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YENİLENEBİLİR VE YENİLENMEYEN ENERJİ TÜKETİMİNİN SEÇİLMİŞ OECD ÜLKELERİNİN EKONOMİK BÜYÜME ÜZERİNE ETKİSİ

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THE EFFECT OF RENEWABLE AND NON-RENEWABLE ENERGY CONSUMPTION ON ECONOMIC GROWTH OF SELECTED OECD COUNTRIES

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Öz

Ekonomik süreçlerin büyüme ve şekillenmesindeki enerji kaynaklarının önemi ve bu kıymetli kaynakların değerlendirme gerekçesi, çeşitli enerji kaynaklarının tanımı ve incelenmesini önemli kılmaktadır. Bu çalışmanın temel amacı, enerji (yenilenebilir ve yenilenmeyen ayrımı ile) tüketimi, beşeri ve fiziki sermaye ve AR-GE harcamalarının etkilerini, 2001-2009 yıllar arası, seçilmiş 21 OECD ülkesinin ekonomik büyüme üzerine incelemektir. Ayrıca, sonuçların ayrıntılarını detaylı bir şekilde ele almak için, yenilenebilir ve yenilenemeyen enerji tüketiminin etkilerini ayrı ayrı incelemenin yanı sıra toplam enerji tüketiminin (yenilenebilir ve yenilenemeyen enerji tüketimi toplamı) etkileri de incelenmiştir. Değişkenlerin etkilerini belirlemek için Genelleştirilmiş En Küçük Kareler (GLS) yöntemi ele alınarak panel veri ekonomik teknik kullanılmıştır. Çalışmanın sonuçlarına göre, diğer değişkenlerin (beşeri sermaye, fiziki sermaye ve Araştırma-Geliştirme (R&D) harcamalarının yanı sıra yenilenebilir, yenilenemeyen enerji tüketimi, seçilmiş OECD ülkelerinin ekonomik büyümesi üzerinde pozitif ve anlamlı bir etkisi olduğu ortaya çıkmıştır. Ayrıca, toplam enerji tüketiminin seçilmiş OECD ülkelerinin ekonomik büyümesi üzerindeki pozitif ve anlamlı etkisi tespit edilmiştir.

Anahtar Kelimeler: *Yenilenebilir, Yenilenmeyen, Enerji, Ekonomik Büyüme, Panel Veri, OECD, Genelleştirilmiş En Küçük Kareler (GLS)*

JEL Kodları: *O5, C33, Q3, Q2, Q4*

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Abstract

The importance of energy resources in the growth and formation of economic processes and also the reason for the evaluation of these valuable resources, make it important to recognize and analyse of various energy sources. The main purpose of this study is to examine the effects of energy (with renewable and non-renewable distinction) consumption, human and physical capital and Research and Development (R&D) expenditures over the period 2001-2009 on the economic growth of selected 21 Organisation for Economic Co-operation and Development (OECD) countries. In addition, in order to elaborate the details of the results, in addition to examining the effects of renewable and non-renewable energy consumption separately, the effects of total energy consumption (sum of renewable and non-renewable energy consumption) were also examined. To determine the effects of variables, considering the Generalized Least Squares (GLS) method, Panel data econometric technique is used. According to the results of the study, beside other variables (human capital, physical capital and Research and Development (R&D) expenditures, renewable, non-renewable energy consumption have positive and significant effects on economic growth of selected OECD countries. Also, positive and significant effect of total energy consumption on economic growth of selected OECD countries has been approved.

