue from the private sector. There are three well-known and time-tested tools for managing moral hazard[395]: making sure that enough of the loss continues to fall on the insured person to maintain the prevention incentive (for example, insurance deductibles and co-pays); conditioning insurance coverage on a commitment to engage in specific loss-prevention efforts; and insisting that some control over the loss be shifted along with the risk. These tools are[396]: leaving some loss with the insured, contracting on care, and taking control. To a very substantial degree, the success and failure of government risk management programs turns on how well it uses these tools.

2.3. Pool Risks in Sound Organizations

The meaning of the third risk management principle is: organizations that serve as risk pools must have the financial and other capacity needed to handle the risks that they take on. For insurance regulators this principle dominates all others. One of the examples[397] of government risk management that violates this principle is presented below.

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[395] Moss, D. (2010). *When All Else Fails: Government as the Ultimate Risk Manager.* Harvard University Press, p. 77.

[396] Hacker, J., O'Leary, A. (2012), op. cit., p. 163.

[397] Baker, T., Moss, D. (2009), op. cit., p. 97.

State-Based Catastrophe Risk Pools: a number of states in USA have created insurance mechanisms to protect their citizens from natural catastrophe risks that are not covered by private insurance policies. The Florida state-based hurricane risk pool, Citizens Property Insurance Corporation (CPIC), is a prominent example. State-based pools are almost always underfunded, for two main reasons. First, most states are too small to fund enough reserves in the early years of a natural-catastrophe risk pool. Second, states often lack the political will to impose adequate risk-based premiums on people who build near a coast, river, or fault line. As a result, there is not enough money on reserve to pay claims when a major disaster hits, particularly during the early years. For example, as researchers from the Wharton School have shown, Florida's CPIC does not charge an adequate premium to property owners living close to the coast and it does not have enough reserves to pay claims from a major hurricane. When the next big hurricane hits Florida, the state's CPIC will have to find more money, most likely from a combination of state government bonds, assessments from private insurers, and possibly even federal support.

2.4. Prefer Market-Conforming Approaches to Public Risk Management

This fourth principle reflects the American preference for free enterprise. It suggests, first, that market enhancement should be preferred to market replacement, where possible. Once the government provides a market-replacing risk management service, it can be hard to change that service and harder to eliminate it, even when there is good evidence that the private market is ready to take over some or all of the risk. By contrast, market competition forces companies to adapt their products over time without the need for centralized decision making. For this reason, market-enhancement programs not only are consistent with core American values, they also increase the odds that risk management services can adapt to meet people's needs over time.

Nevertheless, this principle does not mean that the government should never provide a risk management service. Indeed, some of the most visible and successful federal government risk management programs in the U.S. are market replacement insurance programs: Social Security, unemployment insurance, deposit insurance, and Medicare. In each of these cases, there was and is widespread consensus that the private market could not effectively manage the risks that these government programs took on.

The market-conforming principle also applies to prevention and risk shifting[398]. Rules that shift the risk of loss to those with the greatest control over the risk can represent a market-enhancement approach to prevention. Risk shifting gives people an incentive to reduce loss without dictating how they are supposed to do that. For this reason, liability rules, properly created and applied, represent a free-market, bottom-up alternative to command-and-control–style health and safety regulation.

2.5. Structure Markets to Promote Safe Products

This last principle generalizes from the example of trust-based goods. The idea is to structure markets so that sellers compete in ways that promote safety and other risk management objectives. The government should not pursue safety at any cost, simply that policymakers should be attuned to their ability to structure markets to promote safe products. In particular, policymakers should be on the watch for, and distinguish between, two kinds of situations[399]: first, when consumers cannot easily tell the difference between the quality of different products and, second, when consumers will not adequately consider the risks posed by different products or will not reliably make reasonable judgments based on those risks.

Both kinds of situations call for quality regulation, but the kind of quality regulation they require is different. The government can improve consumer welfare simply by defining and enforcing different grades of quality or mandating the provision of relevant information about the risk. If consumers cannot be counted on to adequately consider risks or to make reasonable judgments based on those risks, however, the government may need to do more, for example, by adopting liability rules, taking the riskiest products off the market, or taxing risky products so that the price the consumer pays takes the risks into account. Product liability law in the USA is a good example of the liability approach; the Consumer Product Safety Commission is a good example of a government agency that takes unsafe products off the market; and cigarette taxes are a good example of using tax policy to discourage overuse of a risk-creating product. This last, market-structuring principle applies with special force to risk management products and services. Research and experience show that consumers often have trouble adequately evaluating the quality of insurance and many other risk management products. Insurance advertising in the USA provides good evidence of this point. "Like a good neighbor, State

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[398] Hacker, J., O'Leary, A. (2012), *op. cit.,* p. 162.

[399] Stanton, T., Webster, D. (2014). *Managing Risk and Performance: A Guide for Government Decision Makers.* New Jersey: Wiley & Sons, Inc., p. 48.

Farm is there." "You're in good hands with Allstate." "Nationwide is on your side." These slogans in USA represent efforts to encourage consumers to trust insurance companies, but like most insurance advertising, they do not convey meaningful information about the quality of the products advertised.

Insurance companies know that people need to trust insurance companies or else they won't buy insurance, so the companies do what they can to convey images of trustworthiness and stability. The companies cannot do very much to sell on the basis of quality, because the quality of most insurance products is not observable by ordinary consumers. Most consumers hope never to make a claim and, when they do, they have little or no basis for comparing the quality of the service that they receive.

There is an important governmental role for regulating the quality of many products, including financial services products and, especially, insurance products.

3. NEW RISK MANAGEMENT TOOLS

The risk management approaches and principles explained above are not always properly employed by the government in practice. The idea of presenting new tools for managing risks is to show how abovementioned approaches and principles could be effectively used in practice. New tools are focused on natural catastrophes, systemic financial risk and import safety[400] (for example, in USA, among major risks are health care for the temporarily unemployed, student loans etc.).

3.1. Natural Catastrophes: Reinsurance for All-Risk Property Insurance

The private insurance market does not handle natural catastrophe risks on its own. In the USA a hodgepodge of state and federal government programs provide coverage for earthquake and flood risks and, in some highly exposed regions, windstorm risk. One promising policy option is replacing this hodgepodge with a federal reinsurance program that would allow ordinary insurance companies to sell "all-risk" property insurance policies to protect homeowners and other property holders. Government reinsurance for natural catastrophes would insure insurance companies against natural catastrophe losses. Private insurance companies would pay risk-based premiums in return

[400] Baker, T., Moss, D. (2009), *op. cit.,* p. 101.

for the government's commitment to reimburse the insurers for a percentage of the payments that they make for losses arising out of the covered natural-catastrophe risk.

The reinsurance approach would improve on the current hodgepodge of government-run direct insurance programs by allowing consumers to buy one insurance policy that covers all of their property risks. This would relieve consumers from battles with their insurance companies about the causes of damage to their homes wind, which is covered by ordinary homeowners insurance, or flood, which is not the aftermath of 102 Baker and Moss Hurricane Katrina. In addition, it would create a national risk pool for natural catastrophes that would be better able to operate on a financially sound basis than state-based pools. Finally, the reinsurance approach would allow private insurers, if they chose, to experiment with absorbing more natural-catastrophe risk by reducing the amount of the reinsurance that they purchase from the government.

This program also meets risk management principles. It shifts the risk of insurance coverage gaps from consumers, who are in a poor position to know what coverage they need from whom and what losses are covered by which policy, to insurers and the government, which have greater ability to assess the natural-catastrophe risk in any area and control the drafting of contracts in a way that prevents coverage gaps. Because the reinsurance would be priced on the basis of risk, the program would better manage the moral hazard created by natural-catastrophe insurance than the existing government programs (in USA some of them encourage people to build homes in disaster-prone areas). In USA a federal reinsurance program is a more sound risk-pooling organization than the state based windstorm and earthquake pools that it would replace, primarily because of the greater geographic reach of a national pool. Finally, a risk-based reinsurance approach enhances the private insurance market, rather than replacing it with government-run retail insurance.

3.2. Unsafe Financial Products: The Insurance Transparency Project

Many insurance products differ from other financial products in one fundamental respect: the consumer only has access to insurance money when something bad happens and the insurance company has tremendous discretion over the claims process. For example, with auto insurance, the consumer can only file a claim after an accident; with homeowners insurance, only after a fire, flood, or other unwanted event. This means that the quality of traditional insurance products consists not only in the explicit terms of the insurance contract, but also in the insurance company's approach to paying claims. With banks and mutual funds, by contrast, consumers don't need to worry about the companies' approach to paying claims. With a bank account or mutual fund consumers can take out their money whenever they want. Today it is impossible for a consumer to reliably evaluate an insurance company's approach to paying claims. Consumers Union in the USA conducts some consumer satisfaction surveys and publishes the results in Consumer Reports magazine, but we cannot assess the validity of those surveys by comparing them to objective evaluations of companies' claims-paying history, because there are no such evaluations. Of course, people can talk to their friends and neighbors, and state insurance departments maintain records of consumers' complaints. But none of these information sources provide any basis to distinguish among insurance. Given advances in information technology, it would be possible for a trusted third party to obtain claims information in electronic form from insurance companies that would allow them to be rated on a scale similar to the credit scores that financial service companies use to rate consumers. In the USA this could be done by the Treasury Department, by a new federal insurance regulator, or even by the National Association of Insurance Commissioners, the coordinating body for the existing state-based insurance regulatory system. This idea satisfies risk management principles. Such a system would place responsibility for good claims behavior on the entities in control of that behavior—insurance companies. It would manage the moral hazard that results when insurance companies are able to sell products that promise to pay claims but are then free to delay or shirk when it comes time to pay. It would encourage consumers to buy insurance from companies with a good track record, thereby pooling more risk in sound organizations. It would enhance the insurance market. And it would structure that market to help good companies with good insurance products win the competition for consumers' insurance money.

3.3. Import Safety: Bonded Warranties and Subsidized Testing

Import safety is currently a very important issue. For example, the USA imports massive amounts of food, medicine, toys, children's clothing, and other products from countries that do not have the same health and safety regulations that USA have. European and USA health and safety regulators are working on ways to improve inspections and other procedures in developing countries, but those efforts are not enough by themselves.

An import safety warranty program[401] is a policy option that would supplement these important efforts to improve regulation and testing in developing

[401] *Ibid,* pp.100.

countries. The program might have four parts[402]. First, importers and sellers of imported products would warrant that the products meet established U.S. safety and health regulations. Second, the importers would back up that warranty by obtaining insurance or posting a bond. Third, consumers would have the option to assign their warranty rights to warranty rights enforcement organizations, preferably with assignment being the default (meaning that the rights would be assigned unless the consumer actively chooses otherwise). Finally, there would be subsidies available for concerned consumers and small retailers who want to send products out for testing, leading to a decentralized testing environment that would supplement government testing and make it harder for importers to evade detection. To ease enforcement, the warranty would operate in a simple fashion. The warranty would obligate the seller or importer to pay statutory damages based on three factors: the retail price of the product, the seriousness of the risk, and the success of the importer in recalling the unsafe products and providing refunds to consumers. The statute would direct an appropriate government agency to create guidelines that would make these factors easy for a court to apply. The statutory damages would allow the warranty claims of many consumers to be brought in a single enforcement action, led by the warranty rights enforcement organization. Otherwise the importers or sellers could avoid Government as Risk Manager 101 responsibility by making each consumer bring an individual claim and prove their individual damages an impossible task in too many cases.

The testing subsidy part of the import safety program would allow consumers and small retailers to send product samples for testing at an affordable cost. The government would provide coupons that could be used at approved testing labs to obtain a discounted price on approved tests. The testing labs would market their services and provide consumer access to the coupons, most likely on the Internet. Consumers and retailers would pay part of the testing costs themselves, to discourage excessive or unwarranted use of the testing system. This new idea takes a risk-shifting approach that satisfies risk management principles. It shifts more of the risk of unsafe products to importers and sellers, who are better positioned than consumers to evaluate risk. The program requires the consumer to bear some of the cost of the testing, managing the moral hazard that could result if the government bore the entire cost. Because of the insurance or bonding requirement, the program pools risks in financially sound organizations. It is a market-enhancement program that gives safe products a support in the competition for consumers' money.

[402] Bagley, C. (2015). *Managers and the Legal Environment: Strategies for the 21st Century.* Boston: Cengage Learning, p. 510.

4. CASE OF SERBIA: GOVERNMENT APPROACH TOWARDS FINANCIAL AND DISASTER RISK MANAGEMENT

As it is mentioned above, risk management represents one of the most powerful tools that government has and today Serbia is one of those countries which proactively works on establishing integrated approach towards, not only debt and financial risk management, but towards Disaster Risk Management as it represents the most critical subject in the current condition the country is in. By establishing Risk Management Department within the Ministry of Finance, Serbian Government will be able to monitor all the potential risks that can influence the macroeconomic stability of the country.

Current Government Debt and Risk Management Project needs to be assessed and reform plan has to be developed. International financial organizations, especially IMF and the WB are providing Serbian Government with the support through visits and trainings on the topics like: elaboration of the medium term debt management strategy based on sensitivity analysis, preparation of domestic borrowing plan, revision of the internal organization as well as recruitment and training plans for qualified staff. Among ongoing activities are: development of debt management information system and establishment of a derivatives framework support[403].

Improved debt and financial risk management system has to provide stable funding base for future activities. It will also help to established conditions for risk-sharing and risk transfer by providing answers to the questions on how much risk can the government take on, considering its overall financial situation, and under what conditions/costs? Ministry of Finance is responsible for designing financing strategies to optimize the allocation of government funds and resources in order to secure the resources for contingent budget if unpredicted events occur.

By ensuring budgetary transparency and discipline on the Government level, it will help reduce vulnerability to financial shocks through strengthened debt and risk management capacity and institutions, and will deeper domestic debt markets. The table 1 below indicates possible risks for the Government of Serbia and it is presented as a matrix of direct and contingent, explicit and implicit liabilities

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[403] World Bank (2016). Disaster Risk Finance and Fiscal Risk Management. *The World Bank Workshop,* Belgrade: World Bank.

Table 1. Possible sources of fiscal risk for the Serbian Government

	Direct liabilities	Indirect (contingent) liabilities

Explicit liabilities (Legal obligation, no choice)	• Foreign and domestic sovereign debt
	• Budget expenditures—both in the current fiscal year and those legally binding over the long term (civil servant salaries and pensions)
		• Guarantees for borrowing and obligations of sub-national governments and SOEs.
		• Guarantees for trade and exchange rate risks
		• Guarantees for private investments
		• State insurance schemes
		  • deposit insurance
		  • private pension funds
		  • crop insurance
		  • flood insurance
		  • war-risk insurance

Implicit liabilities (Expectations – political decision)	• Future public pensions if not required by law • Social security schemes if not required by law • Future health care financing if not required by law • Future recurrent cost of public investments	• Defaults of sub-national governments and SOEs on nonguaranteed debt and other obligations • Liability clean-up in entities being privatized • Bank failures (support beyond state insurance) • Failures of nonguaranteed pension funds, • or other social security funds • Environmental recovery, disaster relief

Source: Contingent Liabilities - a threat to fiscal stability, PREM Notes, No. 9, November 1998, and Government at Risk

Among all the risks presented in the table, risk of floods and natural disasters is one of the major risks that Serbia is currently exposed to. Till today Serbia went through two major flood events. The devastating one, took place in May 2014, and the other, less intense, took place in March 2016. Both events had a huge pressure on the Governments' budget and other resources. Estimated damage was over 2 billion Euros.

During the recovery process from 2014 floods, the Government of Serbia started developing the systematic approach towards prevention and disaster risk management facilitated by the Office for Reconstruction and Flood Relief. In accordance to that, in December 2014 the Government passed National Program for disaster risk management[404] as a National framework for developing National Strategy[405] for DRM and Action Plan in that regard. The specific purposes of the Program is to build a national disaster risk management system with the necessary capacity and clear responsibilities to reduce the existing risks, to avoid the creation of future risks, and respond more efficiently to disasters. The Program is created in a way to ensure that financing will be directed to prioritized investments. This Program is funded by different funding

[404] Government of the Republic of Serbia (2014). *National Program for Disaster Risk Management.* Belgrade: Government of the Republic of Serbia.

[405] National Strategy for Protection and Rescue in Emergency Situations. *Official Gazette of the Republic of Serbia,* No. 86/2011.

mechanisms including a Multi-donor Trust Fund specifically prepared for this purpose. At the moment, the main sources identified are: Multi-Donor Trust Fund (MDTF), Global Facility for Disaster Reduction and Recovery, European Union (EU) Instrument for Pre-Accession Assistance (IPA), Swiss State Secretariat for Economic Affairs (SECO) Disaster Risk and Insurance, World Bank - Austria Urban Partnership Program, United Nations Development Program (UNDP). The Program lays out a framework with six components and will be implemented through annual work plans: 1) Institutional building; 2) Disaster risk identification and monitoring; 3) Structural and nonstructural risk reduction; 4) Early warning systems and preparedness; 5) Risk financing strategies и 6) Risk financing strategies[406].

One of the short comings of the system in Serbia was the lack of adequate legal framework and procedures, for the period before and after the disaster. In that regard, the Serbian Government has adopted a new *Law on Reconstruction Following Natural and Other Hazards* on December 2015 (Official Gazette of the Republic of Serbia, no.112/15) . This Law shall regulate the procedure of reconstruction and aid allocation to the citizens and business entities who have sustained pecuniary damages due to natural and other hazards. Amendments to sectoral laws shell follow, in order to harmonize them with the new law. Another law, the draft *Law on Risk Reduction from Natural and Other Hazard and Crises Management* is prepared in coordination with the Sector for Emergency Situations but, unfortunately is not adopted by the Government yet. One of the important documents is, as well, *the Guide on unique methodology for assessing damage from natural disasters*, adopted in 1987, in some parts outdated, but very successfully applied in determining the categorization of damage to buildings after floods in May 2014. The improvement of that methodology is in preparation process too.

The Action Plan for the implementation of the National Program for Disaster Risk Management is prepared and it defines the detailed implementation of the strategic objectives, responsible institutions, performance indicators, timeframe and necessary funding. The Action plan will be adopted in the coming months.
Following the recommendations from 2015[407], the proposed future actions could involve:

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[16] Chroneos Krasavac, B., Nedeljković, S., Bijelić, M. (2015). The Role of Government in Disaster Risk Management. *Catastrofic Risks and Sustainable Development,* Kočović, J., Jovanović Gavrilović, B., Djukić, V. (eds), Belgrade: Faculty of Economics, University of Belgrade, pp. 61-82.

[407] *Ibid,* p. 82.

