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THE IMPACT OF HIGH-TECH PRODUCTS EXPORTS ON ECONOMIC GROWTH: THE CASE OF SERBIA, BULGARIA, ROMANIA AND HUNGARY

Uticaj izvoza visokotehnoških proizvoda na ekonomski
rast – primer Srbije, Bugarske, Rumunije i Mađarske

Abstract

Innovative capacity represents the ability of long-term production and commercialization of the flow of innovative technologies and is an essential factor influencing competitiveness in modern economies. When it comes to innovation, research and development, gross domestic product (GDP) is often used as an indicator of investment opportunities at the national level to gain insight into the country's ability to improve innovation and competitiveness. Accordingly, this paper aims to determine whether the export of high-tech products, as one of the results of innovation in the economy, measured by GDP growth, has a positive effect on overall economic growth. For the analysis process to have a comparative character, four countries were included in the empirical research: Serbia, Bulgaria, Hungary and Romania. The international Eurostat database was used as the main source of data, and the period covered by this survey is from 2008 to 2018. A simple linear regression model was applied in the analysis to determine the relationship between the share of high-tech products in the country's total exports and GDP per capita. The research results in this paper show that it was not possible to confirm the positive relationship between exports of high-tech products and GDP growth in the case of Serbia, Hungary and Romania, while in the case of Bulgaria, the impact of growth in exports of high-tech products on GDP growth can be confirmed. According to the obtained results, it is most adequate that the issue of innovation, exports and economic growth is not observed exclusively through the development and application of innovations in high-tech industries. We need to look at the broader context in terms of how much innovation can improve exports and the overall business of medium and technologically inferior (less demanding) industries, what innovations these industries need, and how to develop and implement them.

Keywords: *high-tech product, export, innovation, economic growth, gross domestic product.*

Sažetak

Inovativni kapacitet predstavlja sposobnost dugoročne proizvodnje i komercijalizacije protoka inovativnih tehnologija i čini suštinski faktor koji utiče na konkurentnost u modernim ekonomijama. Kada su inovacije, istraživanja i razvoj u pitanju, bruto domaći proizvod (BDP) se veoma često koristi kao pokazatelj mogućnosti za ulaganja na nacionalnom nivou, a zarad sticanja uvida u mogućnosti unapređenja inovativnosti i konkurentnosti jedne zemlje. Shodno tome, cilj ovog rada je da se utvrdi da li izvoz visokotehnoških proizvoda, kao jedan od rezultata primene inovacije u privredi, pozitivno utiče na ukupan privredni rast meren rastom BDP. Da bi sam proces analize imao komparativan karakter u empirijsko istraživanje su bile uključene četiri zemlje: Srbija, Bugarska, Mađarska i Rumunija. Kao glavni izvor podataka korišćena je međunarodna baza podataka Eurostat, a vremenski period obuhvaćen ovim istraživanjem je od 2008. do 2018. godine. Kako bi se utvrdila veza između udela visokotehnoških proizvoda u ukupnom izvozu zemlje i BDP po glavi stanovnika, u analizi je primenjen model jednostavne linearne regresije. Rezultati istraživanja u ovom radu pokazuju da nije bilo moguće potvrditi pozitivan odnos izvoza visokotehnoških proizvoda i rasta BDP u slučaju Srbije, Mađarske i Rumunije, dok je u slučaju Bugarske potvrđen uticaj rasta izvoza visokotehnoških proizvoda na rasta BDP. Imajući u vidu ove dobijene rezultate, najadekvatnije je da se pitanje inovativnosti, izvoza i privrednog rasta ne treba posmatrati isključivo preko razvoja i primene inovacija u visokotehnoškim industrijama, već treba sagledati širi kontekst u smislu koliko inovacije mogu unaprediti ne samo izvoz, već i ukupno poslovanje srednjih i tehnološki nižih (manje zahtevnih) industrija, kakve inovacije su potrebne tim industrijama, kako ih razvijati i primenjivati.

Ključne reči: *visokotehnoški proizvod, izvoz, inovacije, privredni rast, bruto domaći proizvod.*

Introduction

Innovation policy is becoming a pre-eminent component of economic development management in most, especially in the world's leading economies. The concept of the national innovation system has a special place in the innovation policy of each country, and its constitution is in direct connection with the increase of innovation capacity at the national level. A quality institutional environment is essential in situations where there is a need for direct state intervention in the economy. Competitiveness and economic growth are affected by the efficiency of institutions and the quality of institutional infrastructure [27]. Competition between companies, as well as national economies, is intensifying day by day. One of the ways to ensure growth and development, in changing and dynamic conditions, is undoubtedly the development of innovation skills, i.e. the ability to generate innovations.

Technological change and innovation are some of the main drivers of economic growth in most countries. The most commonly used indicator of economic growth is GDP. Economic growth mainly encourages overall social development and leads to numerous changes in society, from strengthening welfare, higher consumption, savings and investment, to the emergence of new products that are primarily the result of creating and applying new techniques and technologies.

Nowadays, it is possible to use various indicators to illustrate the environment of the national innovation system and consider its features and evaluate the results in practice. Therefore, research often pays attention to the effects of innovation activities by exporting high-tech products. On the one hand, it is possible to directly investigate the export of high-tech products within the analysis of national innovation systems. On the other hand, to indirectly analyze the results of knowledge and technology and innovative products and services.

Literature review

The impact of innovation on creating competitive advantage is based on companies' ability to apply innovation to meet current market needs through new ideas and knowledge

stably and sustainably better than the competition by creating new value [11]. According to the evolutionary approach, companies invest in innovation to acquire new resources and explore the possibilities of their responses to the demands of the environment. Companies apply different strategies and react differently to changes in the environment, where economic activities include both the state of imbalance and dynamic change processes. At the same time, the results of the application of new technologies cannot be fully predicted [9].

In the modern era of the competitive market, globalization, and dramatic changes in industries, companies have begun searching for a unique strategy and innovative tactics that will provide them with a sustainable competitive advantage. One of the new models it offers is the business model of innovation, whose primary task is to act as the main driver for achieving competitiveness and top results [7], [2], [4]. Exports of high-tech products can contribute to greater competitiveness and improve the balance of payments of a country [8]. An economy needs to be as competitive as possible, which will significantly contribute to the growth of production and thus exports [12]. Innovation is a significant competitive advantage of any company, given its importance for economic growth, wealth creation, business expansion and technological progress [17], [22]. In addition, the link between innovation and competitive advantage is confirmed by the latest empirical research, which describes it as direct and positive, because the innovation capacity of companies can create, support and make sustainable competitiveness in both domestic and foreign markets [18], [3]. In their research, [13] analyzed the competitiveness of the Serbian economy and concluded that the share of exports in the formation of GDP was significantly reduced during the pandemic, which reflected on its competitiveness.

