THE INNOVATION PARADOX IN THE SERBIAN ECONOMY: THE GRANGER CAUSALITY APPROACH

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ARTICLE INFO

Original Scientific Paper
Received: 06.09.2022
Revised: 01.11.2022
Accepted: 02.11.2022

DOI 10.7251/ACE2237009M
UDC
330.552:330.341.3(497.11)

Keywords: *Serbia, innovations, patent applications, gross domestic product (GDP), gross expenditures for research and development (GERD), vector autoregressive (VAR) model, Granger causality test, innovation paradox, business environment*

JEL Classification: C22, C51, O11, O31, O32

ABSTRACT

Innovations, as the applications of new ideas, solutions and technological practices that improve goods, services and business processes, are the most important driver of economic progress. They lead to greater productivity and efficiency, and therefore to better economic results. The purpose of this article is to examine the state, interrelation and the impact of innovative activities on the economic growth of Serbia. The paper first uses standard multiple regression and concludes that in the period from 2004 to 2020, the number of registered patents did not contribute, while the gross expenditures for research and development (GERD) contributed positively and significantly to the growth of the Serbian GDP. Therefore, it can be said that Serbia is facing a kind of innovation paradox, since the growth of allocations coexists with a dramatic decrease in the number of registered patents. Its second part is based on the construction of the corresponding Vector autoregressive VAR(1) model that traces the causal relationship between GERD and the economic growth of Serbia in the period from 1997 to 2020. It follows that while GERD does not cause GDP in the Granger sense, the GDP causes GERD allocations for innovative activities in Serbia. The scientific research work in Serbia is not efficient and effective enough because it draws funds from the GDP, but does not meet expectations and does not produce tangible results, especially in the expected number of registered patents. Therefore, it is necessary to build an appropriate incentive environment that would stimulate more adequately and value new innovative ventures.

1. INTRODUCTION

It is well known that innovations are a fundamental driver of economic progress that brings benefits to a society as a whole. Today, there is an almost axiomatic view that innovative activities are the only and most important component of long-term economic growth (Rosenberg, 2004, 1). In economic terms, innovation is a consequence of the use of new ideas and technologies that improve goods and services and make production and organizational processes more efficient and effective. Innovations contribute to economic growth through their impact on productivity growth, and thus on increasing the output, profits, competitiveness, living standards and quality of life (European Central Bank, 2017). Innovations and knowledge spillovers they generate contribute to improving the quality of business, competitiveness and market share of companies, industries and entire nations (Hashi & Stojičić, 2013, 7). In addition, innovation is one of the primary ways in which manufacturing and service companies can contribute to sustainable growth and development. They usually start on small scale, in the form of developing and applying new technologies and new ideas at the level of a given enterprise, and then they diffuse and spread to the whole economy, to companies of different sizes and from different economic sectors, benefiting the whole economy and society. The vast majority of contemporary literature (Fagerberg, Verspagen & Srholec, 2010, 4-5; Solow, 1957, 312; Fayomi, Adelakun & Babaremu, 2019, 1-9; OECD, 2007, 6; The World Bank, 2010, 1-2; Maradana et al., 2019, 268-269; Maradana et al., 2017; Galindo & Méndez, 2014, 825; Block, 2002, 1-2; Blach, 2011, 13) highlight the positive relationship between innovation, technological progress and knowledge, on the one hand, and competitiveness and economic growth, on the other. Finally, the knowledge itself appears as the basic leverage of society, while a society that is capable of creating new values represents the basis of economic growth (Jovičić, 2021, 355).

Back in 1934, Joseph A. Shumpeter pointed out the importance of entrepreneurship, technological progress and innovations for economic growth. Schumpeter was the first to connect the concept of innovation with entrepreneurship, as a source of pure entrepreneurial profit based on spiritual creation and intangible wealth (Borojević, 2006, 221). Shumpeter in his epochal book *The Theory of Economic Development – An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle* described innovations as the employment of new combinations of production factors that lead to (Shumpeter, 1934, 66): a) introducing a completely new product; b) developing and introducing a completely new production method; c) opening a completely new market; d) conquering new sources of raw materials and semi-final products; and e) establishing an entirely

new organization of industry. In a dynamic process of competition, these new products and new production methods compete with old ones, in unequal conditions, while in their decisive advantage the new products and production methods can lead to the disappearance of the old ones (Shumpeter, 1943, 32). However, innovations do not always bring the implied success. They are often followed by high research and development (R&D) costs, as well as financial risks arising from the fact that R&D activities do not always lead to new, market-valued products, services and processes. This process can end in failure also because the development of a new product, service or process may require a long period of expenditure on R&D, which could further make their implementation very expensive and unprofitable (Rosenberg, 2004, 1). This article is dedicated to the analysis of the state of innovative activities in the Republic of Serbia (RS), which seems to be facing the problems of insufficient recognition of the importance of adopting new technologies, a weak business environment, as well as limited capacities in designing and implementing the necessary supporting policies.

