ORIGINAL SCIENTIFIC PAPER

INNOVATION AS A DETERMINANT OF ECONOMIC GROWTH: AN EMPIRICAL STUDY OF SERBIA

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ABSTRACT

The aim of this paper to analyze the potential influence and correlation between innovation parameters and economic growth in Serbia from 2012 to 2021. This study aims to analyzing the potential influence and correlation between innovation parameters and economic growth in Serbia from 2012 to 2021. By using multiple linear regressions (MLR), it is determined to which extent the number of patents per million inhabitants and the percentage of internet use affect GDP per capita. The MLR results reveal a statistically significant positive predictive correlation between the percentage of internet use and the value of GDP per capita. On the other hand, the number of patents per million inhabitants has a minimal impact on the analyzed parameter of economic growth in Serbia during the studied period. Considering the positive impact of the percentage of internet use and the number of patents per million inhabitants on Serbia's economy, the research findings suggest that attention should be given to policy strategies that promote innovation in order to promote economic growth.

***Keywords**: Patents, Internet, innovation, economic growth*

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INTRODUCTION

The subject of analysis by many authors was innovations and their impact on economic development [1][2][3][4][5][6][7][8][9][10], which shows the importance of their role in today's business.Economic growth processes attributed to the increase in national production dominate state policies worldwide. The outcomes of economic growth encompass various social changes, ranging from increased well-being, higher consumption, savings, and investments to the emergence of new products. Technological innovations play a crucial role as a driving force behind the economic growth of every country. Innovation is a complex process that involves improving production and business capacities, creating new jobs, transferring technology and knowledge, all leading to enhanced country competitiveness in the global market [11]. Given the direct interaction between technological development and other elements of innovation, the increasing crises in recent years (financial crisis, sovereign debt crisis, migration crisis, COVID-19 pandemic, and the war in Ukraine) necessitate the sustainability of innovations [12], [13]. In such conditions, innovation processes become increasingly complex at both the national and regional levels.

As a result, the correlation between innovation and economic growth has been the focus of numerous researchers. While the connection between innovation and economic growth is undisputed yet complex, some authors have identified a positive connection in their studies [14], [15]. Conversely, other authors have identified a negative correlation. Studies by [16] claim that there is no long-term relationship between patents and economic growth.

Building upon the findings of previous research [17], [18], this paper aims to examine the correlation between innovation parameters and economic growth in Serbia. The motivation for this research stems from the fact that innovations are rapidly adopted and will undoubtedly be a key factor in increasing the rate of economic growth in the coming years, both in developed economies and in developing and transitioning countries.

RESEARCH METHODOLOGY

SAMPLE CONSTRUCTION

The empirical model that will be presented in this paper will analyze the impact of number of patents per million inhabitants and individuals using the Internet (% of population) (IUI) on Serbia's economic growth from 2012 to 2021. This research uses secondary data collected from the World Intellectual Property Organization (2022) and World Bank (2022) (Table1). In this paper, economic growth is a dependent variable on which the independent variables have significance or less importance of influence and is followed through GDP per capita. For more concrete results, the impact on the dependent variable GDP per capita is viewed through the following independent variables:

1. number of patents per million inhabitants and
2. IUI - individuals using the Internet (% of population).

Reviewing the empirical results of research in this area and gathering the necessary data were created to be used to define the research model. The paper analyzes statistical data using the SPSS 19.0 software package.

Table 1. Number of patents, individuals using the Internet, GDP per capita

Variable/Year	Total patents	Total population	Number of patents*	IUI** (%)	GDP ***
2012	234	7.199.077	32.50	48	5.344
2013	333	7.164.132	46.48	53	5.525
2014	289	7.130.576	40.53	62	5.463
2015	248	7.095.383	34.95	65	5.589
2016	279	7.058.322	39.53	67	5.806
2017	296	7.020.858	42.16	70	5.960
2018	309	6.982.604	44.25	73	6.262
2019	290	6.975.761	41.57	77	6.568
2020	236	6.899.126	34.21	78	6.552
2021	271	6.834.326	39.65	81	7.114

Source: [19], [20], [21]
Notes: *authors calculated number of patents per million inhabitants; IUI** = individuals using the Internet (% of population); ***GDP per capita

