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Examination of the Relationship Between Economic Growth and Research and Development Expenditures in Azerbaijan, Kazakhstan and Kyrgyzstan

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ABSTRACT

The article is devoted to topical issues related to the impact of investment in research and development (R&D) on the acceleration of economic growth on the example of Azerbaijan, Kazakhstan, and Kyrgyzstan. All three countries need to modernize and diversify their economies, especially in the context of unstable conditions in the world fuel and raw materials markets and the trend towards decarbonization of the world economy. The relationship between economic growth and R&D expenditures was studied through econometric analysis (Granger test), which increases the accuracy and reliability of the results. The relationship between R&D and economic growth is examined using the annual GDP data of the respective countries and the ratio of R&D expenditures to GDP for the period 2005–2018. The data were analysed using EViews statistical package. It was found that GDP growth in Kyrgyzstan is the reason for cost increases on research and development. At the same time, a causal relationship was not found in Azerbaijan or Kazakhstan. According to the results of the correlation analysis, there is a very high positive correlation (0.92) between the growth data given in Azerbaijan and R&D expenditures. However, in Kyrgyzstan (–0.69) and Kazakhstan (–0.33), on the contrary, there is a moderate relationship in the negative direction. It is concluded that one of the ways to increase economic growth in the long term is to investment in R&D. The results of the research can be used by official institutions to assess the economic profiles of the countries under consideration and in the real sector of the economy.

Keywords: economic growth; research and development (R&D); investments; Granger test; Azerbaijan; Kazakhstan; Kyrgyzstan

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ОРИГИНАЛЬНАЯ СТАТЬЯ

Взаимосвязь между экономическим ростом и расходами на исследования и разработки в Азербайджане, Казахстане и Кыргызстане

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АННОТАЦИЯ

Статья посвящена актуальной проблематике, связанной с влиянием инвестиций в научно-исследовательские и опытно-конструкторские работы (НИОКР) на ускорение экономического роста на примере Азербайджана, Казахстана и Кыргызстана. Все три страны нуждаются в модернизации и диверсификации своей экономики, особенно в условиях нестабильной конъюнктуры на мировых топливно-сырьевых рынках и тренда на декарбонизацию мировой экономики. Взаимосвязь между экономическим ростом и расходами на НИОКР изучалась с помощью эконометрического анализа (тест Грэнджера), что повышает точность и достоверность полученных результатов. Взаимосвязь между НИОКР и экономическим ростом рассмотрена с использованием годовых данных ВВП соответствующих стран и отношения расходов на НИОКР к ВВП за период 2005–2018 гг. Данные проанализированы с использованием статистического пакета EViews. Установлено, что рост ВВП в Кыргызстане является причиной увеличения расходов на исследования и разработки. В то же время причинно-следственная связь не была обнаружена в Азербайджане и Казахстане. Согласно результатам корреляционного анализа установлена очень высокая положительная корреляция (0,92) между данными роста, приведенными в Азербайджане, и расходами на исследования и разработки. Однако в Кыргызстане (–0,69) и Казахстане (–0,33), наоборот, наблюдается умеренная связь в отрицательном направлении. Сделан вывод, что одним из способов увеличения экономического роста в долгосрочной перспективе

являются инвестиции в НИОКР. Результаты исследования могут быть использованы официальными учреждениями экономического профиля рассматриваемых стран и в реальном секторе экономики.
Ключевые слова: экономический рост; исследования и разработки (НИОКР); инвестиции; тест Грейнджера; Азербайджан; Казахстан; Кыргызстан

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INTRODUCTION

Economic growth it is the most important economic phenomenon that increases income in countries, reduces unemployment in general, and raises the welfare level of citizens, and is one of the primary goals of all governments. Decreased economic growth; by reducing unemployment and per capita income, it brings together poverty and a decrease in the level of welfare in countries. For this reason, economic growth is very important for countries.

Today, the creation of innovation by creating new products and production processes and the development of innovative approaches depend on advanced technologies. For this reason, R&D activities are needed to support economic growth. Realizing R&D investments offers various outputs at the macro level. At this point, the concept of the knowledge economy, which focuses on innovation activities, comes first. The transformation of the knowledge economy into practice is possible by allocating the necessary shares for R&D and realizing these expenditures.

In developing countries, sufficient funds and time cannot be allocated to R&D activities in improving production processes and achieving innovation. This situation causes the desired results not to be achieved as a result of R&D activities in developing countries [1–3]. The literature on R&D activities and economic growth is quite rich. However, when the studies dealing with this subject are evaluated in a general perspective, a common empirical finding cannot be obtained. Researches are generally based on causality and cointegration tests, which include panel data analysis, time series or panel data analysis as a method.

