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The Impact of Energy Poverty on Economic Growth: Evidence from EAGLE Countries

Enerji Yoksulluğunun Ekonomik Büyüme Üzerindeki Etkisi: EAGLE Ülkelerinden Kanıtlar

[1]Başak ÖZARSLAN DOĞAN
[2]Onur ÖZDEMİR

Abstract

Aim: The aim of this study is to examine the impact of energy poverty on economic growth in EAGLE countries for the period 2000–2020. Energy poverty is addressed primarily through access to electricity.

Method: The Han and Phillips (2010) method is employed in the analysis. In addition to energy poverty, total labor force, urbanization, patent applications, and carbon emissions are included in the model to evaluate their effects on economic growth

Results: A statistically significant and positive relationship is found between access to electricity and economic growth. Moreover, total labor force, urbanization, and carbon emissions also have a significant and positive effect on economic growth. Although patent applications show a positive impact, this effect is statistically insignificant.

Conclusion: The findings reveal that access to electricity plays a critical role in fostering economic growth and socio-economic development in EAGLE countries. Improved energy access supports technological advancement and increased use of electric power, making it a fundamental driver of economic growth.

Keywords

Energy poverty, Economic growth, Eagle countries, Access to electricity, Panel data

[1]Assoc. Prof. Dr., Istanbul Gelisim University, Department of International Trade and Business, Istanbul, Türkiye.
✉ bozarslan@gelisim.edu.tr

[2]Assoc. Prof. Dr., Istanbul Gelisim University, Department of International Trade and Finance (English), Istanbul, Türkiye
✉ onozdemir@gelisim.edu.tr

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Öz

Amaç: Bu çalışmanın amacı, EAGLE ülkelerinde enerji yoksulluğunun ekonomik büyüme üzerindeki etkisini 2000-2020 dönemi için incelemektir. Enerji yoksulluğu, özellikle elektriğe ulaşım düzeyi üzerinden ele alınmıştır.

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Yöntem: Analizlerde Han ve Phillips (2010) yöntemi kullanılmış; enerji yoksulluğunun yanı sıra toplam işgücü, kentleşme, patent başvuruları ve karbon emisyonları da modele dahil edilerek bu değişkenlerin ekonomik büyüme üzerindeki etkileri değerlendirilmiştir.

Bulgular: Elektriğe erişim ile ekonomik büyüme arasında istatistiki olarak anlamlı ve pozitif bir ilişki tespit edilmiştir. Ayrıca toplam işgücü, kentleşme ve karbon emisyonları da ekonomik büyüme üzerinde pozitif ve anlamlı etkiler göstermektedir. Patent başvuruları ise pozitif yönde etki göstermesine rağmen, bu etkinin istatistiki olarak anlamlı olmadığı bulunmuştur.

Sonuç: Elde edilen bulgular, EAGLE ülkelerinde elektriğe erişimin ekonomik büyüme ve sosyo-ekonomik kalkınma açısından kritik bir rol oynadığını ortaya koymaktadır. Enerjiye erişimin artması, teknolojik gelişmeleri ve elektrik enerjisi kullanımını teşvik ederek ekonomik büyümeyi destekleyen temel bir unsur haline gelmektedir.

Anahtar Kelimeler

Enerji yoksulluğu, Ekonomik büyüme, Eagle ülkeleri, Elektriğe ulaşım, Panel veri

Introduction

Economic growth is a multifaceted concept extensively examined in the literature due to its connections with various micro and macroeconomic factors such as inflation, income, education, health, and the environment. Central to understanding economic growth is the exploration of its key determinants and their interrelationships. The foundational Solow (1956) growth model highlights labor and capital as primary drivers, which has since been expanded to include additional variables such as education, energy consumption, carbon emissions, foreign investments, and industrialization (Jones & Schneider, 2006; Sarwar, Chen, & Waheed, 2017; Ahmad, Draz, Su, Ozturk, Rauf & Ali, 2019; Âmin, Liu, Yu, Chandio, Rasool, Luo & Zaman, 2020). Moreover, factors such as technological progress, population growth, and international trade dynamics also influence economic growth by shaping energy demand and utilization patterns. This study focuses specifically on the conceptual and empirical links between energy consumption and economic growth, emphasizing how energy dependency, especially on fossil fuels, may impact sustainable development and growth performance through mechanisms such as the current account deficit.

