FROM SCIENCE TO MARKET: CHALLENGES AND DEVELOPMENT OPPORTUNITIES OF ACADEMIC SPIN-OFF COMPANIES IN SERBIA

Nikola Radosavljević[1], Gordana Rendulić Davidović[1], Cariša Bešić[1]

[1]Faculty of Technical Sciences, University of Kragujevac, 32000 Čačak, Serbia
Corresponding author e-mail address: nikola.radosavljevic@ftn.kg.ac.rs (N. Radosavljević)

ABSTRACT:
The commercialization of scientific research through the formation of spin-off companies is a crucial pathway for transferring academic knowledge into the economy. In Serbia, however, the development of spin-offs remains limited due to a range of institutional, legal, and organizational barriers. This paper explores the challenges and development opportunities related to the creation and support of academic spin-off companies within Serbian universities and research institutes. The study identifies critical obstacles such as unclear intellectual property frameworks, insufficient incentives for researchers, limited early-stage funding dedicated to the development of academic business ideas, and a lack of entrepreneurial education. The paper also highlights positive developments and growth opportunities, including the emergence of science and technology parks, academic innovation incubators, and increasing awareness of university-business collaboration. Recommendations are offered to enhance both the policy and institutional environment. This research aims to contribute to academic discourse and to inform decision-makers engaged in innovation and higher education policy. Furthermore, it seeks to support academic staff in understanding and navigating the process of developing successful spin-off companies.

Keywords: *spin-off companies, science commercialization, innovation ecosystem, academic entrepreneurship*

1. INTRODUCTION

Transforming scientific discoveries into market-oriented innovations has become a critical challenge for modern economies. Academic spin-off companies represent a key instrument in this process, providing a mechanism through which research outcomes are commercialized and transferred from academia to industry. Through spin-off ventures, scientific findings can move beyond academic journals and patent documents and be developed into products and services for the market. By creating jobs and stimulating local development, spin-offs not only strengthen national competitiveness but also enhance the international visibility of their parent universities. In today’s knowledge-based economy, universities are no longer seen just as institutions of education and research. Instead, they are expected to act as important drivers of innovation and economic development. This evolution has given rise to the concept of the entrepreneurial university that not only produces knowledge, but also actively participates in its application through innovation, commercialization, and collaboration with industry.

Entrepreneurial universities play a central role by combining research, teaching, and commercialization, and by actively collaborating with industry. To support this transformation, such universities often establish internal structures like technology transfer offices, innovation incubators, and entrepreneurship centers. An entrepreneurial university could play a important role in fostering innovation, promoting knowledge transfer, and driving economic and social development through active engagement in commercialization and collaboration with industry.

By engaging in cooperation with enterprises, universities can create favorable conditions for the establishment of spin-offs, providing not only technological know-how and human capital, but also institutional support through incubators, training programs, and entrepreneurship education. Such cooperation facilitates knowledge transfer, strengthens the absorptive capacity of firms, and contributes to regional socio-economic development. Importantly, the motivations for initiating academic spin-offs often extend beyond profit, encompassing the application of research in practice, job creation, and the enhancement of the university's societal role [1].

Globally, academic spin-offs have played a pivotal role in building innovation-driven economies — especially in fields like biotechnology, information and communication technologies (ICT) and advanced engineering. They serve as a bridge between academic excellence and commercial application, ensuring that discoveries made in laboratories do not remain confined to academic journals, but instead to find their way into the real world where they can generate economic value and societal impact. Despite a growing number of research projects and talented researchers, many research findings remain within academia, with few progressing into spin-off ventures in Serbia. This ongoing paper aims to explore the reasons behind that gap — identifying both the barriers that limit spin-off development and the opportunities that could drive future growth in the Serbian context.

2. THE CONCEPT AND CHARACTERISTICS OF ACADEMIC SPIN-OFFS

University research may be commercialized through several channels, most commonly grouped into three categories: patents and licenses, consulting and collaborative projects with industry, and the establishment of academic spin-off companies. Among these mechanisms, spin-offs are often considered the most complex but also the most impactful, since they create entirely new firms that combine scientific knowledge with entrepreneurial initiative. Unlike patents or consulting, which usually provide limited or short-term benefits, spin-offs have the potential to generate long-term economic value, contribute to job creation, and strengthen the role of universities as active players in regional innovation systems.