The authors present their views on opportunities and mechanisms for the development of innovative business of Kazakhstan within the Eurasian Economic Union (EAEU), considering that the basis of the competitiveness of the modern economy is the existence of a dynamically developing innovative business. The article is based on the work done in 2015–2017: and briefly reveals the main problems of the innovative business of Kazakhstan [4]. In a research study by [5], problems related to environmental security and quality of life of the population, which can accelerate or, conversely, slow down socio-economic progress in the Central Eurasian region, are analyzed. Based on international research, the article reveals the difficulty of the socio-ecological situation in Russia and even more worrying in Central Asia. In another research paper [6], the features that determine the development of the Central Asian region countries are discussed, the poverty level, demographic indicators, natural characteristics of the region and individual indicators of economic development are analyzed. A research paper by [7] compares the political institutions responsible for the formulation and implementation of state economic policy in the countries of the Central Asian region (Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan).

In this study, the relationship between economic growth and R&D expenditures in Azerbaijan, Kazakhstan and Kyrgyzstan was examined by econometric analysis. Although there are no comprehensive studies on the subject in Kazakhstan and Kyrgyzstan, there have been few studies on Azerbaijan [8–9].

THEORITICAL BACKGROUND

Economic Growth

Economic growth comes first among the macroeconomic indicators of countries. For this reason, countries around the world are preparing their future plans by accepting this variable as a goal. If the economic growth should be explained in the simplest way, it refers to the increase in the amount of goods and services produced in total or per capita. In the literature, economic growth it is explained as the increase in per capita income from the continued increase in Gross National Product (GDP). Economic growth is measured by the concept of "average growth rate", which expresses the annual variation in per capita income over a long period of time. [10]. According to the definition made by Joseph Schumpeter and widely used in the literature: "Economic growth is not a short-term static, but on the contrary, a long-term dynamic phenomenon" [11]. The aim of every economy is to provide economic development by providing social and cultural development in a way that will raise living standards along with economic growth [12]. Economic growth constitutes the first step of development. There are many indicators of economic growth in an economy. Some of these indicators are natural resources,

industrial production and employment level. The increase in these indicators causes an increase in GDP, GNP, national income, disposable income and per capita national income [13].

One of the most important goals of economic policy is the realization of economic growth. In this sense, the realization of economic-economic growth, which is defined as the outward expansion of production possibilities, is an important prerequisite for increasing the welfare level of the society.

Research & Development

There are different conceptual explanations about the term research and development (R&D) in the literature. According to Jones and Williams, while R&D is described as "an important determinant of long-term productivity and well-being", according to the Frascati Manual it is defined as "a process involving significant transfers of resources between units, institutions and sectors, particularly the government and other enablers" [14]. In addition, it is expressed in the guide as "creative work carried out on a systematic basis to increase the knowledge of people, culture and society and to use this knowledge to design new applications" [13].

As a transformation process with high added value, the way for knowledge to become tangible products and create technology is to allocate resources to R&D [15]. Along with education, R&D investments are accepted as one of the basic criteria in evaluating a country's competitiveness and economic development. It is thought that R&D investments have an impact on economic growth through many factors such as innovation, capital accumulation and development of human capital [16]. R&D, which is defined as innovative studies that allow the increase of human, cultural and social knowledge, also refers to all of the systematic studies aimed at introducing a new product or production process [17]. According to OECD, R&D is defined as "creative work carried out on a systematic basis to increase the knowledge of people, culture and society and to use this knowledge to design new applications" [14].

The realization of R&D activities aimed at increasing profitability and productivity with the use of technology depends on R&D expenditures. Expenditures on R&D activities, which form the basis of innovation, show a quality that encourages economic growth [18]. While R&D expenditures stand out as the key strategy that ensures innovation and economic growth, the decreasing return resulting from the externalities and overflows that occur as a result of the investments made for R&D expenditures at the macro level is transformed into an increasing return. R&D expenditures contribute to the development of technological capability and allow foreign direct investments to enter the country.

R&D activities are described as a new method or perspective for the service, application and problem solving that a country needs in order to meet its economic and social needs. Increasing production capacity in the 21st century, developments in information, communication and transportation technologies, changes in the expectations of individuals and society, and the applicability of production processes based on new technology have led to a rapid transformation in all areas. Countries have started to give more importance to R&D activities in order to keep up with this transformation wave. At this point, R&D expenditure, which is one of the most important indicators of R&D activity, attracts attention as a factor commonly used to define the technological capacities of countries or companies. R&D expenditures constitute the dynamics of activities such as developing new products and production methods, using existing or imported technologies more effectively, updating or transforming them [19].