MODEL SPECIFICATION

This model consists of three variables: two independent and one dependent ie. Number of patents per million inhabitants and individuals using the Internet (% of population) (IUI) and GDP per capita. To determine the relationship between number of patents per million inhabitants and individuals using the Internet (% of population) and economic growth (GDP per capita) in Serbia, in the research was applied linear multiple regression. Accordingly, functional relationships between variables can be expressed as:

$$GDP\ per\ capita = f(Number\ of\ patents\ per\ million\ inhabitants, IUI) \quad (1)$$

The model used in the paper includes the following [22]:

$$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \varepsilon \quad (2)$$

Where: Y = GDP - Gross domestic product per capita (dependent variable),

X1 = Number of patents per million inhabitants (independent variable),

X2 = IUI - Individuals using the Internet (% of population) (independent variable),

b = the coefficients of the independent variables,

a = the error term of the model

Therefore, the regression equation in the paper can be represented by the following expression:

$$Y = \beta 0 + \beta 1Number\ of\ patents\ per\ million\ inhabitants + \beta 2IUI + \varepsilon) \quad (3)$$

The coefficients β1, β2, β3 show how much changes in the value of number of patents per million inhabitants and individuals using the Internet (% of population) (IUI) are made on the variable GDP per capita in the context of Serbia. The paper used a descriptive research design.

RESULTS AND DISCUSSIONS

CORRELATION ANALYSIS

Table 2, shows the matrix of correlation which summarizes the correlations between all variables.

Table 2. The results of Correlation

		Number of patents per million inhabitants	Individuals using the Internet (% of population)	GDP per capita
Number of patents per million inhabitants	Pearson Correlation	1	0,092	0,090
	Sig. (2-tailed)		0,801	0,804
	N	10	10	10
Individuals using the Internet (% of population)	Pearson Correlation	0,092	1	0,904**
	Sig. (2-tailed)	0,801		0,000
	N	10	10	10
GDP per capita	Pearson Correlation	0,090	0,904**	1
	Sig. (2-tailed)	0,804	0,000	
	N	10	10	10

**. Correlation is significant at the 0.01 level (2-tailed).
Source: Authors calculations

Based on the correlation matrix it can be seen that we have a positive correlation between the number of patents per million inhabitants and individuals using the Internet (% of population) (IUI) and GDP per capita in Serbia. As can be seen in Table 2, according to the parameters of the correlation coefficient, number of patents per million inhabitants and individuals using the Internet (% of population) have a positive image concerning the GDP per capita. The positive sign indicates that with the growth of number of patents per million inhabitants and individuals using the Internet (% of population) the value of GDP per capita increases and vice versa. The values of the correlation coefficients in the same table indicate that there is a linear relationship between the number of patents per million inhabitants and individuals using the Internet (% of population) have a positive image concerning the GDP per capita at the significance level of 0.01. The values of the correlation coefficients in the same table show a strong positive correlation (correlation coefficient > 0.5) between the % of internet usage and GDP per capita.

ECONOMETRIC MODEL

To assess how the variables will affect the GDP per capita, we have adapted the model developed by the authors [23] but adjusted to the circumstances in Serbia. A linear multiple regression model was applied to examine the statistical associations of two independent and one dependent variable, at a significance level of $\alpha = 0.05$ and a 95% confidence interval. Based on the results presented in Table 2 the relationship between number of patents per million inhabitants and individuals using the Internet (% of population) (IUI) and GDP per capita can be described in the following linear formulation:

$$LnGDP\ per\ capita = \alpha + 0{,}090 number\ of\ patents\ per\ million\ inhabitants + 0{,}904 IUIt + \varepsilon \quad (4)$$

In Table 3 presented below is summarized a linear regression model where are shown the adjusted R, R square, Adjusted R square, Std. The error of the estimate and the Durbin-Watson test.

