yönetim ve ekonomi araştırmaları dergisi
journal of management and economies research
Cilt/Volume: 20 Sayı/Issue: 3 Eylül/September 2022 ss. /pp. 351-372
S. Konya, A. Şakalak, Z. Karaçor, http://dx.doi.org/10.11611/yead.1108032

CAN R&D ACTIVITIES TRIGGER ECONOMIC GROWTH AND EMPLOYMENT? EMPIRICAL EVIDENCE FROM SELECTED COUNTRIES

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ABSTRACT

This study is targeted to empirically analyze the impact of research & development expenditures on economic growth and unemployment in 25 selected countries from the years 1996-2020. Panel data analysis was carried out with methods that take into account the cross-section dependency. Westerlund's cointegration test was used to determine the cointegration relationship between the variables. After the determination of the cointegration relationship, coefficient estimation was made with panel ARDL methods. It revealed that there is an interaction between research & development expenditures and economic growth in the short and long term. However, while a relation was determined between research & development expenditures and employment in the short run, no relationship was found between the two variables in the long term. Dumitrescu and Hurlin causality analysis was applied to determine the causal relationship. Dumitrescu and Hurlin causality test showed that there is a bidirectional causal relationship between the variables. As a result of the study, it was determined that there is a relationship between R&D expenditures and economic growth and employment. Countries should follow policies that will increase their growth performance and employment sustainably.

Keywords: *Economic Growth, Employment, Unemployment, Panel Data Analysis, R&D Expenditures*

JEL codes: *030, O32, E24, C32.*

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Makale Geçmişi/Article History

Başvuru Tarihi / Date of Application	: 23 Nisan / April 2022
Düzeltme Tarihi / Revision Date	: 6 Ağustos / August 2022
Kabul Tarihi / Acceptance Date	: 9 Ağustos / August 2022

Araştırma Makalesi/Research Article

AR-GE FAALİYETLERİ EKONOMİK BÜYÜME VE İSTİHDAMI TETİKLEYEBİLİR Mİ? SEÇİLMİŞ ÜLKELERDEN AMPİRİK KANITLAR

ÖZET

Bu çalışmada, 1996-2020 yılları için seçilmiş 25 ülkede araştırma & geliştirme harcamalarının ekonomik büyüme ile işsizlik üzerindeki etkisinin ampirik olarak analiz edilmesi amaçlanmıştır. Yatay kesit bağımlılığı dikkate alan yöntemler ile panel veri analizi yapılmıştır. Değişkenler arasındaki eşbütünleşme ilişkisinin tespiti için Westerlud eşbütünleşme testi kullanılmıştır. Eşbütünleşme ilişkisinin tespitinin ardından panel ARDL yöntemleri ile katsayı tahmini yapılmıştır. Kısa ve uzun dönemde araştırma & geliştirme harcamaları ile ekonomik büyüme arasında bir etkileşim olduğunu ortaya çıkarmıştır. Ancak araştırma & geliştirme harcamaları ile istihdam arasında kısa dönemde bir ilişki belirlenmiş iken uzun dönemde iki değişken arasında bir ilişki bulunamamıştır. Nedensel bağıntının tespiti için Dumitrescu ve Hurlin nedensellik analizi uygulanmıştır. Dumitrescu ve Hurlin nedensellik testi değişkenler arasında çift yönlü nedensel ilişki olduğunu göstermiştir. Çalışmanın sonucunda Ar-Ge harcamaları ile ekonomik büyüme ile istihdam arasında bir ilişki olduğu belirlenmiştir. Ülkeler sürdürülebilir şekilde büyüme performanslarını ve istihdamlarını arttıracak politikalar izlemelidir.

Anahtar Kelimeler: *Ekonomik Büyüme, İstihdam, İşsizlik, Panel Veri Analizi, Ar-Ge Harcamaları*

JEL Kodları: *030, O32, E24, C32.*

1. INTRODUCTION

Research results in recent years show that R&D, growth, and employment are among the important issues. R&D, defined as innovation activities, is shown as the resource of economic growth in developing countries. While globalization causes the search for innovation in science and technology among countries, the rapidly increasing competitive environment reveals the importance of R&D expenditures. However, the effect of technological developments caused by R&D activities on employment potential has brought some discussions to the agenda.

R&D is the locomotive power in the growth process of countries. Differences in the development levels of countries cause differences in economic growth and employment rates. In this context, this study aimed to investigate the relationship between R&D expenditures, economic growth, and employment with econometric analysis methods that take into account the cross-sectional dependency.

The study targets to specify the impact of research & development expenditures on economic growth and employment in 25 selected countries, whose data can be accessed in the period covering the years 1996-2020, with second-generation panel data analysis procedures. Unlike other studies in the literature, in our study; Short and long-term relationships and causal relations between research & development expenditures, economic growth, and unemployment are searched with econometric analysis methods that consider cross-sectional dependence and heterogeneity together. At this point, our study differs from other studies in the economic literature due to the econometric methods used, the country sample, and the number of observations.

In our study, following the introduction, in the first part, the knowledge economy was evaluated in the conceptual framework. In the second part, the importance of research & development expenditures is given. In the third chapter, the literature review on the subject is summarized. In the fourth part of the study, the data set and descriptive statistics, and empirical discoveries are included. In the end, in the conclusion part, the study is briefly summarized and policy recommendations are given.

2. EVALUATION OF THE KNOWLEDGE ECONOMY IN THE CONCEPTUAL FRAMEWORK

The knowledge economy, which was first used by Machlup in 1958, shaped the world economy, during the Industrial Revolution, II. It was the basis of events such as world war. Then, in 1969, Drucker included this concept in his work "The Age of discontinuity" In 1994, the advent of the internet, was a turning point and enabled the information economy to take its place in the economic conjuncture (Kevuk, 2006).

Synonymous with many concepts, the term is an information-based new economy based on communication and information technologies. With the introduction of this concept in literature, a new one has been added to the production elements such as human and capital resources (Yılmaz, 2013). Thanks to information and communication technologies, healthy communication will result in decreases in transaction costs (Kevuk, 2006). The characteristics of the information economy that differ from the traditional economy in many aspects are indicated in Table 1 as articles.