According to the Global Innovation Index (GII) for 2021, Serbia took a relatively modest 54th place out of 132 observed countries, meaning that it decreased by one place compared to 2020. Despite the fact that in 2020, the country was declared an innovation achiever (Dutta et al., 2020, 22-319), it still records a relatively low level of innovations compared to other countries. At the same time, in 2021, the country ranked eighth out of 34 upper middle-income countries in terms of innovation activities, as well as 34th out of 39 analysed European economies. Despite its significant potential in the science and R&D sector, Serbia has generally not provided a favourable, stimulating, safe and predictable environment for fostering and developing innovations yet. According to the latest data from the Statistical Office of the Republic of Serbia (SORS) for the period 2018-2020, the share of business entities with at least one type of innovation was 54.8%, while more than 69% of large companies, about 58% of medium enterprises, and around 54% of small firms implemented some kind of innovation. In this period, innovative activities were equally present in the manufacturing and service sectors in Serbia, and the region of Belgrade was in the lead (46.5%) in their introduction and development. The share of sales of innovative products and services, which are completely new to the observed company or to the market, was only around 14% in total sales (SORS, 2021). In the domestic economy, there is still a small number of highly innovative business entities with great potential for growth, as well as a large number of companies that do not introduce innovations sufficiently. In other words, most domestic companies do not base their competitiveness on the development of innovations,

as it is the practice in developed countries, and Serbia still has a low level of scientific R&D expenditures in its total spending for technological innovations. Finally, research of Mitrović and Mitrović (2020, 38) also pointed out that excessive costs, lack of financial resources, uncertainties in market demand for innovative products, as well as strong and unfair competition represent the most significant obstacles to the introduction and development of innovations in Serbia.

The purpose of this article is to determine the causal relationship between innovations, expressed in patent applications and gross domestic expenditures on research and development, and economic growth in Serbia, i.e. to examine whether innovations Granger cause its economic growth, as well as whether economic growth in Granger causality sense has a reciprocal effect on the country's innovation trends. The following section describes the sources of data used, the characteristics of the observed variables, and the methods applied in this research study. The third section is devoted to the description and discussion of the obtained results, while the last section provides conclusions, with concrete implications and recommendations for policy makers.

2. DATA, MATERIALS AND METHODS

As already mentioned, innovation is widely considered to be the main source of economic growth, which explains the need to explore the relationship among indicators of innovation, economic growth and economic performance of a society. This section analyses the diffusion of innovations and their trends in the case of Serbian economy. The innovations can be expressed in several different ways. Despite the fact that there are several indicators of innovations, this article considers the following two observed variables: a) the Total number of patent applications of residents and non-residents, and b) the Gross domestic expenditures for research and development in the Republic of Serbia, as well as their impact on economic growth. The paper also examines the possible reversible impact of economic growth on innovative activities in the country from the aspect of Granger causality approach.

Gross domestic expenditures on R&D (GERD) is considered in this article as total spending on R&D activities and R&D staff at the national level in the following four sectors: a) business enterprises, b) government, c) higher education, and d) private non-profit organizations. Eurostat (2022c) defines research and experimental development as creative and systematic work undertaken with the aim of increasing the scope of knowledge, including knowledge about

humankind, culture and society, as well as devising new ways of applying acquired knowledge. In its *Frascati Manual*, the OECD (2015, 111) defines GERD as the total intramural or internal expenditures on R&D activities that take place in a country's territory during the given reference period. GERD is the main aggregate statistical indicator used to describe a country's R&D activities, covering all R&D expenditures carried out in its territory. Therefore, this indicator also includes domestic R&D activities financed from abroad, i.e. from the rest of the world, but does not include financing R&D activities carried out abroad. The total number of patent applications (TPA) to the Serbian Intellectual Property Office (SIPO) includes the total number of patent protection applications of residents and non-residents in the observed reference year. The article uses this indicator because its data are far more reliable and comprehensive than the data on the number of patents granted to residents and non-residents. Table 1 provides a detailed description of all indicators used in this research, while the analysed data were derived from the Eurostat, World Intellectual Property Organization (WIPO) and the World Bank database.

Table 1: Description of Variables Used

Variable	Variable description
GDP	Gross domestic product: Expansion of the country's economy expressed as an annual change in GDP.
GERD in all sectors	Gross expenditure on R&D: Gross domestic investment in research and experimental development in all sectors on an annual basis. GERD includes expenditures for R&D and R&D staff activities in all four following observed sectors: a) business enterprise, i.e. non-financial institutions, b) government, c) higher education, and d) private non-profit organizations.
TPA	Total patent applications: Exclusive rights to patent the inventions of residents and non-residents on an annual basis. Total number of patent applications of residents and non-residents filed annually to the SIPO. Patents are mostly about a product or process that provides a new way of doing something or offers a new technological solution to a problem. A patent provides its owner with protection of his/her invention for a limited time, usually over a period of 20 years.

Source: The Author and Maradana et al., 2019, 270.