Keywords: *Renewable, Non-renewable, Energy, Economic Growth, Panel Data, OECD, Generalized Least Squares*

Jel Codes: *C33, O44, Q32, Q43, Q58.*

1. INTRODUCTION

Recently, the importance of energy and its role in economy, is apparent to everyone. Energy as an important factor of production, besides other factors of production such as labor, capital and raw materials, play a decisive role in the growth and development processes of countries. The economic developments over the past decade seem to be linked to the use of various energy sources (EbrahimPour 2008). Towards the end of the 1970s, energy is not considered as a production factor in production functions. However, since the economic crisis in the west was synchronized with the oil shocks of 1973 and 1979, new era has begun in the importance of energy as one of the factors of economic growth (Mehr Ara and Zarei 2011). Today, energy as an important factor besides other factors of production such as labor, capital and raw materials, are included in the production functions (Khalil Pour 2006) and even according to some ecologist thinkers like Ayras and Nayer, energy is the most important factor in production and for the use of intermediate factors such as labor and capital, there is a need for energy (EbrahimPour 2008).

On the other hand, the increasingly irregular use of energy carriers such as oil, natural gas and coal in this way, takes attention to two major problems: First, the exhaustible problem of fossil fuels (non-renewable energy sources) and the second is the pollution problems of the ecological environment. In this context, one of the most important features of energy and environmental policies is the diversification of energy sources and also finding energy sources that are economically inexpensive and not pollute the environment or pollute less (Chiang and Chio 2011).

The basic question of this study; what is the relationship between energy consumption and economic growth? In many studies on the relationship between energy consumption and economic growth, renewable energies and especially those in OECD countries have not been taken into consideration and emphasized on renewable energies in general. In this context, in this study, using panel data econometric technique, the effect of both renewable and non-renewable energy consumption at the same time and also the effect of total energy consumption was discussed on the economic growth of selected 21 OECD countries with two different models.

This study consists of three chapters: In the first chapter, theoretical framework and previous studies will be discussed. In the second chapter of the research, the methodology and model of the study will be discussed and in the final section the results and recommendations will be given.

2. LITERATURE REVIEW

There are many studies that examining the relationship between energy consumption and economic growth. Some of these studies are as follows:

Fetros et al. (2012) in their work, discussed the impact of renewable and non-renewable energy consumption on economic growth in some selected developing countries between 1980 and 2009. Study estimates were done using the least squares approach and the panel data method. According to the results of the study, a significant relationship was found between energy consumption and economic growth and the impact of non-renewable energy consumption on growth is greater than the effect of renewable energies consumption. Behboodi et al. (2009) using the least squares approach and pool data technique in their work, have considered the effect of total energy on growth of gross domestic product in some developing and developed countries from 2006-2010. According to the results of the study, there was a positive and significant relationship between energy consumption and gross domestic product growth in both groups of countries. Amadeh et al. (2009) examined the long-term and short-term relationship between the use of various renewable and non-renewable energy carriers and economic growth in different sectors of the Iran economy between the years 1971-2003, using ARDL and ECM approaches. According to the results of the study, there is a one-way long-term and short-term causality relation from marginal consumption of energy to economic growth. Moreover, a short-term causality relationship has emerged from economic growth to marginal consumption of natural gas. Tansel et al. (2012) using panel data technique, examined the effects of renewable and non-renewable energy consumption on economic growth in selected G7 countries during the 1980-2009 period. The results of the study show that consumption of two types of energy is a positive and significant effect on economic growth. Apergis and Payne (2011) using the autoregressive and error correction technique, analysed the effect of renewable and non-renewable energy consumption on economic growth of selected 80 world countries between 1990 and 2007. The results of the study showed a long-term stable relationship between energy consumption and economic growth. In addition, the panel data error correction model showed a two-way causality relationship between energy consumption and economic growth, both in the long run and in the short run. Taiwari (2011) using the PVAR method, analysed the effect of renewable and non-renewable energy consumption on economic growth between 1965 and 2009 in selected European countries. The results show that the non-renewable energy use has a negative effect and renewable energy use has a positive effect on GDP growth. Bowden and Payne (2010) using the Toda Yamamoto method, analysed the causality between renewable and non-renewable energy consumption and economic growth in the US between 1946-2006. Three sectors; commercial, industrial and residential sectors, were considered in the study. According to the results, in the residential sector, a one-way positive causality relationship emerged from renewable energy consumption to economic growth when there was no causal relationship between these variables in commercial and industrial sectors. On the other hand, while there is a two-way positive causality relationship between non-renewable energy consumption and economic growth in the commercial and industrial sectors, in the residential sector, only a one-way negative causality relationship emerged from renewable energy consumption to economic growth. Sadrosky (2009) examined the causality relationship between renewable energy and per capita income in the 18 countries with new economies between 1994 and 2003. According to the results of the study, there is a two-way positive causality relationship between renewable energy and per capita income. Narayan and Doytch (2017) in their study, examined economic growth and