THE RELATIONSHIP BETWEEN ECONOMIC GROWTH AND R&D

There are different studies in the literature examining the relationship between R&D expenditures and economic indicators. However, the number of studies examining the effects of R&D expenditures on stock returns on a firm basis is quite limited.

R&D expenditures provide significant competitive advantage to businesses by creating positive effects on business efficiency and profitability in the long run. In addition, in today's markets, R&D studies of enterprises are seen as a necessity. While the effective execution of R&D expenditures affects the profitability of the enterprise, this situation also reflects positively on the capital markets. R&D expenditures, which strengthen the position of the enterprise in the capital markets, will also increase the income of the investors. This will support the entry of foreign direct capital into the country in the long run [20, 21]. This shows that R&D expenditures not only increase business profitability and investor income, but also contribute to the country's economy.

The recognition of R&D as the driving force of endogenous growth models has led the private and public sectors to attach importance to R&D expenditures. This situation has led to the creation of a large literature on the relationship between R&D expenditures and technological innovation, productivity and growth [19]. Technological change, which is accepted as the main factor of success in economic activities, also allows the development of new markets. Technology, which is one of the most important determinants of human progress and economic development, offers both productivity and quality increase [22].

Factors such as R&D expenditure, number of R&D personnel, number of patents and number of scientific

publications are at the forefront of determining the intensity of countries' R&D activities. Innovations created by the R&D expenditures made accelerate economic growth. Studies conducted in recent years also reveal the importance of the role played by innovation in industrial areas in economic development and regional development. In addition, studies examining the relationship between R&D activities and the competitiveness of firms have found that in the long run, firm productivity is in line with the level of R&D expenditures. Companies that increase their productivity in the long term with their R&D expenditures gain a serious advantage over their current and potential competitors. In parallel with this, growth occurs at both micro and macro levels [23].

There are studies conducted by different researchers in different countries in the literature between R&D expenditures and economic growth. In the study conducted by Inekwe on effect on economic growth in upper middle-income developing countries, while it has an insignificant effect on economic growth in low-income countries [24]. In the study conducted by Freimane and Balina in 27 European Union countries, it was found that a 1% increase in R&D expenditures led to an increase of 0.02% in economic growth in the short term and an increase of 0.09% in the long term [25]. In a study by on G7 countries and Turkey, it was found that a 1% increase in R&D expenditures led to an increase in economic growth by 1.168% [26]. As a result of a study conducted by on 26 developed and developing countries, R&D expenditures were determined as the Granger cause of economic growth [27]. Technological development is directly related to R&D expenditures. R&D activities, which enable the emergence of new information about products and production processes, increase the quality of products on the one hand, and help reduce costs on the other hand. This situation leads to the development of the industry and subsequently to economic growth. In addition to providing long-term economic growth, it is seen that R&D expenditures stand out more than other factors with the externalities it creates [28].

METHODOLOGY

Purpose of the Research

In this research, it is aimed to show whether investments in R&D in Azerbaijan, Kazakhstan and Kyrgyzstan will accelerate economic growth. In this context, the relationship between R&D and economic growth was examined by making use of the annual data on the GDP of these countries and the ratio of R&D expenditures to GDP in the 2005–2018 period. Three Turkish state countries with the least research on the subject were selected. Although there are no comprehensive studies on the subject in Kazakhstan and Kyrgyzstan, studies on Azerbaijan have been made, albeit a little.

Data Set

The data required for the study were collected from the World Bank. The data set includes annual data from 2005 to 2018 for Azerbaijan, Kazakhstan and Kyrgyzstan. Since the 2019 and 2020 data of the countries in question were not available at the time of the research, the data for these years could not be included in the analysis. The data was analyzed by EViews program.

Analysis Method

In this research, time series approach was used as econometric method [28]. Since the data is not stationary, the data are stationary. Given has become stationary only from its second-order value. The stationarity of the variables was tested using the Augmented Dickey-Fuller (ADF) unit root test. Appropriate lag lengths of the data were found for later analysis. After finding the appropriate offset lengths, it was tried to determine the direction of the relationship between the variables using the Granger causality test. Granger method is widely used in causality testing [29, 30]. The cause-effect relationships between the variables were examined with the help of causality analysis, which was first introduced to the literature by Granger and later developed by Hamilton [29–31]. In Granger causality, the direction of the relationship between two variables such as X and Y is investigated. If the current value of Y can be better predicted by the values of the past period than the present value of the variable X, can be said of a Granger causality from variable X to variable Y [31]. It is important to determine the optimal lag length of the variables in the Granger causality method.