The Government of Serbia needs to develop an integrated DRFI strategy. That will involve to identify options for provision of sustainable access to immediate liquidity and adequate resources for longer reconstruction and identify which instruments should be integrated into the risk financing strategy.

Explore of the possibility of establishment of a national disaster fund is recommended. That will help the Government to channel the funds for the full disaster risk management cycle through one budgetary tool (fund resources could accrue over time, subject to legal framework; a portion of funds could be allocated to prevention measures).

Explore of the use of contingent credit is also recommended. That will help the Government to obtain immediate access to financial liquidity (bridging the gap), which is often lacking in post disaster recovery phase.

The Government can conclude a sovereign insurance coverage or risk transfer against: flood, earthquake and all climatic risks in agriculture (drought, flood, hail, frost…). In this way, in case of a catastrophe event the government would receive insurance compensation and secure funds to pay for damaged public and private property and infrastructure.

Analysis of the current system of intergovernmental fiscal transfers indicates that local governments are not sufficiently incentivized to buy insurance protection against natural disasters. To improve the financial resilience of local governments, the Government of Republic of Serbia could consider issuing a decree which would require municipalities to finance at least a part of disaster recovery and reconstruction costs out of their budgets either directly or indirectly in the form of insurance indemnifications received by local governments. The decree could also make it compulsory for local governments to insure at least a part of their potential post-disaster liabilities[408].

The proposed insurance coverage to the Government of Serbia can be in a form of a parametric contract covering (at least partially) government liabilities arising out of future floods, quakes or droughts. A payout would be triggered by occurrence of a significant flood/quake in the country which causes the budget outlays on emergency response and reconstruction in excess of a certain amount.

There are various financial and risk management instruments that can efficiently support the Government of Republic of Serbia in its efforts to cope

[408] World Bank (2016), *op. cit.*

with natural catastrophe events and other hazards. Until insurance penetration at the individual level reaches satisfactory level, the Government can use numerous mechanisms to motivate local governments to buy insurance against catastrophe risks[409].

The recommended measures regarding disaster risk management will be implemented in a months to come coordinated by the Office for Public Investment Management which is legal successor of the Office for Reconstruction and Flood Relief.

Integrated approach towards risk management will help the Government of Serbia to streamline the risk management within the countries´ development agenda with the aim to secure stable development for Serbia in the mid-term and to provide the framework for the sustainable development.

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[409] *Ibid.*

Chapter 32.

SOFTWARE SUPPORT FOR NATURAL DISASTERS DATA ANALYSIS AND RISK MANAGEMENT[410]

The devastating earthquake magnitude 7.84 degrees on the Richter scale that hit Nepal on April 25, 2015 and subsequent earthquakes killed more than 7,000 people, and approximately 18,000 people were injured. This has been the worst earthquake to hit the impoverished South Asian country for the last 80 years. Large parts of Kathmandu were destroyed and the earthquake was significantly felt in some parts of India, Bangladesh, Tibet and Pakistan. The United Nations International Team of Experts (UNDAC) estimated that the earthquake, in some way, had affected at least eight million people.

Only a week before the devastating earthquake struck Nepal, about 50 international experts, seismologists and scientists had gathered in Kathmandu; they knew that this area was threatened by a major earthquake but they did not know when it would happen. The experts discussed how to prepare this poor country for a major earthquake, like the one in 1934 when the capital of Nepal had been leveled to the ground. "It was a sort of nightmare that we have been waiting for to happen. Physically and geologically, what happened was exactly what we had thought would happen", said James Jackson, seismologist from English University of Cambridge. He, however, did not expect the devastating earthquake to happen so quickly.[411]

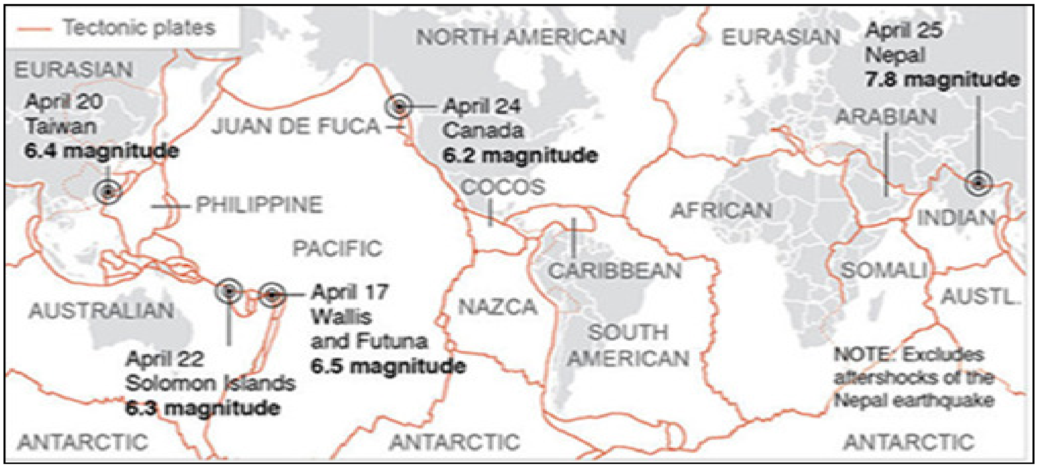
The earthquake magnitude 6.3 on the Richter scale that hit the city of Aquila, in Central Italy, in 2009 killed more than 300 people. The court in Aquila proclaimed seven seismologists and engineers guilty of multiple manslaughter in October 2012, because they had allegedly underestimated the risk that the Italian city could be hit by strong earthquake. The suit stated that the seismologists gave the public "inaccurate, incomplete and contradictory information" about the possibility that after several small earthquakes, which the citizens of Aquila had been able to feel in the weeks and months before the big earthquake, such a strong shock could follow. Seven Italian scientists

[410] Authors gratefully acknowledge the financial support from the Ministry of Education, Science and Technology of the Republic of Serbia, Grant No. 179005.

[411] http://www.usnews.com/news/world/articles/2015/04/25/experts-gathered-in-nepal-a-week-ago-to-ready-for-earthquake, *Associated Press,* April 25, 2015 | 5:37 p.m. EDT, By Seth Borenstein, AP Science Writer.

sentenced by the court to a prison term of six years at the original trial were acquitted in November 2014 after the court had accepted the appeal to the verdict.

Figure 1. Recent significant earthquakes



Source: U.S. Geological Surwey, Associated Press April 25, 2015.

Based on just the two of many examples there is a question: when it comes to natural disasters, are scientists able to make a significant step forward in order to reduce primarily human sacrifice? There is also a question of how much contribution to the analysis of data on natural disasters, both historically and in real-time, can be provided by information and communication technology and specially software solutions created for this purpose?

1. THE ROLE OF INFORMATION, COMMUNICATION, AND SPACE TECHNOLOGIES IN DISASTER MANAGEMENT

Information and communication technologies provide vital support for disaster management in many ways: data collection, monitoring, observation, communication, GIS databases, warning dissemination, expert analysis systems, networking, information resources, service delivery mechanisms. Information and communication technologies have successfully been used to minimize the impact of natural disasters. These include:

- On-line management databases;
- Disaster information networks;
- Satellite navigation system;
- Satellite communication;

- Remote sensing;
- Geographical Information System (GIS);
- Global Positioning System (GPS);
- Mobile technologies:
- Internet, e-mail; and
- Special software packages.

Disaster management professionals use information and communication technologies for:

- information analysis and integration;
- database construction;
- disaster early warning, dissemination, and evacuation;
- disaster scenario simulation and mapping;
- vulnerability assessment;
- disaster trend forecasting;
- hazard assessment and monitoring;
- disaster characteristic factor monitoring;
- logistics preparation for disaster relief;
- planning of disaster response, reduction, and relief ;
- risk investigation and assessment;
- rehabilitation;
- disaster information, quick processing and analysis;
- emergency response decision support;
- needs assessment for disaster recovery and reconstruction;
- monitoring of recovery and reconstruction; and
- disaster loss assessment.

Critical applications of information and communication technologies are focused on the following:

- To improve the quality of analysis of hazard vulnerability;
- To facilitate the planning of disaster risk reductions;
- To develop and design early warning systems which include: monitoring and forecasting impending events; understanding and mapping the hazard;
- To build knowledge warehouses;
- To provide emergency communication and timely relief and response measures.

1.1. Satellite Navigation and Communication

The network of satellites is the only wireless communications infrastructure that is not susceptible to damage from a disaster, because the main equipment to send and receive signals is outside the Earth's atmosphere. Two kinds of satellite communications networks, geo-stationary satellite systems (GEO) and low-earth orbit satellites (LEO), support disaster management.

„*A geostationary satellite* is an earth-orbiting satellite, placed at an altitude of approximately 35,800 kilometers directly over the equator, that revolves in the same direction the earth rotates (west to east).“[412]

„LEO satellites operate in orbits between 780 km and 1,500 km (depending on the system) and provide voice and low speed data communications. These satellites can operate with handheld units about the size of a large cellular phone.“[413]

1.2. Remote Sensing Technology

Remote sensing is the use of electromagnetic wave radiation to acquire information about an object or phenomenon, by recording device that is not in phisical or intimate contact with object. Remote sensing technology is a powerful tool in disaster management. Many types of disasters, such as volcanic eruptions, droughts, floods and cyclones, have certain precursors that satellites can detect. There exist commercial and free software that allow users to view data colected from the many satelites.

Potential applications of remote sensing tecnology in disaster management include:

- Helping to locate the area of a natural disaster;
- Users of the technology do not have to be direct conect with dangers zones;
- Providing information on the disaster reliably and rapidly;
- Monitoring the disaster event;
- Shows image of very large areas of land or space;
- Helping to prevent the recurrence of the same disaster in the future.

[412] http://searchmobilecomputing.techtarget.com

[413] http://www.disaster-resource.com/articles/06p_116.shtml

1.3. Global Positioning System (GPS)

„A critical component of any successful rescue operation is time. Prior knowledge of the precise location of landmarks, emergency service resources, and disaster relief sites saves time – and saves lives. Such information is critical to disaster relief teams and public safety personnel in order to protect life and reduce property loss.“ [414]

GPS is very useful in disaster preparedness. The main application of GPS include:

- Pinpointing the location of the damaged and flooded areas;
- Play an increasingly important role in helping scientists to predict earthquakes in earthquake-prone areas;
- GPS has become an integral part of modern emergency response systems;
- Play a significant role in monitoring the storm and flood prediction;
- Incorporation of GPS in mobile phones;
- Setting the GPS systems in passenger cars and rescue vehicles helps to develop a comprehensive safety net.

1.4. Internet

Today, in the age of electronic communications and digitalized environment, Internet can be a useful platform for informing the population before, during and after natural disasters. The Internet is becoming a precious resource in crisis situations. Well-designed sites have become a tool for rapid, automatic and global dissemination of relevant information about natural disasters. For example, USGS (United States Geological Survey's) website http://earthquake.usgs.gov/earthquakes, in addition to historical information, provides information on earthquakes around the world immediately after their occurrence. Most meteorological services give forecasts, satellite images and other data in real time on their sites. In the period of recovery following the disaster, Internet enables continuous update of information on the effects of disasters, human victims, material damage, the collection of financial and material resources, and distribution of aid to the endangered population and so on.

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[414] Satyabrata, S. (2014). *Guidebook on technologies for disaster preparedness and mitigation*. The Asian and Pacific Centre for Transfer of Technology (APCTT), p. 11.

2. SPECIFIC MODELS AND SOFTWARE TOOLS FOR NATURAL DISASTERS DATA ANALYSIS AND RISK MANAGEMENT

Different types of software tools are being used for natural disasters data analysis and risk management.

2.1. Catastrophe models software

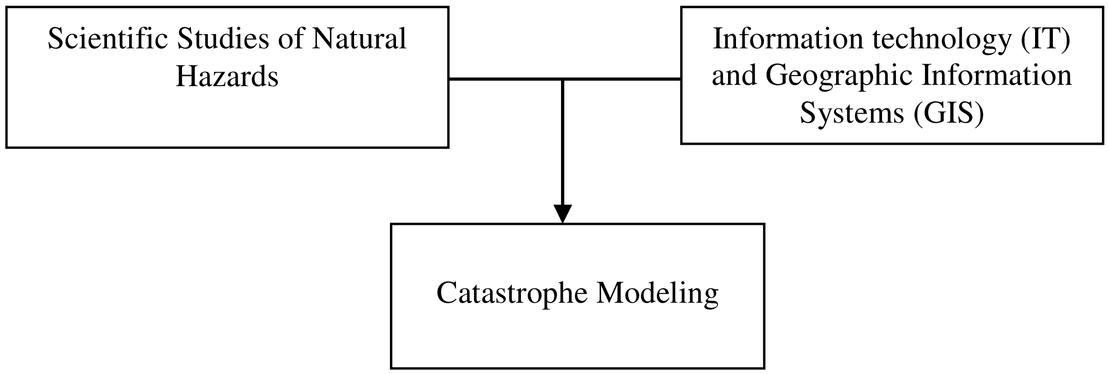
Catastrophe models software provides a numerous catastrophe models (often referred to as “Cat models“) which are beeing used in the last 25 years. Initially these models were designed for the purpose to sutisfied the needs of insurance industry. But latter on the other institutions, organizations and agencies, both the governmental and nongovernmental, were interested to use them. Currently, Cat modelling is extensively used by insurers, reinsurers, other financial institutions and entities, capital markets and governments. Generally these models are used by organizations dealing with the following activities: risk evaluation and selection, underwriting, design of mechanisms for risk transfer and mitigation strategies, reserving and ratemaking, portfolio management and optimization, pricing, reinsurance and capital investment.

Before the first Cat models appeared, the unsurance industry heavily used the actuarial models. These models belong to the group of statistical models which take into account only the frequency of a particular historical event and an acompaning loss data. In many cases in practice actuarial models did not provide the acurate estimate of the potential loss, but usually underestimate it. The first catastrophe modeling company was established in the late1980s under the name Applied Insurance Research, which is now known as AIR Worldwide. At the beging this company was very successful in evaluating the hurricane risk on the US teritory and provided more accurate insured losses than the actuarial models. Now it is one of the leading Cat modeling companies in the world.

The origin of the Cat modeling can be explained as a fruitful combination of the scientific studies of natural hazards and the information technology in general. But, the most prominent informaton technology vital for the Cat models development has been Geographical Information System (GIS). The origin of Cat modelling is presented at the figure 2.

A cat model is a computerised system that generates a set of simulated events and predicts the intensity, magnitude and location of the event to determine the amount of damage and calculate the issured loss, as a result of a catastrophe event such as a earthquake or hurricane or the other natural hazards. Generally, Cat models are dealing with and incorporate the following components: hazard, vulnerability and the potential loss. These models are more sophisticated than the traditional actuarial models. For example, hazard component of Cat model usually takes into account a wide pallete of variables and historical data with an appropriate probability distributions. Based on many simulated events the stochastic catalog is built.

Figure 2. The origin of Catastrophe modeling



Source: Modified according to Grossi, P., Kunreuther, H. (eds.) (2005). Catastrophe Modeling: A New Approach To Managing Risk. Boston: Springer Science + Business Media, Inc., p. 25.

Cat models software includes a number of modules that operate with the purpose of producing the desired risk assessment. Usually the Cat model software comprises the following modules:

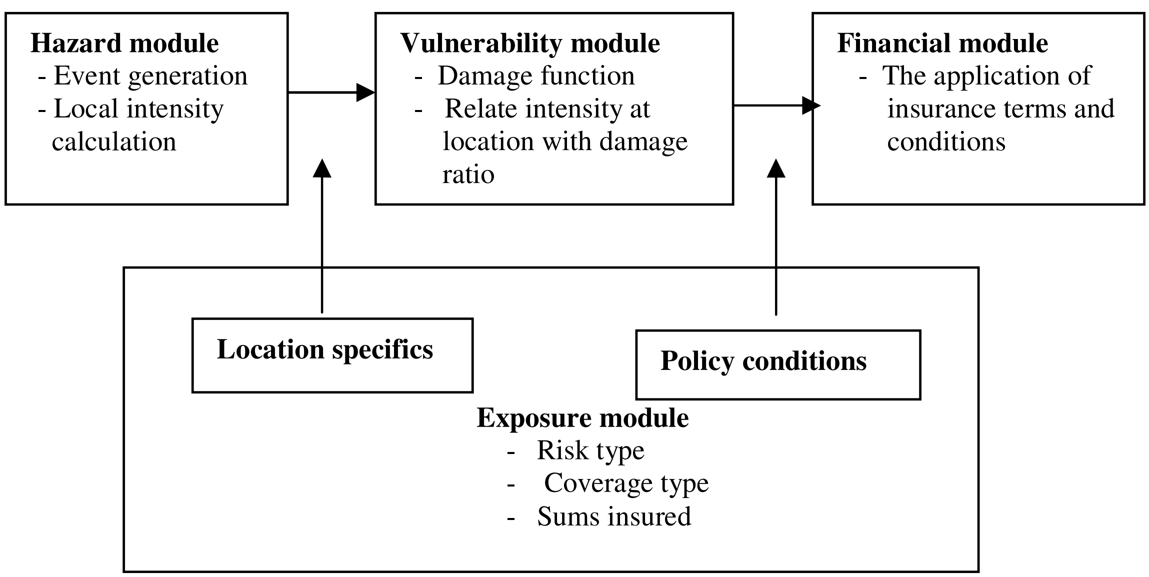
- *Exposure data module* - stores the inputs of risks, such as risk type, coverage type, geo-location and an insured value. Here the term *exposure* reffers to the all assests in the striked areas. The relevant data are stored in the exposure databases, but also the users can input in Cat models their own exposure data or some primary and/or secondary assets' characteristiocs, such as construction type of the property, year built, etc. Some Cat model providers posess high-resolution exposure databases for a specific countries and regions worldwide;
- *Hazard module* - refers to event generation and local intensity calculation. An assessment of the hazard impact at each location must be established in this module;
- *Vulnerability module* - contains a number of vulnerability curves, that are appropriate for different primary and secondary characteristics of the risk, and shows how it will respond under different conditions. Usually these curves are derived from the experience of the historical events and studies

relevant for the specific risk. The final output of this module is a damage ratio which is used for the risk at the specific location;

- *Financial module* – starts with the estimated expected damage ratios for different locations of the area of interest and focuses on applying insurance terms and conditions in providing the financial output. Usually the resulting output is an *Event Loss Table* (ELT) which provides an assessment of the financial risk exposure to individual events. This table may be accompanied with the other derived metrics, such as: an exceedance probability (EP) curve, which may be used to calculate expected losses within a given range, or for benchmark purposes (comparisons over time or for different risks); an Occurrence Exceedance probability (OEP), an Aggregate Exceedance Probability (AEP); Value at Risk (VaR) and Tail Value at Risk (TVaR) – two mathematical measures for risk profile at a single point; Coefficient of Variation (CoV) as a ratio of standard deviation and annual average loss, and so on[415].