This paragraph points to the trends of innovations in Serbia in the period from 2004, when the innovations expressed in patents just started to be included in more detail in the county's statistics, to 2020. Table 1 from the Econometric Appendix indicates the absolute values of Gross domestic expenditures on research and development, the share of GERD in the country's GDP, the number of resident patent applications, the number of non-resident patent applications, the total number of resident and non-resident patent applications summed up, as

well as the values of Serbian real GDP in the observed period. Several important conclusions arise from this Table:

- First, in the examined period 2004-2020, the number of patent applications of both residents and non-residents decreased dramatically (a drop of about 3 and even about 87 times, respectively).
- Second, there were fewer patent applications of non-residents than patent applications of residents. Namely, the average number of patent applications filed by non-residents was almost twice lower than the number of patent applications filed by residents in the period concerned (from 2004 to 2020). At the same time, the number of non-resident patent applications began to decrease sharply from the very beginning of 2004, only to slow down its sharp fall starting from 2009.
- Third, the total number of patent applications filed by residents and non-residents gradually and persistently declined, decreasing at the end of the observed period by as much as impressive 86.6% compared to the beginning of 2004. Their average number was about 394 per year, while total patent applications reached their lowest value at the very end of the examined period (2020).
- Fourth, in the meantime, there was a huge and very rapid growth of GERD by a drastic 466.4%, and also an increase in GDP by a far more modest pace of 45.5%.

Based on the calculated Pearson correlation coefficients of the observed variables with GDP, it is concluded that there was an almost perfectly positive and statistically significant correlation between GERD and GDP, which indicates that when R&D expenditures grow, the country's GDP also grows. However, the same cannot be said for the Total patent applications of residents and non-residents, which showed a very strong negative and statistically significant correlation with the country's GDP. This further means that with the decrease in the number of patent applications, there is an increase in Serbian GDP. Above all, the Pearson correlation matrix points to the fact that innovations measured by GERD have a positive impact on economic growth, while those measured by total patent applications negatively affect economic growth. However, the main observation that this study intends to investigate is whether innovations in Serbia measured by GERD and Total patent applications actually determine economic growth and whether economic growth in turn causes the level and trends of innovations in the country. The following section presents an attempt to solve this research problem.

While in the first part of the research, Standard multiple regression analysis was applied, in its second part the application of Vector autoregressive (VAR) analysis was approached, as well as the development of an appropriate bivariate VAR(1) model. The VAR model enables investigating of one-way, as well as reverse causality between the dependent variable and independent regressors, using their own past values. Therefore, the used bivariate first-order VAR(1) model, after logarithmization of the variables of interest, could be represented by the following system of equations (Shrestha & Bhatta, 2018, 77):

$$\ln Y_t = \delta_1 + \theta_{11} \ln Y_{t-1} + \theta_{12} \ln X_{t-1} + \varepsilon_{1t} \quad (1)$$

$$\ln X_t = \delta_2 + \theta_{21} \ln Y_{t-1} + \theta_{22} \ln X_{t-1} + \varepsilon_{2t} \quad (2)$$

where ε_{1t} and ε_{2t} are mutually uncorrelated white noises, i.e. error terms. In the last step, the Granger causality test was conducted with the aim of determent the causal relationship between the observed variables. Granger causality test looks at short-term relationships between variables and is employed to determine whether one time series can be used to predict another series. This test is a bottom-up procedure, in which it is assumed that the considered time series are independent variables, while it reveals only predictive causality and temporal relations among the series, but not the causality per se (Granger, 1980, 329-352).

3. RESULTS AND DISCUSSIONS

Preliminary data from this analysis indicated that the basic preconditions (no large deviations from normality, no outliers and extreme points, no multicollinearity, homoscedasticity of variance, stationarity of residuals) for the use of Standard multiple linear regression were met, i.e. for assessing the impact of the Total number of annual patent applications and GERD annually on the annual level of GDP in Serbia. The objective limitation of this study refers to the fact that more reliable, detailed and comprehensive data on patent applications began to be included in Serbian statistics in 2004, which is the reason why the time horizon of this research was relatively short. In addition, this empirical research was strictly limited to examining the link between technological progress expressed by innovations and economic growth in Serbia. Therefore, it did not include other relevant factors such as labour, capital, education, infrastructure, entrepreneurship, available natural resources etc., the inclusion of which could change these research findings. A number of other authors, such as Maradana et al. (2017), Maradana et al. (2019) and Pece et al. (2015), had a similar approach

to this research problem, investigating only the relationship between different forms of innovations and GDP. They pointed out a positive nexus between innovative activities expressed in the number of patents, trademarks and R&D expenditures, and the economic growth. However, these issues could be the subject of some other further research.

Preliminary research also indicated that there was most likely no multicollinearity between the observed predictors, i.e. the TPA and GERD. Namely, although Pearson correlation coefficient between these independent variables was r = - 0.82, its value was still lower than the critical allowed value of r = ± 0.9 (Tabachnick & Fidell, 2013, 88-89). In addition, the values of Tolerance and Variance inflation factor (VIF) indicators were within their allowed limits (Tolerance = 0.327 > 0.1 and VIF = 3.058 < 10), also indicating that there was most likely no multicollinearity between the predictors. This finding is one of the key points of this analysis, suggesting that there is a kind of innovation paradox in the Serbian economy – the greater the statistically covered investments in R&D are and the more funds are allocated for GERD, there are fewer patent applications over time. This paradox is even the greater if we take into account the fact that patents represent a real materialization, as well as the concrete and most significant result of each country's innovation activities. The following sections of this article will focus specifically on this issue.