For sustainable development to be achieved, underdeveloped countries must have access to modern, clean, and affordable energy services (Sharma & Karnamadakala Rahul, 2016). Accordingly, within the scope of the global Sustainable Development Goals (SDGs) adopted by all member states of the United Nations in 2015, modern, clean, and affordable energy represents the 7th goal to ensure universal access between 2016 and 2030 (Morton, Pencheon & Squires, (2017). Therefore, access to modern, clean, and affordable energy sources is thought to contribute to the SDGs, which include the following factors such as reducing poverty (SDG1), improving health and well-being (SDG3), and improving the quality of education (SDG4) (Harmelink, 2020).

The United Nations Department of Economic and Social Affairs (UNDESA) states that as a result of global progress in clean energy and energy efficiency, the proportion of people with access to electricity increased from 83 percent in 2010 to 90 percent in 2019, and the proportion of using clean fuels and technologies increased from 57 percent to 66 percent in the same period (UNDESA, 2021). However, millions of people on a global scale still live without electricity and one-third of this proportion do not have access to clean cooking fuels and technologies (Katoch, Sharma, Parihar & Nawaz, 2024).

One of the factors whose effects on economic growth have been examined in recent years is energy poverty. Although energy poverty is expressed as a concept that is not very different from generally known poverty, most of the population in energy poverty generally belongs to developing countries (Âmin et al., 2020). So much so that the issue of not being able to access energy or energy poverty, which is mostly a problem for developing countries and for which they seek a solution in this field, poses a bigger problem for developing countries, where daily electrical appliances, expressed as basic needs (refrigerator, washing machine, refrigerator, etc.), are considered normal today, and societies that need energy even for heating and cooking continue their lives. Although one of the reasons for energy poverty for developing countries is thought to be insufficient income level, the issue of not being able to access energy independent of the income level that countries have, requires it to become an issue that needs to be researched globally (Eke, 2012; Eke & Ayrancı, 2018).

Energy poverty has been the most striking concept in literature in recent years among the concepts of poverty. The most important reason for this is that even basic needs such as cooking, lighting, and heating cannot be met at a minimum level due to a lack of energy. These elements, which are expressed as the most basic vital needs today, are a part of the world's daily life. In this context, it can be said that one of the primary needs purchased by individuals and households is electricity. The definition and measurement of energy poverty can be addressed in four different ways (Barnes, 2010; Köktaş & Selçuk, 2018):

- The minimum amount of physical energy that represents basic human needs, consisting of cooking-heating-lighting,
- The amount and type of energy consumed by those at the poverty line,
- More than a certain percentage of their expenditure is spent on energy,
- Fall of energy use below a certain income level, provided that it remains constant in terms of minimum energy demand.

Based on the above statements, energy poverty can be defined as not being able to access energy resources or not being able to access modern and clean energy resources at reasonable prices. This phenomenon is mostly seen in developing countries, but it can also be seen in developed economies. On the other hand, the Covid-19 pandemic and political crises between countries in recent years (for example, the Russia-Ukraine crisis) have led to the disruption of trade relations between countries since they were affected from these crises which also disrupt the supply and demand structure, leading to global energy crises (Barış & Demir, 2023). According to the 2022 report of the International Energy Agency (IEA), high energy prices resulting from the energy crisis mostly affect low-income households. In low-income countries/regions, the heaviest burden falls on poorer households, where a greater share of income is spent on food and energy. The 2022 report of World Energy Outlook noted that the combination of the Covid-19 pandemic and the current energy crisis could result in around 70 million people who have gained access to electricity losing the ability to afford it, and around 100 million more people unable to cook with clean fuels, reverting to unhealthy and unsafe cooking methods (IEA, 2022; Barış & Demir, 2023).

