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Araştırma Makalesi

Panel Econometric Analysis of the Relationship between Energy Consumption and Economic Growth: The Case of the Bric Countries

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ABSTRACT

Various changes have occurred in many fields in countries during globalization. In the economic field, relationships between countries have developed, and the trade and investment environment has expanded. Industries have entered a highly developmental environment, competition has increased in some sectors, the global production and supply chain has changed, and production has become more integrated. International trade and investments have grown, communication has accelerated with technological development, and international cooperation has strengthened. While some countries have become economically stronger, others have become dependent on countries rich in natural resources. One of the most important areas of this dependence is energy dependence, which is experienced as a result of the increase in energy demand sensitive to production increase. This is because the increase in production is directly related to energy input. This study investigates the relationship between energy consumption and economic growth in BRIC countries, which exhibit similar characteristics in terms of various macroeconomic indicators. The results obtained from dynamic panel data methods using annual data for the period 1990-2020 reveal that a 1% increase in energy consumption across the panel in the countries included in the analysis increases economic growth by 1.46%. Therefore, energy constitutes one of the most important inputs for economic growth.

Key words: Globalization, brıc, economic growth, energy consumption

Enerji Tüketimi ve Ekonomik Büyüme İlişkisinin Panel Ekonometrik Analizi: Bric Ülkeleri Örneği

ÖZ

Küreselleşme sürecinde ülkelerde birçok alanda çeşitli değişimlerin yaşandığı söylenebilir. Ekonomik alanda, ülkeler arasındaki ilişkiler gelişmiş, ticaret ve yatırım ortamı genişlemiştir. Sanayi yüksek bir gelişim ortamına girmiş, bazı sektörlerde rekabet artmış, küresel üretim ve tedarik zinciri değişmiş ve üretim daha entegre hale gelmiştir. Uluslararası ticaret ve yatırımlar artmış, teknolojik gelişmeyle beraber iletişim hızlanmış ve uluslararası iş birlikleri güçlenmiştir. Bazı ülkeler ekonomik olarak daha güçlü hale gelirken bir kısmı da özellikle doğal kaynak zengini ülkelere bağımlı hale gelmiştir. Söz konusu bağımlılıkta en önemli alanlardan birisi, üretim artışına duyarlı enerji talebindeki artış sonucunda yaşanan enerji bağımlılığı olarak görülmektedir. Zira üretimdeki artış enerji girdisi ile doğrudan ilgilidir. Bu çalışmada çeşitli makroekonomik göstergeler açısından benzer özellikler sergileyen BRIC ülkelerinde enerji tüketimi ve ekonomik büyüme arasındaki ilişki araştırılmaktadır. 1990-2020 dönemi yıllık verileriyle dinamik panel veri yöntemlerinden elde edilen sonuçlar, analize dahil edilen ülkelerde panel genelinde enerji tüketiminde meydana gelen %1'lik bir artışın ekonomik büyümeyi %1.46 oranında artırdığını ortaya koymaktadır. Dolayısıyla, enerji ekonomik büyümenin en önemli girdilerinden birisini oluşturmaktadır.

Anahtar Kelimeler: Küreselleşme, brıc, ekonomik büyüme, enerji tüketimi

INTRODUCTION

Since the discovery of energy, it has taken its place at the centre of life as a basic requirement. The fact that energy is an indispensable element for production has been formed together with the need for industrial production. New inventions that emerged with the Industrial Revolution began to be used intensively in industry, the transition to mass production became widespread and global increases in energy demand were observed. Energy input, which is used in many areas, has become increasingly important with population increases, industrialization and globalization. The increasing use of electrically powered devices as a result of technological advances has increased the need and demand for energy. The fact that the increases in energy demand together with the uneven distribution of energy resources make energy production expensive and cause decreases in their reserves have led the world economies to search for different resources. Because while it is necessary to increase production for economic growth, the energy input for production has been one of the most basic factors of the production process.