Standard multiple linear regression was applied to assess a possible impact of the TPA and GERD predictors on the Serbian GDP trend in the period from 2004 to 2020. The model as a whole explained the variance of GDP well and it was statistically significant, *Adjusted R Square* = 94.5%, F(2.14) = 138.118, and Sig. = p = 0.000 < 0.001. In the final model, GERD individually contributed most to the explanation of GDP (23.43% of GDP variance) and was statistically significant, β_2 = 29.375, Sig. = p = 0.000 < 0.001. On the other hand, the TPA explained only a slight 0.76% of the GDP variance, while it was not statistically significant, β_1 = -1.624, Sig. = p =0.159 > 0.05 (Table 3 from the Econometric Appendix). Therefore, based on the estimated parameters, the regression equation from the described model had the following form:

$$y = 25827.353 - 1.624x_1 + 29.375x_2 + \varepsilon \quad (3)$$

where

x_1 is the number of Total patent applications per year,

x_2 is the GERD indicator on annual basis, while

ε is an error term.

Thus the results of the Standard multiple linear regression model showed that the independent variable GERD made a significant unique contribution to the dependent variable GDP, which could not be said for the Total number of patent applications that, in the case of Serbia, explained the dependent variable far less. Based on this, it was concluded that it was possible to reject the null hypothesis H_0, and that it was not possible to reject the alternative hypothesis H_1 about the existence of the relation between innovations and economic growth in Serbia. It seems that in Serbia, investments in R&D do not give any tangible economic results in terms of patents as concrete and the most important materialization of innovative activities. This occurs, among other things, due to insufficiently stimulating environment that would encourage innovations, huge inflows of FDI that bring ready-made technological solutions, quite expensive procedures for patent applications and maintenance, a large number of unvalued patents on the market, as well as the widespread abuse of domestic innovators' licences (Milutinović, 2016). Despite that, the Serbian market has become more attractive for foreign innovators as well, because there is a growing demand for the extension of the European patents (Eurostat, 2022b). This innovation paradox in Serbia is especially sparked by the fact that today the number of patent applications per million inhabitants in Serbia (about 50) is almost five times lower than the European Union (EU) average (230). At the same time, the fact that the number of patent applications and protected patents of individual innovators significantly excides the patent activities of institutional innovators (universities, institutes and companies) means that the situation is particularly unfavourable. It is also remarked that many technological development projects and integral interdisciplinary research programs do not give the expected and sufficient contribution to the realization of new technical solutions and patents (NALED, 2021, 27-28). On the other hand, as far as GERD in Serbia is concerned, this indicator gave quite expected positive and statistically significant results. This finding is well consistent with the results of research by Kutlača, Stefanović Šestić, Jelić & Popović Pantić (2020, 23) which also highlighted the explicit contribution of investment in R&D to real GDP growth. They also found a strong interdependent link between R&D expenditures and economic performance at the national level in Serbia, studying some indicators for the period 1995-2015. These authors also concluded that with the growth of economic activities and the increase of growth rate, the spending on R&D must also increase in order for economic growth to be sustainable.

In view of the statistically significant influence of the GERD predictor on the state and trend of Serbian GDP, the second step of the analysis considered the dynamics of the relation, i.e. the causal relationship between GDP and GERD

in Granger causality sense. The intention of the author was to examine whether GERD Granger causes GDP, as well as whether GDP in Serbia has a recurrent impact on GERD in Granger causality sense. For this purpose, the analysis of data on GDP and GERD variables was first extended to the period from 1997 to 2020, while after that the Augmented Dickey-Fuller (ADF) test and the Breakpoint unite root test were applied in order to determine the stationarity of the variables used. Both tests confirmed that the variable GDP at the level was stationary, while the variable GERD at the level was not stationary. Therefore, logarithmization of these variables was performed, after which the procedure of testing them through these tests was repeated. The results of both, the ADF test and the Breakpoint unite root test on the logarithmic variables indicated the stationarity of these time series, as evidenced in more detail in Table 4 from the Econometric Appendix.

Preliminary research also indicated the normal distribution of logarithmic variables, i.e. the variable lnGDP (Jarque-Bera = 2.507, Prob. = p = 0.285 > 0.05) and the lnGERD (Jarque-Bera = 1.056, Prob. = p = 0.590 > 0.05) (Jarque & Bera, 1987, 163-172). After this step and determining the satisfaction of all needed initial assumptions, the application of Vector autoregressive (VAR) analysis was approached, as well as the development of an appropriate bivariate VAR(1) model. Based on the knowledge of theory and a common sense judgment, as well as the subsequent verification of autocorrelation, i.e. serial correlation of residuals in the VAR model, the optimal number of lags of 1 was chosen, especially since the data were annual. The following Table 2 presents the concrete results of the selected VAR(1) model.

Table 2: The Results of the Selected Bivariate VAR(1) Model

Variables	lnGDP	Statistical significance at 5%	lnGERD	Statistical significance at 5%
lnGDP(-1) Standard errors t-statistics	0.9790 0.0677 14.4582	Significant 14.4582 > 1.96	0.9768 0.3970 2.4602	Significant 2.4605 > 1.96
lnGERD (-1) Standard errors t-statistics	-0.0212 0.0317 -0.6684	Non-significant |-0.6684| < 1.96	0.4870 0.1856 2.6236	Significant 2.6236 > 1.96
Constant Standard errors t-statistics	0.3528 0.5935 0.5944	Non-significant 0.5944 < 1.96	-7.2788 3.4797 -2.0918	Significant |-2.0918| > 1.96