University spin-offs are new firms formed to commercially exploit knowledge, technology, or research results developed within a university [2]. This process generally involves the commercialization of intellectual property and the transfer of technologies generated within academic institutions [3]. They act as catalysts of innovation ecosystems, strengthening collaboration between academia, industry, and government. Beyond their economic role, spin-offs contribute to building a culture of innovation within universities and motivate researchers to pursue practical applications of their scientific work. They also serve as a channel through which academic expertise becomes accessible to industry, strengthening cooperation between the two sectors. In addition, university spin-offs often

act as drivers of regional development, supporting the creation of high-skilled jobs and stimulating the growth of local innovation ecosystems.

The concept of academic spin-offs can be interpreted broadly and may include different types of firms [4]:

- firms founded by university researchers in order to directly commercialize the results of their research;
- firms established by students or graduates who take advantage of the competences and knowledge acquired during their studies;
- firms created by external entrepreneurs who exploit the outcomes of university research.

It's important to make distinction between ventures in which the researcher leaves the university to fully engage in the company, and those where the researcher remains employed in academia while participating in the spin-off, suggesting that spin-offs led by founders who leave the university tend to have an increased probability of success. The process of creating a spin-off typically involves navigating a complex set of challenges — from securing intellectual property rights and developing a viable business model, to obtaining early-stage funding and building a competent interdisciplinary team. These ventures often arise from long-term research projects or breakthrough discoveries, but their success depends not only on technological quality, but also on entrepreneurial orientation, institutional support, and access to markets.

University spin-offs typically go through several critical junctures in the process of transforming a scientific discovery into a viable business venture. This development can be described as a sequence of thresholds that must be crossed in order for a spin-off to become sustainable [5]:

- Research threshold – moving from basic academic research towards recognizing its potential commercial application.
- Opportunity recognition threshold – identifying a concrete market opportunity that can be exploited.
- Pre-organization threshold – assembling a founding team and establishing the initial organizational structure of the spin-off.
- Re-orientation threshold – adapting and refining the business concept and model in response to market and technological challenges.
- Sustainability threshold – securing long-term viability through access to finance, market acceptance, and managerial capabilities.

In this context, the term "threshold" refers to a critical transition point that a spin-off company must cross in order to progress from one stage of development to the next - these thresholds represent critical points in the life cycle of university spin-offs. Failure to successfully cross any of them may undermine the further development of the company but overcoming them increases the chances of building a sustainable and competitive venture.

Academic spin-offs exhibit a set of unique characteristics that distinguish them from other entrepreneurial ventures. Their primary feature lies in the origin of their business idea, which stems directly from universities or research institutes. A second defining characteristic is their strong reliance on intellectual capital. Spin-offs are knowledge-

intensive firms whose competitiveness is based on human, relational, and structural capital rather than on tangible assets [6]. This reliance on intangible resources makes them innovative but also exposes them to high levels of uncertainty and risk.

Also, academic spin-offs founders are often researchers or faculty members who, while maintaining their scientific ambitions, also strive to meet market demands - combining academic and commercial logics at the same time. This dual focus frequently creates tensions between the pursuit of scientific excellence and the requirements of business. This combination often results in a lack of managerial and market experience among founders, which increases the importance of external support mechanisms such as science and technology parks, technology transfer offices, academic incubators and mentoring programs as well entrepreneurship education course both for academic staff and students.

Another characteristic is their dependence on complementary resources. Although rich in technological knowledge, spin-offs frequently lack managerial, marketing, or financial expertise. Consequently, they rely heavily on institutional support mechanisms such as incubators, technology transfer offices, and science parks to acquire the skills and resources necessary for growth [7]. Academic spin-offs are marked by long development cycles and high uncertainty. Bringing a research-based idea to the market requires significant time, funding, and adaptation. If they succeed, spin-offs have a disproportionate impact compared to conventional start-ups. They generate high-quality jobs, stimulate regional innovation systems, and enhance the international reputation of their parent universities [4].

