INTERNATIONAL SCIENTIFIC CONFERENCE

ebm 2018

CONTEMPORARY ISSUES IN ECONOMICS, BUSINESS AND MANAGEMENT

Editor
Verica Babić

FACULTY OF ECONOMICS
UNIVERSITY OF KRAGUJEVAC

CAPITAL ASSET PRICING MODEL VERSUS ARBITRAGE PRICING THEORY

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Abstract: *Capital Asset Pricing Model (CAPM) and Arbitrage Pricing Theory (APT) have been a major challenge for economic theorists and practitioners for decades. Unlike the well-documented contribution of these models to understanding the relationship between return and risk and valuing assets on the capital market in developed countries of the world, literature on the topic of the CAPM and APT models is relatively poor in the Republic of Serbia. This creates the need to process this issue in order to at least partially mitigate the insufficiency of domestic literature in this field. In this regard, the subject of research is a comparative analysis of the CAPM and APT models, with the inevitable critical review of these models and emphasizing their positive and negative aspects. The aim of the research is to find answers to the questions which of these models is superior and which corresponds more to reality. By presenting the realistic theoretical and practical range of CAPM and APT models, it was concluded that neither of the these models is perfect and we can not talk about the general superiority of one or the other model, as both models contain equally serious imperfections that prevent them to accurately evaluate the assets. Indeed, the APT model achieves preponderance over the CAPM model in a theoretical, but not in a practical view. Practitioners still prefer to use the CAPM model, while the APT model is more useful in academic circles as theoretical construction with insufficient use in practice. The general conclusion and, at the same time, the main result of the research is that the APT model is the theoretical winner, and the CAPM model is the winner in practice. Due to the equal complexity of the problems that these models face, significant efforts have been made in empirical research and theoretical discussions to improve their accuracy and applicability. However, half a century of research was not enough to eliminate the imperfection of the CAPM and APT models, which does not reduce their significance as the starting point for the development of more advanced equilibrium models of asset valuation in the future.*

Keywords: *CAPM model, APT model, Expected return, Systemic risk, Risk factors*

JEL Classification: *G12*

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INTRODUCTION

Two basic directions of the development of Modern Portfolio Theory (MPT) are normative and positive portfolio theory. Normative portfolio theory, with its constituent elements: Markowitz model and index models, sought to determine the rules for making investment decisions and provide a systematic approach in determining a set of efficient portfolios and selecting optimal portfolios. On the other hand, the positive portfolio theory and its main representatives: CAPM and APT models, evaluate financial assets, assuming that all investors respect the rules for making investment decisions contained in the normative portfolio theory.

CAPM and APT models are equilibrium models for determining the prices of securities that imply the existence of a price balance, i.e. absence of undervalued and overvalued securities. As models of capital market equilibrium, the CAPM and APT models provide a significant contribution to understanding the relationship between return and risk and asset valuation in the capital market. Both models indicate the linear dependence of return and risk and the relevance of systemic risk only. However, the key difference lies in the fact that the CAPM model, in its essence, is an one-factor model, while the APT model is a multifactor asset valuation model that emerged as a response of critics to the appearance of the CAPM model (Leković, 2017).

Bearing in mind the above mentioned, the subject of research is a comparative analysis of the CAPM and APT models as the main representatives of the positive portfolio theory. The aim of the research is to better understand the real theoretical and practical range of these models. The intention is to enrich literature in this field in the Republic of Serbia, given the small number of domestic papers on the topic of CAPM and APT models.

In accordance with the defined subject and the set goal of the research, the authors start from the following hypothesis:

H_1: Although the multifactor APT model emerged as a critical response to the appearance of the one-factor CAPM model, the described asset valuation models feature similarity and complementarity.

H_2: We can not talk about the superiority of the CAPM or APT model, as both models contain equally serious imperfections that prevent them to accurately evaluate the assets.

The method of qualitative economic analysis will be used in the research, with the intention to provide valid conclusions about the investigated issues by studying the relevant financial literature and presenting the views of the authors.

Taking into account the defined subject, goal and hypotheses, after the introductory consideration, the differences between the CAPM and APT models will be analysed, with the inevitable presentation of the deficiencies and problems that these models face. After that, a comparative performance analysis of the CAPM or APT models will be done based on the results of relevant research. Finally, in the concluding part of the paper, the views on the confirmation of the hypothesis will be summarized, and open issues for future research will be considered.