Source: Author's calculation

The results of the conducted VAR(1) analysis indicated the following system of equations that described the relationship between the considered variables lnGDP and lnGERD:

$$\ln GDP_t = 0.353 + 0.979 \ln GDP_{t-1} - 0.021 \ln GERD_{t-1} + \varepsilon_{1t} \quad (4)$$

$$\ln GERD_t = -7.279 + 0.977 \ln GDP_{t-1} + 0.487 \ln GERD_{t-1} + \varepsilon_{2t} \quad (5)$$

While the impact of the GERD from the previous period on the current GDP was even negative and statistically insignificant, the impact of the GDP from the previous period on the current GERD was positive and statistically significant. After this step, diagnostics of residuals was approached in order to determine the stability conditions of the constructed VAR(1) model. The values of the inverse roots of the AR characteristic polynomial remained within the cycle of the roots (Figure 1 from the Econometric Appendix), while the values of their modulus were less than 1 ($Modulus_1$ = 0.933 and $Modulus_2$ = 0.533) (Table 5 from the Econometric Appendix), all suggesting that this model was stable. In addition, the correlograms, i.e. the serial correlation coefficients of these time series, remained within their permitted boundaries of 2 standard errors (Figure 2 from the Econometric Appendix), which also indicated the stability of this model. Finally, the results of the Autocorrelation LM test (Table 6 from the Econometric Appendix) showed that there was no serial correlation on the order of 1, i.e. at a lag 1 (LM – stat = 6.894, Prob. = p = 0.142 > 0.05).

In the last step, the Granger causality test was conducted with the aim to determine the causal relationship between the observed variables. The basic prerequisite for the use of Granger causality test is the stationarity of the observed time series. Therefore, this test was conducted at the level of logarithmic values of the observed variables, which have already proved to be stationary. At this point, the article started from the following research hypotheses:

H_{0A}: lnGERD does not Granger cause lnGDP,

H_{1A}: lnGERD Granger causes lnGDP,

H_{0B}: lnGDP does not Granger cause lnGERD, and

H_{1B}: lnGDP Granger causes lnGERD.

The conducted Granger causality test led us to the conclusion that changes in the variable lnGERD did not Granger cause changes in the variable lnGDP, while changes in the variable lnGDP caused changes in the variable lnGERD in the

Granger causality sense. This further meant that the null hypotheses H_{1A} and H_{0B} could be rejected, while the initial hypotheses H_{0A} and H_{1B} could not be rejected ($\chi^2(1,22) = 0.447$, Prob. = p = 0.504 > 0.05 and $\chi^2(1,22) = 6.053$, Prob. = p = 0.014 < 0.05). Table 3 illustrates the results of the conducted Granger causality test in detail. Based on the obtained results of all implemented research procedures, it is concluded that the variable lnGDP Granger causes lnGERD, as well as that this one-way causal relation is statistically significant, helping to predict the trend of GERD variable.

Table 3: Results of the Granger Causality Test

	χ^2 test results	df	Prob.
Dependent variable: lnGDP			
Independent variable: lnGERD	0.4468	1	0.504 > 0.05
Dependent variable: lnGERD			
Independent variable: lnGDP	6.0527	1	0.014 < 0.05

Source: Author's calculation

At the very end of the conducted analysis, impulse response functions were constructed which indicated that the current growth of the lnGERD variable of one standard deviation is likely to have a gradual and slight negative impact on the lnGDP variable in the foreseeable future. On the other hand, the current growth of the lnGDP variable of one standard deviation is likely to have a gradual positive effect on the lnGERD variable in the next 10 years (Figure 3 from the Econometric Appendix).

The results of the conducted Granger causality test, and especially its part related to the fact that GERD does not Granger cause GDP in Serbia, fit well with the fact that Serbia still lags significantly behind other European countries in terms of investment in R&D, technology and innovation. This situation also leads to a low share of sophisticated value-added products and services in its total production and exports. In addition, there is still insufficient investment in R&D activities in the Serbian private sector, and there is also no adequate cooperation between the academic community, i.e. universities and research institutes and its business sector. In addition, experience tells us that the purpose of directing and spending funds is far more important than the growth of expenditures for R&D activities. Finally, the fact that in the last decade the country's development policy was based mainly on attracting labour and energy-intensive FDI, which generated cheap and mostly undignified jobs and low investment in physical and human capital, could have contributed to the poor state of R&D activities in Serbia. These trends also caused low average wages and the country's low

average productivity (Deutsche Zusammenarbeit et al., 2020, 51-52). The latest Report of the Serbian National Council for Scientific and Technological Development on the State of Science in 2019 also supports these claims. The Report states that only in 2019 the share of private sector allocations for science and technological development was 0.37% of GDP, pointing to the fact that the conditions for a significant change in innovation and scientific-research environment in the country almost do not exist. In addition, the relatively low level of GDP, the modest ten-year average growth rate of 1.5%, as well as the low rate of investment in R&D and science do not give any hope that the scientific environment in Serbia will significantly improve in the near future (National Council for Scientific and Technological Development, 2020, 15-16). This is also confirmed by the data of the Serbian National Alliance for Local Economic Development from the survey on the economy, stating that only one quarter of companies in Serbia are innovative and digitally transformed, that 40% of them have introduced innovations in their business without digital transformation, while about 40% of them have not introduced any innovation in the last five years. Representatives of the companies cited the lack of the need for innovation, the lack of perception of the benefits of innovation, as well as too many accompanying bureaucratic barriers as the main obstacles in domestic innovation activities (NALED, 2021, 12-13).