per capita energy consumption (in three income groups) in 89 countries between 1971 and 2011. According to the results, renewables are mainly found to support the neutrality hypothesis. Only renewable totals in low and lower middle-income countries are found to drive economic growth and the growth hypothesis strongly features with non-renewables.

When we look at the overall results of the studies above, it is possible to see that there is a positive relationship between energy consumption and economic growth. However, in previous studies, there has been no study of the relationship between energy consumption and economic growth, and also the relationship between renewable and non-renewable energy consumption and economic growth for OECD countries. In addition, in the context of the results of studies conducted in other country groups, in this study, using panel data econometric technique, the effects of renewable and non-renewable energy consumption on economic growth and also the effect of total energy consumption on economic growth are discussed.

3. THEORETICAL FRAMEWORK

As it has been said before, today, the effect of energy and its role in the economy is known by everyone. Accepting the dominance of energy in current and future economies of countries, and because of the urgent need for these valuable resources and also due to the internal and external consumption of these resources, the necessity of economic and productive evaluation of energy, once again emphasizes (EbrahimPour 2008).

To better analyse the relationship between energy consumption and economic growth and development, it is useful to look at the views of some thinkers: Adam Smith (1776) stated that the large-scale production is the reason for the development of the economy. Ricardo and Malthus, on the other hand, put forward the borders of economic growth, dealing with the law of "diminishing returns".

Historically, the first effective factor in economic production and growth has been physical capital. One of the most important theories in this regard is Joseph Schumpeter's theory. According to Schumpeter, technological change and innovations (from the old to the modern) are the most important economic process, causing economic growth (Hayami 2001). Adam Smith (1776), as the first classical economist, has proposed human capital as a definition of capital. However, after Adam Smith, until 1960, the concept of human capital was forgotten. Later, in the 1960s, was taken over by thinkers like Schultz (1961) and at the end of the 1980s, the human capital factor was included in growth and production models as an effective variable in economic growth.

The views of some neoclassical economists is contrary to the views of environmentalist economists. According to them, with indirectly affecting labour and capital by energy, economic growth is also indirectly affected and does not directly affect. Nevertheless, some neoclassical economists such as are even more aware of the effect of energy (EbrahimPour 2008). In the models of Biophysical Growth proposed by ecologist economists such as Ayres and Nair, the primary and only production factor is energy, and the use of intermediate factors, labour force and capital, depend on energy. According to the thermodynamic principle, the amount of energy in the environment is fixed, can be compensated, can be transformed into material and cannot be destroyed. For this reason, the goods produced in the economy (even the production of trained and unqualified labour force) have been obtained with multiple quantities of energy consumption. It is obvious that the source of the value that is converted into economic goods is the use of natural resources. In an important research on the basis of biophysical model studies by Cleveland (2000), there is a close relationship between energy consumption and gross domestic product (GDP) (Daly 1997).

Today, growth and development plans are being made in order to equip the national resources, as well as opportunities to produce more goods and services. But for more and more efficient production, As well as improvements in the construction of production factors, this also requires that all resources (human capital, natural and physical capital resources) be evaluated in a broader way. In other words, increasing the economic growth rate significantly, creates an increasing pressure on resources. In this context, demand for expert labour force, the need for capital and capital equipment and raw material and energy consumption will increase. If further evaluation of the mentioned resources is not possible in parallel with the increase in production, it causes congestion in production (Shakibaee and Ahmadlou 2011). For this reason, the relationship between economic growth and the use of various energy sources has pointed by many economists. The relationship between economy and energy has been described in different ways that each of which demonstrates the theoretical background of the definition and the area of analysis (Stren 2004).