In a growing competitive environment, companies use their strategies to retain market share and increase profits. Only continuous learning ensures that companies adapt to changing market conditions and respond to competitive challenges in the most efficient way [29]. Companies make decisions about investing in technology based on expected profits, where profit is important not only for the evolution of technology, but also for economic

growth. In modern business conditions it can be generated through entrepreneurial initiative and innovation [35].

Comparing the results of national innovation systems is a very complex process [1], [31]. Indicators, such as the amount of allocation or the percentage of gross domestic product intended for research and development, as well as indicators of the results of innovation activities, such as patents, the share of high-tech products in exports and the share of new products in total production, are used for this purpose. Market demands and competition force companies to innovate and develop knowledge in a globalized IT world, change their behavior and innovation processes [20]. Higher exports of high-tech products (HTP) would increase the competitiveness of countries in the world market, and thus achieve higher economic growth and a higher standard of living. Adopting new technological knowledge and applying new technologies increase the company's profit. From a macroeconomic point of view, this means that technology and innovation increase gross domestic product and encourage innovation [30]. From the perspective of the national innovation system, as an approach to the study of innovation, the ability to achieve technological and economic progress depends on the power of countries to organize innovation activities in the broadest economic scope at the national level.

Many studies have observed innovation and correlation of innovation in the manufacturing industry from several aspects, such as factors of influence, transformation and improvement of the manufacturing industry, national innovation system, and innovation's impact on economic development [26]. For the success of the desired innovative products, only the mass production of HTP enables profit in fierce competition. For the production of HTP, it is necessary to have quality technology, employees and resources. Based on the conducted research [28], concluded that there is a significant impact of GDP on the export of high-tech products.

Research methodology

The main goal - the hypothesis in this paper, is to determine whether the export of high-tech products, as one of the results of applying innovations in the economy,

affects economic growth measured by GDP growth. The quantitative research design was applied in the study, as it examines the relationships between variables, measured on an interval or measurement scale, using statistical methods, techniques and tests in data analysis, based on measurements, causal relationships and attempts to come to general conclusions [6], [33]. The features of the quantitative design of the research corresponded to the empirical research in this paper, because the intention was to accurately measure the researched phenomena and discover the connections between them. The studied phenomena and their connections within the quantitative design are analyzed in detail. At the same time, the comparative approach was chosen because it emphasizes that social and economic phenomena can be better understood only if we compare them in several different cases. Therefore, in addition to Serbia, the empirical research includes three neighboring EU member states - Romania, Hungary and Bulgaria.

The period covered by this research was from 2008 to 2018. The internationally recognized Eurostat database was used as the main secondary data source. The reason for choosing this database is the availability of data to be used in the research, the quality and representativeness of the data, and the comparability of data for several different countries. The variables listed in Table 1 were extracted from Eurostat international statistical databases, by the hypothesis for empirical research.

Table 1: Variables included in the research, their types and sources

Independent variable	Dependent variable	Source
Share of exports of high-tech products in total exports of the country	Economic growth measured by GDP per capita	Eurostat

A simple linear regression was used to statistically test the relationship between the share of high-tech products in the country's total resources and GDP per capita. This statistical technique was chosen because it is suitable for detailed research, modeling, describing and evaluating the relationship between two variables [10]. Before performing a simple linear regression, it is necessary to check the fulfillment of several assumptions on which this

statistical technique is based. These assumptions refer to: (1) the existence of two variables that have a continuous nature and are measured on an interval or ratio scale; (2) the existence of a linear relationship between variables; (3) absence of atypical points; (4) the existence of independence observations; (5) the absence of heteroskedasticity, i.e., the variance of random errors should not differ by observations; and (6) the normal distribution of residual errors [37], [23]. The first assumption about the nature of variables was tested by insight into the measurement scales on which they were measured. To test the assumption of a linear relationship between variables and the absence of atypical points, the construction of a distribution diagram was used [37]. The fulfillment of the fourth assumption regarding the independence of observations was checked by calculating the Durbin-Watson statistics according to the formula:

$$d = \frac{\sum_{i=2}^n x(e_i - e_{i-1})^2}{\sum_{i=2}^n x e_i^2} \quad (1)$$

where:

$e_i = y_i - \hat{y}_i$ residuals

n = number of elements in the set.

The values of the Durbin-Watson statistic indicator d between 1.5 and 2.5 indicate that the assumption of the independence of the observations is fulfilled [15]. The fifth and sixth assumptions of simple linear regression, the absence of heteroskedasticity, and the normal distribution of residual errors were verified by constructing histograms and Normal P-P Plot [21]. Data on the magnitude of the

obtained correlation and determination coefficients in the regression model were evaluated according to Cohen's criteria [14].

Research results

The main task in this paper was to check the existence of a positive impact of the growth of exports of high-tech products on economic growth. Exports of high-tech products were expressed as a percentage, as the share of exports of high-tech products in total exports of the country. At the same time, economic growth was measured by gross domestic product (GDP) per capita and was expressed in euros. Data on the share of exports of high-tech products and GDP per capita in the cases of Serbia, Bulgaria, Hungary and Romania are shown in Table 2.

1. *The ratio of the share of exports of high-tech products in total exports and GDP per capita in the case of Serbia*

Before conducting a simple linear regression analysis in the case of Serbia, the assumptions on which it is based were tested. The results of this check are shown in Table 3.

