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The Effect Of R&D Activities Of Universities On Economic Growth: The Case Of Turkey

Üniversitelerin Ar-Ge Faaliyetlerinin Ekonomik Büyüme Üzerindeki Etkisi: Türkiye Örneği

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ABSTRACT

The creation of new products and production processes through innovation is possible with advanced technologies. In this context, R&D activities are needed while developing the production structure and methods currently used. The fact that countries have the power to produce a technology on their own and to export this technology positively affects economic growth. In the research, the effect of R&D activities carried out by universities in Turkey on economic growth was examined using ARDL approach and Granger causality test. The dataset includes 30 observations on an annual basis between 1990 and 2019. In the research, it was revealed that a 1% increase in R&D expenditures increased Turkey's GDP by 0.27%. In addition, bidirectional causality relationship was determined between R&D activities and GDP.

Keywords: R&D expenditures, GDP, ARDL approach

ÖZET

İnovasyon yoluyla yeni ürünlerin ve üretim süreçlerinin oluşturulması ileri teknolojilerle mümkündür. Bu bağlamda, mevcut üretim yapısı ve kullanılan yöntemler geliştirilirken Ar-Ge faaliyetlerine ihtiyaç duyulmaktadır. Ülkelerin kendi başlarına bir teknoloji üretme ve bu teknolojiyi ihraç etme gücüne sahip olmaları ekonomik büyümeyi olumlu etkilemektedir. Araştırmada, Türkiye'deki üniversiteler tarafından yürütülen Ar-Ge faaliyetlerinin ekonomik büyümeye etkisi ARDL yaklaşımı ve Granger nedensellik testi kullanılarak incelenmiştir. Veri setinde 1990 ile 2019 yılları arasında yıllık bazda 30 gözlem yer almaktadır. Araştırmada, Ar-Ge harcamalarındaki %1'lik bir artışın Türkiye'nin GSYİH'sini %0,27 oranında artırdığı ortaya konulmuştur. Ayrıca, Ar-Ge faaliyetleri ile GSYİH arasında çift yönlü nedensellik ilişkisi tespit edilmiştir.

Anahtar Kelimeler: Ar-Ge harcamaları, GSYİH, ARDL yaklaşımı

1. INTRODUCTION

One of the most important conditions for economic growth and gaining international competitiveness is innovations in the technological field. Technological innovations emerge as a result of research and development (R&D). The basis of the R&D subject is all the activities made for R&D and the expenditures made for these activities (Oğuz, 2020). Economic growth occurs as a result of producing more products and services by increasing production capacity. Over time, with the increases in the factors of production of the countries and the developments in the technological level, the production capacity increases and it is possible to produce more products and services (Ertek, 2009) Technological developments, which are shown as one of the factors of production, have the feature of increasing production and reducing costs in the economy (Öztürk, 2003).

When the income level and competitiveness of developed and developing countries are compared, it is seen that the income levels of countries with high competitiveness are also high. In this context, the way to increase income levels for countries is to increase their competitiveness. The main determinants of the competitiveness of the countries are the patented inventions and technological products produced by the companies and universities in the country. It is known that the competitiveness of the countries producing products with advanced technology is higher than the countries producing products with medium and low technology. In this context, countries aiming to increase their income level should produce products with advanced technology. Today, it is seen that the share allocated to R&D and education expenditures in countries producing high-tech products is higher than the share allocated in other countries. In this context, it is thought that R&D and education investments will be an important factor in producing products with advanced technology and accelerate economic growth (İğdeli, 2019)

R&D activities, which were previously carried out on the basis of enterprises, are evaluated on the basis of countries in today's economies. As a result, the debates on whether the R&D activities of the countries have an impact on the country's economy have increased day by day. (Duman & Aydın, 2018) When considering the

economic growth performances of the countries, starting from a single factor is insufficient to measure the performances of the countries. Technology and innovation play an important role in achieving higher growth rates. Factors such as knowledge transfer, internet networks, international networks and innovation have enabled the process to spread rapidly (Ünlükaplan, 2009). The fact that the country in question has the ability to produce a technology of its own and that it has the power to export this technology is one of the most important issues that add development to the country. The ability of both developed and developing countries to export high technology products in order to maintain their development has an important place among the determinants of economic growth (Kızılkaya, Sofuoğlu & Ay, 2017). When the recent studies are examined, it is seen that R&D expenditures play an important role in closing the income and growth gap between countries, increasing the GDP and increasing the high technology exports (Kılıç, Bayar & Özekicioğlu, 2014).