COMPARATIVE ANALYSIS OF THE CAPM AND APT MODELS

The value of assets, or its price, according to the CAPM and APT models, is determined at the level that ensures that the expected return corresponds to the systemic risk assumed. The aim of both models is to ensure that all returns are equal at risk weighted basis. However, the key difference is the existence of one systemic risk factor in the CAPM model and multiple systemic risk factors in the case of the APT model. According to the CAPM model, the return of securities is a function of market risk, while according to the APT model, the return of securities is a function of a large number of unknown risk factors. Incorporating additional risk factors, the

APT model went a step further than the CAPM model, but the absence of their specification is a major drawback of this equilibrium model.

The CAPM model can also be seen as a special case of the APT model, which implies that market risk is the only risk factor. With this assumption, the equation of the multifactor APT model (Francis & Kim, 2013):

$$\bar{r}_i = r_f + \lambda_1\beta_{i1} + \lambda_2\beta_{i2} + \cdots + \lambda_k\beta_{ik}, \quad (1)$$

where:

$\bar{r}_i$ – the expected rate of return of the security i,
r_f – the risk-free rate,
λ_k – factor risk premium related with the *k*-th factor,
β_{ik} – the sensitivity of return of the securitiy *i* to the value of the factor k,

is reduced to the equation with one factor:

$$\bar{r}_i = r_f + \lambda\beta_i. \quad (2)$$

Since the factor risk premium (λ) is equal to the ratio between surplus of return and risk $\left(\frac{\bar{r}_m - r_f}{\beta_m}\right)$, further follows:

$$\bar{r}_i = r_f + \beta_i\left(\frac{\bar{r}_m - r_f}{\beta_m}\right), \quad (3)$$

and how the beta coefficient of the market is equal to one ($\beta_m = 1$), an expression which represents the equation of the standard CAPM model is obtained:

$$\bar{r}_i = r_f + \beta_i(\bar{r}_m - r_f). \quad (4)$$

However, viewed from another angle, different variants of the APT model also can be understood as the application of the multifactor CAPM model. Therefore, it is not necessary to make premature judgments about the superiority of one or another model.

Based on the above mentioned, it can be concluded that the CAPM and the APT model are not competitive, but complementary models that complete each other, as evidenced by the common assumptions of these models (Šoškić, 2013, 244):

- investors prefer higher than a smaller amount of wealth,
- investors have risk aversion,
- the financial market is perfect and efficient,
- investor expectations are homogeneous.

The last two assumptions significantly simplify modern business conditions and limit the applicability of these models. Market perfection implies the absence of transaction costs, the lack of information asymmetry, and the inability of individual investors to affect the price of assets. On the other hand, market efficiency means that prices reflect all available information, which implies that there are no undervalued and overvalued securities in the financial market at any moment. In addition to the above described, a common assumption about the homogeneous expectations of investors is questionable, since it implies that all investors have exactly the same estimates of expected returns and risks.

The remaining assumptions on which these equilibrium models are built are much more restrictive and more numerous in the case of the CAPM model, which includes the assumptions originally set by Harry Markowitz. The alternative APT model is based on fewer less restrictive assumptions, so it is considered a more flexible and more liberal model. The APT model, unlike

the CAPM model, does not require a normal probability distribution of the rate of return on the securities, nor the determination of the real market portfolio. While the CAPM model requires the market portfolio to be effective, the APT model does not have specific requirements when the market portfolio is concerned. The APT model is based on the assumption that in the market equilibrium there is no possibility of obtaining a risk-free arbitrage profit. Therefore, the market portfolio has no similar significance in the APT model as in the CAPM model. However, the problem of specifying the risk factors that in general explain the price variability in the APT model, in its complexity, corresponds to the problem of basing the CAPM model on the incomprehensible market portfolio.

Due to the impossibility of exact presenting the economic reality, the CAPM and APT model are subject of critical review. The key drawback of the standard CAPM model is its foundation on unrealistic assumptions that greatly simplify the economic reality and market conditions of the economy. With the relaxation of certain assumptions, such as the assumption of non-existence of taxes, assumption about the absence of transaction costs, assumption about the homogeneous expectations of investors, etc., alternative two-factor and three-factor forms of CAPM model have been developed that correspond more to economic reality. Incorporating additional systemic risk factors, the single-factor CAPM model is transformed into a multifactor CAPM model that more successfully and fully explains the systemic variability of the returns of securities.