The figure 3 presents one possible structure of the Cat model.

Figure 3. The modular structure of Catastrophe models



Source:[416]*Modified according to: Lloyd`s (2014). Catastrophe modelling and climate change, Lloyd's report 2014., London: Lloyd`s, p. 9.*

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[415] More details may be found in Lloyd’s Market Association (2013.) *Catastrophe Modelling Guidance for Non-Catastrophe Modellers*, London: Lloyd’s Market Association, Retrieved from: www.lmalloyds.com/CMDownload.aspx

[416] Retrieved from: http://www.lloyds.com/~/media/Lloyds/Reports/Emerging%20Risk%20Reports/CC%20and%20modelling%20template%20V6.pdf

The final output of Cat model usually includes the following two metrics: Average annual insured losses (AALs) and an Exceedance Probability (EP) Loss, derived from Exceedance Probability (EP) curve. As it has already been pointed out, EP curve is the probability distribution of the potential losses, and can be specific to particular perils, regions and business lines. Namely, the Cat models are not built to predict exactly the parameters of future events. Rather, they are used to produce reasonable estimates of the probability of various levels of loss. This is demonstrated recently in Japan following the earthquake magnitude - 9.0 and associated tsunami. Despite the fact that scientist did not expect almost the apocalyptic levels of destruction, the resulting insured loss totals were in the predicted range produced by cat models[417]. Althought the cat models are sophisticated they cannot capture all risks that exist in the reality. The majority of catastrophe models vendors have a suite of models that cover specific region and/or dangers that are of interest to their clients. In addition, Cat models, similar as the other models, are constructed as simplified representation of reality. So, it is not realistic to expect that Cat models can cover all specifics of climate, regions, perils and generally environment characteristics. On contrary, currently there are many components and parts of catastrophe risk which cannot be modelled. Therefore, clients are supposed to be able to understand and interpret the Cat models outputs taking into consideration the models' limitations. A clear understanding of the Cat models's assumptions and their inherent uncertainties are of vital importance for users to make sound business decisions[418]. Also, it is adviceable for Cat model users never to lose the common sense approch for risk management.

Currently, one of the important issue that affect the whole insurance industry is the climate change. This topic is examined from the different aspects and by diverse authorities as it can influence the risk of many hazards. Consequently, a broad range of meteorological models (for example, Global Climate Models – GCM) dealing with the problems, such as a global warming, an increasing temperature of sea-surface, an increasing concentration of greenhouse gas in the atmosphere, were designed and associated with Cat models. The observed and scientifically approved climate changes and trends are implicitly or explicitly incorporated into catastrophe models. For the insurers it is of vital interest to examine the economic impact of the climate change, as well as the adequacy of the software tools that can help in estimating the risks' price. Cat models can be

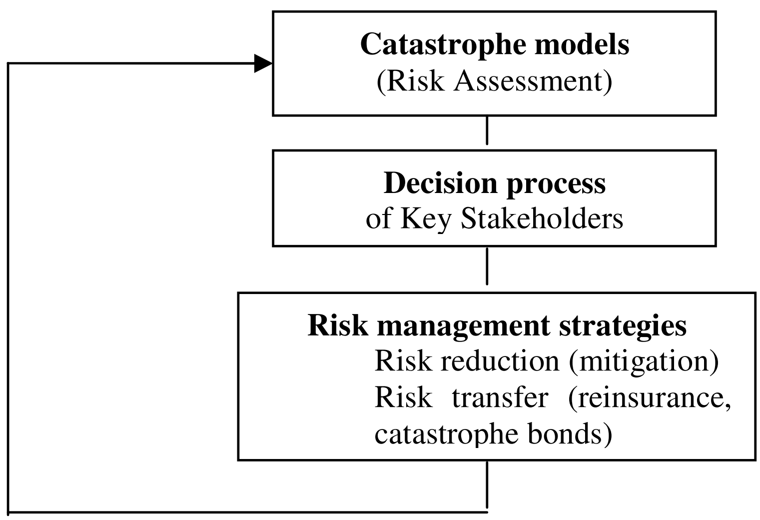
[417] http://www.earthmagazine.org/article/risky-business-modeling-catastrophes.

[418] Chavez-Lopez, G., Zolfaghari, M. (2010). Natual Catastrophe Loss modeling: The value of knowing how little you know. *CATRisk Solutions, 14 ECEE 2010,* Ohrid, 30.08.-03.09.2010.

considered as a element of the general framework of integration of risk assessment and risk management. The figure 4 ilustrates that framework.

Development of Cat modeling software is directed to the domain of more complex hazards and also, on making the software more transparent and accessible for wider public. The most famous and globally recognised catastrophe modelling companies which were founded almost at the same time are: Applied Insurance Research - *AIR Worldwide* – was founded in 1987 in Boston, *Risk Management Solutions* - developed in 1988 at Stanford University, and *EQECAT* (Cat modeling software WORLDCATenterprise) – began in San Francisco in 1994 as a subsidiary of EQE International[419].

Figure 4. Link between Risk assessment and Risk management



Source: Modified according to: Grossi, P., Kunreuther, H. (eds.) (2005). Catastrophe Modeling: A New Approach To Managing Risk. Boston: Springer Science + Business Media, Inc., p. 40.

In addition to these commercialy companies it is worth to mention the open source HAZUS (Hazards US) computer software. It was developed in the United States in 1997 by the Federal Emergency Management Agency in colaboration with the National Institute of Building Sciences. The first edition was termed HAZUS97 and was focused on the developmenet of earthquake model.

[419] Grossi, P., Kunreuther, H. (eds.) (2005). *Catastrophe Modeling: A New Approach To Managing Risk.* Boston: Springer Science + Business Media, Inc., p. 24.

The later editions included the flood and wind loss capabilities. So, in 2004 it was released HASUZ-MH software (MH that stands for 'Multi Hazards'). HAZUS-MH is a powerful software, and at the same time the risk assessment methodology, that is based on Geographic Information Systems (GIS) technology combined with science, engineering and mathematical modeling, with the aim to estimate potential losses from disasters, i.e. physical, economic and social impacts of disasters[420].

Currently, HAZUS-MH 3.0 software is available. It can model four types of hazards: earthquakes, floods, hurricanes and coastal surge. It is permanently updated and new functional enhancements are implemented in new editions. Although HAZUS software is open source *per se*, the proper functioning of the program requires the availability of ArcGIS with ArcView software license. As it was pointed out Cat models are employed to evaluate catastrophe risk and improve decision making in risk management. The list of stakeholders interested for Cat usage is broad. Nowdays, it is extensively used by insurers, reinsurers, capital markets agents, government planners, GIS specialists and emergency managers around the world.

2.2. Geographical Information System (GIS)

„A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. GIS can show many different kinds of data on one map.“ [421]

In the field of disaster management the application of GIS can be considered at the national, subnational and local level. At the national level this system can be used to generate the general image of hazard situation in a particular country, but also to specify areas which need further investigation on estimating the effects of natural hazards. At the subnational and local level the application of GIS may be focused on the identification of potential investment projects and disaster prevention strategies at the concrete geographical regions. Having in mind that GIS has a potential to store the voluminous data necessary for risk and hazard assessment and to combine different data types (spatial, non-spatial, quantitative and qualitative data), the system can be supportive in all phases of the disaster management: investigation of potential hazard situations and effects on the natural resources, planning the activities, preparing the response and disaster recovery, and providing the full analytical capabilities for data and records management.

[420] https://www.fema.gov/hazus/

[421] http://education.nationalgeographic.com

There is a broad spectrum of potential GIS application in disaster management, but as the most common may be specified the following:

- Hazard Mapping to identify the potential dangers of earthquakes, floods, hurricanes, tornadoes, severe winter storms, landslides, and fire hazards across all geo-spatial levels in the region;
- Designing the emergence centers and disaster warning systems where all relevant data are integrated;
- GIS facilitates the analytical work regarding the calculation of various indicators, such as emergency response time, necessary for emergency planners in the event of natural catastrophe;
- GIS provides the capabilities for planning the potential evacuation routes in the endangered areas;
- In the phase of disaster recovery, the application of the GIS may be of crucial importance for rescue operations;
- GIS database plays the fundamental role in preparing the capacities and activities for mobilization of the necessary resources to the specific geographical location in the maximally short time period. In this database different geo-referenced data are stored providing information on incident mapping, real-time satellite snapshots, infrastructure objects and natural resources at risk, etc.;
- A reliable GIS database is necessary for designing Catastrophe Modeling systems and Decision Support systems, which can produce a vast amount of spatially dashboard reports;
- GIS may be extremely helpful in the phase of disaster recovery and rehabilitation providing the capacity for organization of damage information and evaluation of objects for reconstruction.

Also, the combined application of GIS and remote sensing is common in many disaster situations, such as earthquakes, floods, winter storms, landslides etc. These systems may be used for designing the seismic hazards maps, flood hazard zoning and landslide maps. With an inbuilt forecasting module which includes probabilistic concept, they provide the important platform for monitoring, planning and evaluating the exact nature and the magnitude of hazards and risks.

2.3. DesInventar[422]

Disaster Inventory System – DesInventar is a system invented and produced by groups of researchers and academicians organized in a Network of Social Studies in Latin America. The network was aimed at preparing the activities relating to the Prevention of Disasters. In the long period from 1994, these groups have been working on the creation of the conceptual framework and methodology for monitoring and preventing of natural catastrophes.

The DesInventar is a system which includes the conceptualization, methodology and software tools for acquisition, storing, retrieving, extracting and displaying information about different disasters characteristics and effects at a local, national and regional level. It is furnished with multilayer data collected in previous research, published in institutional reports, articles and newspapers in nine countries in Latin America. In particular, this system provides the data and information on the potential natural threats and disasters that are not visible from the global and national level.

The important feature of the system is its capability to simulate disasters and investigate the damaging impacts on the humans, infrastructure and natural resources. For instance, it can simulate an earthquake in non-reality environment and study the effects on small and wider geographical areas: from town to a group of countries. Also, DesInventar includes the forecasting capabilities relating to an assessment of the possible loss of human lives, damages to economic objects and infrastructure, buildings and municipalities destructions, etc. With all these features the system can serve for disaster-related data analysis which could be incorporated in planning, risk evaluation and mitigation activities, as well as in disaster overcoming and recovery.

2.4. Earthquake Alert! (Android)[423]

Earthquake Alert! is the most popular seismic activity monitoring Android application. Application shows the latest Magnitude 1.0+ from the U.S. and Magnitude 4.5+ earthquakes from all over the World. The earthquake data is from the USGS website: http://earthquake.usgs.gov/earthquakes.

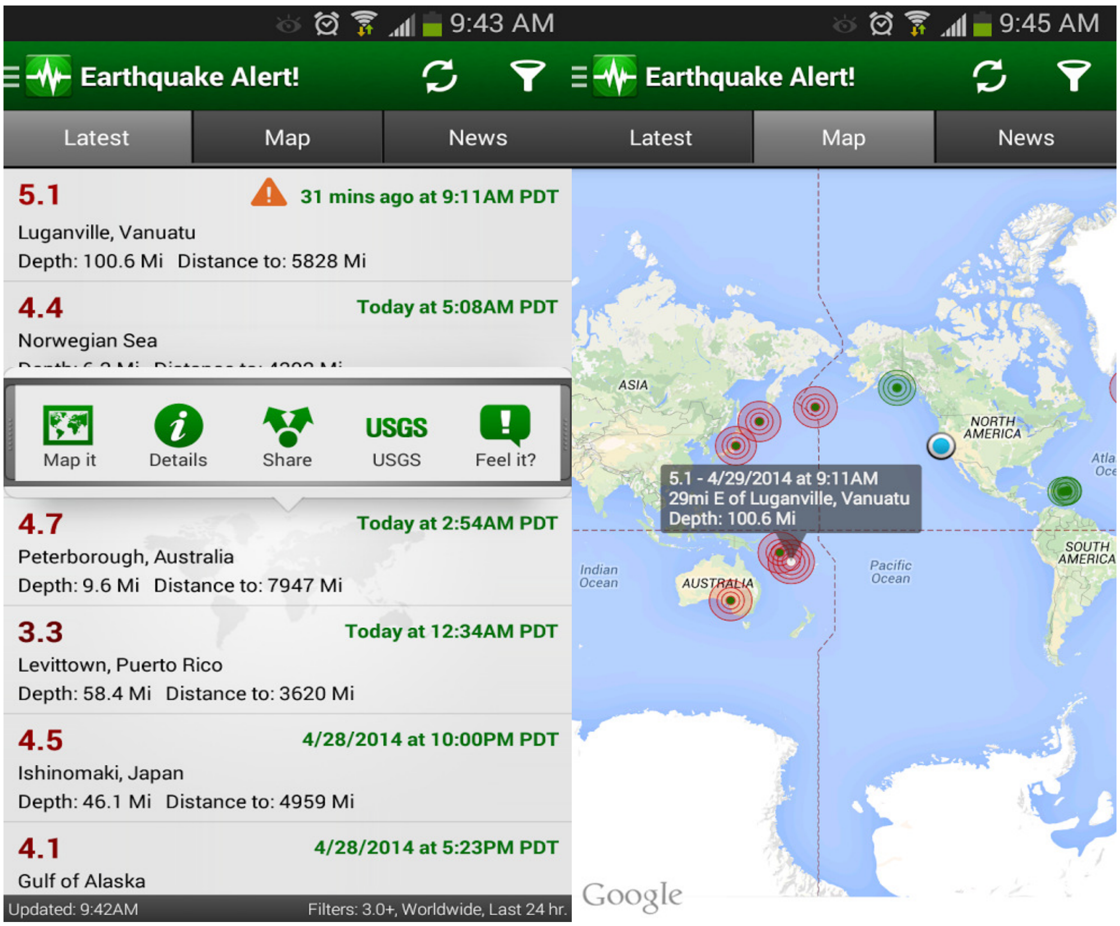
Earthquake Alert! has an ad banner that is visible at the bottom of one of the three tabs in this application – the news feed. The first tab displays all recent earthquakes and tremors while the second shows the map with all the points of

[422] http://www.desinventar.org

[423] https://play.google.com

activity on the map. Powerful earthquakes and tremors are marked in red while smaller ones are marked in green. Users can choose to filter earthquakes by their intensity, distance from you or by time. The application even lets you quickly send the news to others over a few messaging applications.

Figure 5. Earthquake Alert! (Android)



Source: http://tech.firstpost.com, (Retrieved May 2015).

3. WORLD RISK MAP - VISUALIZATION OF COUNTRIES ACCORDING TO THE *WORLD RISK INDEX* (*WRI*) DATA

In addition to the previous software applications for natural disasters data analysis, here we are going to present World Risk Map (WRM), based on the World Risk Index (WRI) data.

Table 1. WRI-World Risk Index

1.	Vanuatu	36,5	44.	Mozamb.	9,0	87.	Romania	6,5	130.	Paraguay	3,7
2.	Philippin.	28,2	45.	Mali	8,9	88.	Malaysia	6,5	131.	Argentina	3,7
3.	Tonga	28,2	46.	Ghana	8,8	89.	Cuba	6,4	132.	Slovenia	3,6
4.	Guatemal.	20,6	47.	Uzbekist.	8,7	90.	Thailand	6,4	133.	Portugal	3,6
5.	Banglad.	19,3	48.	Guinea	8,5	91.	Mexico	6,3	133.	Austria	3,6
6.	Solom. Is.	19,1	49.	Suriname	8,4	92.	Gabon	6,3	135.	Slovakia	3,6
7.	Costa Rica	17,3	50.	Kyrgyzst.	8,3	93.	Eritrea	6,3	136.	Unit. Kin.	3,5
8.	El Salvad.	17,1	51.	Netherlan.	8,3	94.	Armenia	6,2	137.	Czech R.	3,5
9.	Cambodia	17,1	52.	Nigeria	8,2	95.	B. & H.	6,2	138.	Latvia	3,4
10.	Papua N.G.	16,7	53.	Malawi	8,2	96.	FYR Mac.	6,1	139.	Belgium	3,4
11.	Timor-Leste	16,4	54.	Mauritan.	8,2	97.	Yemen	6,1	140.	Kuwait	3,3
12.	Brun.Dar.	16,2	55.	Tanzania	8,1	98.	Azerbaij.	6,0	141.	Poland	3,3
13.	Nicaragua	14,8	56.	Sudan	8,1	99.	Venezuela	5,8	142.	Spain	3,2
14.	Mauritius	14,8	57.	Liberia	7,9	100.	Lao PDR	5,7	143.	Canada	3,1
15.	Gu.Bissau	13,7	58.	Bhutan	7,8	101.	Namibia	5,6	143.	Belarus	3,1
16.	Fiji	13,6	59.	Swaziland	7,7	102.	Syr. A. R.	5,6	145.	Ukraine	3,1
17.	Japan	13,4	60.	Algeria	7,6	103.	Tunisia	5,5	146.	Lithuania	3,0
18.	Viet Nam	13,1	61.	Ecuador	7,6	104.	Hungary	5,5	147.	Germany	3,0
19.	Gambia	12,2	62.	Zambia	7,6	105.	Botswana	5,4	148.	Mongolia	3,0
20.	Jamaica	12,2	63.	Ethiopia	7,6	106.	South Afr.	5,4	149.	Denmark	2,9
21.	Haiti	12,0	64.	Congo	7,5	107.	Turkey	5,3	150.	Cyprus	2,8
22.	Guyana	11,8	65.	Trin. & T	7,5	108.	Nepal	5,3	151.	Oman	2,7
23.	Domin.R.	11,5	66.	Comoros	7,4	109.	Bolivia	5,0	152.	France	2,7
24.	Niger	11,4	67.	Sri Lanka	7,4	110.	Lebanon	5,0	153.	Luxembo.	2,5
25.	Benin	11,4	68.	Panama	7,4	111.	Moldova	4,9	154.	Seychell.	2,5
26.	Chile	11,3	69.	Rwanda	7,3	112.	Iran	4,8	155.	Switzer.	2,5
27.	Chad	11,3	70.	Tajikistan	7,2	113.	Iraq	4,8	156.	Estonia	2,4
28.	Cameroon	11,2	71.	Greece	7,1	114.	Korea, R.	4,8	157.	Israel	2,4
29.	Madagas.	11,2	72.	Pakistan	7,1	115.	Jordan	4,7	158.	Norway	2,3
30.	Senegal	10,9	73.	India	7,0	116.	Equ. Guin.	4,7	159.	Egypt	2,3
31.	Honduras	10,8	74.	Lesotho	7,0	117.	Ireland	4,5	160.	Singapore	2,2
32.	Burundi	10,6	75.	Kenya	7,00	118.	Italy	4,5	161.	Finland	2,2
33.	Sierra L.	10,6	76.	Serbia	6,9	119.	Brazil	4,3	162.	Sweden	2,2
34.	Indonesia	10,5	77.	Peru	6,9	120.	Croatia	4,3	163.	U.Ar.Em.	1,9
35.	Togo	10,5	78.	China	6,9	121.	Bulgaria	4,2	164.	Bahrain	1,8
36.	Cape Verde	10,3	79.	Colombia	6,8	122.	N. Zeal.	4,2	165.	Kiribati	1,7
37.	Albania	10,2	80.	Morocco	6,8	123.	Bahamas	4,2	166.	Iceland	1,6
38.	Zimbabw.	10,0	81.	Georgia	6,8	124.	Uruguay	4,0	167.	Grenada	1,4
39.	Djibouti	9,9	82.	Cen.Afr.R	6,8	125.	Libyan AJ.	4,0	168.	Barbados	1,2
40.	Afghanis.	9,7	83.	Turkmen.	6,7	126.	Australia	3,4	169.	Saud.Arab	1,2
41.	BurkinaF.	9,6	84.	Uganda	6,7	127.	United St.	3,9	170.	Malta	0,6
42.	Cote d'Iv.	9,3	85.	Angola	6,7	128.	Russia	3,8	171.	Qatar	0,1
43.	Myanmar	9,1	86.	Belize	6,6	129.	Kazakhst.	3,7			

Source: http://www.worldriskreport.org

Applying the software program for data visualization Viscovery SOMine 5.1[424] we have generated the World Risk Map presented in Figure 3. This map is based on data on World Risk Index (WRI)[425] prepared by the UN University (Institute for Environment and Human Security) and Alliance Development Works.