In the new growth theories, energy has been put forward as one of the important production factors in macroeconomic issues and has taken an important place in economic growth. For this reason, the production function arises as a function of labour, capital, and energy as,

$$Q= f (L, K, E) \quad (1)$$

In the above function, Q output, K capital, L labour force and E energy are shown. Factor E can cover all of the factors such as oil, natural gas, electricity, coal, etc. called energy carriers. Thus, all of the inputs of labour, capital and energy can change the amount of production. It is also assumed that there is a positive relationship between the use of these factors and the level of production. This means that the increase (fall) in any of these inputs leads to an increase in production. If we express this relation mathematically;

$$\partial Q/\partial L>0 \qquad \partial Q/\partial K>0 \qquad \partial Q/\partial E>0 \quad (2)$$

On the other hand, the energy consumption of the bearers of the various energy providers is an inverse function of the prices of the energy carriers. In other words, an increase (decrease) in the level of energy prices leads to a decrease (increase) in energy consumption, which reduces production (Nahidi and Kiavar 2010).

4. METHODOLOGY OF RESEARCH

4.1. Research Hypothesis

To answer the basic question of this research and to examine the relation between energy consumption and economic growth, the data from 21 selected OECD countries for the 2001-2009 period were analysed. Many of the OECD countries are growing countries with rich and broad energy sources and are obvious examples of natural resources growth models. Accordingly, by using the panel data method, these relations will be examined, and estimates will be made. In addition, the effects of other variables such as physical and human capital and R&D expenditures will be analyzed, as well as energy consumption. Consequently, the following hypotheses of the study will be tested, and the results will be determined:

a) Renewable energy consumption has a significant impact on the economic growth of selected countries.

b) Non-renewable energy consumption has a significant impact on the economic growth of selected countries.

c) Total energy consumption has a significant impact on the economic growth of selected countries.

d) Physical capital, human capital and R&D expenditures have a significant impact on the economic growth of selected countries.

4.2. Research Variables and Model Development

This research is an applied research study in terms of usage, and a causal-analytical in terms of and research method. The data required for the research in general, were obtained from statistical reports and data banks. Economic growth, non-renewable energy consumption, human capital, physical capital, AR-GE expenditure and consumer price index data are derived from the World Bank database, and renewable energy consumption data were obtained from the data base of the Organization for Economic Development and Cooperation (OECD) website. For the data analysis and model estimation, Eviews package program was used. The sample studied includes all countries that necessary data for model variables are available for those countries (21 countries). The list of these countries (sample) is shown in table 1.

Table 1: List of selected OECD countries

Austria	Belgium	Canada	Czech Republic	Estonia
Finland	France	Germany	Hungary	Ireland
Israel	Italy	Netherlands	Portugal	Poland
Russia	Slovak Republic	Slovenia	Spain	United Kingdom
Turkey				

Source: Research Findings

To examine the effects of the variables discussed in this study on economic growth, with reference to the model in Can Tansel et al. (2012), two different models are defined as follows;

$$LnY_{it} = \alpha_{\circ} + \alpha_{1i}LnNRE_{it} + \alpha_{2i}LnRE_{it} + \alpha_{3i}LnH_{it} + \alpha_{4i}LnK_{it} + \alpha_{5i}LnRD_{it} + \varepsilon_{it} \quad (3)$$

$$LnY_{it} = \alpha_{\circ} + \alpha_{1i}LnE_{it} + \alpha_{2i}LnH_{it} + \alpha_{3i}LnK_{it} + \alpha_{4i}LnRD_{it} + \varepsilon_{it} \quad (4)$$

Where;

Y: Real Gross Domestic Product (GDP) as an index of economic growth,

NRE: Compound energy of fossil fuels (coal, petroleum and petroleum derivatives and natural gas) as non-renewable energy consumption,

NR: Ground, solar and wind energy combinations as renewable energy consumption,

E: Total energy consumption (sum of renewable and non-renewable energy consumption),

H: Labour force as a human capital index,

K: Real fixed capital as physical capital index,

RD: R & D expenditure

ε: Error term,

Ln: Natural logarithm.