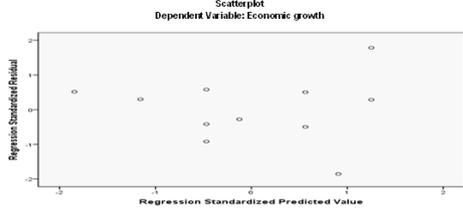
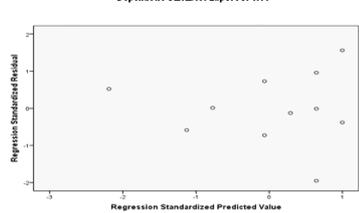
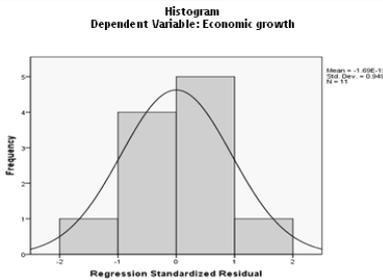
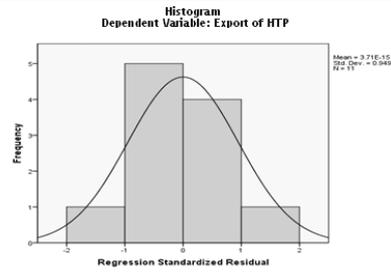
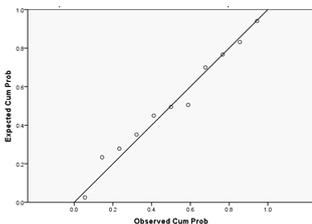
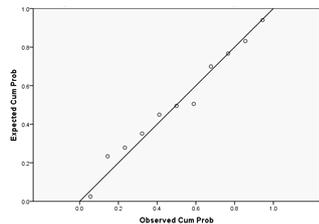
The first assumption, which referred to the continuous nature of variables, was fulfilled. The independent variable share of high-tech products in total exports and the dependent variable GDP per capita were metric variables measured on a ratio scale. The second and third assumptions, which referred to a linear correlation between variables and the absence of atypical points, were not met.

Table 2: Data on the share of exports of high-tech products and GDP per capita in the cases of Serbia, Bulgaria, Hungary and Romania

Country	Serbia		Bulgaria		Hungary		Romania	
Year/data	% HTP exports	GDP	% HTP exports	GDP	% HTP exports	GDP	% HTP exports	GDP
2008.	2,4	4.400	3,6	5.100	20,2	10.500	5,4	6.730
2009.	2,8	4.300	4,4	5.000	22,2	9.810	8,2	6.410
2010.	2,4	4.300	4,1	5.100	21,8	9.900	9,8	6.190
2011.	2,0	4.400	3,7	5.300	20,9	10.110	8,8	6.350
2012.	2,6	4.400	3,8	5.300	17,3	10.010	6,3	6.510
2013.	2,1	4.600	4,0	5.400	16,3	10.230	5,6	6.760
2014.	2,3	4.500	3,9	5.500	14,5	10.690	6,4	7.020
2015.	2,4	4.600	4,4	5.700	15,4	11.130	7,3	7.330
2016.	2,1	4.800	5,1	6.000	15,9	11.410	8,3	7.720
2017.	1,9	4.900	5,4	6.300	16,0	11.930	7,9	8.320
2018.	1,9	5.200	5,9	6.500	15,6	12.560	8,4	8.700

Source: Eurostat (2019), available at: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=htec_si_exp4&lang=en and https://ec.europa.eu/eurostat/web/products-datasets/-/sdg_08_10

Table 3: The results of testing the assumptions of simple linear regression in the case of Serbia

Variable / assumption	Share of exports of high-tech products in total exports (n = 11)	GDP per capita (n = 11)
The nature of the variable	Metrics	Metrics
Distribution diagram		
The value of the Durbin-Watson statistic indicator	d = 1,353	d = 2,579
Histogram		
P-P diagram of normality		

Source: author's research

The fourth assumption related to the independence of observations was not fulfilled, considering the obtained values of the Durbin-Watson coefficient of $d = 1.077$ and $d = 2.536$. The fifth and sixth assumptions about the absence of heteroskedasticity and the normal distribution of residual errors were, like histograms and Normal P-P Plot show, only partially fulfilled. Due to the violation of the assumptions of simple linear regression, data transformation was started. Data on the results of simple linear regression in the case of Serbia, conducted with logarithm-transformed variables, are shown in Table 4.

A correlation coefficient between the export of high-tech products and GDP per capita of $R = 0.760$ was determined, which can be considered large according to Cohen's criteria. The calculated coefficient of determination was $R^2 = 0.578$, and the corrected coefficient of determination was $\text{Adj. } R^2 = 0.531$. They showed that a total of 57.8%, or 53.1% of changes in the dependent variable GDP per

capita, can be explained by changes in the independent variable - the share of high-tech products in total exports.

As the data related to ANOVA showed, the given regression model was statistically significant at the level of $p < 0.050$, since the results of this test were $F(1,9) = 12.304$, $p = 0.007$. This result provides additional information on the ratio of independent and dependent variables included in the regression model. It suggests that exports of high-tech products give a statistically significant explanation for changes in GDP per capita.

By reviewing the regression coefficients, more details describing the relationship of the analyzed variables were obtained. The ordinary regression coefficient B was statistically significant at the level of $p < 0.050$ and amounted to $B = 3.786$ ($\text{SE } B = 0.036$), so the following regression equation can derive based on it:

$$\text{GDP per capita} = 3,786 - 0,3358 * (\% \text{ export of HTP, Serbia}) \quad (2)$$

Table 4: The results of simple linear regression in the case of Serbia

Model Summary ^b					
R	R Square	Adjusted R Square	SE of the Estimate		
0,760 ^a	0,578	0,531	0,01785		
a. Predictors: (Constant), Izvoz_Trans					
b. Dependent Variable: BDP_Trans					
ANOVA ^b					
	Sum of Squares	df	Mean Square	F	p
Regression	0,004	1	0,004	12,304	0,007 ^a
Residual	0,003	9	0,000		
Total	0,007	10			
a. Predictors: (Constant), Izvoz_Trans					
b. Dependent Variable: BDP_Trans					
Coefficients ^a					
	Unstandardized Coefficients		Standardized Coefficients	t	p
	B	Std. Error	Beta		
(Constant)	3,786	0,036		104,362	0,000
Izvoz_Trans	-0,358	0,102	-0,760	-3,508	0,007
a. Dependent Variable: BDP_Trans					

Source: author's research

This means that with each unit of increase in the share of high-tech products in the total exports of Serbia, GDP per capita changes according to the formula $3,786 - 0,3358 \cdot \text{exports of high-tech products}$. In addition, the standardized beta regression coefficient in this case is $\beta = -0.760$, and can be qualified as significant. The obtained negative value of the standardized regression coefficient β should be interpreted as a rule that each unit of increase of the predictor results in a decrease of the value of the dependent variable by the value of the calculated standardized regression coefficient β [34]. In this particular case, this means that with each unit of increasing the share of high-tech products in the total exports of Serbia, GDP per capita decreases by -0.760 . However, since the share of high-tech products in the total exports of Serbia decreased during the observed period, this means that each unit of this decrease was accompanied by GDP growth per capita of 0.760 .