Different approaches are discussed regarding the relationship between electricity consumption and economic growth (Mucuk and Uysal, 2009; Omri, 2014; Şengönül and Koşaroğlu, 2018) The first of these is the growth hypothesis, which states that there is a one-way causality from electricity consumption to economic growth. In this hypothesis, economic growth is dependent on energy. Energy-saving policies adversely affect economic growth. The hypothesis emphasizes that electricity consumption is important for economic growth (Acaravcı, 2010; Matei and Stamin, 2016,; Öztürk, 2010; Adom, 2011). The second is the protectionist hypothesis, which states that there is causality from economic growth to electricity consumption. In this hypothesis, energy conservation policies have little or no effect on economic growth. If there is a unidirectional causality from economic growth to energy consumption, reducing energy consumption can be implemented with little or no negative impact on economic growth (Kıran and Güriş, 2009; Kayhan et al., 2010). The third explains the case of bidirectional causality between economic growth and energy consumption, expressed as the feedback hypothesis. So, there is dependence between these two variables. This hypothesis shows that electricity consumption and economic growth complement each other (Acaravcı, 2010). Finally, it is the objectivity hypothesis that suggests that there is no causal relationship between electricity consumption and growth (Apergis and Payne, 2010). This hypothesis means that electricity consumption is not related to economic growth, that is, neither protective nor comprehensive policies related to electricity consumption have any effect on economic growth (Öztürk, 2010; Adom, 2011; Hamdi and Sbia, 2012; Omri, 2014). Most studies in the literature have found a causal relationship between energy consumption and economic growth (Wong et al., 2013; Belke vd., 2011; Chontanawat et al., 2008; Lee and Chang, 2008; Tsani., 2010; Asafu-Adjaye, 2000).

In order to improve their growth performance, countries must also increase their energy inputs in general. However, countries access to energy is complex and difficult. Because the energy factor is scarce in some countries and access to energy is quite expensive. While fossil resources are insufficient in a part of the globe, some of them are inefficient and insufficient in terms of water resources, some of them are inefficient and insufficient in terms of wind and some of them are sun. Therefore, countries with scarce energy must bear some costs to access energy. Many developing countries are trying to achieve their economic growth targets with their production structure based on energy imports (Recepoğlu et al., 2020). Producing in such an environment also leads to different macroeconomic problems by causing cost increases. This study aims to econometrically test the relationship between energy consumption and economic growth in BRIC (Brazil, Russia, India and China) countries with similar macroeconomic characteristics. This group of countries consists of developing countries called rapidly growing and emerging economies, where a significant part of the increase in energy consumption takes place (Narin and Kutluay, 2013). The unique aspect of the study comes from the econometric methods used. In this study, complementary estimates are made by using the methods applied to the recent developments in panel data econometrics, where the time dimension is also important. Annual data for the period 1990-2020 were used in these estimates. In the data, including the variables of primary energy consumption per capita and GDP (Gross Domestic Product) per capita for countries, the results obtained from dynamic panel econometric methods are interpreted as increasing economic growth by electricity consumption in the panel as a whole. This result is considered an important finding in terms of showing that economic growth is sensitive to electricity consumption and the importance of energy for growth. In the country examples, it is seen that country-specific results emerge.

Following the introductory part, the study briefly mentions the BRIC countries and then includes the literature on electricity consumption and economic growth panel econometric studies. In the other title, the data set and econometric model are introduced and empirical analysis results are included. Finally, econometric findings are discussed and suggestions are presented.

Over the BRIC Countries

The term BRIC was first used in 2001 for the countries of Brazil, Russia, India and China to draw attention to their rise in the global economy. The aim was to express the high growth potential of these countries and the idea that they could play an important role in shaping the world economy in the future. Over time, the BRIC countries have grown and become important players in the global economy, increasing the popularity of this term. With the accession of the Republic of South Africa to these countries in 2010, it started to be used as BRICS.