Granger-Causality Tests in the Framework of Co-Integration Analysis Economic time series are often not stationary when considered as levels. Regression analyzes using non-stationary time series can cause false or misleading regression relationships. This causes the estimated regression equation to have a high coefficient of determination (R^2) but a low Durbin-Watson statistic. In this regression, the error terms are not stationary and the apparently high explanatory power of the regression equation cannot be trusted [33].

If the non-stationarity of the time series is due to the deterministic time trend of the related series, then de-trending of these series can make the series stationary. However, if the time series contains a random trend, they will need to be differentiated until they become stationary. The number of times a series with a random trend needs to be differentiated until it becomes stationary is called

the degree of integration of that series. For example, if the first difference $(\frac{X_t - X_t - 1}{X_t - 1})$ of a non-stationary variable X is stationary, it is said that the variable X is integrated of the first order and is denoted by $X \sim I(1)$ [34].

It is possible to correct a non-equilibrium situation that may occur in the short term for any reason in the long term. This is because the difference (z) between X and Y is stationary in the long run, because the z term shows how much the system deviates from the long run equilibrium [34]. Granger demonstrates the expression of a cointegrated system as an error correction model in the following figure [35]. In the cointegration example given above:

$$z_t = \varepsilon_t = Y_t - \alpha - \beta X_t.$$

$$\Delta Y_t = \Sigma\delta_{1,i}\Delta Y_{t-1} + \Sigma\beta_{1,i}\Delta X_{t-1} + \gamma_1 z_{t-1} + \mu_{1t}, \quad (1)$$

$$\Delta X_t = \Sigma\delta_{2,i}\Delta Y_{t-1} + \Sigma\beta_{2,i}\Delta X_{t-1} + \gamma 2 z_{t-1} + \mu_{2t}. \quad (2)$$

The cointegration of X and Y variables requires that at least one of γ_1 and γ_2 is nonzero in models (1) and (2). Therefore, changes in the dependent variable in the error correction model are partially determined by the lagged value of z. However, since z_{t-1} includes X_{t-1} and Y_{t-1}, this leads to the conclusion that the cointegration relationship requires at least one variable to be the Granger-cause of the other [30].

RESULT

While analyzing, Azerbaijan, Kazakhstan and Kyrgyzstan, which are selected Turkish states, were examined. The relationship between the GDP in these countries and the research and development expenditure in the country is considered. In order to perform the analysis, it was first tested whether the data were stationary or not. It has been observed that they are not stationary given in the stationarity test. The Johansen cointegration test could not be performed because all the data did not become stationary in the first order. In order for the data to give statistically significant results, the stationarity test was carried out with the help of the ADF (Augmented Dickey-Fuller) unit root test. The non-stationary version of the data is presented in *Table 1*.

Vertical-Fuller unit root test results regarding the levels of unit root variables in the series for each country are shown with one percent, five percent and ten percent margin of error.

In general, growth and research and development expenditure values show that the data is not stationary. For this reason, it was tried to take the difference of the series in order to make it stationary. When only the quadratic difference is taken, the series become stationary. For this reason, the series that became stationary by retesting are presented in *Table 2*.

Table 2 shows that the variables used in the study are stationary at second differences in the 2005–2018 periods for all three countries ($p \leqslant 0.05$). The VAR model was established by using the level values of the variables and the appropriate lag number was determined with the help of Akaike (AIC), LL, LR, FBE, SC and HQ information criteria. The analysis results for determining the appropriate lag length are presented in *Table 3*.

As a result of the analysis, the most appropriate lag length was determined as two for Azerbaijan. In terms of Kazakhstan and Kyrgyzstan, the appropriate lag length was found to be three. The value with the most stars indicates the optimal delay length.

According to *Table 4*, it is revealed whether the total growth and research and development expenditure values in Azerbaijan, Kazakhstan and Kyrgyzstan are the cause of each other. According to the results of the analysis, only the realization of growth in Kyrgyzstan, that is, the increase in GDP, is the reason for the increase in research and development expenditure. In other words, GDP is the reason for research and development expenditure Granger. There is a bidirectional interaction between these two variables. In this case, it would be right to accept the H_1 hypothesis for these variables and reject the H_0 hypothesis. No causal relationship was found between the remaining two countries. In this case, the variables do not cause each other in these countries, so the H_0 hypothesis is accepted.