The study of the relevant financial literature indicates a continuous succession of the evidence for and against the validity of the standard CAPM model. Early testing of the CAPM model (Black et al., 1972; Sharpe & Cooper, 1972) resulted in the confirmation of its validity, although not complete accuracy, after that, this model was numerously criticized (Roll, 1977; Fama & French, 1992). The first serious criticism concerns the inability to adequately approximate the market portfolio through the selected market index. Also, the contribution of the beta coefficient to forecasting future returns is relativised, while the importance of other factors, such as company size and B/M (book to market) ratio, is emphasized. However, in contrast to critics of the CAPM model that have been tried to minimize the importance of the beta ratio, the followers of this model (Kim, 2002; Levy, 2010; Zhang & Wihlborg, 2010; Brückner et al., 2012) have been trying to minimize the the importance of criticism. It is important to note that the key criticism of the CAPM model that relates to the inability to determine the real market portfolio is, at the same time, an argument that prevents the rejection of its validity. The inability to determine the real market portfolio implies the inability to test the CAPM model, and therefore the impossibility of passing a final judgment on its validity. Therefore, the critical observations made in the financial literature are not proof against the standard CAPM model based on the market portfolio, but the proof against the derived CAPM model based on the selected market index (Leković, 2017). The succession of evidence for and against the validity of the standard CAPM model is also pointed out by Michailidis et al. (2006), Choudhary and Choudhary (2010), Olakoyo and Aide (2010), Alqisie and Alqurran (2016) and others.

On the other hand, the key shortcoming of the multifactor APT model is reflected in the fact that this model does not specify the systemic risk factors, which is why many attempts have been made in financial literature to evaluate them through factor analysis (Roll & Ross, 1980; Dhrymes et al., 1984), specification of macroeconomic factors (Faruque, 2011; Zhu, 2012; Jamaludin et al., 2017) and specification of microeconomic factors (Tudor, 2010; Uwubanmwenand & Obayagbona, 2012; Idris & Bala, 2015). Among macroeconomic risk factors, unexpected changes in inflation, level of economic activity, interest rates, etc., are highlighted, while the characteristics of securities and companies, for which is empirically confirmed that they are related to returns, are chosen as microeconomic risk factors: amount of dividend, size of the enterprise, uncertainty in earnings, P/E (price-earnings) ratio, B/M ratio,

financial leverage, etc. Despite numerous attempts, the aforementioned shortcoming of the APT model has not yet been eliminated, because of no relevant consensus has been reached in the financial literature on the most important systemic risk factors.

COMPARISON OF CAPM AND APT MODEL PERFORMANCES

In the financial literature, as an example of a direct comparison of the CAPM and APT model performances is most often cited the research carried out by Chen (1983). One of the tests applied was based on the following expression:

$$r_i = \alpha \tilde{r}_{i,APT} + (1-\alpha)\tilde{r}_{i,CAPM} + e_i, \quad (5)$$

where:

$\tilde{r}_{i,APT}$ – the expected rate of return of the security i generated by the APT model,
$\tilde{r}_{i,CAPM}$ – the expected rate of return of the security i generated by the CAPM model.

Based on the previous equation, it is not difficult to conclude that the value of the alpha coefficient approximately equal zero gives priority to the CAPM model in relation to the APT model. On the other hand, the value of the alpha coefficient approximately equal to the unit gives priority to the APT model, in regard to the CAPM model. The results of the research showed that the estimated alpha coefficient had a value greater than 0.9 in the entire observed period from 1963 to 1978, as well as in the four analysed subperiods. Based on the above mentioned, the author concludes that the APT model is superior compared to the CAPM model. Also, the paper points out that the APT model is able to explain the anomalies that were left unclear by the CAPM model, and the best example is the size effect, i.e. small firm effect. The analysis found that the extra return on the shares of small enterprises becomes negligible by controlling the differences in factor sensitivity between the shares of small and the shares of large enterprises.

Proponents of claims that the multifactor APT model succeeds to explain the size effect also are Chan et al. (1985), Connor and Korajczyk (1986) and many others. Chan et al. (1985) researched the size effect in the period 1958-1977 by applying the multifactor APT model. The risk weighted differences between the shares return of 5% of the largest and 5% of the smallest companies listed on the New York Stock Exchange (NYSE) were set at the level between 1% and 2% per year. The fact that the differences between these returns before weighting were 12% annually testifies to the ability of the APT model to explain the size effect. The authors concluded that portfolios composed of shares of companies of different size, after weighting by the risk factors, do not have statistically significant different average returns. Among the involved factors, the unexpected change in industrial production, i.e. at the level of economic activity and the unexpected change in the risk premium, i.e. the difference in returns of low-quality and high-quality bonds explain most of the size effect.

On the other hand, Lehmann and Modest (1988) argue that the size effect is present also after controlling the differences in factor sensitivity between shares of small and large enterprises. They point out that the APT model is able to explain some anomalies such as the dividend effect, but that the size effect even after weighting by factor risks remains unclear. The authors conclude that the APT model still successfully evaluates most of the securities, since the size effect is concentrated in a small percentage of the largest and the smallest enterprises.