3. THE TRIPLE HELIX MODEL AND THE ROLE OF ACADEMIC SPIN-OFFS

Academic spin-offs should not be understood only as instruments of technology transfer, but as indicators of the maturity of the domestic innovation ecosystem. The presence of academic spin-offs shows that universities are not limited to their educational and scientific missions, but are also able to generate concrete social and economic value. In practice, the process of establishing a spin-off requires a combination of scientific excellence, entrepreneurial motivation, and an enabling environment that provides mentoring, incubation, and access to finance. The presence or absence of these conditions often determines whether innovative research will remain within academic publications or evolve into a company with the capacity to influence markets. In this way, spin-offs can be viewed both as outcomes of successful research activities and as catalysts for further collaboration between academia, industry, and government.

The importance of academic spin-offs is not limited to research commercialization, but also extends to their broader role in fostering innovation and collaboration. They act as outcomes of the relationship between universities, industry, and government, demonstrating how innovation is increasingly the result of collaborative networks rather than isolated efforts. Such an understanding naturally leads to the Triple Helix model, which conceptualizes the dynamic interaction of these three actors as the foundation of modern innovation systems. The Triple Helix model provides a useful framework for understanding this interaction. It highlights the growing interdependence of universities, industry, and government in driving innovation and regional development [8]. Within this model, innovation is no longer seen as the outcome of isolated institutional efforts, but rather as the result of continuous collaboration and overlapping roles. Figure 1 presents the Triple Helix model, where universities, industry, and government are conceptualized

as interdependent spheres whose interactions generate innovation. At the intersection of these domains, academic spin-offs take shape, showing how collaborative knowledge exchange can lead to new business activity.

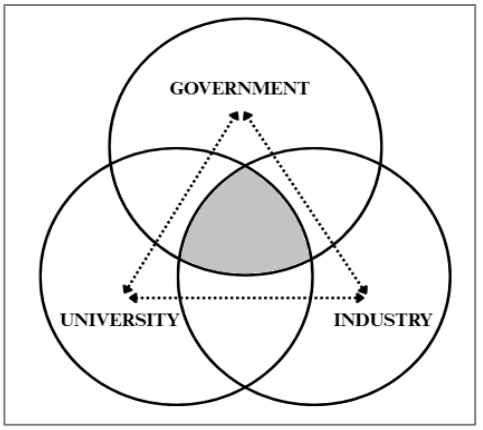

Fig. 1 Triple Helix model; Source: Authors

Unlike traditional models, where universities were perceived as institutions dedicated solely to education and basic research, the Triple Helix perspective emphasizes their entrepreneurial role and capacity to actively contribute to economic growth. Within this framework, universities are no longer passive knowledge producers but proactive actors that engage with industry and government to co-create innovation. Industry, in turn, not only provides the market for research outputs but also becomes a partner in joint projects and commercialization efforts. Government plays as a regulator that defines the legal and institutional framework, and as a facilitator that provides incentives, funding schemes, and strategic direction.

The dynamic interactions of these three spheres create a supportive entrepreneurial environment for the emergence of academic spin-offs, which present the core of the Triple Helix by translating scientific research into tangible economic and social outcomes. Within the Triple Helix model, academic spin-offs can be seen as one of the most tangible outcomes of the interaction between universities, industry, and government. They embody the entrepreneurial role of universities by transforming scientific knowledge into commercial applications, while simultaneously creating a platform for collaboration with industrial partners and attracting public policy support. In this sense, spin-offs not only reflect the overlapping functions of the three spheres, but also reinforce the dynamic evolution of the innovation ecosystem itself [8].

Recent research highlights the importance of hybrid organizations in facilitating Triple Helix dynamics [9]. Academic spin-offs can be understood as one such form, since they combine academic, industrial, and governmental roles within a single organizational setting. However, the extent to which spin-offs can fulfill this role largely depends on the maturity of the national innovation ecosystem. In the case of Serbia, despite significant progress in building innovation infrastructure, the development of academic spin-offs remains limited.