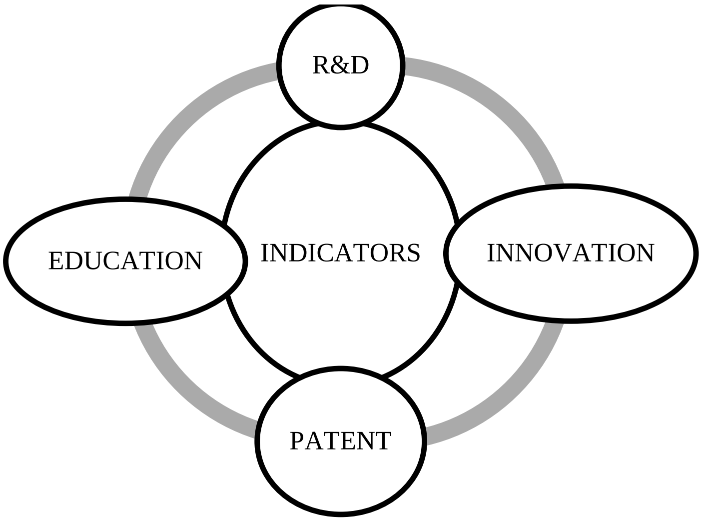
Table 1. Properties of Information Economy

1. Molecular and network economy.
2. Reason and information are at the forefront
3. The digital economy
4. Production factor
5. Has competitive advantage.
6. Creative and innovative.
7. An economy without intermediaries
8. Is a global economy

Source: Created by authors.

As shown in Figure 1, the main indicators of the new economy consist of R & D expenditures, Education, patents, and finally innovation. The R & D expenditures that constitute the subject of the study were examined in detail in the next section.

Figure 1. Main Indicators of Knowledge-Economy



Source: Created by authors

3. CONCEPTUAL FRAMEWORK OF RESEARCH & DEVELOPMENT EXPENDITURES

3.1. Definition and Scope of Research & Development Expenditures

In a rapidly changing world, countries must be open to all developments so that they can achieve sustainable competitive advantage. The countries' adaptation to the changing world order, benefiting from the innovations brought by the technology, and making the necessary investments in the information age will lead to the development of the national economies and thus have a competitive advantage. At this point, the significance of research & development expenditures has emerged for the development of the information age.

Research & Development expenditures, identified as the creation of new production techniques and the creation of new products based on both technology and knowledge, are the driving force of the economic world. At the same time, it is a concept that includes creative works to increase the knowledge level of both individuals and society and transform these into new applications (Kavak, 2009). Research&Development indicators, consisting of five items, are not unidirectional and shed light on the differences in the development levels of countries.

3.2. R&D Expenditures in Global Perspective

As a result of theoretical research, it has been shown that countries are introduced to new technologies thanks to R&D activities and that economic growth occurs in the long run and leads to an increase in productivity. When the studies applied to this subject are examined by countries, it is concluded that a 1% raise in any R & D stock results in a rise of 0.05% and 0.15% in the output Ülger (2017). Table 2 shows the levels of research and development in selected countries after the 2008 crisis that affected the whole world.

Table 2. R&D Expenditures in Selected Countries

COUNTRY	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Austria	2.597	2.726	2.669	2.915	2.955	3.084	3.05	3.117	3.057	3.091	3.13	3.201
Belgium	1.999	2.062	2.173	2.281	2.331	2.37	2.428	2.523	2.667	2.86	3.16	3.477
China	1.665	1.714	1.78	1.912	1.998	2.022	2.057	2.1	2.116	2.141	2.235	2.401
Czech Republic	1.287	1.327	1.545	1.77	1.879	1.958	1.917	1.67	1.769	1.899	1.928	1.991
Finland	3.734	3.705	3.618	3.398	3.271	3.148	2.872	2.724	2.728	2.757	2.8	2.913
France	2.212	2.179	2.192	2.227	2.237	2.276	2.227	2.222	2.199	2.197	2.192	2.355
Germany	2.743	2.73	2.806	2.882	2.836	2.878	2.934	2.94	3.047	3.108	3.168	3.144
Hungary	1.128	1.128	1.179	1.254	1.384	1.344	1.339	1.18	1.317	1.508	1.477	1.608
Ireland	1.614	1.595	1.553	1.558	1.568	1.522	1.183	1.176	1.255	1.169	1.226	1.232
Italy	1.218	1.218	1.202	1.262	1.301	1.338	1.339	1.366	1.37	1.424	1.462	1.531
Japan	3.196	3.105	3.205	3.174	3.279	3.368	3.241	3.107	3.166	3.221	3.215	3.275
Korea	3.147	3.316	3.592	3.85	3.951	4.078	3.978	3.987	4.292	4.516	4.627	4.815
Latvia	0.449	0.606	0.716	0.663	0.613	0.689	0.619	0.435	0.511	0.639	0.637	0.707
Lithuania	0.831	0.783	0.903	0.893	0.949	1.03	1.043	0.842	0.896	0.937	0.995	1.155
Mexico	0.48	0.495	0.471	0.421	0.425	0.435	0.429	0.388	0.328	0.307	0.284	0.297
Netherlands	1.666	1.704	1.881	1.916	2.156	2.173	2.146	2.151	2.179	2.139	2.184	2.294
Poland	0.661	0.72	0.747	0.884	0.876	0.945	1.003	0.963	1.034	1.209	1.321	1.392
Portugal	1.58	1.535	1.457	1.379	1.325	1.29	1.243	1.281	1.319	1.35	1.396	1.617
Romania	0.444	0.457	0.499	0.485	0.388	0.382	0.488	0.481	0.503	0.501	0.478	0.469
Russia	1.166	1.052	1.015	1.028	1.027	1.072	1.101	1.102	1.11	0.99	1.039	1.098
Slovak Republic	0.473	0.608	0.655	0.798	0.823	0.88	1.161	0.791	0.887	0.84	0.826	0.911
Slovenia	1.812	2.051	2.413	2.561	2.565	2.365	2.196	2.008	1.865	1.946	2.047	2.147
Spain	1.364	1.36	1.333	1.299	1.275	1.242	1.222	1.19	1.21	1.242	1.251	1.405
Turkey	0.804	0.794	0.794	0.826	0.812	0.856	0.877	0.938	0.953	1.025	1.064	1.089
United States	2.807	2.725	2.755	2.672	2.702	2.718	2.787	2.853	2.905	3.013	3.175	3.45

Source: OECD, 2022a

According to Table 2, decreases were observed in some periods in countries. However, except for a few countries, there has been an increase in R&D expenditures in general. Especially according to the latest data, Korea ranked first with 4,815, followed by Belgium. Mexico, on the other hand, took the last place with 0.297 out of 25 countries. In our country, the expenditure, which was 0.804 in 2009, increased to 1.089 in 2020 and increased by 0.285.