Basic research, which refers to experimental and theoretical studies aimed at producing new information on the basis of R&D, facts and observable facts; It includes three basic elements: applied research, which is defined as research carried out to create original ideas, and transforming the information obtained as a result of these researches into new product creation activities (OECD, 2002).

Knowledge has a significant impact on economic growth and development. Some of the causes of underdevelopment, apart from the scarcity of financial and real capital accumulation, are the lack of domestic human capital and the inaccessibility to technology. R&D expenditures are also an investment and such expenditures are made because the expenditures made for R&D investments will provide a higher return than the amount of expenditure made (Ağır & Utlu, 2011). R&D, which is one of the most important channels in which international investments create added value, is basically defined as creative works that increase the knowledge of people, including knowledge, and accordingly, systematically carried out to design new applications, also includes activities related to government or institutional innovations (Durgun & Çapik, 2018).

Technology and efficiency play a dominant role in countries' efforts to be superior in terms of competitiveness and economic development. Although technology and efficiency are very important in order to make economic growth sustainable, the main factor that provides this development is essentially R&D activities (Yaman, 2020). Technology and innovation have an impact on productivity and economic growth. It is thought that R&D expenditures increase innovation and thus contribute positively to the economic growth process (Bilbao-Osorio & Rodriguez-Pose, 2004). Today, the creation of innovation by creating new products and production processes and the development of innovative approaches depend on advanced technologies. For this purpose, R&D activities are needed, while the existing production structure is being reshaped, on the other hand, new production methods are being developed (Dereli & Salğar, 2019)

It is important to ensure a sustainable economic growth with the driving force provided by innovation. Innovation can be achieved as a result of company and national R&D activities or by importing technology from developed countries. The product introduced in technological innovations can be a technologically new product or a technologically improved version of an existing product (Korkmaz, 2010).

Universities play a very important role in both regional and national economic development. Although the role of universities in economic development is not fully understood, countries aiming to increase their economic wealth expect universities to contribute more to economic development (Sungur, 2015). Rapid technological innovation and its commercialization are the hallmarks of economic competitiveness and growth today. Universities have a facilitating role in the development and commercialization of technology (Porter, 2007).

It has been observed that there is no study in the literature that directly examines the role of R&D activities of universities in economic growth. In this study, it is aimed to analyze the effect of R&D activities carried out by universities in Turkey on economic growth.

2. LITERATURE REVIEW

In the literature, there are many studies examining the effects of R&D expenditures on economic growth, and the results obtained in the studies may differ due to the use of different variables and data sets. However, monitoring and measuring the relationship between R&D expenditures and GDP using different data sets enriches the existing finance literature and creates a decision support system for policy makers.

Table 1 provides information on studies examining the impact of R&D expenditures on GDP using various methods and data sets.