2. *The ratio of the share of exports of high-tech products in total exports and GDP per capita in the case of Bulgaria*

Before conducting a simple linear regression analysis in the case of Bulgaria, the assumptions on which it is based were tested. The results of this check are shown in Table 5.

The first assumption, which referred to the continuous nature of variables, was fulfilled. The independent variable share of high-tech products in total exports and the dependent

variable GDP per capita were metric variables measured on a ratio scale. The second and third assumptions, which referred to a linear correlation between variables and the absence of atypical points, were not met. The fourth assumption related to the independence of observations was not fulfilled, considering the obtained values of the Durbin-Watson coefficient of $d = 1.267$ and $d = 1.448$. The fifth and sixth assumptions about the absence of heteroskedasticity and the normal distribution of residual errors were not met. Due to the violation of the assumptions of simple linear regression, data transformation was started. Data on the results of simple linear regression in the case of Bulgaria, conducted with logarithm-transformed variables, are shown in Table 6.

A correlation coefficient between the export of high-tech products and GDP per capita of $R = 0.685$ was determined, which can be considered large according to Cohen's criteria. The calculated coefficient of determination was $R^2 = 0.747$, and the corrected coefficient of determination was $\text{Adj. } R^2 = 0.719$. They showed that a total of 74.7%, or 71.9% of changes in the dependent variable GDP per capita, can be explained by changes in the independent variable - the share of high-tech products in total exports.

As the data related to ANOVA showed, the given regression model was statistically significant at the level of $p < 0.050$, since the results of this test were $F(1,9) = 26.629$, $p = 0.001$. This result provides additional information on

Table 5: The results of testing the assumptions of simple linear regression in the case of Bulgaria

Variable / assumption	Share of exports of high-tech products in total exports (n = 11)	GDP per capita (n = 11)
The nature of the variable	Metrics	Metrics
Distribution diagram		
The value of the Durbin-Watson statistic indicator	d = 1,267	d = 1,448
Histogram		
P-P diagram of normality		

Source: author's research

Table 6: The results of simple linear regression in the case of Bulgaria

Model Summary ^b					
R	R Square	Adjusted R Square	SE of the Estimate		
0,865 ^a	0,747	0,719	0,02033		
a. Predictors: (Constant), Izvoz_Trans b. Dependent Variable: BDP_Trans					
ANOVA ^b					
	Sum of Squares	df	Mean Square	F	p
Regression	0,011	1	0,011	26,629	0,001 ^a
Residual	0,004	9	0,000		
Total	0,015	10			
a. Predictors: (Constant), Izvoz_Trans b. Dependent Variable: BDP_Trans					
Coefficients ^a					
	Unstandardized Coefficients		Standardized Coefficients	t	p
	B	Std. Error	Beta		
(Constant)	3,446	0,058		59,470	0,000
Izvoz_Trans	0,467	0,090	0,865	5,160	0,001
a. Dependent Variable: BDP_Trans					

Source: author's research

the ratio of independent and dependent variables included in the regression model. It suggests that exports of high-tech products provide a statistically significant explanation for changes in GDP per capita.

By reviewing the regression coefficients, more details describing the relationship of the analyzed variables were obtained. The ordinary regression coefficient B was statistically significant at the level of $p < 0.050$ and amounted to $B = 3.446$ ($SE B = 0.058$), so the following regression equation can derive based on it:

$$\text{GDP per capita} = 3,446 + 0,467 * (\% \text{ export of HTP, Bulgaria}) \quad (3)$$

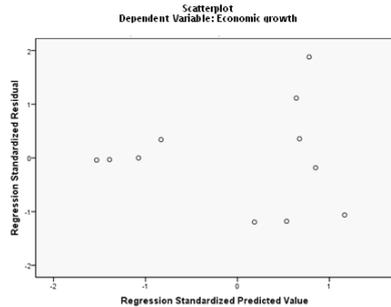
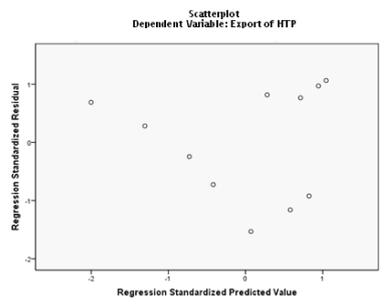
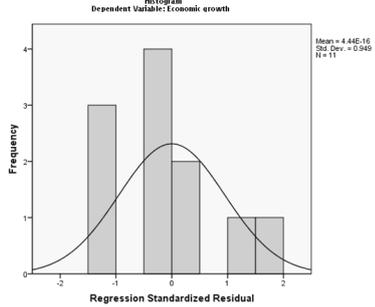
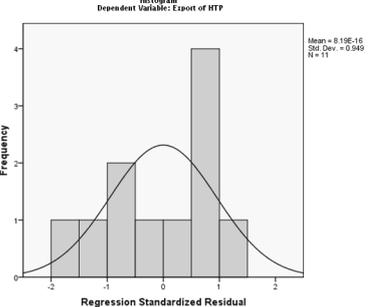
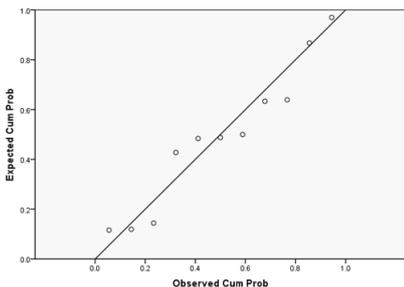
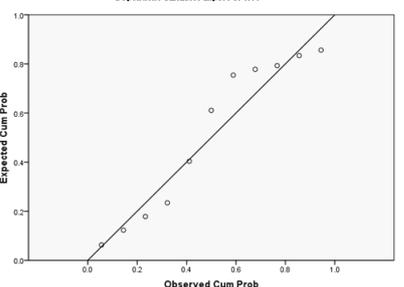
This means that with each unit of increase in the share of high-tech products in the total exports of Bulgaria,

GDP per capita changes according to the formula $33.446 + 0.467 * \text{exports of high-tech products}$. In addition, the standardized beta regression coefficient in this case is $\beta = 0.865$, and can be qualified as large. Its positive sign indicates that in the case of Bulgaria, there was an increase in the share of high-tech exports in total exports during the observed period. An increase followed her in GDP per capita.

3. *The ratio of the share of exports of high-tech products in total exports and GDP per capita in the case of Hungary*

Before conducting a simple linear regression analysis in the case of Hungary, the assumptions on which it is based were tested. The results of this check are shown in Table 7.