Among the similar characteristics of the BRIC countries, they have high populations, rapid economic growth rates, are rich in natural resources, having a young population, the influence of the state on the economy (state intervention) is high, they are increasingly important countries in the world economy and politics, they attach importance to infrastructure investments and the countries attach importance to economic cooperation with each other in the fields of trade and investment. On the other hand, it should be noted that BRIC countries have unique characteristics within themselves and each of them has its own internal dynamics.

The highly populated structures of the BRIC countries offer them the possibility of a dense internal market, increasing consumer demand and significant labor potential. Cheap labor opportunities arising from young population structures offer incentives for export-based production. Exploitation of rich natural resources supports growth in BRIC countries, sectors such as mining, power generation and agriculture. Encouraging infrastructure investments supports economic growth through improvements in transport, energy and communications infrastructure. BRIC countries are focused on developing their technological infrastructure and capabilities. It should be emphasized that India and China, in particular, have made rapid progress in the field of technology.

It is estimated that the BRIC countries, which have reached the fastest growth figures in the world in terms of economic growth in recent years, will be able to take leading positions in the world in the near future. These countries, which attract the attention of enterprises that are leaders in world markets with their low production costs and high-profit margins caused by the cheap labor they provide, create approximately 20% of the world's GNP, according to the information conveyed from Tezcan (2014). BRIC countries have 26% of the world's surface area, 40% of foreign exchange and gold reserves, 45% of the world's population and 44% of the labor force (Slobodnikova and Nagyova, 2011). It is emphasized that in the coming periods, it is estimated that the focus of capital flow, foreign direct investments and global economic dynamics will be the BRIC countries in the trade of goods and services (Morazan et al., 2012). In parallel with this development in the economies of the BRIC countries, energy production and use also increased over time (Tezcan, 2014).

China is known as the country with the largest population in the world and also as the largest energy consumer. Due to the high population and the place of technological advances in human life along with rapid industrialization and urbanization processes, there is a high demand for electricity. China is also notable for its investments in renewable energy sources. India, on the other hand, is an important country in terms of electricity consumption with its large population and growing economy. Rapid population growth, urbanization and industrialization can be listed as factors that increase electricity demand. It should be emphasized that India is dependent on both local sources and external energy imports to meet its energy needs. Russia plays a major role in energy production with its rich natural resources. The country, which has energy resources based on fossil fuels, is one of the most important countries in terms of both domestic consumption and energy exports. Brazil's electricity consumption, on the other hand, is largely based on renewable energy sources. Large hydroelectric power plants play an important role in meeting the country's electricity needs.

According to World Bank statistics, in terms of electric power generation, in the production of energy from coal, natural gas, hydropower, renewable energy and liquid-fueled sources, Brazil's hydroelectric resources; Russia's gas, coal and fuel resources; India's production resources from coal and China's production from gas, fuel oil and coal and hydropower are noteworthy (World Bank, 2023). In the production of electrical energy obtained from renewable energy sources, Brazil obtains more than 10 percent of the total production from these sources, while the share of the Russian Federation in the production of renewable electrical energy in the total electricity production is at the level of 0.1 percent. In the share of energy obtained from renewable sources in total energy, India and China have 5.4 and 3.9 percent, respectively (World Bank, 2023).

LITERATURE REVIEW

The rapid progress in the globalization process, the acceleration of the industrialization process, technological advances and the dependence of new production systems on energy increase the importance of

energy consumption in terms of the sustainability of economic growth. Table 1 includes some empirical studies compiled for econometric analyses on the relationship between electricity consumption and economic growth and dealing with examples of country groups.

Table 1: Selected empirical literature.