Table 3. Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0,904[a]	0,817	0,764	0,284419	0,838

a. Predictors: (Constant), Number of patents per million inhabitants, Individuals using the Internet (% of population)
b. Dependent Variable: GDP per capita
Source: Authors calculations

The value of the correction coefficient r 0.904 (90.4%) in Table 3 shows that there is a real positive relationship between number of patents per million inhabitants and individuals using the Internet (% of population) (IUI) and GDP per capita. The coefficients of determination (R squared) of 0.817 mean number of patents per million inhabitants and individuals using the Internet (% of population) (IUI), explain 81.70% of the variation in economic growth (GDP per capita) of Serbia, while the other 18,30% of the variation is influenced by other factors. This also confirms the real positive relationships between the analyzed variables. To verify the reliability of the model, serial correlation is used in the analysis. The Durbin-Watson test correlation value may be in the range 0 to 4. Therefore, based on this interval, the findings in the study indicate that Durbin-Watson is of value 0,838, which is within the value interval.

Table 4. The results of linear regression ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2,520	2	1,260	15,575	0,003[b]
	Residual	0,566	7	0,081		
	Total	3,086	9			

a. Dependent Variable: GDP per capita
b. Predictors: (Constant), Number of patents per million inhabitants, Individuals using the Internet (% of population)
Source: Authors Calculations

The p value of the test statistic Sig. = 0.003 in Table 4 means that p <0.0005. According to this model, the model is important for predicting the impact of number of patents per million inhabitants and individuals using the Internet (% of population) (IUI) on economic growth (GDP per capita) in Serbia.

From Table 5, individuals using the Internet (% of population) is an important indicator of correlations between dependent and independent variables (Student's mark t = 5,553). In terms of number of patents per million inhabitants, Student's Compensation Value t = 0,045 is an indicator of the positive impact, but of lesser contribution of GDP per capita.

Table 5. Linear regression Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2,676	0,988		2,709	0,030
	Number of patents per million inhabitants	0,001	0,021	0,007	0,045	0,965
	Individuals using the Internet (% of population)	0,049	0,009	0,903	5,553	0,001

a. Dependent Variable: GDP per capita
Source: Authosr calculations

As can be seen in Table 5 there is a significant effect of individuals using the Internet (% of population) on GDP per capita with a coefficient of 0.903 (p value of 0.001 <0.005). The effect of number of patents per million inhabitants on economic growth (GDP per capita) is not significant because the p value is 0.965 (p value<0.005) and a coefficient of 0.007.The multiple regression findings in Table 5, based on equals 2, yield a model that functionally depends on number of patents per million inhabitants, individuals using the Internet (% of population) and GDP per capita of Serbia in the following ways:

$$Y = 2{,}676 + 0{,}001X1 + 0{,}049X2 \quad (5)$$

Assuming that all other factors that are used to increase GDP per capita remain constant and with a growth rate of 95% according to this model, we conclude that only the percentage increase in Internet use in Serbia contributes to the increase.

The results of the study are consistent with research [24] claimed, based on data from 1872 to 1913, that there is no long-term connection between the number of patents and economic growth in Germany. Similarly [25], investigated whether an increase in the number of registered patents per million inhabitants, as a measure of market verification of R&D activities, affects economic growth and the innovation index in a country. The empirical research results showed no correlation, indicating that in the cases of Romania and Bulgaria, there is no dependence between the increase in the number of registered patents per million inhabitants and the growth of the innovation index and GDP per capita. The study also highlighted the main problems in Romania, such as the time required to obtain a patent, high costs, and underdeveloped markets for trading patented products.

CONCLUSION

In this study, the research results provided evidence of a positive correlation between innovation indicators and economic growth, with the percentage of Internet usage making a greater contribution to GDP per capita. In accordance with the above, in order to promote the link between the number of patents and GDP per capita, the obtained results suggest the necessity of creating a stable environment. Therefore, the research findings can be useful in shaping appropriate future policies and strategies for innovation development in Serbia, aiming for economic growth and development.

Despite its contribution, the conducted research has limitations. The first limitation is the inclusion of three independent variables in the model. Future studies could consider other relevant factors, such as production and employment growth, increased number of patents, and unemployment rate. The second limitation is the short time dimension of the data (2012-2021). The research methodology is also a limitation of this study. Future studies could apply other approaches, such as ARCH and GARCH models. These limitations do not diminish the significance of the research findings, which expand the existing literature and provide ideas for future research on the connection between innovation indicators and economic growth.

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