As a result of the Granger analysis, no causal relationship was found between the data in Azerbaijan and Kazakhstan (*Table 4*). Only in Kyrgyzstan, a two-way meaningful result was obtained. After the Granger analysis, correlation (*Table 5*) was used to determine whether there was any relationship between dependent and independent variables for all three countries, and regression analysis (*Table 6*) was used to determine whether there was any effect.

After the Granger analysis, the results of the correlation analysis performed to see in what direction and to what extent the other variable changes when one variable change are presented in *Table 5*.

When *Table 5* is examined, a very high positive correlation (0.92) was found between the growth data given in Azerbaijan and the research and development expenditure. However, in Kyrgyzstan (–0.69) and Kazakhstan (–0.33), on the contrary, a moderate relationship was found in the negative direction.

As a result of the Granger analysis, since there is no causality relationship between the data in Azerbaijan and Kazakhstan, the regression method was also used to determine the causality between the dependent and independent variables of all three countries. As seen in

Table 1

Level Values of Series in Azerbaijan, Kazakhstan and Kyrgyzstan

Country		GDP		Research and development expenditure	
		t-statistics	possibility	t-statistics	possibility
Azerbaijan					
ADF test statistic		0.266675	0.7463	1.156391	0.9261
Test Critical Values	%1	–2.771926		–2.754993	
	%5	–1.974028		–1.970978	
	%10	–1.602922		–1.603693	
Kazakhstan					
ADF test statistic		6.001239	1.0000	–0.594241	0.4404
Test Critical Values	%1	–2.754993		–2.754993	
	%5	–1.970978		–1.970978	
	%10	–1.603693		–1.603693	
Kyrgyzstan					
ADF test statistic		5.203867	1.0000	–1.900818	0.0578
Test Critical Values	%1	–2.754993		–2.792154	
	%5	–1.970978		–1.977738	
	%10	–1.603693		–1.602074	

Source: Prepared by the author in the EViews program.

Table 2

Second Differential Values of Series in Azerbaijan, Kazakhstan and Kyrgyzstan

Country		GDP		Research and development expenditure	
		t-statistics	possibility	t-statistics	possibility
Azerbaijan					
ADF test statistic		–2.335878	0.0248	–6.396019	0.0000
Test Critical Values	%1	–2.792154		–2.792154	
	%5	–1.977738		–1.977738	
	%10	–1.602074		–1.602074	
Kazakhstan					
ADF test statistic		–4.928156	0.0002	–4.848599	0.0002
Test Critical Values	%1	–2.816740		–2.792154	
	%5	–1.982344		–1.977738	
	%10	–1.601144		–1.602074	
Kyrgyzstan					
ADF test statistic		–6.597625	0.0000	–5.436863	0.0001
Test Critical Values	%1	–2.792154		–2.847250	
	%5	–1.977738		–1.988198	
	%10	–1.602074		–1.600140	

Source: Prepared by the author in the EViews program.

Table 3

Appropriate Delay Length in Azerbaijan, Kazakhstan and Kyrgyzstan

Lag	LogL	LR	FPE	AIC	SC	HQ
Azerbaijan						
0	22.09032	NA	8.89e-05	−3.652785	−3.580440	−3.698388
1	38.60023	24.01442*	9.40e-06*	−5.927314*	−5.710281*	−6.064124
2	40.37624	1.937464	1.58e-05	−5.522952	−5.161229	−5.750968
3	46.55861	4.496270	1.46e-05	−5.919747	−5.413335	−6.238969*
Kazakhstan						
0	14.78004	NA	0.000336	−2.323644	−2.251299	−2.369247
1	39.65828	36.18652	7.76e-06	−6.119687	−5.902653	−6.256496
2	44.52409	5.308164	7.43e-06	−6.277108	−5.915385	−6.505124
3	64.25251	14.34794*	5.86e-07*	−9.136819*	−8.630407*	−9.456041*
Kyrgyzstan						
0	23.21735	NA	7.25e-05	−3.857701	−3.785356	−3.903304
1	44.18446	30.49761	3.41e-06	−6.942629	−6.725596	−7.079439
2	59.44402	16.64679*	4.93e-07	−8.989822	−8.628099	−9.217838
3	67.61692	5.943927	3.18e-07*	−9.748531*	−9.242119*	−10.06775*

Source: Prepared by the author in the EViews program.

Note: * indicates the appropriate lag length for the relevant test.

Table 6, the explanatory power of the regression analysis applied to explain the effect of research and development expenditures on GDP was 82% ($p = 0.00$) in Azerbaijan and 47% ($p = 0.01$) in Kyrgyzstan. In the analysis made in Kazakhstan, the results of the regression analysis were not evaluated, since the independent variable did not yield significant results ($p = 0.26$).