Author	Period /Country	Method	Result
Ferguson et al. (2000)	1960-1995 /Some selected countries	Correlation coefficient method	In developed countries, the relationship between the variable of electricity consumption and economic growth is higher than in less developed countries.
Lee (2005)	1975-2001 Developing countries	Pedroni panel cointegration test, FMOLS Granger causality test	There is a cointegration relationship between energy consumption and economic growth.
Lee and Chang (2007)	1965-2002 Developed and developing countries	Panel VAR and panel GMM	From economic growth to energy consumption in developing countries; In developed countries, there is a relationship from energy consumption to economic growth.
Bohm (2008)	1978-2005 15 EU countries	Johansen cointegration and panel causality test	There is no cointegration relationship between electricity consumption and economic growth.
Narayan and Smyth (2008)	1972-2002 G7 countries	Pedroni, Westerlund, FMOLS, DOLS, OLS, Granger	There is a cointegration relationship between energy consumption and economic growth. In the long term, energy consumption positively affects economic growth.
Öztürk et al. (2010)	1971-2005 51 countries	Pedroni cointegration, Granger FMOLS DOLS	From economic growth to energy consumption in low-income countries; In middle-income countries, there is causality from energy consumption to economic growth.
Ciarreta (2010)	1970-2007 European countries	GMM, VECM FMOLS	There is a bidirectional causality between energy consumption and economic growth.
Apergis and Payne (2011)	1990-2006 88 member countries of the World Bank	Panel cointegration and panel causality	There is a bidirectional causality between energy consumption and economic growth. The increase in energy consumption increases economic growth.
Fuinhas and Marques (2012)	1965-2009 Portugal, Italy, Greece, Turkey	ARDL boundary test	There is a bidirectional causality between energy consumption and economic growth.
Cowan, et al. (2014)	1990-2010 BRICS Countries	Dumitrescu-Hurlin (2012), Emirmahmutoğlu and Köse (2011) Causality test	Between electricity consumption and economic growth; There is no causal relationship in Brazil, India, and China. While there is a mutual causality relationship in Russia, a one-way causality relationship has been identified in South Africa.
Alaali et al. (2015)	1981-2009 Petroleum exporting and developed countries	GMM	Energy consumption across the panel positively affects economic growth.
Bozma et al. (2015)	1990-2014 BRICS and MINT	Westerlund cointegration test	Energy consumption positively affects economic growth.

Menegaki (2016)	1992-2008 BRIC Countries	Panel Causality Analysis	The increase in alternative energy consumption increases economic growth.
Buhari and Deger (2016)	2000-2012 BRIC Countries	Granger Causality Analysis	There is a one-way causal relationship from total energy consumption to economic growth.
Özşahin et al. (2016)	2000-2013 BRICS-T Countries	Panel ARDL Analysis	There is a positive long-term relationship between renewable energy consumption and economic development.
Khobai H. (2017)	1990-2014 BRICS Countries	Kao and Johansen Co. Causality Test	There is a long-term relationship between electricity consumption and economic growth. There is a one-way causal relationship from economic growth to electricity consumption.
Syzdykova (2018)	1991-2016 Central Asian Countries	Pedroni Co., Dumitrescu &Hurlin Ca.	There is a bidirectional causality between energy consumption and economic growth.
Balli et al. (2018)	1992-2013 Common Wealth of Independent States Countries	Pedroni, Kao Co. and Dumitrescu-Hurlin causality and FMOLS	There is a bidirectional causality between the variables of energy consumption and economic growth.
Aydin (2019)	1992-2013 BRICS Countries	Panel Causality Test	Biomass energy consumption has a positive impact on economic growth in all BRICS countries except Brazil.
Azam (2019)	1981-2015 BRICS Countries	Panel Causality Test	There is a strong correlation between energy and economic growth. Energy use positively affects economic growth.
Altiner (2019)	1971-2014 MINT Countries	Emirmahmutoğlu and Köse (2011) Causality test	There is no causal relationship between the panel-wide variables of energy consumption and economic growth.
Kahouli (2019)	1990-2015 34 OECD Countries	Panel regression analysis	There is a bidirectional causality between energy consumption and economic growth.
Erdoğan et al. (2020)	1990-2014 MENA Cont.	Granger Causality Test	Energy consumption is the cause of the economic growth variable.
Morshadul (2022)	1992-2019 BRICS Countries	Panel Data Analysis FMOLS	While natural gas production and consumption, electricity production and consumption, biofuel production, oil production, capital formation and openness to trade positively affect economic growth, coal production negatively affects economic growth.