Consumer price index (CPI) is used to convert nominal variables to real variables and 2005 was taken as the base year. For the estimation of the above described models, as previously determined, the data from selected 21 OECD countries between 2001 and 2009 were used.

5. RESEARCH FINDINGS

5.1. Unit Root Tests Results

For testing the hypotheses of this study, it is very important to make sure that variables are static and do not contain spurious regression. For this reason, Levin, Lin and Chu (LLC) unit root test was used. This test is the most important of the unit root tests in the pool data. In this test, the null hypothesis is the assumption that there is a unit root. The results of this test are shown in table 2. Looking at the results in the table, it can be seen that only the non-renewable energy consumption is stable at I(0) and all other variables are stable at the I(1) level with the first difference. For this reason, we can say that all variables are stationary at I(1) level.

Table 2: Unit Root Test results

Levin, Lin ve Chu Test		
Variable	**Trend No constant coefficient [I(0)]**	**Trend No constant coefficient [I(1)]**
LY	0.000 (7.63127)	0.0000 (-5.39683)
LE	1.0000 (4.65383)	0.0000 (-5.44109)
LNRE	0.0000 (-4.86189)	0.0000 (-7.01616)
LRE	0.9999 (3.86029)	0.0000 (-4.90286)
LH	1.0000 (11.8111)	0.0000 (-4.72538)
LK	0.9998 (3.50107)	0.0000 (-6.08244)
LRD	0.9972 (2.76491)	0.0000 (-5.43147)

Source: Research Findings
Note: Figures in brackets indicate t values.

5.2. Panel Cointegration Test Results

Since all variables are stationary in the first difference, the integration of these variables must also be examined. The cointegration test is very important in pool data. This test is used to avoid the spurious regression and to determine whether there is a long-term relationship between variables. In this study, Kao test was applied to perform this test.

When panel data are used, cointegration tests are performed with tests such as Pedroni (1995, 1999), Engle Granger (1987) and Fischer (1994). These tests are based on research and specific assumptions. Another cointegration test is the Kao (1999) test. Kao panel cointegration test is also based on Engle-Granger cointegration test such as Pedroni test. In this study, the Kao test was used for the cointegration test of the variables. The results of this test are shown in Tables 3 and 4.

Table 3: Co-integration test results for Model 1

Kao Co-integration Test		
	t-Statistic	**prob**
ADF	-7.740367	0.0000

Source: Researcher findings

Table 4: Co-integration test results for Model 2

Kao Co-integration Test		
	t-Statistic	**prob**
ADF	-7.050933	0.0000

Source: Researcher findings

Looking at the results of the cointegration test, in the both models at the 1% significance level there is a strong cointegration or long-term relationship between all independent variables and economic growth. Therefore, according to the results of the Kao test, it is possible to say that although the variables are stationary at I(1), they are cointegrated at I(0) and therefore the above regressions do not contain spurious regression (Kao and Chiang 1999).

5.2. Models Estimation

After unit root and co-integration tests, statistical tests should be done to determine the model type; fixed, random or pool data model.

F test results are shown in table 5. According to the results, the $H_{\circ}$ hypothesis that fixed coefficients are equal is rejected. Therefore, different constant coefficients should be considered in estimates (pool data usage is rejected). Thus, the panel data method can be used for estimation.

Table 5: Fixed Effects Model Estimation for Model 1

Effect Test	**Test Coefficient**	**Degree of Freedom**	**Prob**
Cross-section F	39.718981	(20 ,163)	0.0000
Cross-section Chi-square	334.615010	20	0.0000

Source: Researcher findings

Here, the Hausman test can be used to determine the estimation method, either fixed or random effects. The Hausman test results are presented in Table 6. Looking at the results, in all countries, the $H_{\circ}$ hypothesis, which is the compatibility of random estimations, has been rejected. Thus, estimates should be made by the fixed effect method. In this model, since the number of countries is greater

than the number of years examined, in order to eliminate the possible problem of varying variance, the Generalized Least Squares (GLS) method is used.