If so, this brings up a question of how the statistically significant impact of GERD from the results of the regression analysis on Serbia's economic growth could have occurred. One possible explanation for this phenomenon lies in the fact that in the period from 1997 to 2020, GERD in Serbia almost doubled, while the economy grew more slowly by about 87.02%. This trend could have contributed to the country's GDP growth, although the average share of R&D expenditures in the Serbian GDP in the given period remained very low and symbolic (0.72%). Another possible explanation for this phenomenon is that there is a possibility that most of the funded R&D projects were fictitious, as well as that they were initiated with the aim of obtaining and justifying the RS budget or some other funds, while failing in their expected outcomes and tangible results. It is also possible that the official growth of investments in R&D activities was also initiated by new tax incentives introduced with the aim of encouraging innovation activities in Serbia. These incentives above all encompass an increased R&D tax deduction. The Republic of Serbia has also approved a reduction in corporate income tax from 15% to 3% for all those companies that base their business on key forms of intellectual property such as patents and software. Serbian Government also approved tax loans for investments in innovative start-up companies. These tax incentives enable newly established companies to be

exempt from paying taxes, health insurance and social security contributions for their founders up to the amount of € 1,275 of their gross monthly salary in a period of 3 years (Digital Community, 2021). In addition, there are other tax incentives currently in force for domestic and foreign innovative companies aimed at tax, health insurance and social security contribution exemptions, easier employment, encouraging the participation of employees in equity capital and other very innovative supporting programs. Finally, in this process we should not neglect the role of FDI, which today in Serbia appears as the main bearer of contemporary technology, new scientific knowledge, technological experience, tangible and intangible resources and whose R&D activities could certainly significantly contribute to the economic growth of the country.

4. CONCLUSIONS

The conducted research indicated that with the growth of R&D expenditures, there was a surprising decline in the number of patent applications in the Serbian economy, leading the country to a kind of innovation paradox. In addition, the analysis indicated that the R&D allocations had a statistically significant impact on the growth of Serbia's GDP. The second part of this research also pointed out that allocations for R&D activities do not Granger cause GDP, while the Serbian GDP has an impact on R&D financing in Granger causality sense. However, given the fact that Serbia still lags far behind the European countries regarding the innovation ventures, that its investments in R&D in absolute and relative terms are still low and symbolic and that it has failed in the outcomes of R&D projects, from all of the above it can be concluded that there is a need for further encouragement of these activities. Besides, Serbia still has no appropriate environment for encouraging innovations, and a small number of domestic companies have introduced some innovation so far. In addition, innovators in Serbia primarily finance their business from their own funds and commercial loans, while most of them are not even aware of donors' community programs, co-financing opportunities and the possibility for receiving grants (NALED, 2021, 16). Therefore, there is a clear need to build a more favourable, safer, predictable and financially stimulating environment to encourage innovative ventures in the country.

It is also necessary to increase investments in R&D, contemporary technologies and innovations as the most important factors of accelerated growth, technological change and increasing sophistication of products and services. This is especially true when it is necessary to increase innovation capacity in the private sector, as well as in the domestic small and medium enterprises (SMEs) sector. There

is also a need for launching adequate and more comprehensive information campaigns that would make data on innovation incentives more accessible to small business owners and the public. If this information could encourage it to behave more innovatively, the sector of domestic SMEs could grow into the most efficient segment of Serbian economy, and become a bearer of innovations, growth and employment. It is also necessary to encourage further the economic environment for the development of innovations, patents and entrepreneurship as a basic prerequisite for sustainable economic growth and change of economic structure towards more technologically advanced sectors, products and services. The results of the analysis unequivocally indicate the fact that Serbia is facing a kind of innovation paradox, because with the growth of investments in R&D activities, there is a decline in the number of patent applications. On the other hand, scientific research is inefficient and ineffective because it draws funds from GDP, but fails in expectations and tangible results, especially when it comes to patents. In addition, the technological development projects and integrated interdisciplinary research programs also do not give sufficient and expected results. Therefore, when designing the appropriate macroeconomic environment, domestic policy makers should always keep in mind that the purpose of directing and the way of spending funds for R&D activities are far more important than the determined amounts and the growth of R&D expenditures.

Conflict of interests

The author declare there is no conflict of interest.

REFERENCES

Blach, J. (2011). Financial innovations and their role in the modern financial system-identification and systematization of the problem. *e-Finanse: Financial Internet Quarterly*, *7*(3), 13-26.

Block, T. H. (2002). *Financial Systems, Innovation and Economic Performance*. Maastricht, Netherlands: MERIT and International Institute of Infonomics.

Borojević, K. (2006). Knowledge based innovations in modern entrepreneurship. *Acta Economica, 4*(4), 221-246. Retrieved from: http://www.ae.ef.unibl.org/index.php/ae/article/view/285

Deutsche Zusammenarbeit, Swiss Agency for Development and Cooperation SDC, & Deutsche Gesellschaft für Internationale Zusammenarbeit. (2020). *Srbija 2030 Razvojni prioriteti: Izveštaj nedržavnog sektora*. Belgrade, Serbia: Deutsche Zusammenarbeit, SDC, & GIZ.