CONCLUSION

This research was analyzed using the Granger method in order to see whether investments in R&D in Azerbaijan, Kazakhstan and Kyrgyzstan would accelerate economic growth, and some findings were reached by testing several hypotheses. According to the results of the Granger analysis, only the realization of growth in Kyrgyzstan, that is, the increase in GDP, is the reason for the increase in research and development expenditure. In other words, GDP is the reason for research and development expenditure Granger. There is a bidirectional interaction between these two variables ($p < 0.05$). A causal relationship was not found in Azerbaijan and Kazakhstan. In this case, the variables in these countries are not the cause of each other.

After the Granger analysis, correlation was used to determine whether there was any relationship between dependent and independent variables for all three countries, and regression analysis was used to determine whether there was any effect. According to the results of the correlation analysis, a very high positive correlation (0.92) was found between the growth data given in Azerbaijan and the research and development expenditure. However, in Kyrgyzstan (−0.69) and Kazakhstan (−0.33), on the contrary, a moderate relationship was found in the negative direction. According to the results of the regression analysis, the explanatory power of the regression analysis applied to explain the effect of research and development expenditures on GDP was 82% ($p = 0.00$) in Azerbaijan and 47% ($p = 0.01$) in Kyrgyzstan. In the analysis made in Kazakhstan, the results of the regression analysis were not evaluated, since the independent variable did not yield significant results ($p = 0.26$).

As a result of this research, which was carried out with Granger causality analysis with data covering the years 2005–2018, a significant bidirectional result was found between R&D expenditures and economic growth in Kyrgyzstan, and no causal relationship was found in Azerbaijan and Kazakhstan. These results are similar to the results of research conducted with Granger causality analysis in the literature. Namely, in a study conducted by Hong [36] in Korea between 1988 and 2013, a bilateral causality was found between economic growth and R&D (based on information and communication technologies) investment. In the study conducted by Sokolov-Mladenović, Cvetanović and Mladenović on 28 EU countries covering

Table 4

Granger Causality Test Results in Azerbaijan, Kazakhstan and Kyrgyzstan

Hypotheses	F-Value	Probability value (p)	Decision at 5% significance level
Azerbaijan			
Research and development expenditure is not a reason for GDP	0.201120	0.9043	Rejected
GDP is not a reason for research and development expenditure	2.891806	0.2355	Rejected
Kazakhstan			
Research and development expenditure is not a reason for GDP	0.895985	0.6389	Rejected
GDP is not a reason for research and development expenditure	2.977140	0.2257	Rejected
Kyrgyzstan			
Research and development expenditure is the cause of GDP	22.63884	0.0000	Accepted
GDP is a reason for research and development expenditure	37.29067	0.0000	Accepted

Source: Prepared by the author in the EViews program.

Table 5

Correlation Analysis Results in Azerbaijan, Kazakhstan and Kyrgyzstan

	GDP	Research and development expenditure
Azerbaijan		
GDP	1	0.92
Research and development expenditure	0.92	1
Kazakhstan		
GDP	1	–0.33
Research and development expenditure	–0.33	1
Kyrgyzstan		
GDP	1	–0.69
Research and development expenditure	–0.69	1

Source: Prepared by the author in the EViews program.

Table 6

Regression Analysis Results in Azerbaijan, Kazakhstan and Kyrgyzstan

GDP			
	Azerbaijan	Kazakhstan	Kyrgyzstan
Multiple R	0.91	0.32	0.68
R Square	0.82	0.10	0.47
Adjusted R Square	0.81	0.03	0.42
Significance F	0.00	0.26	0.01
Research and development expenditure			

Source: Prepared by the author in the EViews program.

the years 2002–2012, it was determined that R&D expenditures (GDP%) positively affected the real growth rate [3]. In the study conducted by Börü and Çelik with data between 2004–2016 in Turkey, a strong causality relationship was found between R&D expenditures and economic growth variables [37].

The findings of the analysis offer some suggestions to policy makers, entrepreneurs and researchers: one of the ways to increase economic growth in the long run is through investments in R&D. It is predicted that investments in R&D will have a significant contribution to economic growth in the long run. However, in future research, the effect of R&D expenditures on the economic growth of all Turkish states can be examined and qualitative studies on the content of R&D expenditures can be made.