Relevant data are published in the UN document World Risk Report 2014 that presents the WRI profile of 171 countries around the world (Table 1).

The Index calculates the disaster risk for each country and comprises the following indicators:

- *Exposure* of the country toward the naturals hazards, such as earthquakes, floods, drought, cyclones, typhoons and sea level rise;
- *Susceptibility* of the country relating to the infrastructure, housing, food and other economic conditions;
- *Copying capacities* of the country in the scope of government measures to risk reduction, early warning, healthcare, social and material help, etc.;
- *Adaptive capacities* are concerning to the future natural hazards and the impacts of climate change.

The Index is calculated by multiplying the index of *exposure* to natural hazards with *vulnerability* index, which presents the average of the above-mentioned components: *susceptibility, copying capacities* and *adaptive capacities.*

According to this report Serbia ranked at the 76th position with *WRI* value 6,91. The first ranked country Vanuatu has *WRI* value 36,50 and the last ranked country Qatar - *WRI* value of 0,08.

The map in Figure 6 shows a visual image of 171 countries and the appropriate intrinsic grouping in four clusters. Due to the general SOM property of topology preserving, the closer the positions of two countries on a map, the more similar their profiles regarding the respective WRI values.

The Kohonen map is usually accompanied by the appropriate component planes[426] - Figure 7.

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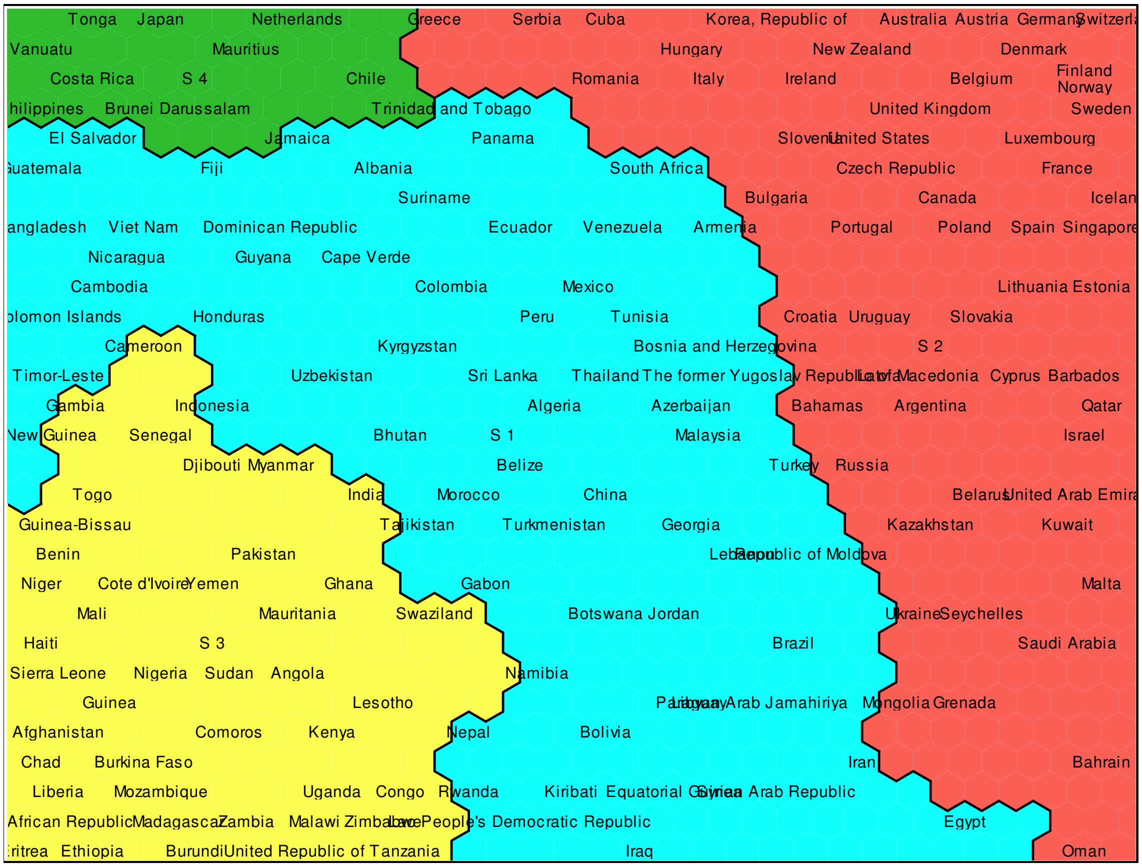
[424] http://www.viscovery.net

[425] https://www.ehs.unu.edu/article/read/world-risk-report-2014

[426] A component plane is a picture which displays the distribution of values of the respective component (indicator) over the map, thereby representing a cross-section through the map.

Figure 6. World Risk Map – Kohonen SOM map



Source: Authors' calculation.

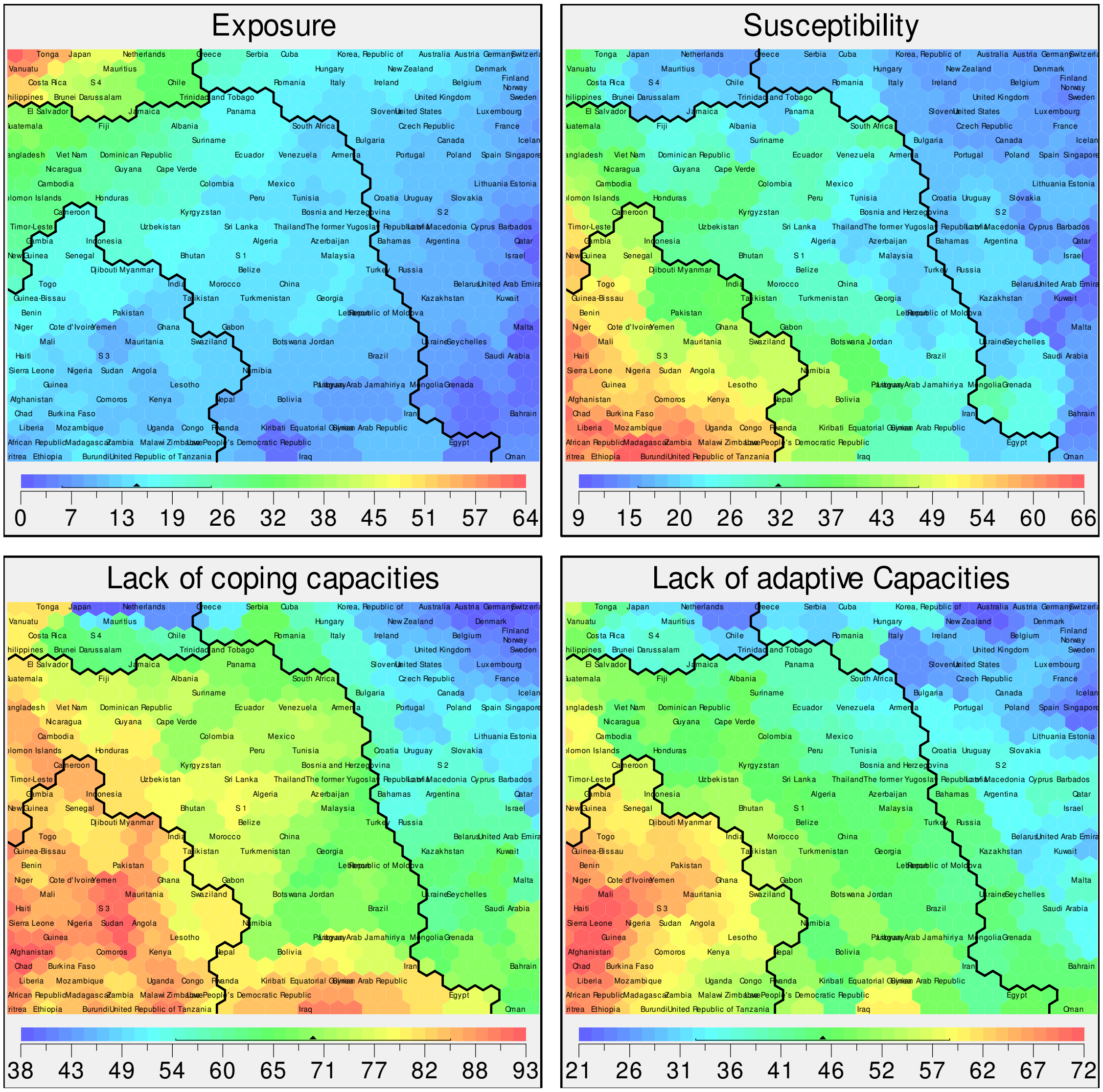
These planes are the projection of the particular indicators – *exposure*, *susceptibility, lack of copying capabilities* and *lack of adaptive capacities* onto the map and have a crucial importance for the map interpretation. Actually, they provide information on the relative distribution of a particular indicator and its influence on the final map giving a cross-section through the map.

Different colors are used to indicate lower and higher values. Generally, "cool" colors indicate low values, while "warm" ones indicate high values.

Thus, the contribution of a particular indicator to the map and the correlation between indicators may be easily observed. It is evident that indicators of *lack of copying capabilities* and *lack of adaptive capacities* are very similarly colored demonstrating similar structure and contribution to the final map.

On contrary, the distribution of indicator – *exposure* is specific indicating low correlation with other indicators.

Figure 7. Component planes of the WRI Kohonen map



Source: Authors' calculation.

In recent years, intensive research in the field of supporting information and communication technology and different types of software tools, the collection, processing and analysis of data relating to natural disasters has resulted in the development of many new and advanced systems that are able to assist in early warning, forecasting and mitigating the impacts of natural disasters.

The software solutions created specifically for these purposes, with the use of the latest technology, can provide a major contribution to data analysis related to natural disasters, both historically and in real time, in order to mitigate the damage and primarily casualties.

Chapter 33.

GLOBAL IMPORTANCE OF MANAGING CATASTROPHIC AND ESPECIALLY TERRORISM RISKS

The terrorist attacks on the buildings of the World Trade Organisation in New York and the Pentagon in Washington on 11 September 2001 led to new knowledge about the risks of terrorism. Such an attack was a new dimension of damage, both tangible and intangible. It was not the beginning of the era of terrorist attacks, but its suddenness, strength and consequences had, by all means, surprised the whole world.

These attacks had shown that it is not possible to foresee such threats and uncertainty, that it is not possible to define the probability of loss, while the level of risk - in view of its significance and frequency - is absolutely uncertain. Terrorism as a threat appeared in the recent history of humanity. It is difficult to distinguish it from other forms of violence, because its manifestations are numerous depending on persons using it, the range of its harmful impacts and other outcomes. A distinction should be made between terrorist actions and act of theft, sabotage and the like.

The current risks, like: extreme climatic changes, nuclear explosions, environmental disasters, global pandemic, together with terrorism risks represent catastrophic risks. Natural phenomena, where the rules of their occurrence and the estimation of their impact can be foreseen more easily, represent a larger threat to humanity. Potential hazards, which can have catastrophic consequences for humanity, come from celestial bodies, asteroids and comets hitting the earth, the activation of devastating volcanos, large-scale earthquakes etc. We should also be aware of evolving risks, such as synthetic biology, nanotechnology, artificial intelligence, global, political management of states and others.

All these risks are hazards for the insurers in the world, thus managing terrorism risk took the course, that this risk should be excluded from the insurance protection, since it is too large and unpredictable, and the state should be included in order to form a national system of protection from the impacts of terrorism. The risk of terrorism would be covered via a terrorism insurance pool, which would provide a reinsurance protection to insurers above the amount set in advance, whereby the possibility of the state's inclusion in solving the issue of such large-scale damages should also be foreseen.

The Criminal Code of the Republic of Serbia in its Article 314 excludes from the insurance coverage terrorism and sabotage risks, committed by persons acting with political purpose and who can be linked to any of the terrorist organisations. Yet, it should be kept in mind, that excluding the risk of sabotage foreseen by the conditions of insurance, set by domestic insurers, has a much broader scope and that it includes all situations of sabotage of the policy holder's property likewise his/her employees and other persons, who damage the insured property as described above. Article 312 of the same Code stipulates that: *"... bringing about explosion or fire, undertaking any other hazardous act, abduction, any other act of violence or threat of committing any act, which may jeopardize others' lives, or the use of nuclear, chemical, bacteriological or any other generally hazardous substance, whereby it causes the feeling of fear or insecurity among citizens."* (Ronfeld et al, 2001).

First and foremost, it should be borne in mind, that insurers in our country have never provided insurance against terrorism and its consequences and have always left it to the potential injured parties as their share in covering the damage and subsidies provided by state authorities. Thus, the General Conditions of Insurance of persons and property do not include such coverage and do not contain any definition of such risk.

The act of terrorism denotes a procedure which involves the use of force or violence and/or threats to movable or immovable property or infrastructure, and which has the aim or is intended to influence the government or the public opinion or generate fear within a specific part of the public. In the past, in the practice of most foreign insurers, insurance against fire, regardless of its cause and with the exception of war, civil war, manifestations and demonstrations, covered all cases of fire and explosion, which would incur as consequences of terrorist attack.

In each human act, undertaken deliberately, the objective is expected and defined in advance. However, on the road of achieving that objective, there are many things unknown. In our daily lives, we face situations, which are more or less expected. Whether in a dream or waking reality, we are surrounded by sudden and unexpected events. These events may be pleasant or unpleasant, harmful or not harmful materially, hazardous or not hazardous to health, but they always have the character of futurity. Risk, as a term, in a given moment, associates us with a number of presumptions depending on the perspective from which we look at it and analyse it.[427]

1. CATASTROPHIC RISKS

When we are talking about exposure to catastrophic risks, basically, we distinguish two larger risk groups: 1) *catastrophic risks related to natural forces, and* 2) any other non-natural peril*, falling outside that circle, which can decisively be linked to human factor*. Risks from the latter group can be categorized further to: a) so called *not deliberate events*, which happen as an aftermath of, for example, accident, explosion, fire; b) such, so called *deliberate events*, which are consequences of, for example, riots or terrorist acts. By 11 September 2001, i.e. the terrorist attack against the World Trade Centre, the losses of disasters falling in the circle of deliberate acts mentioned under point 2.b), were not forming a decisive part among disaster losses in international relation.

Terrorist actions are committed by special organisations founded to cause general turmoil and insecurity of citizens. Such organisations advocate ideas which are very close to radical Islamism, and, because of their method of work, they are organised in a less centralized and hierarchical manner, with prominent departments - cells, through which they achieve their goals from distance. The ideological sources of such organisations are religion and political decisions, while their strength and driving power is the fanaticism of their followers.[428]

The terrorist attack on the USA on 11 September 2001 shook the insurance industry with its estimated damage of about forty billion dollars, which was a terrorism risk loss of unprecedented magnitude. That even was registered among the most costly catastrophic events in history and, at the same time, significantly increased the reserve liabilities of the whole reinsurance market. (According to the Swiss Re and Insurance Information Institute, that event still ranks second among the catastrophic events with the highest losses in the last 15 years.)

This raised the question of insurance protection mechanism against such risks, the risk of terrorism with such disastrous impacts, and the role of the state in such situations. Since that risk, according to loss probability estimates, was not

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[427] Vojinović, Ž., Žarković, N. (2016). *Rizici i osiguranje*. Subotica: Faculty of Economics, University of Novi Sad, p. 9.

[428] https://www.brainyquote.com/quotes/authors/m/margaret_thatcher.html, 10.03.2016.

objective, yet there is an exceptional necessity for the protection against that risk, the USA was involved in covering the damage.

Till then, one of the biggest catastrophic losses incurred from a natural disaster risk, Hurricane Andrew, where the estimated damage amounted to about 19, 6 billion dollars. Then, the insurers paid the damage fully, although their maximum coverage amounted to eight billion dollars. The question of loss payments for catastrophic risks gained importance only after more frequent and increasing losses from catastrophic risks, terrorism and natural phenomena, as a serious and lasting problem in the insurers' operations.

Although, terrorism and natural disaster risks, by their nature, obviously, have catastrophic impacts, they are different in their subjectivity and predictability. Terrorism involves the participation of humans, i.e. the subjective character, but terrorist actions out of the blue with unbelievable proportions. Natural phenomena happen without human impact, they fail to have subjective character and, by implementing modern technological achievements, their occurrence is predictable and easier to assess. Human knowledge about natural phenomena is on a higher level, since generations and generations have monitored them, but it is not the case with the perils of terrorist actions.

However, the estimation models for terrorism risks are advancing year by year. The core problem is, indeed, in the subjectivity of these risks, due to which innovative risk assessment models fail to have full practical sense, which, as a disadvantage of adequate risk insurance and reinsurance may have significant impacts in other spheres of economy. If they assume the solving the impacts of such hazards at all, states do it only in the field of their form of appearance and devolve this burden later to insurers, hence, insurers find themselves facing the unknown, and the result of it is, that they assume higher risk, but, in practice, they fail to have an elaborated model for managing such risk.