4. LITERATURE REVIEW

Studies on research & development activities have been the subject of discussion for many years. Studies with different samples and different analysis methods have revealed the result of a wide examination of the literature. However, the relation between employment and economic growth has become the topic of discussion after the 2000s. Depending on the relations between employment and R&D activities, there are generally studies conducted with a microeconomic perspective. This study, it is aimed to promote the literature by searching the impact of research & development activities on economic growth and employment from a macroeconomic perspective.

Sylwester (2001), in his study, the relation between economic growth and research & development in G7 and 20 OECD countries was examined through a multivariate regression model. As a consequence of the analysis, it was found that there is a positive relation between the changeable in G7 countries and accomplished that there is no relationship in 20 OECD countries.

Zachariadis (2004), covering 10 OECD countries in the study, the impact of research & development expenditures on economic growth was analyzed with the help of regression analysis between 1971-1995. He linked R&D intensity to two reasons in the equations. These are productivity and growth increases. As a consequence of econometric analysis, it was concluded that the rise in research & development expenditures had a positive impact on output levels and growth rates in productivity.

Yanyun and Mingqian (2004), researched the long-run relation between research & development expenditure and economic growth for 8 Asean +3 economy countries for the period 1994-2013. As a consequence of the study, they specified a positive relation between research & development expenditures and growth.

Falk (2007), in his study, viewed the effect of research & development expenditures and high-tech research & development investments on income per capita in 15 OECD countries from the period 1970-2004. In consequence, the study found that research & development expenditures and high technology research & development investments, in the long term, had a positive impact on both GDP per hour worked and GDP per capita.

Goel, Payne, and Ram (2008), searched the relation between research & development expenditure and economic growth for the 1953-2000 period in the USA. As a consequence of the study, they found a stronger relation between economic growth and federal research & development expenditures compared to non-federal research & development expenditures.

Mate-Garcia and Rodriguez Fernandez (2008), researched the interaction of research & development with growth in Spain from the period 1990-1999. Analysis through time series revealed a positive relationship.

Samimi and Alerasoul (2009), researched the effect of research & development expenditures on economic growth in 30 developing countries in the period 2000-2006. As a consequence of the study, they specified that research & development expenditures did not affect economic growth. They saw the reason for the lack of a relationship between the two variables as low R&D expenditure in developing countries.

Kaya and Altın (2009), Vector Error Correction model correlating the framework of research & development spending and growth was examined in Turkey. As a result of the study, differences between the periods were determined. While there was no relationship in the short run, it was revealed that research & development expenditures were the reason for the growth in the long term.

Zhanga et al. (2010), panel data analysis procedures were carried out in the study in which the relation between faculty member employment and external research & development expenditures was investigated. The results of the study exposed that those expenditures are considerably affected by both the amount of their own institutionally funded and the level of federal funding.

Yaylalı et al. (2010), in their study, studied the effect of the economic growth of investment in research & development expenditures in Turkey. In their study in which ADF unit root test, causality, and cointegration tests were used, 1990 - 2009 periods were taken as the basis. As a consequence of the econometric analysis, a one-way relation has been specified between research & development investment expenditures to economic growth in the long run.

Peng (2010), searched the relation between research & development expenditure and growth in China. He used time series analysis in his study covering the period 1987-2007. The results revealed the long-run relation between the changeable.

Eid (2012), study aims to measure the rate of return on the research & development of higher education in 17 high-income OECD countries based on 1981-2006. Dynamic panel data analysis was used as the econometric model in the study. As a consequence of the study, it was revealed that the research & development expenditures made in the next years created a positive increase in productivity.

Tuna, Kayacan, and Bektaş (2015), in their study, the impact of research & development expenditures on growth in Turkey between 1990-2013 were investigated. As a consequence of the analysis, neither cointegration nor causality could be detected.

Dam and Yıldız (2015), examined whether research & development and innovation have any effect on growth for BRICS-TM countries. Panel data analysis was performed using data covering the years 2000-2012. Test results showed that both had a significant positive effect on growth.

In the study of Szarowská (2016), the relation between growth and research & development expenditures was investigated in 20 European Union member countries between the years 1995-2013. According to the consequences of the empirical study using the dynamic panel data procedure, it has been revealed that there is a statistically meaningful relation between the changeable.

Alper et al. (2017), in the study conducted in Turkey, the relation between growth and research & development expenditures was analyzed with Bayer-Hanck cointegration and the Hatemi-J asymmetric causality test tool. As a consequence of the results; While a long-run relation emerged between the changeable in 1996-2015, research&development expenditures of the negative and positive components of economic growth to the negative and positive components in the correct causality have been determined.

Ülger (2017), in the study, analyzed the relation between growth and research & development expenditures in 38 OECD countries using 1996-2015 data. As a consequence of the study, he revealed that there is a positive relation between the changeable.

Kesikoğlu and Saraç (2017), research&development effects on growth in Turkey on a regional level are examined. Depending on the growth of 12 regions and research & development expenditures based on 2010 and 2014 periods, a regional comparison was made. As a consequence of the analysis, it was found that the region which had the most effect was Northeast Anatolia and there was a positive relation between research & development expenditures (GDP) in other regions.

Bayraktutan and Kethudaoğlu (2017), stated that research & development gained importance with the internalization of the technology element, and the effect of research & development expenditures, as well as research & development personal employment on growth by using the panel data set procedure in 29 OECD countries, was investigated. As a result of this research, it has been shown that researchers working full-time in the research & development field and research & development expenditures affect economic growth positively.

Odabaşı and Erdal (2018), selected OECD countries were examined within the scope of the study and it was revealed that there is a high level of growth in countries with a high level of scientific publications such as research & development expenditures and several patents, and thus a positive relation exists between knowledge economy and growth.

Özcan (2018), covering 23 OECD countries, in his study, the effect of patent application and research & development expenditures on economic growth was researched with the help of panel data analysis. Although the econometric results show that there is a positive relation in both the long and short run, no statistically significant relation was found in the short term.

Gerçeker et al. (2020), the relation between unemployment and research & development expenditures in the G7 countries between 1990 and 2016 was analyzed. In compliance with the results of Kónya's (2006) Panel Bootstrap Granger causality test, it was found that there is a one-direction relation between research & development expenditures and unemployment in both Canada and the USA, while there is a reciprocal link in the remaining four countries

Akarsu et al. (2020), the relation between research & development expenditures and the growth figures of patent applications in 14 countries between 1996-2017 was examined. As regards the panel data results, it was determined that while the patent application had a negative relationship, research & development expenditures had a positive effect of 0.87 on growth.