Table 6: Hausman Test Results of Model 1

Effects Test	Test Coefficient	Degree of Freedom	Prob.
Cross-section random	31.451811	5	0.0000

Source: Researcher findings

The estimation results of the first model are given in table 7. According to the results of the fixed-effect model application, consumption of renewable and non-renewable energies seems to have positive effects on economic growth and Significant at 5% and 1% level respectively. The human capital index (labour force) also has a positive effect on economic growth and is significant at 10% level. The effect of the physical capital index on economic growth, as expected, is positive and significant at 1% level. Finally, R&D expenditures has a positive effect on economic growth and is significant at 10% level.

Table 7: Estimated Results for Model 1

Variables	Coefficient	Standard Error	t-Statistic	Prob
C	0.922832	3.686005	0.250361	0.8027
LNRE	0.192430**	0.076367	2.519803	0.0129
LRE	0.072677*	0.023608	3.078420	0.0025
LH	0.425723***	0.219309	1.941199	0.0542
LK	0.651557*	0.022730	28.66562	0.0000
LRD	0.059366***	0.032424	1.830903	0.0692
AR(1)	0.658905*	0.055353	11.90368	0.0000
R^2	0.999672			
Adjusted R^2	0.999611			
D.W	1.61			
Sample Number	189			

Source: Researcher findings

Note: *, **, and *** indicate significance levels of 1%, 5% and 10%, respectively.

The fixed effect test results of the second model are shown in table 8. Looking at the table, in all the countries studied, the H_0 hypothesis that the constant coefficients are equal is rejected. This means that different constant coefficients should be considered in estimates and therefore the pooled method should not be used and panel data method should be used.

Table 8. Fixed model Estimations for Model 2

Impact Test	Test Coefficient	Degree of Freedom	Prob.
Cross-section F	39.917931	(20 ,164)	0.0000
Cross-section Chi-square	331.703107	20	0.0000

Source: Researcher findings

To determine the estimation method of fixed effects or random effects, again the Hausman test can be used. The results of this test are shown in table 9. Looking at the table, in all the countries studied, the H_0 hypothesis, which is the compatibility of random effects estimates, has been rejected.

For this reason, in the second model, the estimation should be made by the fixed effect method. Again, in this model, since the number of countries is more than the number of years studied, the Generalized Least Squares (GLS) method will be used to remove the problem of possible varying variance.

Table 9. Hausman Test Results of Model 2

Effects Test	Test Coefficient	Degree of Freedom	Prob.
Cross-section random	21.150838	4	0.0000

Source: Researcher findings

The second model estimation results are presented in Table 10. When the results of the fixed effect method application are considered, total energy consumption has a positive effect on economic growth and it is significant at 1% level. As expected, the human capital index (labor force) and physical capital index (gross fixed capital) have positive effects on economic growth and are significant at 10% level. Lastly, R&D expenditures have a positive effect on economic growth and seem to be significant at 1% level.

Table 10. Estimated Results for Model 2

Variables	Coefficient	Standard Error	t-Statistic	Prob
C	1.513955	3.449216	0.438927	0.6614
LE	0.653655*	0.023373	27.96672	0.0000
LH	0.420074***	0.214317	1.960056	0.0519
LK	0.058258***	0.030408	1.915901	0.0574
LRD	0.068971*	0.023577	2.925303	0.0040
AR(1)	0.642411*	0.059933	10.71880	0.0000
R^2	0.999667			
Adjusted R^2	0.999608			
D.W	1.62			
Sample Number	189			

Source: Researcher findings
Note: *, **, and *** indicate significance levels of 1%, 5% and 10%, respectively.