Therefore, insurers have joined their forces to form a pool for insurance and, now, they create joint funds, from which they could cover the catastrophic damages of terrorism risk. In the management modalities of such risks, a special role is played by coinsurers and reinsurers in the sense of their larger dispersion, i.e. by further dividing hazards and impacts more broadly in space and time.

In the early 21st century, the capital of reinsurers was about 125 billion USD, which proved to be insufficient in the new situation and growth of terrorism threats and other catastrophic events. Therefore, risk diversification had to be extended from the primary coverage, made up by the insurers, to the secondary protection, which is the insurance of reinsurance, i.e. to the reinsurers. Even that proved to be an insufficient coverage for such sizeable consequences; hence, new levels of defence had to be created.

Banks and other financial institutions, as guarantors, or institutions diversifying risks by buying the shares of insurers or buying ”catastrophe bonds”, as well as the state, i.e. taxpayers as the “last line of defence”, all with the aim to share the risk among more sides, so that the insurance industry would not bear the burden of compensating damages alone, which would exceed the potential of both insurers and reinsurers alike.

Catastrophe bond appeared for the first time in 1994 with higher returns than the average bonds, and with a possible loss of principle due to catastrophic events. In a period of six years, only a total of seven billion USD of such bonds was emitted, which indicates that, as risk coverage instruments, they failed to achieve what was expected from them, and the reason for that lies in the inadequate tax treatment.

Hence, the institutional system of protecting property and persons found itself amid the problem of paramount damages, and such a situation necessitated the extension of protection levels to the state as well. Countries approach catastrophic hazards differently; thereby they have diverse models for resolving and managing such losses. Special attention is devoted to agricultural risk insurances, crop and fruit insurances, animal insurances etc. Agricultural risks are floods, storms, hail, frost, technological risks, animal diseases, terrorism and others.

Serbia has introduces subsidies in agricultural insurance. It can be concluded from the above presented, that there is scarce interest among the farmers to insure their crops and produce. Insurance coverage of a mere 10-15 percent indicates a weak status in this field, but also, scares opportunities at the insurers' disposal. On the one hand, we have the insured area, which is not increasing, nor is the number of farmers changing, while on the other hand, we have insurances offered by a large number of insurers.[429]

Some countries have special funds for covering catastrophic losses, terrorism risks, technological catastrophe risks, etc. France would be an example for that. Such funds are founded and managed by the state, and, essentially, these funds have the basic functions of insurers and the aim that they share the risks they

[429] Birovljev, J., Vojinović, Ž., Balaban, M. (2015). Potential of agricultural production and its impact on insurance premiums. *Economics of Agriculture,* 62(3), p. 709.

had assumed on an international level with other states, who jointly and severally participate in covering catastrophic losses.

The causes of ten damages/losses with highest costs for the world's insurers and reinsurers during the past four and a half decades, in most cases, are: storms, thunderstorms, floods and earthquakes. Only one of the largest losses was caused by man. Of course, it was the attack on the World Trade Centre in New York, in September 2001.[430]

According to scientists from the Oxford, risks with catastrophic impacts are:

- extreme climate changes,
- nuclear wars,
- environmental disasters,
- global pandemic,
- breakdown of the global systems,
- impacts of large celestial bodies,
- super volcano eruption.

Future events with possible catastrophic impacts are:

- synthetic biology,
- nanotechnology,
- artificial intelligence,
- future bad governance of states and other unknown risks.

The notion of terrorism risk and the question of its insurability and financing - since, regretfully, both are hot topics - are always on the agenda and the subjects of discussion on international forums and conferences. From the aspect of forming appropriate compensation systems, defining terrorism risks is still a crucial issue in the world's insurance sector and in scientific workshops. Therefore, the aim is to define the criteria for categorizing certain events as terrorist acts, yet, it is also an open question, how and at which financial levels can the insurance coverage of such risks be efficiently solved. It should be added, that the international professional jargon already uses the notion of "megaterrorism". Megaterrorism can be defined as such acts causing damages, which in total exceed both the market's and the concerned government's resources, so international and regional cooperation is indispensable in the settlement of losses and damages. For a long time, one of the disputable questions of the international fora was whether it is permitted and necessary at all to create a closed system for notional definition. According to the standpoint

[430] Vojinović, Ž., Žarković, N. (2016), *op. cit.,* p. 9.

of the OECD, it is necessary to provide a definition for those criteria, based on which an act can be considered terrorism. For example: based on the impact and aim of the event, can an event be qualified as terrorist act; in view of compensation factors, the need to apply state and non-state financing mechanisms, e.g. bonds. Terrorism is such a risk factor, which exceeds the frames of a single state, hence, it requires the creation of novel, efficient mechanisms for risk sharing and compensation, which make the inclusion of states necessary. Namely, from insurability aspect, terrorism risk is a fundamental challenge, bearing in mind the potential paramount magnitude of non-assessable damages. Specifically, the general conditions of risk insurability may be as follows:

- larger number of observation units, so it can be analysed based on probability calculations, and thus it could be an effective risk sharing,
- risks to be homogeneous,
- possible damages should be random,
- possible damages should be unambiguously describable and assessable,
- the possible contract should be economical for both parties (contracting party, insurer).

Defining the notion of terrorism from the aspect of compensation, therefore, requires a principled approach, based on complex economic and legal grounds, whereby the building of new channels of information and strengthening public-private partnerships should be an integral part, in order to create effective methods of insurance in the future. From this point of view, the catastrophic risk category of terrorism occurred through intentional events should be separated from other catastrophic risks. Defining, assessing and measuring the risk of terrorism, and the creation of financial coverage techniques respectively, makes this type of risk specific and treats it as accentuated among other catastrophic risks.

2. MEASURING CATASTROPHIC RISKS

Assessing the magnitude of losses from terrorism risk is very difficult and the consequences of such attacks are unforeseeable.

Although possible terrorism risks have already been mapped, modelled after the ones for the geographic location of potential points of risk and the probability of their occurrence during natural disasters, it should be pointed out, that mapping this type of risk cannot provide predictions with high level of certainty, due to the pivotal impact of the unpredictable human factor.

In assessing the distribution of loss magnitude, it is important to assess the probability of annual surpass of the expected loss by using the best estimate, considering the overall frequency of planned attacks and the decision tree to detect planned attacks, so that both successful and prevented attacks could be taken into account as threats. This type of risk calculation inevitably takes into consideration diverse subjective factors.

When talking about assessments, the best evidence would be a once classified study, titled Terror 2000 by the Pentagon. Its purpose was to support elite, intellectual and governing circles to get familiar with the hazards of terrorism. Terrorism risk is assessed systematically with the simultaneous support of international experts.

Measuring terrorism risks is a serious and difficult task for insurers. The process of risk measuring can be described by the following difficulties and characteristics:

- The frequency and seriousness of the planned attacks will mostly depend on the network architecture of the terrorist organisation.
- Being permanently under the pressure of anti-terrorist units, terrorist organisation will transform, one by one, into a network based on propagating clusters principle. It will be a difficult task to reveal and stop these quickly growing virtual cells, communicating via the internet.
- Network-type terrorist organisations will commission their actions with increasing frequency, but these actions will be less planned, less ambitious and will produce less damage.
- An event tree can be made to estimate the probability, whether the planned attack would be successful depending on the possibility and level of using intelligent systems, efficiency of safety barriers, technical and logistic failures.
- The distribution of the magnitude of losses may be calculated from the mapped model of losses stemming from real potential terrorist scenarios, and then the cost function should be added to each scenario. The cost function would include such factors as: time of planning, technological barriers and the use of deficient resources.

A comprehensive computer estimation of the probability of exceeding the expected losses can also be made, whereby it should be taken into account, that the values of all subjective factors are to be proposed by experts of the given field, who are, mostly, members of intelligence agencies of the most developed countries in the world (Arquilla et al, 2001).

3. SPECIAL RISK MANAGEMENT FORMS OF THE MARKET AND THE STATE

3.1. Risk management categories

Very often we lack precise information on the value of individual input parameters, or the values of coefficients in constraint and goal functions, and imprecise formulation of limitations themselves is possible as well.[431]

In the practice of insurance markets, there two major types of catastrophic risks in market-based risk management:

- mechanisms, techniques for risk placements, "atomization" of risks, and
- other market tools.

The first category includes traditional insurance contracts and different reinsurance types, new capital market techniques, including such securitized mechanisms as the, e.g.:

- catastrophe bonds („cat-bonds");
- other risk-linked securities;
- bilateral agreements, such as catastrophic risk swaps;
- stock exchange and OTC catastrophe derivatives.

In the case of the second category, we can talk about special bank/financial market loans and capital market mechanisms, by which, in view of risk coverage, apart from events under category 1, a link is created between the insurance sector and the capital market. From the above mentioned set of tools, direct insurance contracts and the reinsurance sector, as the traditional institutional circle of risk "atomization", have been and, supposedly will be, the main area of perceiving and treating catastrophic risks. Insurers providing insurance for special disasters (e.g. hurricanes, floods etc.) may exclude certain disasters from the circle of general coverage. Excluding damages caused by war or civil riots can be considered a general phenomenon, so these are not qualified as insured events. Catastrophic risks are special in a sense that their occurrence is characterized by high level of uncertainty, whilst their potential loss can achieve extreme magnitude. From risk management perspective it is an aggravating circumstance, that these events are not independent from each

[431] Sedlak, O., Birovljev, J., Vunjak, N., Ćirić, Z. (2015). New Products Market with Fuzzy Linear Programming, In: *Proceedings 16th International Scientific Conference*, 5.-6. November 2015, Bratislava: University of Economics in Bratislava, Faculty of Economic Informatics, p. 7.

other, and they may be in a tight correlation within a given geographical area. That is why these high risks are being placed into the reinsurance sector, where there is ample opportunity to geographically diversify these risks more extensively on the global reinsurance market. The placement of catastrophic risks is, usually, optional, in a form of non-proportional reinsurance contracts. (Optional insurance contracts are made for the coverage of such special risks as e.g. hurricane, earthquake... This type of contract does not include the element of risk coverage proportional to the price, but the reinsurer's liability covers liabilities up to a maximum amount, which is, in most cases, an amount exceeding a set value.) The reinsurer assumes the risks from the insurer against a payment of a set price. In the case of the second large group of catastrophic risks, there is a non-insurance, financial institution (bank, capital market institution). During the so called "catastrophe risk financing", there is an opportunity to provide supplemental sources (e.g. short-term loans, automatic revolving loans, syndicated loans, investment banks, capital instruments offered by security trading companies...), if the risk assuming institution needs it after the loss has incurred, because of its increased liquidity demands.

When we talk about the influence of humans on events with harmful consequences, we say, that it is a subjective order or sequence of events. Human impact on the strength and type of risk is more and more discernible these days. For example, the hazards of destructive natural disasters (typhoon, hurricane, storms and others), which are considered objective, were, in large measure, directly or indirectly caused by humans over the past couple of years. Hence, it may be concluded that the once firm borders between objective and subjective risks are being wiped out.[432].

3.2. Risk positioning and measuring

Decision making is said to be performed under conditions of certainty, when the outcomes of any action can be precisely determined and arranged. In such cases, alternatives are chosen that lead to outcomes with maximum utility. On the other hand, a decision is made under conditions of risk, when the only knowledge available regarding the state of outcomes is their probability distribution. [433]

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[432] Vojinović, Ž., Žarković, N. (2016), *op. cit.,* p. 28.

[433] Sedlak, O., Čileg, M., Kiš, T., Ćirić, I. (2013). Marketing decision making under conditions of uncertainty and risk. 2nd International M-Sphere Conference, Dubrovnik, 9-11. october 2013, *Book of proceedings part-2*, University of Zagreb and Faculty of Economics in Dubrovnik, pp.505-515.

Risk reduction and risk placement can be implemented only after a well-functioning, internal risk-detecting and monitoring system is in place. In addition to many constraints under the given conditions, one must particularly bear in mind limitations, i.e. constraints such as:

- that the selected alternative (goal) is to be accomplished in the shortest possible period;
- that investment in accomplishing the selected alternative should not be excessive.[434]

The steps and the correlation of elements of such risk management process are: Defining the most significant catastrophic risks - Direct economic potential, preliminary indicator of risk exposure magnitude - Risk reduction techniques, cost-benefit analysis - (Risk management and reduction) - Definition of state inclusion - Assessment possibilities of risk placement and financing - Various forms of residual risk financing - (Risk financing - reducing economic exposure to risk).

It is obvious, that the set of risk management tools is not and cannot be limited to the borders of the private sphere in the case of certain high risks. The state's intervention becomes necessary when we are talking about uninsurable *risk*, i.e. the size and magnitude of the catastrophic risks makes it absolutely necessary. (Non-insurable catastrophic risks mean that circle, which cannot be included under usual, normal insurance market conditions.) The state's role to assume additional risks can be considered as a role of the insurer of last resort.

4. THE STATE'S ROLE ON THE INSURANCE MARKET

As set by the principles of neo-liberalism, there are numerous reasons, economic by nature, on account of which the interference of the government in the private insurance market is not desirable. By its nature, market enables private and social benefits, which can be reduced by the state interference in market as an active player. On the insurance market these benefits are: incentives for efficient investment at risk distribution measures, cautious adjustment of claims and capacity development in order to meet the demand.

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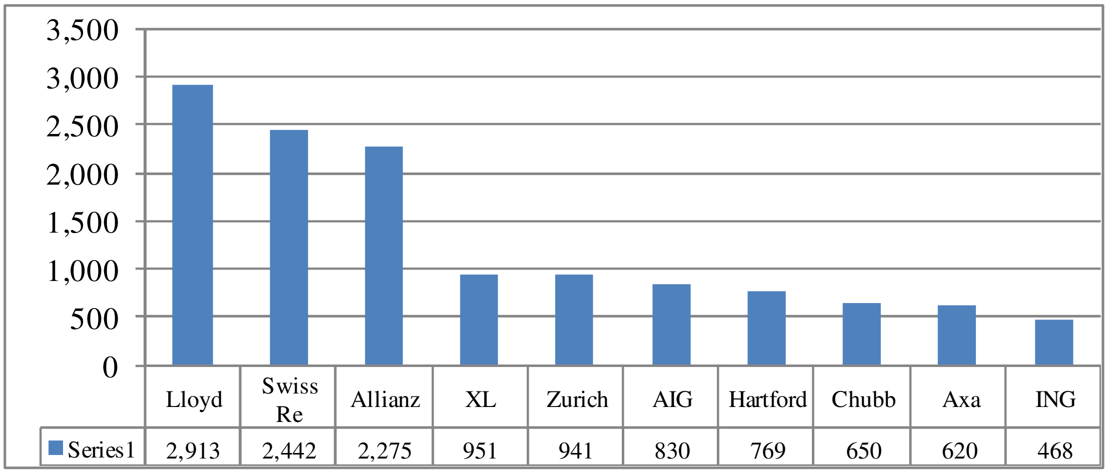
[434] Sedlak, O., Čileg, M., Kiš, T. (2013). Decision Support System with Mark-giving Method, ICORES 2013 - *International Conference on Operations Research and Enterprise Systems* (Conference), Barcelona: SCITEPRESS - Science and Technology Publications, pp. 338-343.

Nevertheless, a number of shocks on the market resulted in dysfunctional trends and temporary, yet serious problems in the market of property and life insurance.

Graph 1. The loss of insurance companies due to terrorist attack on the USA on 11 September 2001 (in million USD)



Source: https://www.genevaassociation.org/media/586501/insurance-and-september-11-one-year-after.pdf

4.1. Incentives for risk mitigation

One of the virtues of the free markets are the incentives provided by the markets to market participants for investments and conduct in socially optimal manner. One of the major reasons why state interference in free markets is undesirable is that prices do not reflect the real status on the market, which, under usual conditions, signals the companies and buyers how to allocate their resources efficiently.

In case the government supports the insurance of terrorism risk, it is to be feared that prices, which do not reflect the real market status, would force companies to make sub-optimum decisions about investing into risk reduction. With regard to limited resources, a company exposed to risk, has two alternatives: to make an insurance on losses against a given risk or it can invest in measures, which will reduce the possibility of a major loss to occur in the case of terrorist attack. A for-profit organisation will invest in risk reduction up to a point, where the marginal cost of additional risk reduction equals the marginal cost of insurance against risk.

Incentives for risk reduction provided by the insurance market can be classified in two categories. There are incentives for investment in measures aimed at making existing buildings safer, and there are incentives which will influence the development of new buildings and projects. The first type of incentives, which reduces risk, i.e. the one referring to existing buildings, includes an advanced security which may divert, discourage or prevent the attack, or can upgrade the building's structure (stronger windows, valves), thus can limit losses if the attack would occur. The second type of incentives for risk mitigation may influence decision-making about the location of the building, its size, design and the nature of future buildings and facilities. The usual insurance mechanisms would, for example, discourage the construction of buildings attractive for terrorist attacks.

In both cases of risk mitigation it is of key importance that the insured persons may not know whether the attack would occur, but can, preventively, influence risk reduction, if the attack occurs.

4.2. Incentives for claim adjustments

On insurance markets which function normally, the insurer will pay attention to the evaluation of policyholders' policy-based claims, because these funds are to be paid directly out of the insurer's “pocket”. In case of government intervention and support to private insurers in the payment of the policyholders' claims, and if loss occurs, insurers may fail to pay sufficient attention to the evaluation of such claims, which leads to information asymmetry and market quakes.

More importantly, insurers may, in such cases, behave generously on the government's account and sign attractive contracts with policy buyers in order to attract them, knowing, that if loss occurs, the government will intervene with its financial injection. It leads to moral hazard. If the government does not participate in the market as an active player, the insurer will be more cautious.

4.3. The squeeze-out effect

Squeeze-out effect is a phenomenon when the government offers a product or service, usually offered by the private sector, so there is a risk of private companies being “squeezed-out”. Government dominance on the insurance market may eliminate private insurers' and reinsurers' incentives for building additional capacities or for investing in capacities for the assessment of risk distribution. In a short-term, the squeeze-out effect usually exists in smaller scales, because some insurers and reinsurers withdraw from the insurance market. On a long-term, the government's role may hamper private insurers to develop their capacities for covering terrorism risks. A potentially successful solution for a government would be to act as a bridge, which surmounts current obstacles, while the private sector develops adequate capacities and expertise necessary to meet the demand in insurance against terrorism.

An important reason why is the long-term substitution of private insurers by governments is inefficient is the fact, that there are significant costs involved in providing insurance against terrorism. The direct cost is that taxpayers assume the risk. In case of an attack, they assume the burden of paying claims. When the government is responsible for the payment of losses from insurance against terrorism, one way of such payment is tax increase, which can have strong economic and social implications, or, the second way is to reduce public expenses, which also affects citizens.

There are indirect costs as well, when the state changes some of the private sector's roles. Providing a product or service, the government, unlike the private sector, is not a subject of competitive pressure on the market. Consequently, there are reasonable concerns, that the government's long-term dominance on a certain market may lead to loss of efficiency and innovation triggered by healthy competition within the private sector.