Olaoye et al. (2021), the effect of government efficiency and research & development on GDP was investigated in selected African countries between 2000 and 2016, covering 16 periods. The results of the analysis, in which linear and PCSE's regression models were applied, revealed that both variables had a decisive impact on growth.

Ali et al. (2021), the effect of research & development investments on GDP in the world's top 100 economies was analyzed with the Panel ARDL Model approach. In consequence of the results of the research covering the years 1995-2015, although no effect was found in a short time, a strong positive relationship was detected in the long term.

Gür (2021), in the research based on EU member countries, the impact of research & development expenditures on youth unemployment was analysed. In the scope of the study, panel co-integration analysis was made based on the years 2000-2018. According to the empirical application results, although unemployment has decreased in all countries, the effect on former members is determined to be 1.5% higher.

Fendoğdu et al. (2021), the relation between the number of researchers working in the field of research & development, research & development expenditures, growth, and total factor productivity in 10 newly industrialized countries, including Turkey. Within the scope of the study, panel data analysis was carried out based on the 1996-2019 periods. In consequence of the results of the research, a positive correlation was found between all changeable, although it was stronger in economic growth.

Konya and Durgun (2022), with the help of panel data, the relation between employment and research & development expenditures in G7 countries researched. According to the results of the analysis made with the help of 1980-2019 data, there is a long-term relation between the two changeable.

Tekin et al. (2022), used the Vector Error Correction Model (VECM), Pedroni cointegration test, and Granger causality to analyze the impact of both technological and scientific performance on GDP between 2003 and 2016. While the analysis showed that research & development expenditures and the number of patents had a long-run relation with GDP, it was revealed that GDP was also the cause of research & development expenditures.

The relation between research & development expenditures and economic growth has been the topic of discussion for many years and therefore has a large literature. Since the literature is large, the literature section of our study includes studies that explain the relation between research & development expenditures and economic growth after the 2000s. Within this scope, when the relations between research & development expenditures and economic growth are studied, it is seen that research & development expenditures have a positive and meaningful impact on economic growth. When we evaluate the studies explaining the relation between research & development expenditures and employment, it is seen that the causality relation between research & development expenditures and employment are investigated. As a consequence of causality analysis, it is generally seen that the results are in the direction of a bidirectional causal link.

5. DATA SET AND DESCRIPTIVE STATISTICS

In the study, which targets to specify the effect of research & development expenditures on economic growth and employment (unemployment) by panel data analysis procedures, panel data analysis was carried out with a 25-year series the study covering the 1996-2020 period. The countries that are the subject of the research consist of 25 selected countries[1] whose data can be accessed. The data set and data sources used in the econometric analysis are explained in Table 3.

Table 3. Data Set

Data	**Data Set Used**	**Abbreviation**	**Source**
Research & Development expenditures	Gross domestic expenditure on R&D Total, % of GDP	RD	OECD (2022a)
Economic Growth	GDP growth per capita (% annual)	GROWTH	World Bank (2022)
Unemployment	Unemployment Rate	UN	OECD (2022b) and World Bank (2022)

Source: constituted by the authors

The models in which the impacts of research & development expenditures on economic growth and employment are investigated are shown with the help of the following equations:

$$\text{Model 1: } GROWTH = a_0 + \beta_i RD_t + \varepsilon_{it} \quad (1)$$

$$\text{Model 2: } UN = a_0 + \beta_i RD_t + \varepsilon_{it} \quad (2)$$

i is the country with cross-section units, t is the time dimension, a and β are the long-term coefficients. Descriptive statistics of the changeable are shown in Table 4.

Table 4. Descriptive Statistics

Variables	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**
RD	625	6.732024	74.42666	.251	1155
GROWTH	625	2.461406	3.834369	-13.88775	23.99909
UN	625	8.004099	3.989119	2.016667	26.11667

Source: Authors' calculations

As is seen in Table 4, the data set used in the research consists of 625 observation numbers. The average research and development expenditure was found to be approximately 6.73. While the maximum value was found to be approximately 26.12 for the relevant period in unemployment rates, the minimum value was found to be approximately 2.02.

[1] Austria, Belgium, China, Czech Republic, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Korea, Latvia, Lithuania, Mexico, Netherlands, Poland, Portugal, Romania, Russia, Slovak R., Slovenia, Spain, Turkey, United States

5.1. Cross-Section Dependence and Unit Root Test

Breusch and Pagan's (1980) LM Test can be used in models where the cross-sectional dimension is smaller than the time dimension. Pesaran (2004) developed a method that is valid for both cross-sectional and small sample sizes (Pesaran, 2004: 1-5). The results of the cross-section dependency test performed on the changeable are shown in Table 5.

Table 5. Cross-Section Dependency Test Results of Variables

	RD		Growth		UN	
	Statistics	p-value	Statistics	p-value	Statistics	p-value
CD_{lm} (BP,1980)	2906.736	0.000***	2685.298	0.000***	1406.011	0.000***
CD_{lm} (Pesaran, 2004)	106.4196	0.000***	97.37940	0.000***	45.15272	0.000***
CD (Pesaran, 2004)	43.65924	0.000***	48.08122	0.000***	15.09545	0.000***
LM_{adj} (PUY, 2008)	105.8987	0.000***	96.85857	0.000***	44.63189	0.000***

Note: ***, ** and * 1%, 5%, and 10% respectively represent significance. The findings for the research were obtained from Eviews 10.
Source: Authors' calculations.

When the results in Table 5 are researched, it is concluded that the variables contain cross-section dependency. CIPS unit root test, which is the second-generation unit root test, was performed due to the cross-section dependency of the changeable. The findings of the CIPS unit root test are reported in Table 6.

Table 6. CIPS Unit Root Test Results

	Constant		**Constant and Trend**	
LEVEL				
Variable	**Statistics**	**P value**	**Statistics**	**P value**
RD	-0.645	1.000	-1.629	1.000
GROWTH	-2.354	0.001***	-2.426	0.266
UN	-2.079	0.047**	-2.982	0.000***
FIRST DIFFERENCE				
RD	-2.019	0.085*	-2.233	0.660
GROWTH	-2.545	0.000***	-2.485	0.174
UN	-2.817	0.000***	-2.857	0.002***
		% 10	% 5	% 1
Critical values	**Constant**	-2.070	-2.150	-2.300
Critical values	**Constant and Trend**	-2.580	-2.660	-2.810

Note: ***,** and * 1%, 5%, and 10% respectively represent significance.
Source: Authors' calculations.