When the studies in Table 1 are examined, it is seen that there is no consensus on the relationship between economic growth and energy consumption variables. It is seen that this situation differs according to empirical analysis methods, sample period and country/country group and variables used.

EMPIRICAL ANALYSIS

Data Set and Model

The relationship between energy consumption and economic growth in the BRIC country group is investigated through the variables of annual per capita income and primary energy consumption per capita for the 1990-2020 sample period. The information for these variables is given in Table 2.

Table 2: Information on variables.

Variables	Explanation	Source
LGDP	Logarithmic GDP Per Capita ($)	World Bank (WDI)
LEC	Logarithmic Primary Energy Consumption Per Capita	Energy Institute (EI)

The equation (1) of the model created by using the logarithmic transformations of both variables belonging to the BRIC countries is given.

$$LGDP_{it} = a_i + \beta_{1i} LEC_{it} + \varepsilon_{it} \quad (1)$$

The relationship expressed in equation (1) is the econometric relationship predicted in the relevant literature, and i; the cross-sectional size and t; shows the size of the time. The variable on the left side of the equation represents GDP, while the variable on the right side represents primary energy consumption per capita.

Empirical Method

In the study, energy consumption and economic growth data sets of BRIC countries and dynamic panel data analyses are used. The cointegration relationship between the variables was tested by multiple structural fracture panel cointegration analysis developed by Westerlund (2006). Some preliminary tests need to be examined before applying the cointegration analysis. The first of these preliminary tests is the tests that show whether there is a cross-sectional dependency or not. The situation that reveals that a macroeconomic change seen in one of the countries affects the other countries also shows the existence of inter-sectional dependence. In the absence of this test, an important assumption is ignored in countries where the globalization process is deepened. This may cause the results of empirical analysis to contain deviated information (Breusch and Pagan, 1980). The LM test proposed by Breusch and Pagan (1980) to investigate the existence of dependence between cross-sectional units is investigated by the LMadj test with the CD test developed by Pesaran (2004) and the CDLM test proposed by Peseran (2004) and Peseran et al. (2008) respectively. The aforementioned tests may vary according to the time and cross-sectional size of the data model. So much so that the LM test; t > n, CD test can be applied in n/t→∞, n > t states, and CDLM test can be applied in both t→∞ or n→∞, n> t , t > n states. However, the relevant tests can give deviated results because the group mean is zero and the individual mean is different from zero (Nazlıoğlu et al., 2011). This problem is solved by adding variance and mean to the LMadj test statistic (Peseran et al., 2008). For all four of the cross-sectional dependence tests, the basic hypothesis is “H0: There is no cross-sectional dependence”, while the alternative hypothesis is “H1: There is a cross-sectional dependence”.

The Panel Fourier LM unit root test developed by Nazlıoğlu and Karul (2017) takes into account the inter-cross-sectional dependence. This test, which is a current test in the panel unit root literature, is among the tests that take into account structural breaks among the second generation panel unit root tests. In this test, it is not necessary to know the number and dates of structural fractures in advance. The basic hypothesis of the relevant unit root test is “H0: There is a unit root”, while the alternative hypothesis is “H1: There is no unit root”.

Another preliminary test is to test whether the coefficients are homogeneous or not. With the homogeneity test, it is examined whether a change in the cross-sectional units is affected at the same level in other countries in the panel. The Delta and Deltaadj tests proposed by Pesaran and Yagamata (2008) are used to test this condition. In the method, two different tests are recommended according to the size of the sample. Delta test, for large samples; The deltaadj test is valid for small samples. The basic hypothesis of these tests is “H0: βi = β (The slope coefficients are homogeneous), while the alternative hypothesis is “H1: βi ≠ β (The slope coefficients are heterogeneous)”.