5. ANALYSING RISK AND INSURANCE AGAINST TERRORISM

5.1. Risk and terrorism insurance analysis in historical context

Terrorism risk and costs as its consequences have been increasing in the recent years and the world is aware of it. The decision maker's expertise and appropriate assessment of tolerable risk levels (i.e. the subjective factor) is therefore of extreme importance for the final effects of decision made. [435]

Graph 2 clearly shows such a situation. High costs for the year 2001 were the result of the terrorist attack on the USA, which is considered the largest individual terrorist attack in the history of humanity and that was the attack which changed the insurance community the most, as has been elaborated above.

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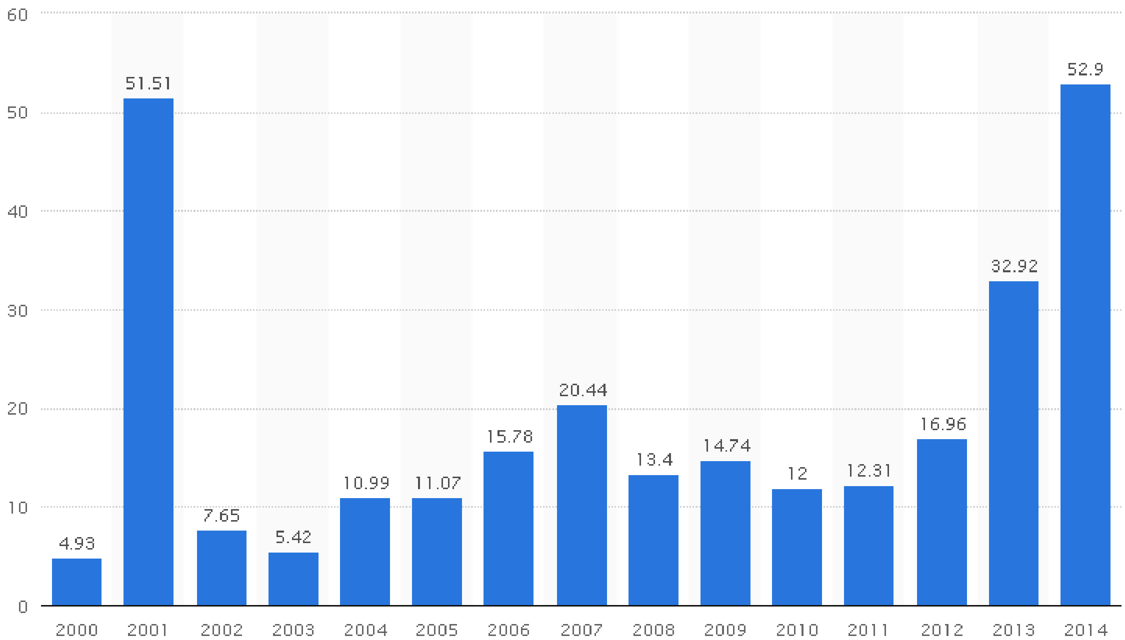
[435] Sedlak, O., Ćirić, Z., Ćirić, I. (2013). Strategic Management Under the Conditions of Uncertainty and Indefiniteness. *Strategic Management - International Journal of Strategic Management and Decision Support Systems in Strategic Management*, 18(1), No. 1, pp. 62-68.

Graph 2. Global economic costs of terrorism in the period 2000-2014 (in billion USD)



Source: http://www.statista.com/statistics/489649/global-economic-costs-of-terrorism, 7.1.2015

The amounts of insurance costs as consequences of the attack are shown in the Tables 1 and 2:

Table 1. Estimated insurance market loss due to terrorist attack on the World Trade Centre (in billion USD)

Business area	**Value (from - to)**	
Property	10	12
Business interruption	3.5	7
Employee compensations	3	4
Aviation	3	5
Liability	5	20
Other non-life insurance	1	2
Life and health	4,5	6
Total	**30**	**50.8**

Source: http://media.swissre.com/documents/FocusReport_Terrorism_e.pdf, 7.01.2015.

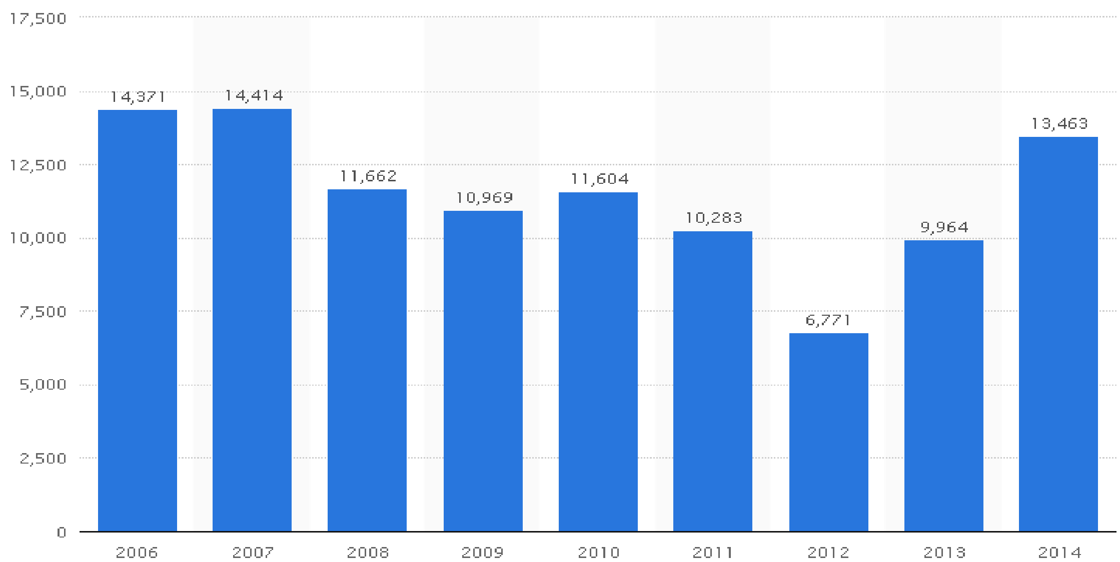
Table 2. Top 10 countries attacked by terrorists, prior and after 11 September 2001

	from 1970 to 11 September 2001		**from 11 September 2001 to 2014**	
Serial number	**Country**	**% of all attacks**	**Country**	**% of all attacks**
1.	Columbia	8.88%	Iraq	25.77%
2.	Peru	8.35%	India	9.48%
3.	Salvador	7.38%	Afghanistan	9.03%
4.	Northern Ireland	5.13%	Pakistan	7.63%
5.	India	4.61%	Thailand	5.84%
6.	Spain	4.14%	Philippines	3.85%
7.	Turkey	3.49%	Russia	3.65%
8.	Chile	3.15%	Columbia	3.22%
9.	Sri Lanka	3.03%	Israel	2.89%
10.	Philippines	2.96%	Nepal	2.55%

Source: http://ourworldindata.org/data/war-peace/terrorism, 7.01.2015.

Worryingly, despite rising awareness on terrorism, its strength is not weakening and it is not being combated, on the contrary, it is strengthening.

Graph 3. The number of terrorist attack in the world in 2006-2014



Source: http://www.statista.com/statistics/202864/number-of-terrorist-attacks-world wide, 7.01.2015.

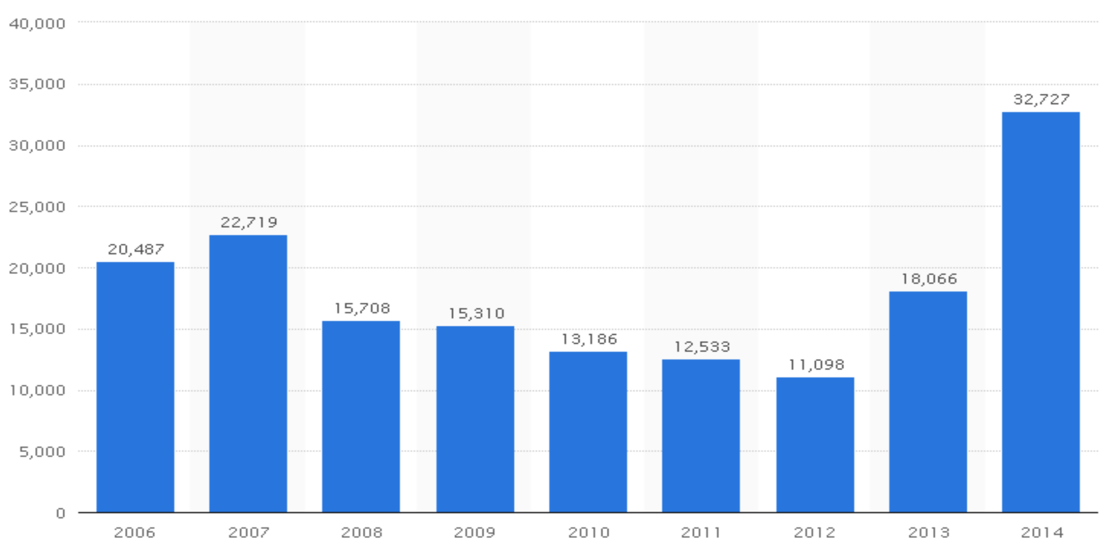
As years go by, terrorist commit increasingly massive attacks, which is proved by Table 3 and Graph 4. The average loss caused by a terrorist attack increased in 2014 for 357.84% compared to 2006 and this result is, regretfully, only part of a multi-year trend in the increase of risks and losses as consequences of terrorism. On the other hand, the 10 largest, recorded terrorist attacks occurred prior to 2002, and it shows that the precaution measures had their results in avoiding losses and damages of unprecedented magnitude, like the one of 11 September 2001.

Table 3. Average losses due to terrorist attacks in USD in the period 2007-2014 and the increment percent of loss values compared to 2006

Year	Average loss caused by a terrorist attack	Increment per cent of loss value compared to 2006
2006	1098044.673	/
2007	1418065.769	129.14%
2008	1149031.041	104.64%
2009	1343787.036	122.38%
2010	1034126.163	94.18%
2011	1197121.463	109.02%
2012	2504799.882	228.11%
2013	3303894.018	300.89%
2014	3929287.677	357.84%

Source: Prepared based on: http://www.statista.com/statistics/489649/global-economic-costs-of-terrorism and http://www.statista.com/statistics/202864/ number-of-terrorist-attacks-worldwide/, 7.01.2015

Graph 4. Number of fatalities by terrorist attacks in the world in 2006-2014



Source: http://www.statista.com/statistics/202871/number-of-fatalities-by-terrorist-attacks-worldwide/, 7.01.2015.

5.2. Global Terrorism Index

Global Terrorism Index (GTI) is a study which considers the direct and indirect impacts of terrorism on 162 countries in view of its effect on fatalities, casualties, destroyed property and its phsychological effect. The study covers 99.6% of the world's population.

This study is the most complex and competent source of data about terrorism today and it is supported by the Global Terrorism Database (GTD). GTD is unique in comprising systematic information and data about 140,000 terrorist incidents. It is important to analyse total data in the context of: various social and economic conditions in which terrorism happens, geo-political situations and the strategies of terrorist groups, their tactical objectives and their evaluation through time. The aim of the GTI is to set terrorism risk trends, in order to overcome or alleviate them in the best possible manner.

GTI results for 2015 are as follows:[436]

1) Terrorist activities increased for 80% in 2014 to a record level. The largest increase in fatalities was in 2013 and 2014, from 18,111 to 32,685. The number of deaths from terrorism has increased nine times since 2000.
2) Boko Haram has overtaken ISIS in the number of deaths from their terrorist attacks. The number of fatalities relating to Boko Haram increased for 317% in 2014 and that organisation is responsible for 6,644 deaths. ISIS is responsible for 6,073 deaths.
3) Terrorist activities are highly concentrated in 5 countries where 78% of fatalities from terrorism happened. Data show that 57% of all attacks and 78% of all fatalities happened in five countries: Irak, Nigeria, Afghanistan, Pakistan and Syria.
4) Almost 60% of the countries covered by the GTI research had no victims of terrorism in 2014, because 92 out of the 162 states had no victims, while 67 countries had one or more victims of terrorist attacks.
5) Nevertheless, most of the countries experienced some sort of terrorist attack, because the number of countries which experienced terrorist attack is 93, while this number was 88 in 2013.
6) More countries than ever recorder a high level of terrorism. The number of countries with more than 500 victims is larger for 120%. This number increased from 5 to 11 in the former year.

[436] http://economicsandpeace.org/wp-content/uploads/2015/11/Global-Terrorism-Index-2015.pdf, 7.01.2015.

Some patterns were observed in the terrorist attacks in 2014, and based on the GTI research, these are:[437]

- *More and more civilians become the target of terrorists* - the number of civilian fatalities increased for 172% compared to 2013;
- *Terrorist attacks on religious targets resulted for 11% less victims than in 2013;*
- *There are two groups responsible for half of the terrorism victims:* Boko Haram and ISIS;
- *Nigeria experienced the largest increase in the number of terrorism victims* – 7,512 victims, which is a rise of 312% compared to 2013;
- *The number of ISIS victims is larger in battle fields than in terrorist attacks* – 20,000 and 6,000 respectively;
- *The arrival of foreign fighters in Iraq and Syria continued* - their number was between 25,000 and 30,000 until 2001, and 7,000 in the first six months of 2015;
- *If we do not include Turkey, 21% of the foreign fighters come from Europe.*

Terrorism in western countries had certain characteristics in 2014. Most of the terrorism victims were not located in western countries, except for 11 September 2001. Only 0.5% of terrorism victims have fallen victim after 2000. Including 11 September, that percent is 2.6. Individuals, and not organisations, are the greatest terrorism threats in western countries, because, since 2006, 70% of terrorism victims were attacked by individuals, who do not belong to any terrorist group. Islamic fundamentalism was not the major cause of terrorism in western countries during the last nine years, because 80% of the victims were killed by individuals guided by extremism, nationalism, anti-government feelings, political extremism and the like.

Terrorist activities trigger fleeing. Countries with the highest number of refugees, as a rule, have the largest number of terrorism victims. From the viewpoint of countries with over 500 terrorism victims, 10 out of 11 of such countries had a higher level of migration to western countries of the world. [438]

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[437] http://economicsandpeace.org/wp-content/uploads/2015/11/Global-Terrorism-Index-2015.pdf, p. 4, 7.01.2015.

[438] http://economicsandpeace.org/wp-content/uploads/2015/11/Global-Terrorism-Index-2015.pdf, p. 5, 7.01.2015.

The economic costs of terrorism in 2014 were: [439]

- *The economic costs of terrorism increased for 61% in 2014*. The economic costs of terrorism reached their peak of 52.9 billion USD in that year. This is a growth of 61% compared to 2013 and it is ten times higher compared to 2000.
- *The costs of security against and prevention of terrorism are immense and exceed the direct terrorism costs* - the total of all expenses against terrorism by national security agencies was about 117 billion USD.

According to this research, Serbia ranks 106 out of 162 countries and faces no serious terrorism threats.

5.3. The perspective of defining the price of terrorism risk

According to the Marsh and McLennan reports, the take-up rate and purchase of insurance policies against terrorism risk increased over time, and in 2003 it was 27%, which, by 2009, increased up to 61%. Table 4 shows the leading industries in take-up rate. Most of Marsh's clients bought insurance against terrorism risk, and the demand for it has been increasing.

Table 4. Take-up rates of policies in terrorism insurance industries

Industry	rate (%)
Public utility services	80
Property	76
Medical protection	76
Transportation	75
Financial institutions	74
Media	71
Tourism	68
Education	65
Technology	61
Public companies	61

Source: Walsh, T. (2010). The Marsh Report: Terrorism Risk Insurance, Marsh and McLennan Companies, pp. 10–11.

As to policy prices, terrorism insurance costs had decreased over the years, recording the most significant drop in 2009. The median of the premium rate for the terrorism insurance fell from 37 USD per 1 million USD coverage to 25

[439] http://economicsandpeace.org/wp-content/uploads/2015/11/Global-Terrorism-Index-2015.pdf, p. 5, 8.01.2015.

USD per 1 million USD coverage.[440] During 2008, the terrorism insurance premium median was 9,541 USD per a total insured value median of 303 million USD, which is 0.0000315 USD per premium for each dollar of total insured value. This price level further shows that, in 2008, for 1 USD of premium a property insurance value of 31,758 USD was bought. Let's compare this median of the price level for terrorism insurance premium with the median for property insurance premium for the same period. The property insurance premium median was 295,755 USD per total insured value of 303 million USD, which is 0.0000967 USD premium per each dollar of the total insured value or 1 USD of purchased premium per 1,024 property insurance. This is a ratio of 1:3 between the terrorism insurance price and property insurance price.

This ratio, more specifically relation, shows that the loss or property damage risk is much higher than terrorism risk, which can be concluded from the insurance price. Sceptics may argue that the terrorism insurance prices are low because of TRIA, and if TRIA hadn't existed, prices would rise dramatically. There are two problems related to this argument.

The first one is, why would the terrorism insurance price be kept low, artificially by the USA Government, instead of allowing price formation on the free market? The answer that market prices would be extremely high is not the right answer. Principally, low price costs would be borne by citizens due to government intervention. Practically, even if prices increase dramatically after the withdrawal of TRIA, terrorism insurance will further be significantly cheaper than the price of property insurance, due to their current difference, i.e. the policyholders will prefer buying more expensive terrorism insurance policies.

The second problem is, that, as stated in the Marsh report, there is a significant standalone terrorism insurance market (without TRIA), including coverage for uncertified risks and international risks (risks not covered by TRIA). Insurance capacities on this market amounted to 3.76 billion USD in 2010.[441] The capacities of terrorism insurance market with TRIA are even larger. The existence of a gigantic, standalone terrorism insurance market is the evidence, that the insurance industry has capital and capacities to provide insurance even without the support of the TRIA.

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440 Walsh, T. (2010). *The Marsh Report: Terrorism Risk Insurance*, Marsh and McLennan Companies, pp. 12-19.

441 *Ibid.*

The coverage of terrorism risks without TRIA would be a smaller portion of the property and life insurance premiums, and would be accessible for purchase by foreign commercial policyholders. The disputes about TRIA and the lobby by the insurance industry, likewise the business interests of many stakeholders are aimed at lowering the terrorism insurance price on the account of the public (taxpayers, state).

5.4. The role of TRIA in risk and price assessment

The attacks on 11 September showed us that the old method of setting the prices in terrorism insurance was wrong. Now, experience is engraved in all pores of the insurers in this field, and assessing terrorism risks will be easier. Without the TRIA, the free market would take the market with its mechanisms into a new status of equilibrium: premium prices would rise, while their purchase would fall, and market would later find a new equilibrium after reasonable risk assessment, and risk would be more concentrated on the insurance industry and commercial policyholders. Fatal predictions, that the insurance market would disappear, were not based on reality.