As is seen from Table 6, accordingly the CIPS unit root test outcomes, economic growth becomes stationary when the first difference is taken in the fixed model. In research&development expenditures, on the one hand, stagnation was achieved at the level value in the fixed model. The unemployment variable is stationary in level value according to the model with both constant and trend. After determining the stationarity of the variables, the cross-section dependency test and the Swamy homogeneity test were applied to the models that were the subject of our study. The findings obtained from the cross-section dependency and homogeneity test are reported in Table 7.

Table 7. Cross-section Dependency and Swamy S Homogeneity Tests

Regression Model:		
Model 1: $\boldsymbol{GROWTH = a_0 + \beta_i RD_t + \varepsilon_{it}}$	**Statistic**	**p-value**
Cross-section dependency tests:		
LM (BP,1980)	2076	0.0000***
CD_{lm} (Pesaran, 2004)	40.98	0.0000***
LM_{adj} (PUY, 2008)	198.6	0.0000***
Swamy S Homogeneity tests:		
chi2(48) = 444.82	Prob > chi2 = 0.0000***	
Regression Model:		
Model 2: $\boldsymbol{UN = a_0 + \beta_i RD_t + \varepsilon_{it}}$	**Statistic**	**p-value**
Cross-section dependency tests:		
LM (BP,1980)	1164	0.0000***
CD_{lm} (Pesaran, 2004)	95.73	0.0000***
LM_{adj} (PUY, 2008)	17.39	0.0000***
Swamy S Homogeneity tests:		
chi2(48) = 2528.58	Prob > chi2 = 0.0000***	

Note: ***,** and * 1%, 5%, and 10% respectively represent significance.
Source: Authors' calculations.

As regards the results of the cross-section dependency test in Table 7, the null hypothesis that there is no cross-section for both models is rejected. In this direction, it is concluded that there is a cross-section dependency between the countries that make up the panel. According to the results of the Swamy S homogeneity test, the H_0 hypothesis was refused and it was accepted that the parameters were not homogeneous and changed from unit to unit. In this case, for the determination of the cointegration relationship, the cointegration test, which pay regard to the cross-section dependency and is applied for the heterogeneous panel method, should be applied.

5.2. Estimation of Cointegration Relationship Between Variables

After the unit root test, the long-term relationship is determined by the Westerlund (2007) cointegration test, which pay attention to the cross-section dependency and is used in the case of a heterogeneous panel. The findings of the Westerlund (2007) cointegration test are shown in Table 8.

Table 8. Westerlund (2007) Cointegration Test Results

Model 1: $GROWTH = a_0 + \beta_i RD_t + \varepsilon_{it}$						
	Constant			Constant and Trend		
Statistics	Value	Z-value	P- Value	Value	Z-value	P-Value
G_t	-3.511	-9.664	0.000***	-3.641	-7.997	0.000***
G_a	-19.313	-11.175	0.000***	-21.423	-7.160	0.000***
P_t	-17.779	-10.272	0.000***	-19.063	-9.899	0.000***
P_a	-16.235	-12.945	0.000***	-17.884	-7.475	0.000***
Model 2: $UN = a_0 + \beta_i RD_t + \varepsilon_{it}$						
	Constant				Constant and Trend	
Statistics	Value	Z-value	P- Value	Value	Z-value	P-Value
G_t	-2.947	-6.489	0.000***	-3.503	-7.141	0.000***
G_a	-13.406	-5.725	0.000***	-18.358	-4.856	0.000***
P_t	-9.945	-2.539	0.006***	-9.482	1.260	0.896
P_a	-6.145	-1.950	0.026**	-6.820	1.786	0.963

Note: ***,** and * 1%, 5%, and 10% respectively represent significance.
Source: Authors' calculations.

In Westerlund (2007) cointegration test, the H_0 hypothesis is established as no cointegration. According to the results in Table 8 when the results for model 1 are examined, the H_0hypothesis is rejected according to the G_t, G_a, P_t, P_a tests that include both constant and constant and trend. As a consequence, there is a cointegration relation between the GROWTH and RD changeable. When the results for Model 2 are examined, the H_0 hypothesis is rejected according to the G_t, G_a, P_t, P_a tests in the model with constants. There is a cointegration relation between the UN and RD changeable. When the constant and trend-containing results for Model 2 are evaluated, the H_0 hypothesis is rejected according to the G_t and G_a statistics. As a consequence of that, there is a cointegration relation between the UN and RD changeable. According to P_t and P_a statistics, no cointegration relationship was found between the changeable in the fixed and containing model of Model 2.

5.3. Coefficient Estimation

After determining the entity of a long-term relation between the changeable, it was decided to estimate the model with the help of MG, PMG, and DFE Estimators. The prediction results of these estimators are given in Table 9.

Table 9. Error Correction Model Prediction Results for Models

	MG		PMG		DFE	
Model 1: $GROWTH = a_0 + \beta_i RD_t + \varepsilon_{it}$						
D.GDP	**Coefficient**	**Std. Dev. (Probability Value)**	**Coefficient**	**Std. Dev. (Probability Value)**	**Coefficient**	**Std. Dev. (Probability Value)**
Long Term						
RD	-4.986202	1.468355 (0.001)	-.004327	.0050014 (0.387)	-.0044419	.0039408 (0.260)
ECT	-.7598341	.0549804 (0.000)	-.6659414	.054328 (0.000)	-.6750738	.0436964 (0.000)
Short Term						
RD D1.	-8.471366	4.354142 (0.052)	-11.28164	4.351133 (0.010)	.0002373	.0025089 (0.925)
Constant	6.459257	.8915413 (0.000)	1.741759	.2560974 (0.000)	1.549911	.1819873 (0.000)
	MG		**PMG**		**DFE**	
Model 2: $UN = a_0 + \beta_i RD_t + \varepsilon_{it}$						
D.GDP	**Coefficient**	**Std. Dev. (Probability Value)**	**Coefficient**	**Std. Dev. (Probability Value)**	**Coefficient**	**Std. Dev. (Probability Value)**
Long Term						
RD	-13.98295	9.65359 (0.147)	-.0052889	.0070915 (0.456)	-.0081589	.0079489 (0.305)
ECT	-.1844482	.0291763 (0.000)	-.1861879	.0303641 (0.000)	-.1316697	.0204552 (0.000)
Short Term						
RD D1.	2.234582	1.149103 (0.052)	2.068761	1.115876 (0.064)	.0015093	.0009813 (0.124)
Constant	.6938487	.299178 (0.020)	.2598831	.0610686 (0.000)	.947063	.1738382 (0.000)

Source: Authors' calculations.