Table 1: Literature Review

Author	Method	Data Set	Results
Horvath, (2011)	Panel data analysis	72 countries (1960-1992)	R&D → GDP (+)
Sezgin, (2017)	Panel regression analysis	Developing and developed countries (2010-2016)	R&D → GDP (+)
Gülmez and Akpolat, (2014)	Panel GMM	Turkey and 15 EU countries (200-2010)	R&D and number of patents → GDP (+)
Falk, (2007)	Panel data analysis	19 OECD countries (1970-2004)	R&D → GDP (+)
Altıntaş and Mercan, (2015)	Durbin-Hausman Panel cointegration analysis	21 OECD countries (1996-2011)	R&D → GDP, fixed capital investment, employment (+)
Durgun and Çapik, (2018)	Johansen cointegration analysis and VECM	Turkey (1993-2016)	R&D → GDP and high-tech exports (+)
Dereli and Salğar, (2019)	Johansen cointegration analysis and Granger causality test	Turkey (1990-2015)	R&D → GDP (+) and bidirectional causality
Dağlı and Ezanoğlu, (2021)	Arellano and Bond GMM	36 OECD countries (2007-2017)	R&D and number of patents → GDP (+)
Genç and Tandoğan, (2020)	Fourier cointegration analysis	Turkey (1990-2017)	R&D → GDP (+) and bidirectional causality
Oğuz, (2020)	Panel data analysis	G8 countries (1997-2017)	R&D → GDP (+)
Özcan and Özer, (2017)	Westerlund Panel cointegration	23 OECD countries (1995 – 2013)	R&D and number of patents → GDP (+)
Yıldırım and Kantarcı, (2018)	Panel data analysis	15 Developing countries (1998-2013)	R&D → GDP (≠)
Korkmaz, (2010)	Johansen cointegration analysis	Turkey (1990-2008)	R&D → GDP (+)
Köse and Şentürk, (2017)	OLS method	Turkey (1989-2012)	R&D → GDP (+)
Bayraktutan and Kethudaoğlu, (2019)	Panel data analysis	29 OECD countries (1996-2015)	R&D → GDP (+)
Duman and Aydın, (2018)	Causality analysis	Turkey (1998-2015)	One-way causality R&D → GDP
İğdeli, (2019)	ARDL bounds test	Turkey (1990-2016)	R&D → GDP (+) (One-way causality R&D → GDP)
Börü and Çelik, (2019)	Causality analysis	Turkey (2004-2016)	One-way causality R&D → GDP
Gülmez and Yardımcıoğlu, (2012)	Panel cointegration analysis and causality test	21 OECD countries (1990-2010)	R&D → GDP (+) and bidirectional causality
Özcan and Arı, (2014)	Panel data analysis	15 OECD countries (1990-2011)	R&D → GDP (+)
Taban and Şengür, (2014)	Johansen cointegration analysis and VECM	Turkey (1990-2012)	R&D → GDP (+)
İnal, Altıntaş and Çalışkan, (2016)	Causality analysis	Turkey (1990-2013)	One-way causality GDP per capita → R&D
Taş, Taşar and Açcı, (2017)	VAR analysis	Turkey (2005-2015)	One-way causality R&D → GDP
Güneş, (2019)	Panel data analysis	32 OECD countries (2000-2014)	R&D → GDP (+) one-way causality GDP → R&D
Kesikoğlu and Saraç, (2017)	Panel regression analysis	12 statistical regions in Turkey (2010-2014)	R&D → GDP (+)
Yıldırım, Akkılıç and Dikici, (2018)	Panel data analysis	G-20 countries	R&D → GDP and export (+)
Özkan and Yılmaz, (2017)	Panel data analysis	12 EU countries and Turkey (1996-2015)	R&D → high-tech product exports and GDP (+)
Torun and Çabaş, (2020)	FMOLS and DOLS	Turkey (1990-2018)	R&D → GDP (+)
Uyğun and Durmuş, (2020).	Causality analysis	Turkey (1990-2016)	One-way causality GDP → R&D

Note: The table was created by the author and positive effect, negative effect or no effect among the variables are expressed with +, - and ≠ signs, respectively.

3. DATA AND VARIABLES

The dataset of this study includes 30 observations on an annual basis between 1990 and 2019. In the study, while Turkey's GDP is determined as the dependent variable, R&D expenditures made by universities in Turkey constitute the independent variable. GDP and R&D expenditures were made real with the GDP deflator and their natural logarithms were taken.