The APT model showed particularly clear superiority to the CAPM model in Japan. In contrast to other markets, in Japan, shares of small enterprises[3] have a lower beta coefficient than shares

[3] Small enterprises include all companies except hundred of the largest enterprises listed on the Tokyo Stock Exchange.

of large companies. According to the CAPM model, the lower beta coefficient should result in a lower expected return. However, shares of small enterprises consistently bring statistically significant higher returns compared to shares of large enterprises. On the other hand, the problem described loses its the intensity and significance by applying a multifactor APT model. Therefore, in Japan, the APT model is almost universally used as a replacement for the CAPM model (Elton et al., 2011, 369).

Sun and Zhang (2001), Cagnetti (2002), Dhankar and Singh (2005), Muzir et al. (2010) and others also found evidence of the superiority of the APT model in relation to the CAPM model. Previously cited researches claim that the APT model is able to explain most of the anomalies that have remained unclear by the CAPM model. However, despite numerous advantages, this model did not succeed to replace the CAPM model. Some authors, like Bodie et al. (2009), claim that models such as the Fama-French three-factor model and Chen et al. (1986) model, represent the application of the multifactor CAPM model, rather than rejecting the essential ideas on which the CAPM model is based.

The reason for the absence of wider application of the APT model by the investment community lies in the greatest disadvantage of this model – the unnaming of factors that systematically affect the returns of securities. On the other hand, the CAPM model unequivocally argues that the covariance between the return of securities and the return of the market portfolio is the only systemic source of investment risk. The number of institutional investors who use the APT model when valuing and managing the assets is small. Among them, the most prominent is the *Roll & Ross Asset Management Corporation* (Sharpe et al., 1995, 333).

The APT model is more used in academic circles, than by investors and analysts in practice. Practitioners still prefer to use the CAPM model, primarily because of its simplicity and clearly defining the market risk, expressed by beta coefficient, as a systemic risk factor. However, it is useful to understand the limitations and get to know the realistic range of both models so that they would not be uncritically applied, but also not be *a priori* discarded (Pavlović & Muminović, 2005).

It should be highlighted that neither of the these models do not succeed to accurately evaluate the assets and explain the variability in securities prices, but their role in improving the portfolio management function and measuring the realized investment performance is more than precious. The models described are a major challenge for both theoreticians and practitioners. For decades, they have been, and will surely be in the forthcoming period the subject of numerous empirical research and theoretical discussions, but also a useful basis for the development of more advanced, more contemporary and more accurate equilibrium models of asset valuation.

CONCLUSIONS AND RECOMMENDATIONS

The basic idea of the CAPM and APT models is that securities exposed to the same level of systemic risk should have the same level of expected return. The difference is that the CAPM model implies the existence of one, and the APT model the existence of more systemic risk factors. Valuation of securities is carried out in a manner that ensures that the expected return of the security corresponds to the systematic risk assumed, which is expressed by the beta coefficient as a measure of market risk in the CAPM model, and by the sensitivity of the return of securities to a greater number of unknown risk factors in the APT model. Thus, according to the CAPM model, investors require compensation for market risk, while according to the APT model, investors require compensation for more types of systemic risk. Both models include the absence of undervalued and overvalued securities, that is, the presence of entirely properly valued securities, which is in line with the Efficient Market Hypothesis (EMH) as a common starting point for these models.

Despite the fact that the multifactor APT model emerged as critics' response to the appearance of the one-factor CAPM model, the described asset valuation models feature similarity and complementarity. In support of this, not only are the numerous common assumptions of these models and the same conclusion about the linear dependence of the expected return and systemic risk, but also the fact that the CAPM model can be considered as a special case of an APT model that implies the application of market risk as the only risk factor. Similarly, the APT model, as already emphasized, can be understood as the application of the multifactor CAPM model. This confirms the validity of the first set hypothesis H_1.

Since the problem of determining the market portfolio from the CAPM model is replaced by the equally large problem of selecting the systemic risk factors, the expected superiority of the APT model as a more flexible and more liberal model which avoids many restrictive assumptions of the CAPM model is not achieved. Although more suited to reality, the APT model is not a dominant applied model in practice. Financial analysts give a practical advantage to the CAPM model as a simpler model with a clearly defined systemic risk factor. The general conclusion is that the superiority of one or the other model can not be confirmed, since both models contain defects that prevent them from accurately evaluating the assets and explaining the variability of the price of securities. The models described are not perfect, but they are a useful basis for the development of more advanced asset valuation models. This represents a confirmation of the second set hypothesis H_2.

The views presented have been developed with the aim of pointing to the real theoretical and practical range of the CAPM and APT models. The key limitation of paper is reflected in the fact that the theoretical, but not the empirical comparative analysis of these models has been carried out. The proposal for future research is the implementation of an adequate empirical analysis, based on the research described in the relevant foreign literature.

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