Digital Community. (2021). *Poreski podsticaji za novoosnovana inovaciona privredna društva*, Belgrade, Serbia: DC. Retrieved from: https://www.digitalnazajednica.

org/2021/07/01/poreske-olaksice-za-novoosnovana-inovaciona-privredna-drustva/

Dutta, S., Lanvin, B., & Wunsch-Vincent, S. (2020). *Global Innovation Index 2020: Who Will Finance Innovation?*. 13th ed. Cornell SC Johnson College of Business, Geneva, Switzerland: INSEAD & WIPO. Retrieved from: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020.pdf

European Central Bank. (2017). *How does innovation lead to growth?* Frankfurt, Germany: ECB. Retrieved from: https://www.ecb.europa.eu/explainers/tell-me-more/html/growth.en.html

Eurostat. (2022a). *GDP and main components*. Retrieved from: https://ec.europa.eu/eurostat/databrowser/view/NAMA_10_GDP__custom_1844550/default/table?lang=en

Eurostat. (2022b). *Patent applications to the European Patent Office (source: EPO)*. Retrieved from: https://ec.europa.eu/eurostat/cache/metadata/en/sdg_09_40_esmsip2.htm

Eurostat. (2022c). *Research and development (R&D)*. Retrieved from: https://ec.europa.eu/eurostat/cache/metadata/en/rd_esms.htm

Fagerberg, J., Verspagen, B., & Srholec, M. (2010). Innovation and Economic Development. In: Hall. B., & Rosenberg. N. (eds.), *Handbook of the Economics of Innovation*. Amsterdam: North Holland, 1-62. Retrieved from: https://www.researchgate.net/publication/266265812_Innovation_and_Economic_Development

Galindo, M. A., & Méndez, M. T. (2014). Entrepreneurship, economic growth, and innovation: Are feedback effects at work? *Journal of Business Research*, *67*(5), 825-829. DOI: 10.1016/j.jbusres.2013.11.052

Granger, C. W. J. (1980). Testing for causality: A personal viewpoint. *Journal of Economic Dynamics and Control*, *2*, 329–352. DOI:10.1016%2F0165-1889%2880%2990069-X

Fayomi, O. S. I., Adelakun, J. O., & Babaremu, K. O. (2019). The Impact of Technological Innovation on Production. *Journal of Physics: Conference Series*, 1378 022014, 1-9. DOI:10.1088/1742-6596/1378/2/022014

Hashi, I., & Stojičić, N. (2013). Knowledge Spillovers, Innovation Activities, and Competitiveness of Industries in EU Member and Candidate Countries. *Economic Annals*, *58*(198), 7-34. DOI: 10.2298/EKA1398007H

Jarque, C. M., & Bera, A. K. (1987). A test for normality of observations and regression residuals. *International Statistical Review*, *55*(2), 163–172.

Jovičić, Ž. (2009). Investing into Scientific Research and Economic Growth. *Acta Economica*, *7*(10), 355-371. Retrieved from: http://www.ae.ef.unibl.org/index.php/ae/article/view/239/239

Kutlača, Đ., Stefanović Šestić, S., Jelić. S., & Popović Pantić, S. (2020). The Impact of investment in Research and Development on the Economic Growth in Serbia. *Industrija*, *48*(1), 23-46. DOI: 10.5937/industrija48-24949

Maradana, R. P., Pradhan, R. P., Dash, S., Gaurav, K., Jayakumar, M., & Chatterjee, D. (2017). Does innovation promote economic growth? Evidence from European

countries. *Journal of Innovation and Entrepreneurship*, *1*(2017), January 10. DOI: 10.1186/s13731-016-0061-9

Maradana, R. P., Pradhan, R. P., Dash, S., Zaki, D. B., Gaurav, K., Jayakumar, M., & Sarangi, A. K. (2019). Innovation and economic growth in European Economic Area countries: The Granger causality approach. *IIMB Management Review*, *31*(3), 268-282. DOI: 10.1016/j.iimb.2019.03.002

Milutinović, J. (2016). Inovatorima u Srbiji neisplativa registracija patenata. *Al Jazeera*, November 28, 2016. Retrieved from: https://balkans.aljazeera.net/news/balkan/2016/11/28/inovatorima-u-srbiji-neisplativa-registracija-patenata

Mitrović, V., & Mitrović, I. (2020). Politika inovacija poslovnih subjekata u industriji kao faktor održivog razvoja u tranzicionom okruženju. *Ekonomski signali*, *15*(2), 31-47. DOI: 10.5937/ekonsig2002031M

National Alliance for Local Development. (2021). *Analiza stanja inovacija i procesa digitalne transformacije u Republici Srbiji.* Belgrade, Serbia: Philip Morris Operations AD Niš, The Government of the Republic of Serbia & NALED.

National Council for Scientific and Technological Development. (2020). Izveštaj o stanju u nauci u 2019. godini, sa predlozima i sugestijama za narednu godinu. Belgrade, Serbia: NCSTD.

Organization for Economic Co-operation and Development. (2007). *Innovation and Growth: Rationale for an Innovation Strategy*. Paris, France: OECD.

Organization for Economic Co-operation and Development. (2015). *Frascati Manual: Guidelines for Collecting and Reporting Data on Research and Experimental Development*. Paris, France: OECD.