The financial recovery of the insurance industry from losses due to the 2001 attack on the USA deserves attention. In the months after the attack, the prices of the insurance market stocks increased, because investors wanted to earn profit due to "stiffened" prices (due to government guarantees) and higher return on equity. [442] The return on equity of the industry happened very quickly and after a couple of years it had more equity than before 11 September 2001.[443] Between 2002 and 2006, the surplus in the life and non-life insurance industry increased from 302 billion USD to 508 billion USD. [444] In the years after the

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[442] Oxford Metrica (2003). *Shareholder Value Analysis of the Global (Re)insurance Industry*. Oxford, p. 2.

[443] From September 2001 till July 2002, "66 companies generated a profit of 28 billion USD and made 47 contract worth 46 billion USD" according to: Hubbard, G.R., Deal, B. (2005). The Economic Effects of Federal Participation in Terrorism. *Risk Management and Insurance Review*, 8(2), p. 37. In late 2000, the property and life insurance sector of the USA had 290 billion dollars surplus, and at the end of the first three months in 2004, their equity amounted to 361 billion USD. Hubbard, Deal, *op. cit.,* p. 30. On top of that, the reinsurers' equity had doubled since 11 September 2011. *Ibid,* p. 39.

[444] U.S. Treasury Department (2011). Terrorism: Terror Market Continues to Provide Abundant Cover *Report of the President's Working Group on Financial Markets: Market Guy Carpenter and Company*, Washington, DC: U.S. Treasury Department, p. 14.

attack, the return of equity (ROE) exceeded the ROE of the whole American industry. [445]

With amassed capital and the opportunity of providing insurance under new conditions of risk, the insurers would, probably, be compelled to provide broader terrorism insurance even without TRIA, in order to prevent that the new equity gained would not end in the hands of shareholders as dividends. Under the pressure of generating new capital, the market overtakes the control of prices, supply and demand, while a gradual drop in premium prices is inevitable as the negotiating power of suppliers and buyers changes. Presently, there is an extremely large supply of reinsurance on the terrorism risk market, which will result in a pressure on the prices to decrease.

Besides stabilizing the market, one of the aims of TRIA was to provide sufficient time to private insurers to elaborate a long-term solution on how to overcome the catastrophic risk of terrorism. Yet, the US Government concluded, that private insurers had not made much in creating a mechanism in which the private sector would develop the capacities of independent terrorism risk loss absorption without the assistance of the Government. [446] Lobbying activities are ongoing in order to find a long-term solution by prolonging TRIA as a public-private partnership.[447]

Solving the problem of the magnitude of damage caused by catastrophic risks, which are unpredictable in their number of occurrence and magnitude of damage they cause, should rather be sought in the relation of the state and the reinsurance, in a sense of creating funds, which may provide coverage on an international level and pooling a larger number of states. The shortest definition of the term "reinsurance" is that it is the insurance of the insurance. In any case, reinsurance would not exist without insurance. The insurance contract is the prerequisite of the reinsurance contract. [448]
Some groups have always been lobbying to maintain this status. On the other hand, a whole spectrum of consumer groups, the public, likewise academic,

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[445] Hubbard, Deal, *op. cit.,* p. 36

[446] U.S. Government Accountability Office (2004). *Terrorism Insurance: Implementation of the Terrorism Risk Insurance Act of 2002.* Washington, DC: U.S. Government Accountability Office, p. 28.

[447] American Insurance Association (2005). Ensuring Economic Security in the Face of Terrorism: A Public-Private Partnership. *American Insurance Association Advocate*, 3/2005, p. 3.

[448] Vojinović, Ž. (2016). Preuzimanje rizika i poslova osiguranja u reosiguranje. *NUBL,* Svarog, No. 6, pp. 231-241.

financial and insurance circles are against providing subsidies to the insurance industry on a permanent basis, because it is very well capitalized and financially healthy.[449] From the insurers' perspective, there is no good reason for terminating a good agreement, because, practically, they have reinsurance policy provided without paying premium. The lobbying activities of the insurance industry and business community led to the prolongation of TRIA both in 2005 and 2007 alike. There is no reason to think that they would not attempt it in the years to come. Although TRIA was envisaged as a temporary response, in order to stabilize the market (the primary plan was for three years), it has evolved into a public-private partnership where costs are shared. There are no intentions in the insurance industry to change this situation.

Indeed, terrorism risk and the number of its victims is increasing with immense speed and change the every days of citizens and of insurers alike. The insurance industry is forced to take huge efforts and progress in technological, financial and intellectual capacities, because only a proactive approach to cooperation with national states can uphold the insurance community and the safety of humanity a step ahead of the terrorist organisations. The key factors which should be taken into consideration in buying a terrorism risk insurance policy are the following:

- All national schemes will include different notions, terms and conditions for defining terrorism and various exclusions.
- Almost all national terrorism insurance schemes cover insurance valid for the territory of that given country.
- There is a strong terrorism risk insurance market at national and international level.
- Many international companies would like to have international terrorism insurance policies, which would replace or supplement their national insurance policies.
    - The international terrorism insurance policy requires a complex approach to its elaboration and the participation of renowned experts.

In solving the problems from this field, the cooperation between commercial insurers and national governments is needed worldwide, so that a synergic effect could be created and efficacy would be enabled under conditions of increasing terrorism threats and their consequences and impacts on humanity.

[449] Harrington, S.E., Kroszner, R.S. (2004). The Possible Extension of the Terrorism Risk Insurance Act, *AEI Research Statement,* No. 207, Washington, DC: American Enterprise Institute.

Chapter 34.

THE ROLE OF STATE IN THE INSURANCE OF CULTURAL HERITAGE FROM TERRORISM RISK

Catastrophic risks are related to risks of natural disasters, and to risks resulting from human related activities. These risks might cause huge material losses, casualties and loss of inheritance and represent a threat to sustainable development: the entire (national) economy, society, ecology and culture. Due to their growing intensity and frequency, catastrophic risks represent a considerable threat to sustainable development on a global scale.

Considering their increasing frequency, the topic of this chapter is devoted to the role of the state in managing catastrophic risk which the cultural heritage is exposed to, with particular emphasis on the risks caused by human action, such as the risk of terrorism. However, the necessity and legitimacy of the government engagement does not imply its exclusive responsibility for protection of catastrophic risks. Without social partnerships with all stakeholders: citizens and companies, especially with insurance companies, government is not able to effectively prevent and significantly reduce the size of catastrophic risks, nor that in real terms compensate affected, given the tendency of increasing loses from catastrophic events in Serbia and the entire world.

The complexity of this problem in a global context can be seen through numerous examples of destruction of the world cultural heritage worldwide. The most current example is the destruction of ancient monuments of culture in the protected archaeological zone "Palmira" in Syria, which was devastated by militant terrorist organization "Islamic State" even though this site is under the protection of the country of Syria, and is also on the UNESCO list of world cultural heritage. Its World importance is related to the fact that Palmira represents a symbol of cultural diversity and tolerance, and the whole region was called "the cradle of civilization" by UNESCO. In the local context, the problem of the risk of terrorism in Serbia appeared much earlier, in the period between 1999 and 2004 when the sacred medieval heritage of Serbian people in Kosovo and Metohija was systematically destroyed by Albanian militant terrorist groups. Both examples confirm the limited ability of the state to prevent the destruction of cultural heritage and reduce the size of catastrophic risk by diplomatic activities. Therefore, in this chapter we study the possibilities to insure heritage in order to mitigate and reduce the risk of terrorism. Here we encounter a numerous theoretical and practical problems.

The first problem that we consider concerns the limited possibilities of diplomatic efforts to prevent the destruction of heritage by political means. Synchronous perennial diplomatic activities of Serbia and the Serbian Orthodox Church (SPC), which owns vulnerable sacred monuments in Kosovo, shows only partial effectiveness of linking strategy, although the focus of diplomatic activity was to internationalize the problem of catastrophic risks. Although theoretically this strategy delivers significant results because of the international problem of recognition, its practical limitations can be seen in both the case of Serbia, and in the case of Syria. In both cases, the world's cultural heritage, due to terrorist activities, was partially or completely destroyed, despite the fact that both countries implemented the strategy of linking with all relevant stakeholders in the country and in the world, engaging all political resources in an attempt to preserve and protected world cultural heritage.

Due to the many terrorist attacks on cultural heritage around the world, this chapter will study in more detail linking strategies through cooperation between the public, private and NGO sector focused on preserving Serbian Orthodox cultural heritage in Kosovo. Stakeholders in the link in this case are: the Serbian Orthodox Church, the Serbian government, the Provisional Institutions of Kosovo (PISG), UN peace mission UNMIK (later NATO KFOR), the International Organization of the UN for Education, Science and Culture - UNESCO, the Council of Europe, OSCE and many other national and international organizations. In the field of culture this strategy is manifested by replacing cooperation with assimilation, and even cultural imperialism as a legitimate strategy used by practical public policies (Đukić, 2012: 246), that so far has been the only possible solution that exist in Kosova and Metohija.

Within the linking strategy, internationalization is developed as a special form of cooperation and partnerships at the international level. In this chapter, strategy of internationalization will involve various forms of international cooperation between stakeholders to achieve better recognition (Đukić, 2012: 264), i.e. recognizing the catastrophic risks facing the Serbian Orthodox cultural heritage in Kosovo and Metohija. It is also natural that the process is enhanced by numerous international documents, which have the power of a normative instrument, in this case, they are: international conventions on human rights and religious freedoms, the protection of cultural heritage, and besides numerous other documents, the special role in Kosovo and Metohija is reserved for Resolution 1244 by the United Nations security Council adopted on 10 June 1999 as a political solution for the Kosovo crisis that represent a threat from catastrophic risks for Serbian cultural heritage in Kosovo. In accordance with this, the Resolution among other things foresees demilitarization of the Kosovo Liberation Army (KLA) and other armed groups of Kosovo's Albanians who are required to end immediately all offensive actions.

However, despite all undertaken measures and activities in the period from 1999 to 2015, catastrophic risks are not eliminated but remain as a threat for the preservation and use of Serbian cultural heritage in Kosovo. And despite this, guidelines for cultural heritage as a technical instrument for the protection and management of heritage of the European Union and the Council of Europe adopted for professionals in the field of protection and management of cultural heritage in Kosovo does not involve insurance of heritage as a measure of its protection and management. Therefore, in order to show its full effectiveness, the linking strategy and internationalization should, besides diplomatic political activity of Serbian state entities and the inclusion of vulnerable Orthodox heritage in Kosovo and Metohija in the international list of edangered monuments , include the creation of pools of insurance and reinsurance activities and the establishment of a compensation fund for loses that cannot be covered by insurance.

Thus, we are coming to the second key issue related to the valuation of heritage as the object of insurance. When we talk about cultural heritage, in economic terms it belongs to the category of public goods available to all. It is necessary to have in mind at least two things: responsibility for the maintenance of public good is on the entire society, and we should also focus on valuation of these monuments. Valuation continues to be a major challenge. The necessity of determining the value of heritage is important for providing adequate support to cross-sector measures taken to avoid risks that endanger heritage.

1. CASE STUDY: THE DESTRUCTION OF SERBIAN CULTURAL HERITAGE IN KOSOVO AND METOHIJA

Kosovo and Metohija is an area of great cultural and historical importance for the whole world, not only for Serbia. Some of the most important monuments of the world cultural heritage are in this area. In addition to the Orthodox cultural heritage, many other monuments in this region belong equally to everyone: archaeological sites and ambient units. Today it is the area with the most ruins of Christian cultural monuments. Since June 1999, more than ten hundred churches, monasteries and parish homes were destroyed. Along with immovable heritage, about ten thousand icons and other liturgical objects were also destroyed. In the turbulent history of this geopolitical space, this kind of destruction (several Orthodox sacred places etc.) was never seen before, not even during the five centuries of Ottoman occupation.

That is why (after 2000th), a team of experts was formed, within the Office of the President of the Federal Republic of Yugoslavia, Vojislav Kostunica, that tried to protect Serbian priceless historical, cultural and spiritual treasures in Kosovo and Metohija by all available diplomatic means. In the field of foreign policy, team included not only employees in state entities and institutions dealing with the protection of cultural monuments, but also the Serbian Orthodox Church and public figures from Serbia and Diaspora, who based on their knowledge and authority tried to emphasize the problems to the world, especially UNESCO experts and other international organizations responsible for taking care of the world cultural heritage.

The highest violation of property rights and a threat to monuments of the Serbian Orthodox Church, after 1999, was a pogrom in March 2004, when monasteries and churches were destroyed and demolished in 16 settlements in the territory of Kosovo and Metohija and in Pristina, Kosovo Polje Vucitrn, Obilic, Mitrovica, Podujevo, Istok, Vitina, Stimlje, Decan, Skenderaj, Prizren, Djakovica, Pec, Urosevac, Kosovska Kamenica and Orahovac.[450] Indication on the dramatic situation of religious architecture that European civilization inherited from the Christian East, which is located in the territory of Kosovo and Metohija, is based on the fact that during the pogrom 19 cultural monuments - six in the first category of protection (churches from 14, 15 and 16 century), 16 shrines, churches that are not categorized were destroyed, making a total of 35 monuments and churches. Besides these, in the period from 1999 to 2004, 15 monuments in the first category of protection and 23 in the third category were also destroyed, which is a total of 38 monuments and sites under state protection. If we take into account all the other destroyed cultural property and holy shrines, the final number exceeds 140 monuments, shrines and buildings destroyed in an organized and deliberate demolition, "which aims to erase every trace of the existence of Christian civilization and cultural heritage in this part of Serbia, that is under UN interim administration Mission."[451] Results of the perennial activities on the implementation of the strategy of

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[450] According to data from the Diocese of Raska-Prizren and Kosovsko_Metohijska Serbian Orthodox Church made public on the occasion of the anniversary of the pogrom of 2013, http://www.eparhija-prizren.com/sr/vesti/podsecanje-na-martovski-pogrom-2004

[451] Ministry of Culture (2004). Sudbina kulturne baštine na Kosovu i Metohiji. *Martovski pogrom na Kosovu i Metohiji,* Belgrade: Ministry of Culture of the Republic of Serbia, p. 19-20, http://www.media.srbija.gov.rs/medsrp/dokumenti/ sudbina_kulturne _bastine.pdf.

internationalization of synchronized actions of church and state - on the one hand, and international organizations - on the other, were evident in the reconstruction of destroyed Orthodox shrines on the basis of the Memorandum of Understanding agreed on the general principles for the reconstruction of Serbian Orthodox Church (Memorandum of Understanding on agreed General Principles For the Reconstruction of Serbian Orthodox Religious Sites)[452] from 2005, and the inclusion of endangered heritage in the UNESCO list of World Heritage in Danger 2006. (The list of World Heritage in Danger).[453] Memorandum of Understanding was signed on 24 March 2005 between the Serbian Orthodox Church and the Ministry of Culture, Youth and Sports of the Provisional Institutions of Self-Government in Kosovo (PISG), with the mediation of the testimony of the United Nations Mission (UNMIK), whose power in the territory of its southern province Serbia recognizes on the basis of Resolution 1244. The first point of the document envisages the establishment of a five-member Commission, which "will be governed by an international expert who should be appointed by the Council of Europe or the European Commission or any other international agency. The other four will be representatives of the: Serbian Orthodox Church, Institute for Protection of Cultural Monuments (IPM) in Belgrade, a representative of the IPM from Kosovo and a representative of the Ministry of Culture, Youth and Sports, the PISG. "Apart from this first point, second and the third point anticipates implementation of the strategy of internationalization and it should be done by "UNMIK who will support the work of the Commission by coordinating security issues and mediating between the parties as and when necessary", while the Commission will follow the recommendations of the Council of Europe[454]

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[452] Memorandum of Understanding on Agreed General Principles For the Reconstruction of Serbian Orthodox Religious Sites, http://www.spc.rs/files/u6/ Memorandum_o_ razumevanju_Eng_i_Serb.pdf

[453] The list of World Heritage in Danger, http://whc.unesco.org/en/danger/

[454] The public is not aware of the content, in general, of these recommendations and it can not be concluded to what extent they correspond with the results of the project Support to the promotion of cultural diversity PCDK in which the document was created entitled Guidelines for Cultural Heritage, Technical Instruments for the Protection and Management of Heritage for professionals in the field of cultural heritage in Kosovo, and developed in cooperation of the European Union, Council of Europe and the Ministry of culture, Youth and Sports who, as temporary institutions of self-government in Kosovo PISG was one of the signatories of the Memorandum of understanding agreed on the general principles for the reconstruction of Serbian Orthodox Church; more see: European Union, Council of Europe (2012). *Guidelines for cultural heritage, technical instruments for the protection and management of heritage*. Brussels: European Union and Council of Europe.

and UNESCO "for intervention, rehabilitation and reconstruction of churches, monasteries and other religious sites damaged in March 2004."