Energy poverty is a major problem not only for countries with very low incomes but also for developing and developed countries. The best example of this situation is the EU countries. According to the report published by the EU (2022), high and volatile energy prices affect consumers in all EU Member States, affecting not only low-income households but also lower-middle-income households, SMEs, and industries. According to the same report, the average share of energy expenditure across EU Member States increased by more than a third between 2019 and 2022, and in some countries, this share almost doubled. As a result, approximately 35 million EU citizens (approximately 8% of the EU population) could not keep their homes sufficiently warm in 2020 (EU, 2022).

Access to energy for any society is also a prerequisite for human development. The welfare and development of countries are closely related to the access of citizens to energy and the type of this access. In this context, diversification of energy sources and the provision of modern energy sources to users at reasonable prices and without interruption are among the issues that governments should prioritize (Köktaş & Selçuk, 2018). The absence of commercially provided energy, especially electricity, can cause inequality in the living conditions of society. In this context, there is a general belief that with increased access to electricity, a higher growth rate and a better quality of life will be achieved in society (Pereira, Freitas & da Silva, 2010).

There are two different approaches most frequently used in the economic literature regarding energy poverty. The first of these approaches determines energy poverty using minimum units of measurement for individuals or households. In this approach, individuals or households that consume electricity below a certain level of 'watts', which is the unit of measurement for electricity consumption, are considered energy poor. The other approach accepts individuals or households that consume fuel below a certain level of 'calories' as energy poor (Foster & Yepes, 2006; Silva, Klytchniova & Radeviç, 2007; Fankhauser, Rodionova & Falcetti, 2008; Eke & Ayrancı, 2018).

With access to energy, especially electricity, being considered one of the United Nations Sustainable Development Goals, the importance of energy supply in ensuring human development has become more prominent. As a result of global efforts, the 1.1 billion of people without access to electricity in 2015 decreased to 840 million in 2017 (UN, 2017, 2019; Son & Yoon, 2020). Although this progress is significant, it is unlikely that welfare improvements will be realized unless households or individuals use the available electricity. For instance, low-income households may postpone their use of electricity if traditional fuels or lighting sources are available, which may lead to electricity consumption inequalities between low- and high-income households.

In recent years, studies have increasingly shown that household income is an important determinant of energy consumption. It has been found that income is an important determinant of energy consumption, especially in upper-middle-income and high-income countries (Romero-Jordán, Del Rio & Peñasco, 2016). Since higher income levels eliminate financial constraints on energy use, households or individuals can more easily access devices that contribute significantly to energy consumption. Thus, energy poverty can remain at low levels in these countries.

This study aims to examine the impact of energy poverty, measured by access to electricity, on economic growth in EAGLE countries from 2000 to 2020. The study is important as it highlights how improving energy access can drive sustainable economic development in emerging economies, filling a gap in existing literature. The next section of this study, which examines the empirical relationship between energy poverty and economic growth for EAGLE countries with data for the period 2000-2020, includes a summary of selected international and national literature on the subject. EAGLE countries, consisting of China, India, Indonesia, Brazil, Russia, Türkiye, and Mexico, are defined by BBVA Research as developing economies whose growth is expected to exceed the contribution of G7 countries, excluding the USA, to world growth in the coming years (BBVA, 2012). For this purpose, the countries in question are selected in this study where the relationship between energy poverty and economic growth will be examined. Then, the model and data set that constitute the empirical part of the study will be introduced and the findings obtained will be shared. The last section includes policy recommendations and general findings.

Literature Review

Although the relationship between energy consumption and economic growth has been widely studied (Sadorsky, 2010; Ozturk, 2010; Lee & Chang, 2008), research specifically focusing on the impact of energy poverty on economic growth remains relatively limited. In this context, the fact that the sample group of the study consists of EAGLE countries increases the originality and importance of the subject. One of the important studies examining the relationship between energy poverty and economic growth is the study conducted by Rehman & Deyuan (2018), finding that the total population's access to electricity, the urban population's access to electricity, and energy use positively affect economic growth by using the 1985-2015 period data for Pakistan and the ARDL bounds test.