REFERENCES

1. Coccia M. Public and private R&D investments as complementary inputs for productivity growth. *International Journal of Technology, Policy and Management.* 2010;10(1–2):73–91. DOI: 10.1504/IJTPM.2010.032855
2. Mercan B., Göktaş D., Gömleksiz M. AR-GE faaliyetleri ve girişimcilerin inovasyon üzerindeki etkileri: Patent verileri üzerinde bir uygulama. *Paradoks: Ekonomi, Sosyoloji ve Politika Dergisi*. 2011;7(2):27–44. URL: https://dergipark.org.tr/tr/download/article-file/610068
3. Sokolov-Mladenović S., Cvetanović S., Mladenović I. R&D expenditure and economic growth: EU 28 evidence for the period 2002–2012. *Economic Research-Ekonomska Istraživanja.* 2016;29(1):1005–1020. DOI: 10.1080/1331677X.2016.1211948
4. Ulybyshev D.N., Kenzhebekov N.D. Options and mechanisms for development of Kazakhstan's innovative business within the framework of the Eurasian Economic Union. *Ekonomika Tsentral'noi Azii = Journal of Central Asia Economy.* 2017;1(3):145–154. (In Russ.). DOI: 10.18334/asia.1.3.38490
5. Niyazi A. Sh. Russia and Central Asia: Environmental problems of integration. *Tsentral'naya Evraziya = Central Eurasian Studies.* 2018;(1):148–174. (In Russ.).
6. Turaeva M.O. General and special in the economic development of the countries of the Central Asian region. *Regional'naya ekonomika: teoriya i praktika = Regional Economics: Theory and Practice*. 2011;(34):58–67. (In Russ.).
7. Turayeva M.O. Economic policy institutions in Central Asian countries: From general to specific. *Vestnik Rossiiskogo ekonomicheskogo universiteta imeni G.V. Plekhanova = Vestnik of the Plekhanov Russian University of Economics*. 2011;(5):126–133. (In Russ.).
8. Alizada T. Analysis of research and development (R&D) expenditures as a share of GDP during 1998–2015 in Azerbaijan. Economic and social development: Book of proceedings. Varazdin: Varazdin Development and Entrepreneurship Agency; 2019:30–41.
9. Ismayilov A., Kasumov A., Ahmadova E. The impact of R&D indicators on the economic growth of Azerbaijan. Economic and social development: Book of proceedings. Varazdin: Varazdin Development and Entrepreneurship Agency; 2021:1079–1087.
10. Ünal T., Seçilmiş N. Ar-Ge göstergeleri açısından Türkiye ve gelişmiş ülkelerle kıyaslaması. *İşletme Ve İktisat Çalışmaları Dergisi.* 2013;1(1):12–25. URL: https://www.acarindex.com/dosyalar/makale/acarindex-1423904911.pdf
11. Taban S. İktisadi Büyüme: Kavram ve Modeller. 1st ed. Ankara: Nobel Akademik Yayıncılık; 2008. 195 p.
12. Kar M., Taban S. İktisadi Gelişmenin Temel Dinamikleri ve Kaynakları. In: Kar M., Taban S., eds. İktisadi Kalkınmada Sosyal, Kültürel ve Siyasal Faktörlerin Rolü. İstanbul: Ekin Yayınevi; 2005:7–51.
13. Acar Y. İktisadi Büyüme ve Büyüme Modelleri. 4th ed. Bursa: Vipaş Yayınları; 2002. 172 p.
14. Frascati Kılavuzu 2002. Bilimsel ve Teknolojik Faaliyetlerin Ölçümü. Araştırma ve Deneysel Geliştirme Taramaları İçin Önerilen Standart Uygulama. Paris: OECD; 2002. 257 p. URL: https://www.tubitak.gov.tr/tubitak_content_files/BTYPD/kilavuzlar/frascati_tr.pdf
15. Krugman P., Wells R. Makroiktisat. 2nd ed. Transl. from Eng. Ankara: Palme Yayıncılık; 2011. 587 p.
16. Korkmaz S. Türkiye'de Ar-ge Yatırımları ve Ekonomik Büyüme Arasındaki İlişkinin VAR Modeli ile Analizi. *Journal of Yaşar University.* 2010;20(5):3320–3330. URL: https://dergipark.org.tr/tr/download/article-file/179292
17. Ertürk M. İşletme Biliminin Temel İlkeleri. İstanbul: Beta Yayınları; 2000. 596 p.
18. Kocamış T.U., Güngör A. Türkiye'de Ar-Ge Harcamaları ve Teknoloji Sektöründe Ar-Ge Giderlerinin Karlılık Üzerine Etkisi: Borsa İstanbul Uygulaması. *Maliye Dergisi*. 2014;(166):127–138. URL: https://ms.hmb.gov.tr/uploads/2019/09/166–08.pdf
19. Güzel S. Ar-Ge Harcamaları ve Vergi Teşvikleri: Belirli Ülkeler Karşısında Türkiye'nin Durumu. *Eskişehir Osman Gazi Üniversitesi İİBF Dergisi.* 2009;4(2):29–48.