Table 7: The results of testing the assumptions of simple linear regression in the case of Hungary

Variable / assumption	Share of exports of high-tech products in total exports (n = 11)	GDP per capita (n = 11)
The nature of the variable	Metrics	Metrics
Distribution diagram		
The value of the Durbin-Watson statistic indicator	$d = 0,423$	$d = 0,497$
Histogram		
P-P diagram of normality		

Source: author's research

The first assumption, which referred to the continuous nature of variables, was fulfilled. The independent variable share of high-tech products in total exports and the dependent variable GDP per capita were metric variables measured on a ratio scale. The second and third assumptions, which referred to a linear correlation between variables and the absence of atypical points, were not met. The fourth assumption related to the independence of observations was not fulfilled, considering the obtained values of the Durbin-Watson coefficient of $d = 0.423$ and $d = 0.497$. The fifth and sixth assumptions about the absence of heteroskedasticity and the normal distribution of residual errors were partly met. Due to the violation of the assumptions of simple linear regression, data transformation was started. Data on the results of simple linear regression in the case of Hungary, conducted with logarithm-transformed variables, are shown in Table 8.

A correlation coefficient between the export of high-tech products and GDP per capita of $R = 0.673$ was determined, which can be considered large according to Cohen's criteria. The calculated coefficient of determination was $R^2 = 0.453$, and the corrected coefficient of determination was $Adj. R^2 = 0.392$. They showed that a total of 45.3%, or 39.2% of changes in the dependent variable GDP per capita, can be explained by changes in the independent variable - the share of high-tech products in total exports.

As the data related to ANOVA showed, the given regression model was statistically significant at the level of $p < 0.050$, since the results of this test were $F(1,9) = 7.461$, $p = 0.023$. This result provides additional information on the ratio of independent and dependent variables included in the regression model. It suggests that exports of high-tech products provide a statistically significant explanation for changes in GDP per capita.

By reviewing the regression coefficients, more details describing the relationship of the analyzed variables were obtained. The ordinary regression coefficient B was statistically significant at the level of $p < 0.050$ and amounted to $B = 3.446$ ($SE B = 0.058$), so the following regression equation can derive based on it:

$$\text{GDP per capita} = 4,469 - 0,352 * (\% \text{ export of HTP, Hungary}) \quad (4)$$

This means that with each unit of increase in the share of high-tech products in the total exports of Hungary, GDP per capita changes according to the formula $4.469 - 0.352 * \text{exports of high-tech products}$. In addition, the standardized beta regression coefficient in this case is $\beta = -0.673$, and can be qualified as large. As in the previous case of Serbia, its negative sign indicates that in the case of Hungary, the share of exports of high-tech products in total exports decreased, and this decrease was accompanied by an increase in GDP per capita, during the observed period.

Table 8: The results of simple linear regression in the case of Hungary

Model Summary ^b					
R	R Square	Adjusted R Square	SE of the Estimate		
0,673a	0,453	0,392	0,026766		
a. Predictors: (Constant), Izvoz_Trans					
b. Dependent Variable: BDP_Trans					
ANOVA ^b					
	Sum of Squares	df	Mean Square	F	p
Regression	0,006	1	0,006	7,461	0,023 a
Residual	0,007	9	0,001		
Total	0,013	10			
a. Predictors: (Constant), Izvoz_Trans					
b. Dependent Variable: BDP_Trans					
Coefficients ^a					
	Unstandardized Coefficients		Standardized Coefficients	t	p
	B	Std. Error	Beta		
(Constant)	4,469	0,161		27,758	0,000
Izvoz_Trans	-0,352	0,129	-0,673	-2,731	0,023
a. Dependent Variable: BDP_Trans					

Source: author's research

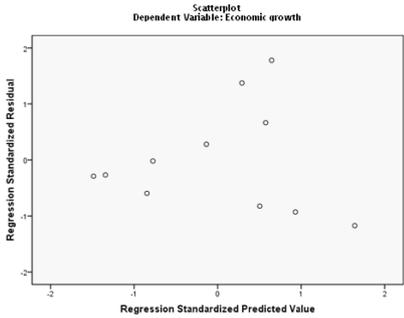
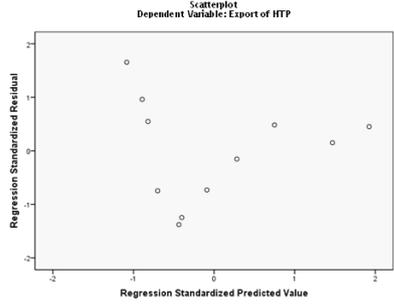
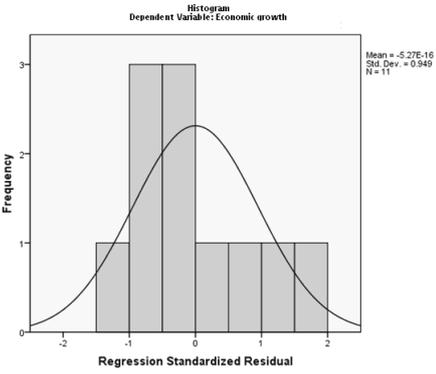
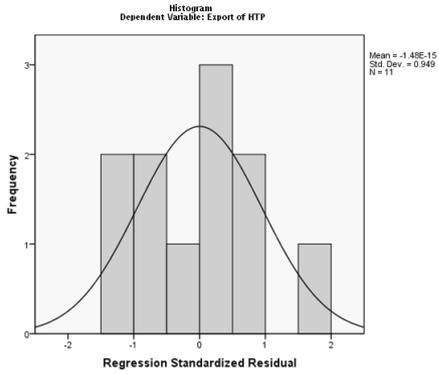
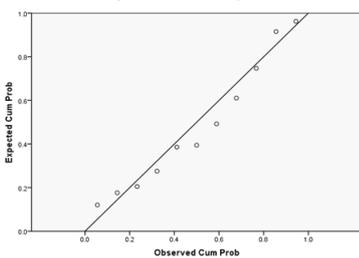
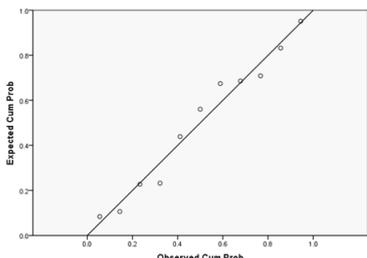
4. *The ratio of the share of exports of high-tech products in total exports and GDP per capita in the case of Romania*

Before conducting a simple linear regression analysis in the case of Romania, the assumptions on which it is based were tested. The results of this check are shown in Table 9.