Table 9 shows the long- and short-run results of the Mean Group (MG) Estimator, Pooled Mean Group (PMG) Estimator, and Dynamic Fixed Effects (DFE) Estimator. In Table 9 the long and short-term coefficients, standard error values and probability values of the variables, and the error correction term (ECT) values showing the entity of a long-term relation are presented. It is seen that the sign of the ECT long-term coefficient is negative in all three estimators in both models and the probability value is less than 0.05. This situation affirms the entity of a long-run relation between GROWTH and RD and between UN and RD. Before interpreting the coefficients of all three error correction models, the appropriate Estimator for the Model will be selected with the Hausman Test, and long and short-term interpretations will be made accordingly. Accordingly, the Hausman Test results are explained in Table 10.

Table 10. Hausman Test Results

Model	Estimator	Chi-square value	Probability Value	Decision
Model 1: $GROWTH = a_0 + \beta_i RD_t + \varepsilon_{it}$	MG, PMG	9.78	0.0018	MG
	MG, DFE	51.23	0.0000	MG
Model 2: $UN = a_0 + \beta_i RD_t + \varepsilon_{it}$	MG, PMG	0.02	0.8750	PMG
	PMG, DFE	0.14	0.7086	PMG

Note: H_0: There is no systematic difference between the coefficients.
Source: Authors' calculations.

In Table 10, the results of the Chi-square and probability values of the Hausman test are applied to choose between the MG Estimator and the PMG Estimator in the first line of the first model, and between the MG estimator and the DFE Estimator in the second line of the first model, and the decisions are taken accordingly are reported. When the first line is examined since the probability value is less than 0.0018 and 0.05, the H_0 hypothesis was refused and it was decided that the MG Estimator was appropriate in the estimation of the model. When the second line of the first model is studied since the probability value is less than 0.0000 and 0.05, the H_0 hypothesis was refused and it was decided that the MG Estimator was appropriate in the estimation of the model. Accordingly, the results produced by the MG Estimator from the three estimators for the first model will be interpreted.

In Table 10, the results of the Chi-square and probability values of the Hausman test are applied to choose between the MG Estimator and the PMG Estimator in the first line of the second model, and between the PMG Estimator and the DFE Estimator in the second line, and the decisions are taken accordingly are reported. When the first line is examined for the probability value is greater than 0.8750 and 0.05, the H_0 hypothesis was accepted and it was decided that the PMG Estimator was appropriate for the prediction of the model. In the second model, a Hausman test was applied between PMG and DFE, since the PMG estimator gave more efficient results as a result of the first comparison. Similarly, when the second line of the second model is examined for the probability value is 0.7086 and greater than 0.05, the H_0 hypothesis was accepted and it was decided that the PMG Estimator was appropriate for the prediction of the model. Accordingly, in the second model, the results produced by the PMG Estimator from three estimators will be interpreted.

As it can be seen from Table 9, when the short-term results of the MG Estimator for Model 1 are examined, it is seen that the probability value of the RD variable coefficient is less than 0.052 and 0.10, and therefore it is statistically significant. Accordingly, there is a meaningful relation between research & development expenditures and economic growth in the short term. That is, a 1% raise in research & development expenditures decreases economic growth by about 8.47%. When the long-term results for Model 1 are examined, it is observed that the probability value is meaningful because it is less than 0.001 and therefore less than 0.05. Accordingly, there is a meaningful relation between research & development expenditures and economic growth in the long run, and a 1% raise in research & development expenditures decreases economic growth by roughly 4.99%. When the short-term results of the PMG estimator for Model 2 are examined, it is seen that the probability value of the coefficient of the RD variable is less than 0.064 and 0.10, and therefore it is statistically significant. Accordingly, there is a meaningful relation between research & development expenditures and unemployment (employment) in the short run. In other words, a 1% rise in research & development expenditures rises economic growth by 1.12%. When the long-term results for Model 2 are examined, it is observed that the probability value is meaningless because it is greater than 0.456 and therefore 0.05. Accordingly, there is no significant long-run relation between research & development expenditures and employment (unemployment).

5.4. Causality Test

In the study, causality analysis was performed to specify the short-run relation between the changeable. For this reason, the results of the causality test enhanced by Dumitrescu and Hurlin (2012) are shown in Table 11.

Table 11. Dumitrescu and Hurlin (2012) Causality Test Results

	W-bar statistics	Z-bar statistics	Probability value
RD→GDP	9.0390	4.3864	0.0000*
GDP→RD	2.4134	4.9971	0.0000*
RD→UN	10.5383	6.5505	0.0000*
UN→RD	13.0347	10.1537	0.0000*

Note: * Significant at the %1(0.01) level.
Source: Authors' calculations.

The main hypothesis of the Dumitrescu and Hurlin (2012) panel causality test is that there is no causality for the entire panel. The lag length was specified concerning the AIC information criterion. According to the Dumitrescu and Hurlin causality test results between economic growth and research & development expenditures are shown in Table 11 it is deduced that there is a two-way relation between economic growth and research & development expenditures, and thus, economic growth research & development expenditures, and research & development expenditures are the cause of economic growth. is reached. According to Table 11, according to the Dumitrescu and Hurlin causality test results between economic growth and employment (unemployment), there is a two-way relation between economic growth and employment, and thus unemployment (employment) research & development expenditures, and research & development expenditures are the cause of unemployment (employment). the conclusion is reached

6. CONCLUSION

Globalization, which can be expressed as the disappearance of borders, has taken on a completely different identity with the invention of the internet. The period we are in for what is expressed as "Globalization 3.0" has become the period in which end-to-end communication can be provided across the world. In this period of development for countries, the most important condition of being able to hold on to competition has been the investment in knowledge. In today's information age, the most important concept in investments in information is research & development expenditures (Gerçek, 2011: 1). From this point of view, our study was conducted in 25 selected countries (Austria, Belgium, China, Czech Republic, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Korea, Latvia, Lithuania, Mexico, Netherlands, Poland, Portugal, Romania, Russia, Slovak R., Slovenia, Spain, Turkey, United States) research & development expenditures and economic growth and whether there is a relation between R&D expenditures and employment were examined using annual data covering the 1996-2020 period. For this reason, first of all, the entity of cross-section dependency between countries and the homogeneity of the coefficients, in the long run, were investigated. The results obtained showed that there is a cross-section dependency in the sample and that the countries have heterogeneous characteristics. Thus, panel data analysis procedures that consider the cross-section dependency were utilized. The research is targeted to search the impact of research & development expenditures on both economic growth and employment by using two different models.