In this study, it is aimed to examine the role of R&D activities of universities on GDP. The relationship between the variables is given in Equation 1. Information about the variables in the equation is given in Table 2.

$$lnGDP_t = \beta_0 + \beta lnR\&D_t + \varepsilon_t \quad (1)$$

Table 2: Variable Information Used in the Study

Variable	Description of the Variable	Period	Source of Data
lnGDP	Turkey's GDP	1990-2019	World Bank Database
lnR&D	R&D expenditures made by universities in Turkey	1990-2019	TUIK Database

4. EMPIRICAL ANALYSIS

4.1. Descriptives, Methodology, Empirical Results And Discussion

The problem of spurious regression is to obtain a high level of correlation by ignoring the characteristics of the variables while creating dynamic econometric models (Holden & Thomson, 1992). In this study, the ARDL bounds test was used to avoid the constraints of cointegration tests such as Engle & Granger (1987) and Johansen & Juselius (1990). The created ARDL model is given below.

$$\Delta lnGDP_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta lnGDP_{t-i} + \sum_{i=0}^{q} \beta_{2i} \Delta \mathrm{lnR\&D}_{t-i} + \lambda_{1i} lnGDP_{t-1} + \lambda_{2i} ln\mathrm{R\&D}_{t-1} + v_{1t,} \quad (2)$$

According to the ARDL approach, in order to accept the existence of a cointegration relationship between the variables, F statistic must be greater than the upper value limit (Pesaran, Shin & Smith, 2001). In case of long-term cointegration relationship, long (Equation 3) and short-term (Equation 4) model parameters are estimated with the following equations.

$$lnGDP_t = \propto_1 + \sum_{j=1}^{p} \varphi 1_j ln\, GDP_{t-i} + \sum_{j=1}^{p} \omega 1_j lnR\&D_{t-i} + \mu_t \quad (3)$$

$$\Delta lnGDP_t = \gamma_0 + \sum_{j=1}^{p1} \gamma_{1i} \Delta lnGDP_{t-i} + \sum_{j=1}^{p2} \gamma_{2i} \Delta lnR\&D_{t-i} + + \psi ECT_{t-1} + \vartheta t, \quad (4)$$

At the beginning of the econometric analysis, the stationarities of the variables were examined with unit root tests, and it was seen that the lnGDP and lnR&D series were not I(2) as given in Table 3.

Table 3: Unit Root Tests

Variables	Augmented Dickey–Fuller	Phillips–Perron
lnGDP	-5.6025* I(1)	-5.6113* I(1)
lnR&D	-5.0142* I(0)	-3.8913* I(0)

**Significant at the 5%*

As seen in Figure 1, the appropriate model was determined as ARDL (4,3) model using Akaike Information Criteria. The model included 4 lags for the dependent variable and 3 lags for the independent variable.

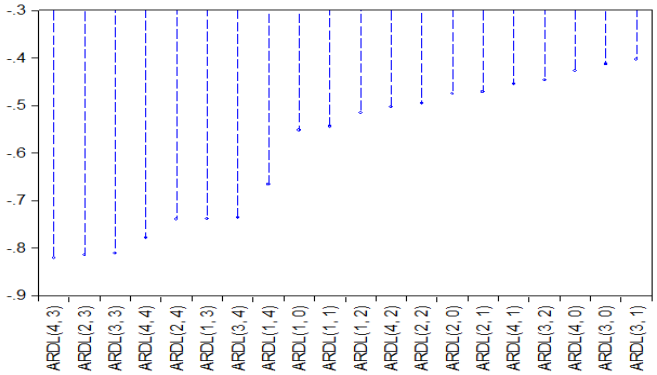

Figure 1: Akaike Information Criteria

The ARDL bounds test results, which were conducted to investigate the cointegration relationship between R&D activities of universities and economic growth, are given in Table 4. It was determined that the F statistic value was greater than the upper critical value at all significance levels, and a long-term cointegration relationship was found.