The first assumption, which referred to the continuous nature of variables, was fulfilled. The independent variable share of high-tech products in total exports and the dependent variable GDP per capita were metric variables measured on a ratio scale. The second and third

assumptions, which referred to a linear correlation between variables and the absence of atypical points, were not met. The fourth assumption related to the independence of observations was not fulfilled, considering the obtained values of the Durbin-Watson coefficient of $d = 0.183$ and $d = 1.089$. The fifth and sixth assumptions about the absence of heteroskedasticity and the normal distribution of residual errors were partly met. Due to the violation of the assumptions of simple linear regression, data transformation was started. Data on the results of simple linear regression in the case of Romania, conducted with logarithm-transformed variables, are shown in Table 10.

Table 9: The results of testing the assumptions of simple linear regression in the case of Romania

Variable / assumption	Share of exports of high-tech products in total exports (n = 11)	GDP per capita (n = 11)
The nature of the variable	Metrics	Metrics
Distribution diagram	 <p>Scatterplot Dependent Variable: Economic growth</p>	 <p>Scatterplot Dependent Variable: Export of HTP</p>
The value of the Durbin-Watson statistic indicator	$d = 0,183$	$d = 1,089$
Histogram	 <p>Histogram Dependent Variable: Economic growth</p>	 <p>Histogram Dependent Variable: Export of HTP</p>
P-P diagram of normality	 <p>Normal P-P Plot of Regression Standardized Residual Dependent Variable: Economic growth</p>	 <p>Normal P-P Plot of Regression Standardized Residual Dependent Variable: Export of HTP</p>

Source: author's research

A correlation coefficient between the export of high-tech products and GDP per capita of $R = 0.103$ was determined, which can be considered small according to Cohen's criteria. The calculated coefficient of determination was $R^2 = 0.011$, and the corrected coefficient of determination was $\text{Adj. } R^2 = -0.099$. The obtained negative value of the corrected coefficient of determination requires additional explanation. According to statistical theory, a negative value of the corrected coefficient of determination occurs when the value of the sum of the residual squares is close to the total sum of squares. Then the explanatory power of the regression model is very small or impossible to determine [19]. A correlation coefficient between the export of high-tech products and GDP per capita of $R = 0.103$ was determined, which can be considered small according to Cohen's criteria. The calculated coefficient of determination was $R^2 = 0.011$, and the corrected coefficient of determination was $\text{Adj. } R^2 = -0.099$. The obtained negative value of the corrected coefficient of determination requires additional explanation. According to statistical theory, a negative value of the corrected coefficient of determination occurs when the value of the sum of the residual squares is close to the total sum of squares. Then the explanatory power of the regression model is very small or impossible to determine (Fogarty, 2019). With this in mind, even with a very low value of the obtained

coefficient of determination of 1.1% (according to which a total of 1.1% of changes in the dependent variable GDP per capita can be explained by changes in the independent variable), the share of high-tech in total exports one should take with reserve, and thus evaluate the entire explanatory power of the regression model as insignificant. According to Cohen's criteria, the reason for this situation can be found in the small size of the calculated coefficient of determination, the existence of only one predictor, or the inclusion of only one independent variable in the model, and the small sample size which in this case was $n = 11$.

As the data related to ANOVA showed, the given regression model was not statistically significant at the level of $p < 0.050$ since the results of this test were $F(1,9) = 0.097$, $p = 0.762$.

By reviewing the regression coefficients, more details were obtained that describe the correlation of the analyzed variables. The usual regression coefficient was not statistically significant at $p < 0.050$ and was $B = 3.796$ ($\text{SE } B = 0.169$). The standardized regression coefficient beta in this case is $\beta = 0.103$, and can be qualified as small. The small values of the correlation and determination coefficients and the absence of statistical significance of the regression model suggest that in the case of Romania, there is no link between the share of exports of high-tech products in total exports per GDP per capita.

Table 10: The results of simple linear regression in the case of Romania

Model Summary ^b					
	R	R Square	Adjusted R Square	SE of the Estimate	
	0,103 ^a	0,011	-0,099	0,05164	
a. Predictors: (Constant), Izvoz_Trans					
b. Dependent Variable: BDP_Trans					
ANOVA ^b					
	Sum of Squares	df	Mean Square	F	p
Regression	0,000	1	0,000	0,097	0,762 ^a
Residual	0,024	9	0,003		
Total	0,024	10			
a. Predictors: (Constant), Izvoz_Trans					
b. Dependent Variable: BDP_Trans					
Coefficients ^a					
	Unstandardized Coefficients		Standardized Coefficients	t	p
	B	Std. Error	Beta		
(Constant)	3,796	0,169		22,501	0,000
Izvoz_Trans	0,060	0,194	0,103	0,312	0,762
a. Dependent Variable: BDP_Trans					

Source: author's research

A comparative overview of the obtained results in all four countries and summaries of the hypothesis test are presented in Table 11.

Based on the presented data and previous analyzes in the cases of Serbia, Bulgaria, Hungary and Romania, it was concluded that the hypothesis regarding the existence of a positive impact of the share of high-tech products in total exports on economic growth, measured GDP per capita, was not disproved only in the case of Bulgaria. The following findings of the conducted analysis led to this conclusion:

1. in the case of Bulgaria, evaluated according to Cohen's criteria, there is a strong relationship between these two variables ($r = 0.865$, $r > 0.500$), the regression model is statistically significant $F(1,9) = 26.629$, $p = 0.001$, and the obtained regression coefficient has a positive value $\beta = 0.865$;
2. in the case of Serbia, evaluated according to Cohen's criteria, there is a strong relationship between these two variables ($r = 0.760$, $r > 0.500$), the regression model is statistically significant $F(1,9) = 12.304$, $p = 0.007$, but the resulting regression coefficient has a negative value $\beta = -0.760$;
3. in the case of Hungary, evaluated according to Cohen's criteria, there is a strong relationship between these two variables ($r = 0.673$, $r > 0.500$), the regression model is statistically significant, $F(1,9) = 7.461$, $p = 0.023$, but the resulting regression coefficient has negative value $\beta = -0.673$;
4. in the case of Romania, evaluated according to Cohen's criteria, there is a weak relationship between these two variables ($r = 0.103$, $r < 0.300$), and the regression model was not statistically significant $F(1,9) = 0.097$, $p = 0.762$

Discussion

After the analysis, the hypothesis about the impact of exports of high-tech products on GDP growth was withdrawn in the cases of Serbia, Hungary and Romania. At the same time, this was not the case with Bulgaria. At the same time, the ratio of these two variables in the case of Bulgaria can be described as strong and positive, in the case of Serbia and Hungary as weak and negative, and in the case of Romania the applied statistical analysis did not determine any correlation between exports of high-tech products and GDP growth. Such heterogeneous results require further explanation using both the data included in the analysis and relevant data from other theoretical studies and empirical studies that have addressed the correlation between these two variables.