4. ACADEMIC SPIN-OFFS IN SERBIA: CHALLENGES AND PERSPECTIVES

The development of academic spin-offs in Serbia is still at a very early stage compared to EU countries with more mature innovation systems. Although Serbian universities and research institutes generate high-quality scientific output, only a very limited number of research results are transferred into the market through newly created companies. In the past five years, only a few academic spin-offs have been created in Serbia, and most of them remain in the prototype or early testing phase.

Most spin-offs that do emerge remain confined to the proof-of-concept or prototype stage, relying on small-scale grants or short-term project funding without successfully entering the commercialization phase. A significant structural issue lies in the weak integration of scientific excellence and entrepreneurial orientation within academic institutions and researchers.

While Serbian researchers are internationally competitive in several fields such as information technology, engineering, and natural sciences, their work rarely translates into market-ready innovations. Another important challenge is the lack of systematic monitoring and statistical data on spin-offs. There is no central database that records the number, field of activity, or performance of university-based companies, which makes it difficult to evaluate their actual role within the national innovation ecosystem.

Role of universities is a decisive factor in shaping the success of academic spin-offs. Universities that adopt the model of the entrepreneurial university—by integrating teaching, research, and commercialization—are more likely to generate sustainable startup and academic spin-off companies. Institutional characteristics such as clear intellectual property policies, functional technology transfer offices, entrepreneurship education, and incubator support are identified as essential mechanisms for knowledge commercialization. However, the formation of spin-offs in Serbia is still in its early stages, and most universities lack consistent strategies and resources to support such ventures. This indicates that, in addition to national policies, university-level initiatives could play a crucial role in creating an environment where research results can be transformed into viable business ventures [10].

4.1. Institutional and Legal Framework

The institutional framework for the development of academic spin-offs in Serbia is still evolving. The key legislative acts relevant for this area are the Law on Innovation Activity and the Law on Higher Education, both of which regulate the ownership of intellectual property, the role of universities in commercialization, and the possibility of establishing university-linked companies. However, ambiguities remain, particularly concerning the distribution of intellectual property rights between researchers and their parent institutions, which often discourages academics to engage in entrepreneurship.

At the policy level, the Government of Serbia has adopted several strategic documents aimed at strengthening innovation and entrepreneurship. Among the most relevant are the Smart Specialization Strategy (2019–2024), the Strategy for the Development of Startups in Serbia (2021–2025), and the Strategy for Scientific and Technological Development of the Republic of Serbia (2021–2025). These strategies emphasize the need to support technology transfer, university-industry collaboration, and the creation of spin-offs as mechanisms for economic growth.

The Startup Ecosystem Development Strategy of the Republic of Serbia (2021–2025) explicitly recognizes academic spin-offs as a distinct category of knowledge-based enterprises and highlights their importance for strengthening the national innovation system. The document points out that the number of spin-offs emerging from Serbian universities and research institutes is still extremely low, primarily due to unclear intellectual property regulations, insufficient entrepreneurial motivation among researchers, and limited access to early-stage funding. To address these challenges, the strategy emphasizes the need to build the capacities of technology transfer offices, provide entrepreneurship training for academic staff and students, and foster stronger university–industry linkages. In this way, academic spin-offs are positioned not only as an underutilized mechanism of knowledge commercialization, but also as a strategic priority for the development of Serbia's startup ecosystem [11].

In addition to national strategies, the ongoing SAIGE project - Serbia Accelerating Innovation and Growth Entrepreneurship 2021–2026 plays a central role in strengthening the institutional environment for academic entrepreneurship [12]. The project, supported by the World Bank, the European Union, and the Government of Serbia, is focused on enhancing the commercialization of research and the development of university-based innovation infrastructure. Its activities include funding instruments for early-stage ventures, capacity building for technology transfer offices, and support for science and technology parks. By addressing structural gaps in the innovation ecosystem, SAIGE aims to create more favorable conditions for the emergence and growth of academic spin-off companies, ultimately fostering stronger links between academia, industry, and government.