20. Klette T.J., Møen J. R&D investment responses to R&D subsidies: A theoretical analysis and a microeconometric study. NHH Department of Finance and Management Science Discussion Paper. 2011;(15). URL: https://openaccess.nhh.no/nhh-xmlui/bitstream/handle/11250/164177/dpfor2011–15.pdf?sequence=1
21. Karakaş M., Adak M. Türkiye'de Ar-Ge, patent ve ekonomik büyüme ilişkisi (1970–2012). *Yalova Üniversitesi Sosyal Bilimler Dergisi.* 2015;5(9):127–145. DOI: 10.17828/yalovasosbil.234209
22. Genç M.C., Atasoy Y. Ar&Ge Harcamaları ve Ekonomik Büyüme Ilişkisi: Panel Veri Analizi. *Bilgi Ekonomisi ve Yönetimi Dergisi.* 2010;5(2):27–34. URL: http://www.beykon.org/dergi/2010/FALL/M.Genc.pdf
23. Akın H.B. Yeni Ekonomi: Strateji, Rekabet, Teknoloji Yönetimi. Konya: Çizgi Kitabevi; 2001. 356 p.
24. Ghaffar A., Khan W.A. Impact of research and development on firm performance. *International Journal of Accounting and Financial Reporting.* 2014;4(1):357–367. DOI: 10.5296/ijafr.v4i1.6087
25. Freimane R., Bāliņa S. Research and development expenditures and economic growth in the EU: A panel data analysis. *Economics and Business.* 2016;29(1):5–10. DOI: 10.1515/eb-2016–0016
26. Inekwe J.N. The contribution of R&D expenditure to economic growth in developing economies. *Social Indicator Research.* 2015;124(3):727–745. DOI: 10.1007/s11205–014–0807–3
27. Erdemli M., Çelik H. Ar-Ge Harcamaları ve Ekonomik Büyüme İlişkisi: Türkiye ve G7 Ülkeleri için Bir Uygulama. *Sosyal Bilimler Dergisi.* 2017;7(13):122–137.
28. Sağlam Y., Egeli H.A., Egeli P. Gelişmiş ve Gelişmekte Olan Ülkelerde Ar&Ge Harcmaları ve Ekonomik Büyüme Arasındaki İlişki: Panel Veri Analizi. *Sosyoekonomi.* 2017;25(31):149–165. DOI: 10.17233/sosyoekonomi.288873
29. Özkan G., Yılmaz H. Ar-Ge Harcamalarının Yüksek Teknoloji Ürün İhracatı ve Kişi Başı Gelir Üzerindeki Etkileri: 12 AB Ülkesi ve Türkiye İçin Uygulama (1996–2015). *Bilgi Ekonomisi ve Yönetimi Dergisi.* 2017;12(1):1–12. URL: https://dergipark.org.tr/tr/download/article-file/364578
30. Verbeek M. A guide to modern econometrics. Chichester: John Wiley & Sons Ltd; 2008. 514 p.
31. Granger C.W.J. Investigating causal relations by econometric models and cross-spectral methods. *Econometrica.* 1969;37(3):424–438. 10.2307/1912791
32. Granger C.W.J. Developments in the study of cointegrated economic variables. *Oxford Bulletin of Economics and Statistics.* 1986;48(3):213–228. DOI: 10.1111/j.1468–0084.1986.mp48003002.x
33. Hamilton J.D. Time series analysis. Princeton NJ: Princeton University Press; 1994. 820 p.
34. Charemza W.W., Deadman D.F. New directions in econometric practice: General to specific modelling, cointegration and vector autoregression. Cheltenham: Edward Elgar Publishing; 1993. 370 p.
35. Matthews P.H. Paradise lost and found? The econometric contributions of Clive W.J. Granger and Robert F. Engle. *Review of Poltical Economy.* 2005;17(1):1–28. DOI: 10.1080/0953825042000313780
36. Hong J.P. Causal relationship between ICT R&D investment and economic growth in Korea. *Technological Forecasting & Social Change.* 2017;116:70–75. DOI: 10.1016/j.techfore.2016.11.005
37. Börü M., Çelik D. Türkiye'de Ar-Ge Harcamaları, İnovasyon ve Ekonomik Büyüme İlişkisi. *R&S — Research Studies Anatolia Journal.* 2019;2(5):196–206. DOI: 10.33723/rs.537587

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