Pece, A. M., Oros, S. O. E., & Salisteanu, F. (2015). Innovation and economic growth: An empirical analysis for CEE countries. *Procedia Economics and Finance*, *26* (2015), 461-467. DOI: 10.1016/S2212-5671(15)00874-6

Rosenberg, N. (2004). Innovation and Economic Growth. Paris, France: OECD. Retrieved from: https://www.oecd.org/industry/tourism/34267902.pdf

Schumpeter, J. A. (1934). *The Theory of Economic Development – An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle*. New Brunswick & London, UK: Transaction Publishers.

Schumpeter, J. A. (1943). *Capitalism, Socialism and Democracy*. 1st ed. London, UK & New York, US: Routledge.

Shrestha, M. B., & Bhatta, G. R. (2018). Selecting appropriate methodological framework for time series data analysis. *The Journal of Finance and Data Science*, *4*(2018), 71-89. DOI: 10.1016/j.jfds.2017.11.001

Solow, R. M. (1957). Technical Change and the Aggregate Production Function. *The Review of Economics and Statistics*, *39*(3), 312-320.

Statistical Office of the Republic of Serbia. (2021). Indikatori inovativnih aktivnosti, 2018-2020. Belgrade, Serbia: SORS. Retrieved from: https://www.stat.gov.rs/sr-latn/vesti/20211203-indikatori-inovativnih-aktivnosti-2018-2020/

Tabachnick, B. G., & Fidell, L. S. (2013). *Using Multivariate Statistics*. 6th ed., Boston, US: Pearson.

The World Bank. (2010). Innovation Policy: A Guide for Developing Countries. Washington, D.C., US: The World Bank.

The World Bank. (2022). *Research and Development Expediture (% of GDP) – Serbia*. Retrieved from: https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?locations=RS

World Intellectual Property Organization. (2022). *Statistical Country Profiles: Serbia*. Retrieved from: https://www.wipo.int/ipstats/en/statistics/country_profile/profile.jsp?code=RS

ИНОВАТИВНИ ПАРАДОКС У ПРИВРЕДИ СРБИЈЕ: ПРИСТУП ГРЕЈНЏЕРОВЕ УЗРОЧНОСТИ

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САЖЕТАК

Иновације, као примјена нових идеја, рјешења и технолошких пракси које унапређују робу, услуге и пословне процесе, представљају најважнији покретач привредног напретка сваке земље. Оне доприносе економском расту својим утицајем на раст продуктивности, а самим тим и на повећање производње, профита, конкурентности, животног стандарда и квалитета живота, доносећи користи друштву у цјелини. Циљ овог чланка јесте да утврди стање иновационих активности у Републици Србији (РС), као и да испита међусобни однос између иновација и привредног раста са аспекта Грејнџерове каузалности. Другим ријечима: овај чланак намјерава да утврди да ли иновације у Грејнџеровом смислу изазивају привредни раст у Србији, као и да ли сам привредни раст има реципрочан утицај на стање и трендове иновативних активности у земљи. У првом дијелу анализе примијењен је модел стандардне вишеструке линеарне регресије како би се испитао утицај броја патентних пријава и бруто домаћих расхода за истраживање и развој (ГЕРД) на бруто домаћи производ (БДП) Србије у периоду од 2004. до 2020. године. Док је ГЕРД показао статистички значајан допринос тренду БДП-а земље, то се не може рећи и за укупан број патентних пријава које су у посматраном периоду драстично опале за чак 86,6%. Дакле, Србија се суочава са својеврсним иновационим парадоксом, јер са растом издвајања за истраживање и развој (ИР) опада број патентних пријава. Ово се, између осталог, јавља као посљедица недовољно подстицајног амбијента за развој иновација, огромног прилива страних директних инвестиција (СДИ) које са собом носе готова технолошка рјешења, прилично скупих процедура за њихову примјену и одржавање, као и великог броја тржишно

невалоризованих патената домаћих иноватора. Други дио истраживања се заснива на изградњи одговарајућег векторског ауторегресионог – VAR(1) модела који прати узрочну везу између ГЕРД-а и привредног раста Србије у периоду од 1997. до 2020. године, као и на примјени Грејнџеровог теста каузалности на подацима о привредном расту и ГЕРД-у Србије. Из анализе произилази да док ГЕРД не узрокује БДП у Грејнџеровом смислу, сам БДП узрокује ГЕРД. Закључује се да научно-истраживачки рад у земљи није довољно ефикасан и дјелотворан јер црпи средства из БДП-а, док не испуњава очекивања и не даје опипљиве резултате, а посебно не у очекиваном броју пријављених патената. Осим тога, пројекти технолошког развоја и интердисциплинарни истраживачки програми такође не дају довољан и очекиван допринос. Стога је неопходно градити повољније макроекономско окружење и континуирано повећавати улагања у истраживање и развој, савремену технологију и иновације као најважније покретаче убрзаног раста, технолошких промјена и софистицираности производа и услуга.

Кључне ријечи: *Србија, иновације, патентне пријаве, бруто домаћи производ (БДП), бруто издвајања за истраживање и развој (ГЕРД), векторски ауторегресиони (VAR) модел, Грејнџеров тест узрочности, иновативни парадокс, пословно окружење.*