The CIPS unit root test, which pay attention to the cross-section dependency, was applied and it was specified that the variables were stationary at the first difference. As a result of the Westerlund (2007) technique, the entity of a long-run relation was determined and long-run coefficients were predicted with the panel ARDL method. The analysis showed that research & development expenditures negatively and statistically significantly impacted economic growth rates in both the short and long term within the scope of model 1, which was first investigated throughout the panel. Within the framework of our analysis, within the scope of model 2, there is a positive and meaningful relation between research & development expenditures and employment in the short run, but no relation was found between research & development expenditures and employment in the long term. In the study, Dumitrescu and Hurlin's (2012) panel causality test was performed to specify the direction of causality between the changeable. As a consequence of the causality analysis of Dumitrescu and Hurlin (2012), a bidirectional causality link was found between research & development expenditures and economic growth. In consequence of the causality analysis, a bidirectional causal relation was specified between research & development expenditures and employment.

In our study, the findings explaining the relation between research & development expenditures and employment were reported by Piva (2017) and Konya and Durgun (2022) appeared to support the studies.

In consequence, it has been seen that there is a relation between research & development expenditures and economic growth and unemployment. For this reason, it is necessary to work on permanent solutions to increase the growth performance of countries sustainably. For this, not only the state, but also the private sector and universities should work as a whole to ensure permanent development, and new policies and technological performances should be integrated into countries.

The impact of research & development activities on employment in the economy is one of the topics that has been frequently discussed recently. In this context, studying the impact of research & development activities on employment with different methods and different country groups will contribute to the literature. This point constitutes the limitation of our research.

REFERENCES

Akarsu, Y., Alacahan, N., D. and Atakişi, A. (2020) "Ülke Karşılaştırmaları ile Araştırma Geliştirme Harcamaları ve Ekonomik Büyüme İlişkisi: Panel Veri Analizi", Sosyal Bilimler Araştırma Dergisi, 9(4):159-167.

Ali, T., M., Kiani. A. K., Bashir, T. and Khan, T. N. (2021) "R&D Expenditure as an Accelerator of Economic Growth with Special Reference to Developing Countries", Journal of Business and Social Review in Emerging Economies, 7(3): 561-589.

Alper, A. E. (2017) "Türkiye'de Patent, Ar-Ge Harcamaları, İhracat ve Ekonomik Büyüme Arasındaki İlişki: Bayer-Hanck Eş Bütünleşme Analizi", 3nd International Congress on Political, Economic and Social Studies (ICPESS), 17-26.

Bayraktutan, Y. and Kethudaoğlu, F. (2017) "AR-GE ve İktisadi Büyüme İlişkisi: OECD Örneği", Uluslararası Sosyal Araştırmalar Dergisi, 10(53): 680-694.

Berberoğlu, B. (2010) "Yaşam Boyu Öğrenme ile Bilgi ve İletişim Teknolojileri Açısından Türkiye'nin Avrupa Birliğindeki Konumu", The Journal of Knowledge Economy & Knowledge Management, 5(2): 113-126.

Breusch, T. S. and Pagan, A.R. (1980) "The Lagrange Multiplier Test and Its Applications to Model Specification in Econometrics", Review of Economic Studies, 47: 239-253.

Dam, M. M. and Yıldız, B. (2016) "BRICS-TM Ülkelerinde Ar-Ge ve Inovasyonun Ekonomik Büyüme Üzerine Etkisi: Ekonometrik Bir Analiz", Akdeniz İİBF Dergisi, 33: 220-236.

Dumitrescu, E. and Hurlin, C. (2012) "Testing for Granger non-causality in heterogeneous panels", Economic Modelling, 29 (2012):1450–1460.

Eid, A. (2012) "Higher Education R&D and Productivity Growth: An Emprical Study on High Income OECD Countries", Education Economics [e-journal], 20(1): 53-68.

Falk, M. (2007) "R&D spending in the high-tech sector and economic growth", Research in Economics, 61.3:140-147.

Fendoğlu, E. and Polat, M. A. (2021) "The Relationship Between R&D Expenditures and Economic Growth: Panel Data Analysis in Selected New Industrializing Countries", Kent Akademisi, 14(3): 728-747.

Gerçekler, M., Özmen, İ. and Mucuk, M. (2020) "Ar-Ge Harcamaları ve İşsizlik Arasındaki Nedenselliğin Ampirik Analizi: G7 Ülkeleri Örneği", Marmara Üniversitesi İktisadi ve İdari Bilimler Dergisi, 41(2): 413-431.

Goel, R.K., Payne J.E. and Ram R. (2008) "R&D Expenditures and U.S. Economic Growth: A Disaggregated Approach", Journal of Policy Modelling, 30:237-250.

Gerçek, A. (2011) "AR-GE harcamalarının önemi ve Türkiye'deki durumu", Bursa Bilanço, 132. https://docplayer.biz.tr/133538-Ar-ge-harcamalarinin-onemi-ve-turkiye-deki-durumu.html.

Gür B. (2021) "The Relationship Between R&D Expenditures and Youth Unemployment in the European Union Countries: A Comparison of the Old and New Member States", In: Bilgin M.H., Danis H., Demir E. (eds) Eurasian Business and Economics Perspectives. Eurasian Studies in Business and Economics, vol 18. Springer, Cham.

Güzel, S. (2009) "Ar-Ge Harcamaları ve Vergi Teşvikleri: Belirli Ülkeler Karşısında Türkiye'nin Durumu", Eskişehir Osmangazi Üniversitesi İİBF Dergisi, 4(2):29-48.

Kavak, Ç. (2009) "Bilgi Ekonomisinde İnovasyon Kavramı ve Temel Göstergeleri", Akademik Bilişim'09-XI. Akademik Bilişim Konferansı Bildirileri, 11-13 Şubat 2009, Türkiye: Şanlıurfa.

Kaya, A. A. and Altın, O. (2009) "Türkiyede' de Ar-Ge Harcamaları ve Ekonomik Büyüme Arasındaki Nedensel İlişkinin Analizi", Ege Academic Review, 9(1): 251-259.