Institutional infrastructure has also expanded through the development of science and technology parks (Belgrade, Novi Sad, Niš, Čačak), technology transfer offices (TTOs) at major universities and academic Innovation incubators at various faculties. While these organizations play an important role in providing incubation, mentoring, and access to networks. Despite all these institutional efforts, the number of successfully established academic spin-offs remains very small, indicating a gap between policy intentions and practical outcomes.

4.2. Barriers and Development Opportunities

Despite recent progress in strengthening the institutional framework and expanding innovation infrastructure, the development of academic spin-offs in Serbia is still constrained by numerous obstacles. These barriers are rooted in legal, financial, cultural, and organizational factors that collectively limit the ability of researchers to transform scientific knowledge into entrepreneurial ventures. Understanding these constraints is essential, as they explain why the number of academic spin-offs in Serbia remains very small compared to more developed innovation systems. One of the key issues is the unclear intellectual property (IP) framework. Many universities still lack well-defined policies regarding IP ownership and licensing, which creates legal uncertainty and discourages researchers from engaging in commercialization efforts. Another significant barrier is the lack of institutional incentives. Academic promotion and career advancement continue to rely heavily on scientific publications, while entrepreneurial activities such as patenting, product development, and company formation are largely overlooked.

Limited early-stage funding dedicated to the development of academic business ideas, although there are some public grant schemes and innovation funds, very few are specifically designed to support the earliest phase of transforming a research idea into a viable business concept The lack of entrepreneurial education and institutional support at the university or faculty level represents a significant barrier. Many researchers are not familiar with the basic elements of entrepreneurship, including how to develop a business model, navigate intellectual property processes, or pitch ideas to investors.

There are positive trends and growing opportunities for the development of academic spin-offs in Serbia. One of the most significant developments is the establishment of science and technology parks in Belgrade, Novi Sad, Niš, and Čačak, as well as plans for new facilities such as the BIO4 Campus in Belgrade. These parks provide essential infrastructure, co-working space, mentoring, and access to start-up programs. By acting as bridges between academia and industry, they create physical and institutional environments in which innovation can thrive. In parallel, many faculties have launched academic innovation incubators that support early-stage academic entrepreneurs. These incubators provide services for helping researchers and students to shape their business models, validate ideas, and connect with funding opportunities and mentors.

In addition, a growing number of entrepreneurship training programs and workshops are now available to university staff, researchers, and PhD students. Such programs aim to equip academics with the skills and mindset needed to recognize entrepreneurial opportunities, design viable business concepts, and participate more actively in technology transfer processes. These initiatives are gradually creating a more favorable environment for academic spin-offs to emerge, survive, and grow. However, their long-term impact will depend on whether they are matched with adequate policy support, sustainable funding mechanisms, and strong institutional commitment.

For the further development of academic spin-off companies in Serbia, several targeted actions should be prioritized. First, intellectual property (IP) policies should be standardized and clarified across universities, ensuring transparent and fair rules regarding ownership and commercialization rights. Second, the introduction of dedicated pre-seed funding instruments—such as university-managed seed funds—would significantly help researchers bridge the critical early gap between scientific discovery and business application.

Entrepreneurial education needs to be systematically integrated into academic programs, particularly at the postgraduate level, with tailored modules designed for researchers, doctoral candidates, and technical staff. Finally, building a strong network of mentors, industry partners, and alumni entrepreneurs could provide spin-off teams with practical guidance, credibility, and access to markets. Implementing these steps consistently would create a framework more supportive to innovation and to enable Serbian universities to play a stronger role in entrepreneurship and regional development.

5. CONCLUSION

Among the various forms of knowledge transfer, academic spin-offs are the clearest example of how research results can be turned into innovation and market value. They embody the entrepreneurial role of universities and reflect the dynamics of the Triple Helix model, where academia, industry, and government jointly contribute to the creation of knowledge-intensive ventures. The analysis presented in this paper confirms that in

Serbia, despite recent progress in building innovation infrastructure and adopting national strategies, the number of academic spin-offs remains very limited. The main barriers lie in the unclear intellectual property framework, insufficient institutional incentives, lack of early-stage funding, and weak entrepreneurial education for researchers. The expansion of science and technology parks, the creation of university incubators, targeted educational programs, and the SAIGE project together provide a more favorable environment for creation of academic spin-offs.