Another important study in this sense is the study of Singh and Inglesi-Lotz (2021). Singh & Inglesi-Lotz (2021) selected 4 Sub-Saharan African countries as a sample group in their study and examined the effect of electricity access on economic growth for the period 1990-2016 with the help of Generalized Method of Moments (GMM). Their findings indicate that access to electricity positively and significantly affects GDP. On the other hand, Manga (2020) examines the causality relationship between access to electricity, which represents energy poverty, and economic growth in Malawi, Burkina Faso, Gambia, Haiti, Madagascar, Central African Republic, and Mali with data for the period 1995-2016. The empirical findings show that while there is a two-way cause-effect relationship between energy poverty and economic growth in Madagascar and the Central African Republic, there is a one-way cause-effect relationship from economic growth to energy poverty in Malawi and Burkina Faso, and from energy poverty to economic growth in Haiti. On the other hand, no relationship is found between energy poverty and economic growth in Mali and the Gambia.

The work of Munyanyi & Awaworyi Churchill (2022) is also an important study in examining the relationship in question. Accordingly, the authors state that the decrease in poverty in income due to the increase in foreign aid will contribute to the reduction of poverty in energy. In their study, Âmin et al. (2020) find a negative relationship between energy poverty and economic growth in both the long and short term, with the ARDL bounds test covering the years 1995-2017 in countries located in South Asia. On the other hand, Tatlı & Barak (2019) examine the relationship between access to electricity and economic growth in their study for the period 1990-2015 in Türkiye with the help of the ARDL bounds test. Their findings reveal that there is a positive relationship between energy poverty and economic growth.

There are important studies in the literature that also investigate the impact of energy poverty on the environment. For example, Ansari, Villathenkosath, Akram & Rath (2022) conclude that energy poverty reduces the ecological footprint in a study conducted for Sub-Saharan Africa with data for the period 1995-2018. The study also examines the effects of energy poverty on economic growth, but it is found that energy poverty in Sub-Saharan Africa does not affect economic growth. Filippidis, Tzouvanas & Chatziantoniou, (2021) examine the concept of energy poverty by taking into account the population's access to energy consumption in their study with a panel data set consisting of more than 200 countries for the period 2000-2019. In this context, the study conducts a three-stage analysis including (i) economic growth and energy consumption, (ii) energy consumption and income inequality, and (iii) economic growth and electricity production. The main findings of the study are that it supports the Energy-Environmental Kuznets Curve hypothesis. They find that the relationship between economic growth and renewable energy is a U-shaped curve, the relationship between economic growth and fossil fuel energy consumption is an inverted U-shaped curve, and that increasing renewable energy consumption reduces income inequality, and finally, stronger economic growth positively affects electricity production from renewable sources while decreasing electricity production from coal. They emphasize that the impact of renewable energy on energy poverty is particularly significant.

In addition to these studies, Sadorsky (2010) examined the impact of energy consumption on economic growth in emerging economies, highlighting the important role of energy in the growth process. Ozturk (2010) provided a comprehensive literature survey on the energy–growth nexus, underlining the complexity and multifaceted nature of this relationship. Furthermore, Lee & Chang (2008) conducted a panel data analysis of Asian economies, confirming a significant relationship between energy consumption and economic growth.

This study is important because it is one of the limited studies examining the relationship between energy poverty and economic growth for EAGLE countries. On the other hand, it also includes patent applications used to represent urbanization, total labor force, carbon emissions, and technological progress, and in this respect, it differs from other studies.

Data and Methodology

The relationship between energy poverty and economic growth is analyzed for the EAGLE country group consisting of China, India, Indonesia, Brazil, Russia, Türkiye, and Mexico with annual data between 2000-2020. EAGLE countries are distinguished from other similar countries based on their higher growth and development potential as identified by the BBVA Research group. Specifically, EAGLE economies are a subset of developing countries projected to contribute substantially to global economic growth in the coming years, following the G7 countries excluding the USA. This classification reflects their significant expected share in world growth, emphasizing their increasing economic influence on the global stage.

In the examination of the relationship between energy poverty and economic growth, a model was created as specified below, and the variables and data sources used in the model are presented in Table 1.

$$LGDP_{it} = \partial_t = \beta_1 LGDP_{it-1} + \beta_2 Lpatent_{it} + \beta_3 Lurban_{it} + \beta_4 Laccess_{it} + \beta_5 Llabor_{it} + \beta_6 CO2_{it} + \varepsilon_{it} \quad (1)$$

where i represents the panel individual (country), t is the time, and ε defines the error term with constant variance and zero mean. In addition, L shows the logarithm of the variables.