The case of positive correlation of exports of high-tech products to GDP growth in the case of Bulgaria has its theoretical explanation in economics in the well-known export-led growth hypothesis. This hypothesis states that at the level of the national economy there is a positive interdependence between export growth, productivity and economic growth [32]. In addition, if in the period analyzed, variables related to the export of high-tech products and GDP growth are observed in parallel, in the case of Bulgaria, it is noticed that since 2014, the growth of exports of high-tech products has been constantly accompanied by Bulgarian GDP growth. In other words, in the period from 2014 to 2018, the percentage of growth in the share of high-tech products in total Bulgarian exports increased from 3.9% to 5.9%. It was accompanied by parallel GDP growth from 5,500 to 6,500 euros per capita. At the same time, in the cases of Serbia and Hungary, the share of exports of high-tech products in total exports from 2008 to 2018 decreased from 2.4% to 1.9% in the case of

Table 11: Hypothesis test summary

	Serbia	Bulgaria	Hungary	Romania
Hypothesis test result	Not confirmed	Confirmed	Not confirmed	Not confirmed
Calculated values of the correlation coefficient	0,760	0,865	0,673	0,103
Calculated values of the coefficient of determination	0,578	0,719	0,453	0,011
The obtained regression equation	GDP = 3,786 - 0,3358 * % export of HTP	GDP = 3,446 + 0,467 * % export of HTP	GDP = 4,469 - 0,352 * % export of HTP	-
Statistical significance of the regression model	Exists	Exists	Exists	No exist
Relation of variables in the regression equation	Negative	Positive	Negative	-

Source: author's research

Serbia, and from 20.2% to 15.6% in the case of Hungary. Results similar to those obtained in the case of Bulgaria can be found in a number of similar studies examining the impact of high-tech exports on economic and GDP growth [5], [16], [38], [24].

The results obtained for Serbia and Hungary have been explained in previous studies. Thus, some authors [36] conclude that the export of high-tech products is not crucial for economic and GDP growth in some countries. They are dominated by exports of products from medium and lower technology industries. Keep in mind that such industries are mainly based on labor-intensive work and that their exports are usually based on large imports. In the case of Romania, no correlation has been found between exports of high-tech products and GDP growth, and such a result is confirmed in previous research [25].

Conclusions

Innovation is one of the key factors of competitiveness in the global market. High technologies are generally known for innovation and exports, contributing to economic development. Therefore, the state needs to create conditions for raising the export capacities of companies operating in high technologies to increase the economy's competitiveness on a global level. Activities should be aimed at creating conditions that will enable the greatest possible performance in the field of innovation, which will automatically be reflected in the country's ranking on the list of the Global Competitiveness Index. The country can expect accelerated technological development if it creates a favorable environment for knowledge transfer, development of new technologies, commercialization of products, and networking and stimulating the growth of the knowledge-based economy.

In the previous decade, there was an increase in exports of high and medium technological complexity products in Serbia. This is especially true for high-tech products whose export value has increased almost 15 times. In addition, there is a high degree of production concentration in the exports of the hi-tech group. In contrast, the concentration in the export of products of medium technological complexity is close to the average

of the countries in the region. In this regard, one of the goals set by the Hungarian government was to take a leading role in applying new, innovative technologies at the regional and European level, all to become a leader when it comes to technological research. According to the IMF analysis from 2019, Hungary and Germany are ranked first in the share of high-tech products. Romania has a small number of companies and a low average of R&D spending and a lower share of employment in high- and medium-tech industries. The situation can be explained by low technology in the economy and the limited number of multinational companies establishing R&D centers in Romania, but also by the weak interest of companies in R&D reporting. Bulgaria's innovation system operates below its potential, whether measured by system inputs (based on R&D spending), output (by number of patents), or economic growth (measured by high-tech exports).

Accordingly, this paper aimed to investigate the share of exports of high-tech products, as one of the results of the application of innovations in the economy, in total economic growth measured by GDP growth. The main task was to check the positive impact of the growth of exports of high-tech products on the economic growth of four countries (Serbia, Bulgaria, Hungary and Romania). The analysis results showed that the positive relationship between exports of high-tech products and GDP growth could not be confirmed in the case of Serbia, Hungary and Romania. In contrast to these countries, in the case of Bulgaria, the impact of growth in exports of high-tech products on GDP growth has been confirmed. The pronounced negative correlation between the share of exports of high-tech products in total exports of Serbia and GDP per capita shows that the percentage of exports of high-tech products in total exports decreased during the study period, while GDP per capita grew. This tells us that Serbia did not base its economic development in the previous period on strengthening the export of high-tech products. Regarding the share of high-tech products in total exports, in the last ten years there has been a decline from 2.8% in 2009 to 1.9% in 2018.

After a detailed analysis, the main conclusions of this research were adopted, which indicate that (a) a decrease in the share of high-tech products in total

exports is accompanied by an increase in GDP per capita (Serbia), (b) a decrease in the share of exports of high-tech products is accompanied by an increase in GDP per capita (Hungary), (c) the increase in the share of exports of high-tech products is accompanied by an increase in GDP per capita (Bulgaria) and (d) there is no correlation between the share of exports of high-tech products and GDP per capita (Romania). The obtained results have significant and concrete implications for decision-makers. Although the cases of Serbia and Hungary show that economic growth is possible without increasing the share of exports of high-tech products in total exports, the question of sustainability of such development remains open and the application of innovations in medium-tech low-tech industries. On the one hand, the highest profit rates and the highest growth rates are provided by the products of high-tech sectors and compatible technological innovations. Still, other industries also need the improvement of technologies and innovations for their better results.