The panel cointegration test proposed by Westerlund (2006) can be used when cross-sectional dependence applies. The test also takes into account multiple structural fractures. The basic hypothesis of this test is based on the assumption that “H0: There is a cointegration relation”. In the test, structural breaks in both trend and constant can be detected. In the presence of cointegration, panel cointegration estimator tests can be used. In empirical analysis, the CCE method, which assumes heterogeneity and takes into account the dependence between cross-sections, is used in the long-term coefficients of the variables. The CCE method developed by Pesaran (2006) makes long-term coefficient estimations and takes into account cross-sectional dependence. It can be applied regardless of whether the time dimension and the section size are smaller or larger than each other. In these cases, it can produce results that provide a consistent and asymptotic normal

distribution. In addition, this estimator can calculate the long-term equilibrium coefficients of the cross-sectional units separately (Pesaran, 2006).

Empirical Findings

The cross-section dependency test findings revealing whether there is dependency among the countries included in the analysis are given in Table 3. The test in question is an important point of differentiation in terms of which unit root and cointegration test to use .

In Table 3, cross-sectional dependency test findings of the variables and cointegration equation of BRIC countries are given. CD test findings show that the basic hypothesis is rejected at a significance level of 1%. In other words, the existence of cross-sectional dependence in the said country group in accordance with the expectations was reached.

Table 3: Cross-sectional dependence test findings

Variables	**LGDP**		**LEC**	
Cross-Sectional Dependency Tests	Statistical Value	Probability Value	Statistical Value	Probability Value
CDlm1 (BP, 1980)	81.785***	0.000	22.888***	0.001
CDlm2 (Pesaran, 2004)	21.877***	0.000	2.882***	0.001
CDlm3 (Pesaran, 2004)	-2.361***	0.009	-3.040***	0.001
LMadj (PUY, 2008)	27.188***	0.000	42.716***	0.000
Variables	Cointegration Equation			
Cross-Sectional Dependency Tests	Statistical Value		Probability Value	
CDlm1 (BP, 1980)	64.740***		0.000	
CDlm2 (Pesaran, 2004)	16.957***		0.000	
CDlm3 (Pesaran, 2004)	7.570***		0.000	
LMadj (PUY, 2008)	12.852***		0.000	

Note: "***" represents significance at the level of 1%.

In fact, it is concluded that in the event of a shock in one country included in the analysis during the sample period, other countries will be affected. As a result, it is seen that the Panel Fourier LM unit root test proposed by Nazlıoğlu and Karul (2017) and taking into account the cross-sectional dependence can be performed. Table 4 shows the relevant test findings.

Table 4 unit root test findings showed that the variables included in the analysis had a unit root process at the level. This result allows the investigation of the cointegration test. Before investigating the existence of cointegration, the homogeneity of the cointegration coefficients of the model is examined. These results are set out in

Table 4: Panel fourier lm unit root test findings

Variables	**LGDP**			**LEC**		
Countries	**Fourier tau LM1 k=1**	**Fourier tau LM2 k=2**	**Fourier tau LM3 k=3**	**Fourier tau LM1 k=1**	**Fourier tau LM2 k=2**	**Fourier tau LM3 k=3**
Brazil	-1.8162	-1.0407	-1.7496	-3.2244	-0.7592	-3.3145
Russia	-0.4937	-0.0004	0.6077	-3.6778	-1.0164	1.8983
India	1.6975	0.2782	0.4081	-2.0209	-1.4739	-2.3076
China	1.6063	0.3976	0.0119	-0.3906	0.8286	2.4411
ZLM (St. V.)	10.4111	5.8591	5.7690	2.0285	4.4419	5.3415
p- value	1.0000	1.0000	1.0000	0.9787	1.0000	1.0000

The homogeneity test results given in Table 5 indicate that the interaction in question is heterogeneous, in other words, the resulting economic shocks will affect each country to different levels. The fact that the variables obtained as a result of the unit root tests contain unit roots at the level shows the applicability of the cointegration test. In the analysis, it was concluded that the variables contained unit roots at the level.