6. DISCUSSION AND CONCLUSION

The main purpose of this study is to examine the effects of renewable and non-renewable energy consumption over the period 2001-2009 on the economic growth of selected 21 OECD countries. In addition, in order to elaborate the details of the results, in addition to examining the effects of renewable and non-renewable energy consumption separately, the effects of total energy consumption (sum of renewable and non-renewable energy consumption) were also examined. First, the unit root test was performed using the Levin, Lin, and Chu (LLC) test. The results of this test show that the variables are stationary at level I(1). For co-integration, the Kao test is used. The results of this test explain that the residuals are co-integrated at I(0) level and therefore the regression examined is not spurious. Also emphasized that there is a very strong long-term relationship between independent variables and economic growth. Using F and Hausman tests, it is appropriate to use the fixed effect

method to estimate the model. Accordingly, the results of the study supported all hypotheses of the study and all were accepted and also seems to have been aligned in parallel with previous studies. The detailed results of the work can be listed as follows:

a) Renewable energy, non-renewable energy and total energy consumption have positive and significant effects on economic growth. The reason is that energy has a high share in different economic sectors. In other words, in every country's economy, the economic sectors are qualified as the greatest energy consumers and for that reason it is impossible for the economic growth process to occur without paying attention to the energy factor.
b) The human capital index (labour force) has a positive and significant effect on economic growth. Today, the growth and development of organizations depends on the number of employees in those organizations. We can understand this by looking at the increase in labour force and the increase in the current development of organizations. In fact, the qualitative characteristics of a person are regarded as a kind of capital. Because these characteristics lead to an increase in production and productivity, more income and welfare, and an acceleration of economic growth and resulting in higher development levels.
c) Physical capital index (gross fixed capital) has a positive and significant effect on economic growth. This relationship is clear because in every country, investment is one of the important components of economic growth and is in fact one of the basic requirements of economic development. If capital is not provided, it is clear that economic growth is slowing down and taking place at high costs.
d) R&D expenditures has a positive and significant impact on economic growth. In today's world, R&D studies and its increasing effects cause internal technological development and thus increasing the productivity of production factors through creativity and innovation so as a result, it seems to speed up economic growth.

Looking at the previous studies, it is possible to see that there is a positive relationship between energy consumption and economic growth. The results obtained in this study, in parallel with previous studies, supporting a positive relationship between energy consumption and economic growth. Considering the discussion and conclusion of the study, the following political recommendations can be suggested:

a) According to the positive relationship between energy consumption indices (renewable, non-renewable and total) and economic growth, governments need to take important steps towards energy consumption management. Not being insensitive to the energy needs of the sectors is an inevitable reality for the governments. However, if energy consumption exceeds standard consumption, the consequences of this on energy sources are obvious. Given that economic growth is not possible without the use of energy factors, and also that non-renewable sources of energy are limited, the authorities, with appropriate economic planning, need to proceed in the management of energy consumption in one side and form the background of economic growth and development at the other side. With respect to countries' economies, the form of energy security, the increase of energy efficiency, the use of new and renewable energy sources and incentive policies can be counted in some policies of this planning. In other words, the optimum components of renewable and non-renewable energies must be selected and even if renewable energy consumption is costly, non-renewable energy consumption should be minimized.
b) According to the positive relation between the human capital index (labour force) and economic growth, it is suggested to increase investment in human capital and governments, on the basis of correct and timely planning, must provide the necessary training for the

labour force and accordingly, pay more attention to human resource management, by implementing appropriate policies. One of the most important issues here is the consideration of the quality and quantity of the labour force. As soon as this infrastructure is built, looking at the expertise and capabilities of the labour force in different economic sectors, the effects of the human capital index on economic growth will be further increased.

c) Given the positive relationship between the physical capital index (gross fixed capital) and economic growth, we can say with certainty that the increase in investments in various production sectors provides a basis for economic growth and development.
d) Given the positive relationship between R&D expenditures and economic growth, to accelerate the economic growth, speeding up the recruitment of innovative and researchers, and establishing and development of more research and development centres should be supported.

Compliance with Ethical Standards

Conflict of Interest: Authors declare that they have no conflict of interest.
Ethical approval: This article does not contain any studies with human participants performed by any of the authors.
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