Table 4: ARDL Bounds Test

Test Statistic	**Value**	**Significance**	I(0)	I(1)
F-statistic	8.4176	10%	4.04	4.78
k	1	5%	4.94	5.73
		2.5%	5.77	6.68
		1%	6.84	7.84

The estimated coefficient for the long-term relationship between the variables and the direction of the coefficient are given in Table 5. According to the cointegration model, R&D activities carried out by universities increase Turkey's GDP by 0.27%. In addition, the error correction term coefficient in the model has been determined as -0.58, and the fact that the said value is between 0 and -1 indicates that the long-term equilibrium relationship returns to the stationary state when the system is shocked.

Table 5: Cointegrating Form and Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNGDP(-1))	0.319064	0.167518	1.904659	0.0739
D(LNGDP(-2))	0.189638	0.174582	1.086238	0.2925
D(LNGDP(-3))	0.169459	0.136686	1.239768	0.2319
D(LNR&D)	0.452141	0.196956	2.295641	0.0347
D(LNR&D (-1))	0.239332	0.296251	0.807868	0.4303
D(LNR&D (-2))	-0.619043	0.215887	-2.867438	0.0107
CointEq(-1)	-0.581454	0.156101	-3.724849	0.0017
LNR&D	0.271487	0.040777	6.657782	0.0000
C	21.334846	0.946741	22.535034	0.0000
Cointeq = LNGDP - (0.2715*LNR&D + 21.3348)				

The results of the tests performed to investigate the normal distribution of the series, the existence of heteroskedasticity in the model and autocorrelation problems in the model results are given in Table 6. Model was formulated without a violation of functional form according to Ramsey Reset test.

Table 6: Diagnostic Tests

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	0.6228	Prob. F(2,34)	0.5497
Obs*R-squared	1.9937	Prob. Chi-Square(1)	0.3690
Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F- statistic	1.2214	Prob. F(2,36)	0.3415
Obs*R-squared	8.3728	Prob. Chi-Square(8)	0.3009
Jarque-Bera	1,1084	Prob.	0,5745
Ramsey Reset Test	0.7848	Prob.	0.3888

The coefficient estimated by the ARDL model was examined by the structural break tests developed by Brown, Durbin & Evans (1975). As a result of the CUSUM and CUSUMQ tests given in Figure 2, it was determined that the coefficient was between the curve. This indicates that the estimated coefficient does not contain structural break.

Figure 2: Plot of CUSUM (left panel) and CUSUMQ (right panel)

Finally, the causal relationship between the variables is examined in Table 7. As seen in the table, two-way Granger causality was detected between the variables.

Table 7: Granger Causality Test

H_0	F-statistic	Prob.
lnGDP → lnR&D	4.79950	0.0181
lnR&D → lnGDP	6.75075	0.0049

4. CONCLUSION

Economic growth, which is among the main problems of macroeconomics, is important in terms of affecting the living standards and welfare in countries. R&D investments are accepted as one of the important parameters in evaluating the competitiveness and economic development of a country. R&D activities of businesses, universities and countries in general affect economic growth in many ways. Knowledge, R&D, qualified workforce and technological development are of great importance in increasing economic growth in a sustainable way, and R&D

is the most important investment in knowledge creation. For this reason, when defining R&D, the expression of transformation process with high added value, in which knowledge becomes a tangible product, is used.

In this study, it is aimed to analyze the effect of R&D activities carried out by universities on economic growth. When the findings obtained from the analysis of the research were evaluated, it was seen that they were compatible with the results in the literature. As a result of the ARDL bounds test, a cointegration relationship was determined between the R&D activities of universities and GDP. In the study, the long-term cointegration coefficient of R&D was found to be 0.27%. Structural break in the estimated coefficient was examined by CUSUM and CUSUMQ tests and it was determined that there was no structural break. In addition, in the study, bidirectional Granger causality between GDP and R&D was revealed.

Due to the fact that R&D activities of universities are of great importance for economic growth, universities should be encouraged to increase their R&D activities.

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