Westerlund (2006) allows the application of panel cointegration testing. Table 6 shows the structural fracture panel cointegration test results.

Table 5: Slope homogeneity test findings.

Tests	Test Statistics	Probability Value
Delta Tilde	2.603	0.005
Delta Tildeadj	2.739	0.003

Note: "" refers to the significance level of 1%.

Table 6 shows the findings of cointegration. In this test, bootstrap critical values are taken into account because there is cross-sectional dependence between the countries included in the analysis. The findings show that the basic hypothesis of the cointegration test is rejected in the structural fracture-free model. In other words, it was concluded that there was no cointegration relationship. However, in the structural fracture model, this result changes and the existence of a cointegration relationship is revealed. It is observed that the 2008 global crisis and the 1999 Russian crisis came to the fore in the breaking dates. After the existence of the cointegration relationship is reached, the cointegration coefficient estimator test can be performed.

Table 6: Structural rupture panel cointegration test findings.

	LM Test Statistics	Asymptotic Probability Value	Bootstrap Probability Value
	Structural Unbreakable Model		
Constant	3.814	0.000	0.050
Fixed and Trendy	7.621	0.000	0.000
	Structural Rupture Model		
Constant	2.417	0.008	0.790
Fixed and Trendy	5.357	0.000	0.870
	Breaking Dates		
Countries	Stationary Model	Fixed and Trend Model	
Brazil	1999 2009	1999	
Russia	1999 2006	1999 2008	
India	1999	1999	
China	1999	1999	

The CCE estimator findings proposed by Pesaran (2006) are given in Table 7. When Table 7 is examined, it is concluded that the long-term coefficient of the energy consumption variable for the panel showing all BRIC countries is statistically significant.

Table 7: CCE findings.

Countries	Coefficient	Standard Error	p-value
Brazil	2.401***	0.363	0.000
Russia	2.552***	0.214	0.000
India	0.803***	0.233	0.001
China	0.110	0.513	0.829
CCE	1.464 **	0.600	0.015

Note: The "**" and "***" significance at the level of 5% and 1%, respectively.

This result shows that a 1% increase in energy consumption in the BRIC countries increases economic growth by 1.46%. When the countries are examined separately, it is seen that the long-term coefficients of energy consumption for Brazil, Russia and India are statistically significant. In Brazil, Russia and India, a 1% increase in energy consumption boosted economic growth, respectively; 2.40%, 2.55% and 0.80%.

CONCLUSION

Especially after the 1990s, it is seen that globalization tendencies have increased with regional integrations, population increases, industrialization and capital mobility have experienced significant changes in production processes. While all these processes are in progress, countries are making efforts to maintain their economic growth rates. The increasing importance of inputs in the production process, especially in the context of energy, shows that developing countries have increased their efforts to access energy.

In this study, the relationship between economic growth and energy consumption in BRIC countries was investigated. Empirical estimates suggest that a 1% increase in energy consumption across the panel increases economic growth by 1.46%. When the cross-sectional units are examined separately, a 1% increase in energy consumption in Brazil, Russia and India is expected to increase economic growth by 2.40%, respectively, while the result that it increased by 2.55% and 0.80% was reached as a statistically significant result, the positive parameter of the Chinese economy was not statistically significant. These results reveal that energy consumption is an important input for economic growth in the relevant country group. Therefore, ensuring energy supply security in this group of countries is considered important for sustainable economic growth. However, it is considered that it is of great importance to encourage renewable energy sources in the BRIC countries in order to ensure uninterrupted energy production as a resource needed by economic growth.

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