For spin-offs to become an effective instrument of Serbia's innovation policy, several actions are required: clarifying IP ownership, introducing dedicated pre-seed financing instruments, integrating entrepreneurship education into academic curricula, and strengthening networks of mentors and industry partners. If consistently implemented, these steps could bring Serbia closer to successful European models and allow spin-offs to become a stronger driver of national growth and regional competitiveness. In future research, the focus will be placed on conducting empirical analysis of academic spin-offs in Serbia, in order to provide deeper insights into their characteristics, performance, and developmental challenges.

6. ACKNOWLEDGEMENT

This study was supported by the Ministry of Science, Technological Development and Innovation of Serbia, and these results are parts of the Grant No. 451-03-136/2025-03/200132, with University of Kragujevac - Faculty of Technical Sciences Čačak.

7. LITERATURE

[1] Pacheco, A., Franco, M. (2024). *The role of higher education institutions (HEI) in academic spin-off creation: A cooperation perspective*, Journal of the Knowledge Economy, 15(5), 7523–7541. https://doi.org/10.1007/s13132-023-01390-x

[2] Shane, S. (2004). *Academic entrepreneurship: University spinoffs and wealth creation*, Edward Elgar, p.11

[3] Djokovic, D., Souitaris, V. (2008). *Spinouts from academic institutions: A literature review with suggestions for further research*, The Journal of Technology Transfer, 33(3), pp. 225–247.

[4] Iacobucci, D., Micozzi, A. (2014). *How to evaluate the impact of academic spin-offs on local development: An empirical analysis of the Italian case,* The Journal of Technology Transfer, 40(3), pp.434–452. https://doi.org/10.1007/s10961-014-9357-8

[5] Vohora, A., Wright, M., Lockett, A. (2004). *Critical junctures in the development of university high-tech spinout companies*, Research Policy, 33(1), pp. 147–175. https://doi.org/10.1016/S0048-7333(03)00107-0

[6] Passavanti, C., Primario, S., Rippa, P. (2025). *The influence of knowledge and intellectual capital on the economic outcomes of academic spin-offs: Evidence from Italy*, Journal of Innovation & Knowledge, 10 (5), https://doi.org/10.1016/j.jik.2025.100768

[7] Neves, M., Franco, M. (2016). *Academic spin-off creation: Barriers and how to overcome them*, R&D Management, 46(3), pp. 579–590. https://doi.org/10.1111/radm.12231

[8] Etzkowitz, H., Leydesdorff, L. (2000). *The Dynamics of Innovation: From National Systems and "Mode 2" to a Triple Helix of University-Industry-Government Relations,* Research Policy, 29, pp. 109-123. http://dx.doi.org/10.1016/S0048-7333(99)00055-4
[9] Linton, G. O. (2024). *Triple Helix dynamics and hybrid organizations: An analysis of value creation processes*, Journal of the Knowledge Economy, 15(4), pp. 20797–20822, https://doi.org/10.1007/s13132-024-01911-2
[10] Babić, L., Savović, S. (2018). *University characteristics as the success factor of academic spin-offs.* Zagreb International Review of Economics and Business, 21(1), 113–127. https://doi.org/10.22598/zireb.2018.21.1.113
[11] Official Gazette of the Republic of Serbia, *Startup ecosystem development strategy of the Republic of Serbia for the period 2021-2025,* Official Gazette of the Republic of Serbia, No. 30/18, Belgrade, Republic of Serbia, 2021.
[12] *Serbia Accelerating Innovation and Growth Entrepreneurship Project – SAIGE (2024)*, Innovation fund of Republic of Serbia (https://www.inovacionifond.rs/en/int-projects/serbia-accelerating-innovation-and-growth-entrepreneurship-project-saige, accessed 14 August 2025.)