Table 1. Data Description

Variables	Description	Source
GDP	Real Gross Domestic Product (in US dollars at constant 2015 prices)	World Bank (World Development Indicators)
Patent	Patent application numbers (residents)	World Bank (World Development Indicators)
Urban	Urban population (% of total population)	World Bank (World Development Indicators)
Access	Access to electricity (% of total population)	World Bank (World Development Indicators)
Labor	Total Labor Force	World Bank (World Development Indicators)
CO2	Carbon emissions (metric tons per capita)	World Bank (World Development Indicators)

In the first phase, the GDP is used as the dependent variable to examine the effect of energy poverty on economic growth. It is also used on the logarithmic scale, in which 2015 is chosen as the base year. On the other hand, energy poverty is represented by the population's access to electricity on a logarithmic scale. In addition, the number of patent applications, total labor force, urban population, and carbon emissions are used as control variables in the model. All these variables are calculated on a logarithmic scale, except for carbon emissions, and they are extracted from the World Bank's World Development Indicators (WDI) database.

There are several variables affecting GDP in economic discipline. However, the motivation for this study is the concept of energy poverty. For this reason, energy poverty is selected as the core independent variable, besides the other variables, which are also statistically significant on GDP. On the other hand, the SDGs are also considered in the model. In this direction, Urban, Access, and CO2 are selected to represent access to electricity, sustainable cities and communities, and climate action, respectively. In addition to these variables, the number of patent applications (namely, patent) is used as an innovation indicator. It is thought that increasing innovation activities will positively affect economic growth by reducing costs and increasing the competitiveness of countries (Özcan & Özer, 2018). Finally, the labor force (namely, labor) is added as a control variable to show that economies with increasing populations will be also high number of labor force, thus resulting in the emergence of lower-cost labor. This increases the demand of businesses for cheaper labor (Becker, Murphy & Tamura, 1990). Therefore, it is expected that the labor force will positively affect economic growth.

In this study, the relationship between energy poverty and economic growth is analyzed using the Dynamic Panel Data method put forward by Han & Phillips (2010). The Dynamic Panel Data method is one of the most frequently used methods among other panel data-based methods. Dynamic panel data methods, unlike static ones, use lagged models (Tatoğlu, 2013; Özçağ, Bozdağlıoğlu & Küçükkaya, 2019). The traditional Dynamic Panel Data method is expressed as in Eqs. 2 and 3 below:

$$\gamma_{it} = \delta \gamma_{it-1} + X'_{it-1} \beta + \epsilon_{it} \tag{2}$$

$$\epsilon_{it} = \mu_{it} + \upsilon_{it} \tag{3}$$

where i is the country and t represents the time dimension. In addition, μ_{it} indicates the i^{th} unit effect and does not change throughout the period. For this reason, both γ_{it} and γ_{it-1} constitute a function of this unit effect (Baltagi, 2005).

In econometric analyses using fixed effect dynamic panel methods, the Ordinary Least Squares (OLS) method, along with the data in first difference transformation, causes efficiency deviations in the parameter of the lagged variable. For example, taking the average technique of variables or Arellano & Bond's (1991) estimator to solve this problem helps to avoid such biases. However, Arellano & Bover (1995) and Blundell & Bond (1998) state that these options may increase the weight of problems in obtaining effective results, especially when the parameter of the lagged variable is close to one. Therefore, it is more proper to develop a new estimator to overcome these problems (Wooldridge, 2003; Greene, 2007). At this point, Han & Phillips (2010) suggest a different estimator for making dynamic panel estimations to eliminate the problems of weak instruments even when the parameter of the lagged variable is close to one. Thus, this can provide statistically more reliable estimation results for stationary data as well as non-stationary data. In addition, this estimator does not impose any restrictions on the panel size. The only assumption required for the estimation of the model is that the residuals follow a white noise process (Doğan & Doğan, 2023). On the other hand, the Dynamic Panel Data approach takes into account any increase in heterogeneity across the units resulting from the OLS estimation and, hence, provides more consistent estimates compared to fixed or random effect models that address assumptions about heterogeneity across countries and time (Mitze, 2010). Since there is a possibility of two-way causality between the variables, this may, however, lead to an endogeneity problem in the model. Therefore, the Dynamic Panel Data approach pursued by Han & Phillips (2010) provides more effective and more unbiased estimates since it also considers such possible problems as the endogeneity problem (Tian, Huang, Zhao & Peng, 2024).