Endangered sacral heritage was inscribed on the UNESCO list named Medieval Monuments in Kosovo and it includes four monuments at risk: Visoki Decani Monastery - declared a world cultural heritage 2004th, Gracanica, Pecka Patriarchia with its four churches and Church of the Bogoridice (Virgin) Ljeviške, targeted with fire arms and burned in March 2004 when Nemanjić portraits of the narthex were severely damaged, painting of the towers, and to a lesser extent, the painting of the nave. With architecture, frescoes, icons and church furnishings that were preserved in them, they reflect and provide a rich picture of artistic events in medieval Serbia. They are characterized by advanced tracking of Byzantine art, combined with elements of Western art, and that, owing to donors, and their associates, these monuments highly surpass the boundaries of the local community. The description of monuments in danger states that they: *"Reflect the high points of the Byzantine-Romanesque ecclesiastical culture, with its distinct style of wall painting, which developed in the Balkans between the 13th and 17th centuries. The Dečani Monastery was built in the mid-14th century for the Serbian king Stefan Dečanski and is also his mausoleum. The Patriarchate of Peć Monastery is a group of four domed churches featuring series of wall paintings. The 13th-century frescoes of the Church of Holy Apostles are painted in a unique, monumental style. Early 14th-century frescoes in the church of the Holy Virgin of Ljeviska represent the appearance of the new so-called Palaiologian Renaissance style, combining the influences of the eastern Orthodox Byzantine and the Western Romanesque traditions. The style played a decisive role in subsequent Balkan art."*[455]

2. AESTHETIC VALUES OF MURAL PAINTING IN MEDIEVAL SERBIA

Detailed explanations of the development and significance of the painting style of medieval Serbia for the development of art in the entire Balkan Peninsula, were provided by Vojislav Djuric in his work Painting of the Middle Ages. Following its development in the central areas of the Balkan Peninsula in which from 9th to the 15th century there were Serb state formations, ranging from Raska to Kosovo, and others, he points out[456]: *„The life of Serbian painting in*

[455] Medieval Monuments in Kosovo, http://whc.unesco.org/en/list/724

[456] Đurić, V. (1994). Slikarstvo u srednjem veku. *Istorija srpske kulture,* Ivić, P. (ed.), Gornji Milanovac: Dečje novine. The paper is available in its entirety on Internet

in the Middle Ages was defined by a series of factors of different level and power, including, of course, the most important: size, power and fate of Serbian states; denominational affiliation of the nation and the position of church institutions with respect to Constantinople and Rome; development of society and the ability of the founder; the purpose of religious painting, but also its political role. The time frame of artwork among the Serbs in the Middle Ages may be accurately determined. With the religious content, without any laic trace it was rooted in the Serbian environment after accepting Christianity, in the second half of the 9th century. Indeed, the first works were destroyed - the oldest are preserved from the late 10th century. Artwork vanished together with the disappearance of the last Serbian state before the end of the 15th century, when it lost some of the key creative properties. The historic theater was the central area of the Balkan peninsula between the rivers Sava and Danube in the north and the Adriatic and the Aegean Sea in the south, from the Timok and Struma River in the east to the Vrbas and Cetina to the west. In the begining it was centered around the river Raska, and then on the Adriatic coast between the Cetina and Bojana, hence in the first areas of first Serbian states. It then followed the rise and spread of Serbia and Bosnia, that reached their greatest expanse in the 14th century. Gradually it was regionalized as individual Serb areas became more or less independent states in Seru, Epirus and Thessaly, in the lower Vardar area, Kosovo, Morava, Herzegovina, Bosnia, Montenegro, in the coastal communes".

Further explaining the characteristics of this particular style of Serbian medieval religious art developed for the construction of a large number of churches and monasteries, Djuric says:

"Standing face to face, for centuries, the Orthodox and Catholic painting behaved differently then architecture or sculpture. While the Orthodox churches and their sculpted decorations could look completely western and be implemented in the Romanesque and Gothic styles, while preserving the function of the Orthodox space, so far , painting was very obstinate in its Byzantine iconographic and stylistic conceptions. The paintings were so often the subject of theological debate in the Eastern church, stubbornly preserved its Orthodox. Catholic painting along the coast, as in many Italian cities, all the way to the victory of Gothic style preferred the Byzantine-Romanesque and Byzantine-Gothic permeation of frescoes and icons, enriching with new iconography humanist content of images. With no major conflicts on the edges

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owing to the history of Serbian culture "Rastko" and is located at the site http://www.rastko.org.rs/isk/isk_07.html.

of Orthodoxy and Catholicism, but always vigilant, both churches followed their own approach in painting, until the end of the Middle Ages ".

Finally, Djuric in his work clearly identifies the holders of Serbian medieval artistic creation: *"Holders of artistic creation were primarily members of royal houses and church leaders, and from the 14th century even eminent aristocrats and lords. (...)Patrons and donors influenced the artistic program and its ideological content. Everyone wanted to record their own role and the role of ancestries in their state or church. Examples existed in Byzantine and Western capitals. Thus the iconographic models were borrowed but also revisited for home use. Thus, Serbia managed to build, mostly through various portraits of patrons, special rulers and the aristocracy, church and monastic iconography"* owing to cultural heritage in Kosovo and Metohija, was declared as a world cultural heritage.

3. TERRORISM VS HUMAN RIGHTS AND RELIGIOUS FREEDOMS

However, the catastrophic risks in Kosovo are not reduced, although the answer of Serbian government is not absent. The last action of state authorities was conducted during 2015 in order to defer the debate on the admission of Kosovo to UNESCO and to prevent Kosovo authorities from managing the cultural heritage which has been destroyed from 1999 to today. This is particularly due to the unstable political situation when the authorities cannot prevent terrorist actions nor they can guarantee the respect of human rights and religious freedoms of Serbian and other non-Albanian population of Kosovo and Metohija. In secular democratic states, church does not participate in the government, but the believers and churches have guarantee of human rights and religious freedoms. The first and basic international standard in the area of religious freedoms predicts the protection of *"freedom of worship or gathering in connection with faith and freedom"* to establish and maintain places for this purpose.[457] Consequently, the state is obliged to guarantee freedom of worship and gatherings in churches, monasteries and other buildings in connection with faith. Thus, the position of church is connected with the question of democratic transformation of transitional society, because only the rule of law can provide

[457] Ministry of Human and Minority Rights (2005). *Razumevanje ljudskih prava: priručnik o obrazovanju za ljudska prava.* Belgrade: Ministry of Human and Minority Rights of Serbia and Montenegro; original: Benedek, W. (ed.) (2003). *Understanding human rights, manual of human rights education.* Graz: European Training and Research Centre for Human Rights and Democracy.

a reliable guarantee for the respect of religious freedoms. The problem in the application of international standards is connected with totalitarian political past of newly established states in the former Yugoslavia. Within the strong atheistic society, church was suppressed for half a century from the civil society institutions and located exclusively in the area of people's "privacy", religion was declared as "non-public", private matter, and as such was excluded from the political process.

Although Yugoslavia, and after that Serbia, at the very beginning of the process of democratic transition, established the rule of law creating new legal and political framework for relations between church and state, yet a large part of the public and the academic community in Serbia believe that the term secularism means *"indifference or opposition to religion "and includes" its removal from the public domain and its relocation to privacy "* (Prnjat, 2013: 474). This part of the the public even today does not allow Serbian Orthodox Church to take the place in society where it belongs according to its spiritual and moral values, nor religion to be accepted as a constitutive element of collective cultural identity of Serbian society. Therefore, religious freedoms are sensitive issue and cause many difficulties in the interpretation and practical application more than other human rights, especially because it can be considered as the right to accept or not accept any religious norms or attitudes. The problem escalates in Kosovo and Metohija, where individuals and organized terrorist groups directly threaten the Orthodox cultural heritage in Kosovo, presenting a threat to religious freedoms of Serbians Orthodox citizens. This is due to the fact that they took for targets of their terrorist actions Orthodox monasteries and churches, with active spiritual life and with regular worship. This leads to abuse of many other internationally recognized rights, starting with the right on property (of the Serbian Orthodox Church), through the right on inheritance, the right to participate in cultural life, the right of freedom of thought and religion to the rights of minority groups to enjoy their own culture. As stated in the document Challenges in the protection of immovable tangible cultural heritage in Kosovo[458] *"The right of everyone to participate in cultural life, prescribed in the Universal Declaration of Human Rights and the International Covenant on Economic, Social and Cultural Rights (ICESCR), imposes to institutions an obligation to respect, protect and facilitate the enjoyment of this right. The obligation to respect and protect the right to participate in cultural life requires the institutions to refrain from interference and take steps to prevent the interference of third parties, directly or indirectly,*

[458] OSCE (2014). Challenges in the protection of immovable tangible cultural heritage in Kosovo. Vienna: Organization for Security and Co-operation in Europe, Mission in Kosovo, p. 8.

with the enjoyment of this right, while obligations of enabling require institutions to take appropriate legislative, administrative, judicial, budgetary, promotional and other measures aimed at full realization of this right ".

On the other hand, if we start from the definition of identity politics as a thoughtful, ie. planned activities of cultural policy aimed at the creation, development and strengthening of collective identity, which as an instrument of operationalization uses three identifiers: language, national and / or ethnic and religious affiliation (Dragicevic-Šešić, Stojković, 2011: 287), we see that all three key elements of contemporary Serbian identity policy established in the medieval state entities under the rule of Nemanjic dynasty. According to the criterion of ethnicity, these key elements of collective identity have remained unchanged, and in the first place is religious affiliation to Orthodox Christianity, which causes all other characteristics.

Therefore, when the problem of political risks and risks of terrorism are moved into the domain of public policy, the basic question is: What Serbia, in addition to diplomatic activities that it carries out, can do to protect endangered Orthodox cultural heritage in Kosovo and Metohija (which is not only cultural property under country protection, but is also an identifier of Serbian cultural identity)? Since cultural heritage is in majority owned by the Serbian Orthodox Church, which, among numerous documents on the ownership, has in its possession, the original founding charter of the endangered monastery "Decani" from 1330, significant cooperation between church and state is required in order to protect against the risk of terrorism and other risks of natural disasters.

4. THE PROBLEMS OF INSURANCE OF CULTURAL HERITAGE

Insurance of terrorism risk is not significantly represented in the world, and in Serbia this type of insurance does not exist, and the risk of terrorism is excluded as well as the risk of war dangers. The reasons for this situation will be discussed in detail below.

Exclusion of terrorism risk as an insurance option, is based on the fact that this is a risk which cannot be easily measured taking into account the history of its atypical events, and the uncertainty of the time of origin, the number of terrorist acts and the amount of damage directly resulting from the realization of this risk. Terrorist attack on the Trade Center in New York has seriously shaken the insurance and reinsurance market due to the huge material and non-material damage incurred as a result of the realization of the risk of terrorism. Some of the most reputable insurance companies such as Swiss Re, the first time in their long history of business reported a loss. This has changed insurers' approach to insurance from terrorism risk in the sense that the acceptance of this type of risk as their coverage can seriously endanger their financial position. This situation has led to the conclusion about the necessity of introducing public-private insurance model for this type of risk, when the state would amortize the excess risk that exceeds the financial capacity of insurer which will be discussed below.

Catastrophic risk management model in which the State is acting as reinsurer, in the literature is known as the market-stimulating approach of the state.[459] The state relies on the administrative capacity of private insurance market in performing appropriate functions including marketing, broadcasting of insurance policies, collecting premiums, assessment and payment of claims. The financial resources of the state are activated when the insured losses upon occurrence of a catastrophic event overcome the retention of direct insurers. This approach combines the ability of the state to provide a wide range of insurance coverage with the ability of private markets to apply effectively the principles of insurance.[460] Last, but not least, insurance companies no matter to which sector they belong, on behalf of corporate responsibility, can consider investing in common goods, through policies and better terms. In this way, a positive image on the operations of insurance company is sent to the public, which would have a positive impact for the image of insurance company (and its perception by the public). At the same time this can initiate and wider acceptance of values and valuation of common goods by the society.

In this regard, the insurance model for the risk of terrorism that could be applied in Serbia should be based on the use of foreign experience in insurance of catastrophic risks. One of the models should be based on the establishment of insurance pool, whose members would be insurance companies that would be evaluated by independent experts selected in public competition on the basis of their professional reference. Also, the state would have the responsibility for the selection of reinsurers in the proposed insurance pool.

Concerning the insurance of cultural heritage, the state needs to form a compensatory fund for managing catastrophic risks, that cultural heritage is

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[459] Lewis, C.M., Murdock, K.C. (1999). Alternative Means of Redistributing Catastrophic Risk in a National Risk-Management System. *The Financing of Catastrophe Risk,* Froot, K.A. (ed.), Chicago: Chicago University Press, p. 54.

[460] OECD (2005). Catastrophic Risks and Insurance. *Proceedings Policy Issues in Insurance,* No. 8., Paris: OECD, p. 199.

exposed to. Within this fund resources could be specifically allocated for the risk of terrorism in Kosovo. Shrines in Kosovo and Metohija could be ensured by insurance pool on certain insured amount, harmful consequences above that amount would be endured by specially established compensation fund.

Hereinafter, we will explain the problem of determining the value of cultural heritage and the related problem of determinination of the insured sum, and give suggestions to overcome this problem.

4.1 The problem of determining the value of heritage

From the perspective of economic theories, cultural and natural heritage could be seen as categories of common goods. The value of common goods can not be easily expressed in monetary equivalent, because it is verified by creators, users, individuals (professionals, creators, critics from various disciplines) and society. However, major contributions to the economic evaluation of the contribution of culture as well as the interconnection between culture and economics, was provided by David Throsby through fundamental economic theories applied to the field of cultural policy. Concerning the valuation of cultural heritage, Throsbys perspective of seing it, is through the economic and cultural capital. Cultural heritage can be seen as an asset with properties that are usually attributed to economic capital. Their production and maintenance require certain investments, , since they can lose their value if not properly maintained.[461] If we look from this point on monasteries and churches in Kosovo and Metohija, the material part of their value can refer to the construction value of the building, funds for their maintenance and operation, and also on the value of the land on which they are located. The complexity of the problem is manifested, when we try to determining the value of tangible and intangible cultural heritage that refers to historical and other qualities that no ordinary building has. In this sense, Throsby talks about cultural capital as a distinctive, which embodies or allows two kinds of values: economic and cultural. When it comes to cultural values, the author lists the following constituent elements that together make the value of cultural heritage: aesthetic, spiritual, social, historical, symbolic value, and the value of authenticity, and the position value.[462] If we apply this approach to determining the value of cultural shrines in Kosovo and Metohija, we will be able to explain some of its elements.

[461] Throsby, D. (2012). *The Economics of Cultural Policy.* Belgrade: Clio, pp. 112-113.
[462] *Ibid.*

This part of the cultural heritage, possesses a harmony of heritage, history and identity, recognized and acknowledged by its aesthetic and religious values, which especially characterize medieval frescoes and icons.

Spiritual value arises from preserved national, religious and cultural identity of the Serbian nation.

Social value is derived from the common religious and cultural values that members of the Serbian nation in Kosovo and Metohija connect and hold together.

The historical value of the holy shrines in Kosovo is priceless because it indicates the connection of the present and the past. The largest number of Serbian medieval monasteries and churches are located in Kosovo and Metohija.

The symbolic value of our holy shrines in Kosovo is of paramount importance for the preservation of national identity and religion of Serbian nation.

The value of authenticity refers to the fact that the medieval monasteries and churches in Kosovo are unique and have already suffered a lot of damages over the past decade. The authenticity supports conservation, not restoration.

The position value is important since all our sacred heritage is linked territorially mostly because it is located on a relatively small area. However from the value of position, also arises also their vulnerability to catastrophic risks, including the risk of terrorism.

According to the UNESCO Convention, cultural expressions are defined as "the result of creative work of individuals, groups and communities that have cultural content." Throsby sees culture and cultural activity as "part of a broader and more dynamic spheres of economic activity that are connected via the information, economy based on knowledge, encouraging creativity through new technologies and innovations".[463] As we have already pointed out, we can identify the complexity of the problem of determining the value of cultural heritage by qualitative indicators that are difficult quantify.

Speaking in terms of nature of the cultural market, goods and services, Throsby states features of the nature of cultural activities:

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[463] Throsby, D. (2008). Modeling the Cultural Industries. *International Journal of Cultural Policy,* 14(3), pp. 217-232.

1. Include creative manufacturing/ production,
2. Continuously interested in the generation and communication of symbolic meanings,
3. Their output potentially embodies at least some form of property.[464]

The application of economics in the field of culture can improve the current practice of the cultural policy in a time of rapid change. Throsby lists various forms from the field of culture that have created greater value by interdisciplinary synergy: the cultural and creative industries, cultural heritage, cultural tourism, cultural diversity, through the parallel development on local and regional level (according to socio-economic criteria, encouraged by investment in culture). This is particularly important in the context of decentralization and local development. More specifically, in his papers Throsby points to a positive correlation between investment in culture and other lateral branches and sectors of the economy, observed in the short, medium and long run.

Accordingly, through the synergy that culture can create with other departments, it is possible to speak about added value. To make this possible to implement practically, it is necessary to conduct comprehensive multi-sectoral analyzes through the time, in order to precisely quantify these values.

Throsby’s theories, justify the approach to finding solutions to ensure cultural heritage. The aim of this study was to highlight the problem of determining the insured sum, which is determined by the value of cultural heritage. In its (insured sum) determination data from the past about the cost of restoring damaged and destroyed (sacred) cultural heritage should be used. This issue must be accompanied by significant financial resources for preventive protection of cultural heritage facilities from catastrophic risks, especially risks arising from negative human action, including the risk of terrorism.

Similarly with the natural heritage, one of the possibilities for protection from risks of ecological disasters and catastrophes is certainly ecological insurance, regardless of the source of initiation (natural disaster risks or human actions (Kočović, 2015a)).

Ecological insurance has been present for a long time in countries with developed insurance market. It imposes mandatory application of preventive measures by policyholders, such as companies and entrepreneurs, whose

[464] Throsby, D. (2001). *Economics and Culture*. Cambridge: Cambridge University Press.

activity results in disruption of the functioning of the environment in protected areas. This type of insurance can provide inclusion of all kinds of environmental risks that pollute nature, impair biological diversity, risks of destruction of plant and animal species, the risks of nuclear power plants accidents and others that may endanger protected areas.

The ecological aspect is one of the pillars of sustainable development, as is the culture (fourth pillar). In this context, sustainable solution of ensuring cultural heritage could be reflected in the introduction of new types of "sustainable insurance" that should be mandatory for legal entities and individuals, "up setters" of environment (which directly and adversely affect the other pillars of sustainable development, assuming equal distribution of total funds to other pillars of sustainable development).

Finally, the economic theory of risk management and practice of certain countries indicate that state should "establish funds intended for compensation“ in such cases and that will allow the formation of insurance pools. The state aid is reflected in the fact that state provides funds for damages that can not be covered with funds of insurance and reinsurance "(Vujovic, 2009: 274, 481).

In line with current practice in Switzerland and other countries in the world with a developed system of insurance, in the case of political risks and risks of terrorism, the objective of such cooperation should focus on ensuring heritage at risk, and treat it as another form of protection against the risk of terrorism in the volatile political circumstances in Kosovo. The state should initiate cooperation with all stakeholders, and take the role of carrier of development and implementation of the model for managing catastrophic risks that adversely affect cultural heritage. It should be a coordinator of a partnership between different sectors of society by ensuring the transition to a more secure and sustainable development trajectory.

Decisive role in launching this initiative should have a Ministry of Culture as a institution that should receive budgetary funds for financing insurance premiums, should be responsible for concluding insurance contracts for cultural heritage.

Also all the stakeholders in this partnership are welcome (Institutes for the protection of heritage, society, legal entities and individuals, as well as the civil sector). Due to the equal importance of this issue for the society, specific actions can be initiated and / or conducted by using a "bottom-up" approach and better involvement of civil organizations. Kočović (2015b) emphasizes that cultural heritage has an invaluable material value, and points out that one of the solutions can be found in the analogy with the determination of the value of human life in life insurance. Since life is priceless, insured amount we want to ensure is determined. In accordance with possibilities of the state and other sectors, certain insurance sum is determined to provide insurance for a concrete monument, in line with the frequency and intensity of risk against which it is insured, certain premium is paid and compensation for losses is received, up to a maximum level, which corresponds to the insured amount.

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