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References

- Aksnes, D.W., Sivertsen, G, van Leeuwen, T.N., & Wendt, K.K. (2017). Measuring the productivity of national R&D systems: challenges in cross-national comparisons of R&D input and publication output indicators. *Science and Public Policy*, 44 (2), 246-258.
- Amit, R., & Zott, C. (2012). Creating value through business model innovation. *MIT Sloan Management Review*, 53, 41-49.
- Anning-Dorson, T. (2018). Innovation and competitive advantage creation: the role of organizational leadership in service firms from emerging markets. *International Marketing Review*, 35 (4), 580-600.
- Bashir, M., & Verma, R. (2017). Why business model innovation is the new competitive advantage. *The IUP Journal of Business Strategy*, 14 (1), 7-17.
- Bernard, A.B., & Jensen, J.B. (2004). Exporting and productivity in the USA. *Oxford Review of Economic Policy*, 20 (3), 343-357.
- Bryman, A. (2012). *Social research methods*. New York: Oxford University Press.
- Chesbrough, H. (2010). Business model innovation: opportunities and barriers. *Long Range Planning*, 43 (2/3), 354-363.
- Domazet, I., Marjanović, D., Ahmetagić, D., & Bugarčić, M. (2021). The impact of innovation indicators on increasing exports of high technology products. *Ekonomika preduzeća*, 69 (1-2), 31-40.
- Dosi, G. (2000). *Innovation, organization, and economic dynamics: selected essays*. London: Edward Elgar Publishing.
- Douglas C., Montgomery, D.C., Peck, E.A., & Vining, G.G. (2013). *Introduction to linear regression analysis*. Hoboken: John Wiley & Sons.
- Dustin, G., Bharat, M., & Jitendra, M. (2014). Competitive advantage and motivating innovation. *Advances in Management*, 7 (1), 1-7.
- Đuričin, D., & Lončar, D. (2020). Shaping the future of Serbia's economy: the new growth model and related economic policy platform. *Ekonomika preduzeća*, 68 (1-2), 1-21.
- Đuričin, D., & Vuksanović Herceg, I. (2021). The Great Reset of Serbia's Economy During and after the Covid-19 Crisis. *Ekonomika preduzeća*, 69 (3-4), 117-136.
- Ellis, P. D. (2010). *The essential guide to effect sizes: an introduction to statistical power, meta-analysis, and the interpretation of research results*. Cambridge: Cambridge University Press.
- Evans, J. R., & Basu, A. (2015). *Statistics, data analysis and decision modeling*. Upper Saddle River: Pearson Education.
- Falk, M. (2009). High-tech exports and economic growth in industrialized countries. *Applied Economics Letters*, 16 (10), 1025-1028.
- Ferauge, P. (2012). A conceptual framework of corporate social responsibility and innovation. *Global Journal of Business Research*, 6 (5), 85-96.
- Ferreira, J., Arnaldo Coelho, A., & Moutinho, L. (2020). Dynamic capabilities, creativity and innovation capability and their impact on competitive advantage and firm performance: the moderating role of entrepreneurial orientation. *Technovation*, 92-93.
- Fogarty, B. J. (2019). *Quantitative social science data with R: An introduction*. Thousand Oaks, CA: SAGE Publications.
- Golebiovski, T., & Lewandovska, M.S. (2015). Influence of internal and external relationships of foreign subsidiaries on innovation performance. Evidence from Germany, Czech Republic and Romania. *Journal of East European Management Studies*, 20 (3), 304-327.
- Goos, P., & Meintrup, D. (2016). *Statistics with JMP: hypothesis tests, ANOVA and regression*. Chichester: John Wiley & Sons.
- Herrera, M.E.B. (2015). Creating competitive advantage by institutionalizing corporate social innovation. *Journal of Business Research*, 68 (7), 1468-1474.
- Ho, R. (2006). *Handbook of univariate and multivariate data analysis and interpretation with SPSS*. Boca Raton, FL: Chapman and Hall/CRC - Taylor & Francis Group.
- Kabaklarli, E., Duran, M.S., & Ucler, Y.T. (2018). High-technology export and economic growth: panel data analysis for selected OECD countries. *Forum Scientiae Oeconomica*, 6 (2), 47-60.
- Kundu, A. (2013). Bi-directional relationships between exports and growth: a panel data approach. *Journal of Economics and Development Studies*, 1 (1), 10-23.
- Li, B., & Huang, L. (2019). The Effect of Incremental Innovation and Disruptive Innovation on the Sustainable Development of Manufacturing in China. *SAGE Open*, January-March, 1-14.
- Marjanović, D., & Domazet, I. (2021). Tax competitiveness as a significant factor in attracting foreign investment – the case of Serbia. *Argumenta Oeconomica*, 2 (47), 63-80.

28. Marjanović, D., Ahmetagić, D., & Beraha, I. (2019). *Comparative Analysis of High Technology Exports and selected Innovation Indicators for Serbia and CEE Countries*. *Economic Analysis: Applied Research in Emerging Markets*, 52 (2), 93-103.
29. Perilla Jimenez, J.R. (2019). Mainstream and evolutionary views of technology, economic growth and catching up. *Journal of Evolutionary Economics*, 29, 823-852.
30. Sachs, J.D. (2014). A New Macroeconomic Strategy, available at: <https://www.project-syndicate.org/commentary/declining-investment-in-rich-countries-by-jeffrey-d-sachs-2014-10?barrier=accesspaylog>
31. Samara, E., Georgiadis, P., & Bakouros, I. (2012). The impact of innovation policies on the performance of national innovation systems: a system dynamics analysis. *Technovation*, 32 (11), 624-638.
32. Sannasee, R. V., Seetanah, B., & Jugessur, J. (2014). Export-led growth hypothesis: a meta-analysis. *The Journal of Developing Areas*, 48 (1), 361-385.
33. Saunders, M., Lewis, P., & Thornhill, A. (2016). *Research methods for business students*. Harlow: Pearson Education.
34. Sreejesh, S., Mohapatra, S., & Anusree, M. R. (2014). *Business research methods: an applied orientation*. Cham: Springer.
35. Teece, D. J. (2019). A capability theory of the firm: an economics and (strategic) management perspective. *New Zealand Economic Papers*, 53, 1-43.
36. Trlakovic, J., Despotovic, D., & Ristic, L. (2018). Impact of technology-intensive exports on GDP of Western Balkan countries. *Journal of Policy Modeling*, 40 (5), 1038-1049.
37. Verma, J.P., & Abdel-Salam, A.G. (2019). *Testing statistical assumptions in research*. Hoboken, NJ: John Wiley & Sons.
38. Yoo, S.H. (2008). High-technology exports and economic output: an empirical investigation. *Applied Economics Letters*, 15 (7), 523-525.



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