Kesikoğlu, F. and Saraç, Ş. (2017) "Ar-Ge Harcamalarının Büyüme Üzerindeki Etkisi: İbbs Düzey 1 Bölgelerinin Karşılaştırmalı Analizi", Uluslararası Yönetim İktisat ve İşletme Dergisi, ICMEB17 Özel Sayısı,617-627.

Kevük, S. (2006) "Bilgi Ekonomisi". Journal of Yasar University, 1(4): 319-350.

Konya, S. and Durgun, Ö. (2022) "G7 Ülkelerinde Ar-Ge Harcamaları ile İstihdam İlişkisi", Sakarya İktisat Dergisi,11(1):17-32.

Mate-Garcia, J. J. and Rodriguez-Fernandez, J. M. (2008) "Productivity and R&D: An Econometric Evidence from Spanish Firm-Level Data". Applied Economics, 40: 1827-1837.

Odabaşı, Y. and Erdal, E. (2018) "Bilgi Ekonomisi ve Ekonomik Büyüme: Seçilmiş OECD Ülkeleri Üzerine Bir İnceleme", Avrasya Sosyal ve Ekonomi Araştırmaları Dergisi, 5(12): 439-459.

OECD (2022a). Gross domestic spending on R&D (indicator). doi: 10.1787/d8b068b4-en (Accessed on 10 April 2022).

OECD (2022b). Unemployment rate (indicator). doi: 10.1787/52570002-en (Accessed on 10 April 2022).

Olaoye, I. J., Ayinde, O. E., Ajewole, O. O. and Adebisi L. O. (2021) "The Role of Research and Development (R&D) Expenditure and Governance On Economic Growth In Selected African Countries", African Journal of Science, Technology, Innovation and Development, 13(6): 663-670.

Özcan, S. E. and Özer, P. (2018) "Ar-ge Harcamaları ve Patent Başvuru Sayısının Ekonomik Büyüme Üzerine Etkileri: OECD Ülkeleri Üzerine Bir Uygulama", Anadolu Üniversitesi Sosyal Bilimler Dergisi, 18(1): 15-28.

Peng L. (2010) "Study on Relationship Between R&D Expenditure and Economic Growth of China", Proceeding of the 7th International Conference on Innovation & Management, http://www4.pucsp.br/icim/ingles/downloads/papers_2010/part_8/1_Study%20on%20Relationship%20between.pdf, 1725-1728.

Pesaran, M. H., Shin, Y. and Smith, R. J. (1999) "Pooled Mean Group Estimation of Dynamic Heterogeneous Panels", Journal of the American Statistical Association, 94:621–634.

Pesaran, M.H. and Yamagata, T. (2008) "Testing Slope Homogeneity in Large Panels". Journal of Econometrics, 142(1):50-93.

Pesaran, M.H. (2004) "General Diagnostic Tests for Cross Section Dependence in Panels", Cambridge Working Papers in Economics 0435, Faculty of Economics, University of Cambridge.

Pesaran, M.H. (2007) "A Simple Panel Unit Root Test in the Presence of Cross-Section Dependence. Journal of Applied Econometrics", 22:265-312.

Pesaran, M.H., Ullah, A. and Yamagata, T. (2008) "A Bias-Adjusted LM Test of Error Cross-Section Independence. Econometrics Journal", 11:105-127.

Samimi, A.J. and Alerasoul, S. M. (2009) "R&D and Economic Growth: New Evidence From Some Developing Countries. Australian Journal of Basic and Applied Sciences", 3(4): 3464-3469.

Sylwester, K. (2001). "R&D and Economic Growth, Journal of Development Economics", 13(4):71-84.

Szarowská, İ. (2016) "Impact of Public R&D Expenditure On Economic Growth in Selected EU Countries, 9th International Scientific Conference "Business and Management 2016", 1-9, Vilnius, Lithuania.

Tekin, A. and Demirel, O. (2022) "Bilimsel ve Teknolojik Performansın Ekonomik Büyümeye Etkisi: OECD Ülkeleri Üzerine Bir Panel Veri Analizi", Sosyoekonomi, 30 (51): 353-364.

Tuna, K., Kayacan, E. and Bektaş, H. (2015) "The Relationship Between Research & Development Expenditures and Economic Growth: The Case of Turkey", Procedia - Social and Behavioral Sciences, 195(2015):501 – 507.

Ülger, Ö. (2017) "OECD Ülkelerinde AR-GE Harcamalarının Büyüme Üzerine Etkileri: Panel Veri Analizi (1996-2015)", Sosyal Bilimler Dergisi, 4(15):165-177.

Ünal, T. and Seçilmiş, N. (2013) "AR-GE Göstergeleri Açısından Türkiye ve Gelişmiş Ülkelerle Kıyaslaması", İşletme ve İktisat Çalışmaları Dergisi,1(1):12-25.

Westerlund, J. (2007) "Testing for Error Correction in Panel Data, Oxford Bulletin of Economics and Statistics", 69: 709-748.

World Bank (2022). https://databank.worldbank.org/source/world-development-indicators (Accesed 10 April 2022).

Yanyun Z. and Mingqian Z. (2004) "R&D and Economic Growth-Panel Data Analysis in ASEAN+3 Countries., Seoul Conference, https://pdfs.semanticscholar.org/7c26/80e3fcb99957a65ba33cd89ccf6f88d55bb3.pdf, Korea.

Yaylalı, M., Akan, Y. and Işık, C. (2010) "Türkiye'de Ar&Ge Yatırım Harcamaları ve Ekonomik Büyüme Arasındaki Eş-Bütünleşme ve Nedensellik İlişkisi:1990–2009", The Journal of Knowledge Economy & Knowledge Management, 5(2):13-26.

Yılmaz, M., (2013) "Küreselleşmenin Oluşumuna Zemin Hazırladığı Yeni Ekonomik Anlayış: Bilgi Ekonomisi", Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi, 27(1):241-255.

Zachariadis, M. (2004) "R&D Induced Growth In The OECD? ", Review of Development Economics, 8(3):423-439.

Zhanga, L. and Ehrenberg, R. G. (2010) "Faculty Employment and R&D Expenditures at Research Universities", Economics of Education Review, 29: 329–337.

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Hakem Değerlendirmesi: Dış bağımsız.

Çıkar Çatışması: Yazar çıkar çatışması bildirmemiştir.

Finansal Destek: Yazar bu çalışma için finansal destek almadığını beyan etmiştir.

Teşekkür: -

Peer-review: Externally peer-reviewed.

Conflict of Interest: The author has no conflict of interest to declare.

Grant Support: The author declared that this study has received no financial support.

Acknowledgement: -