According to the Han & Phillips (2010) approach, which is considered within the framework of the dynamic panel data approach, the model created to examine the effect of energy poverty on economic growth is expressed in Eq. 4 as follows:

$$Y_{it} = \alpha I + \beta Y_{i0} + \lambda Y_{i(t-1)} + \gamma X + \rho_1 \omega Y_{i0} + \rho_2 \omega X + \epsilon_{it} \tag{4}$$

where Y_{it} represents the economic growth in year t and for unit i. Y_{i0} denotes the initial value of economic growth, I is the unit matrix; ω is a spatial weight matrix of order nxn. In addition, X represents the impact factor matrix, ρ_1 and ρ_2 are the spatial effects, α, β, λ and γ show the coefficient parameters to be estimated, and finally ε denotes the random error term.

Before estimating the model pursued to examine the relationship between energy poverty and economic growth, the descriptive statistics of the variables are examined. In this context, the descriptive statistics of the variables are presented in Table 2.

Table 2. Descriptive Statistics

Variables	**LGDP**	**LPatent**	**LUrban**	**LLabor**	**LAccess**	**CO2**
Mean	27.93	8.66	4.07	18.60	4.54	4.29
Maximum	30.31	14.14	4.46	20.47	4.60	11.88
Minimum	26.68	5.05	3.32	16.90	4.09	0.88
Standard Deviation	0.81	2.13	0.34	1.11	0.10	3.28
No. of Observations	147	147	147	147	147	147

According to the descriptive statistics represented in Table 2, the variable with the highest standard deviation is CO2, while LAccess has the lowest standard deviation. When the mean values of the variables are examined, it is 27.93 for the LGDP, 8.66 for the LPatent, 4.07 for the LUrban, 18.60 for the LLabor, 4.54 for the LAccess, and 4.29 for the CO2.

Table 3 shows the correlation matrix of the variables. The correlation matrix values are of great importance in detecting any multicollinearity problem among the control variables. If the correlation coefficient between the variables exceeds 0.90, it can be said that there is a multicollinearity problem (Tabachnick, Fidell & Ullman, 2013). In this context, since the highest correlation coefficient calculated between the selected variables in the study was 0.88, it is possible to support the argument that there is no problem indicating multicollinearity between the selected variables.

Table 3. Correlation Matrix

	LGDP	**LPatent**	**LUrban**	**LLabor**	**LAccess**	**CO2**
LGDP	1.000					
LPatent	0.8838	1.000				
LUrban	-0.1462	-0.1128	1.000			
LLabor	0.7486	0.6310	-0.7177	1.000		
LAccess	0.1613	0.1474	0.7468	-0.3913	1.000	
CO2	0.2324	0.5362	0.3873	-0.1201	0.4052	1.000

Empirical Findings

When using the panel data method, the heterogeneity or homogeneity of the units is closely related to the sample selection methodology. Therefore, the heterogeneity or homogeneity of the model must be determined. For this purpose, the Swammy homogeneity test was first performed in the study. Accordingly, it can be argued that the panel is heterogeneous. Table 4 below presents the results of the Swammy homogeneity test.

Table 4. Swammy Homogeneity Test

chi2(36)	6603.69
Prob > chi2	0.0000

The model examining the relationship between energy poverty and economic growth is analyzed through the Han & Phillips (2010) method, which is expressed by Eq. 1. The robust Hausman test is also used to determine which model is more appropriate when producing the estimation results. The Robust Hausman test is important in terms of obtaining more accurate results in selecting the appropriate model, even in the event of deviations from the assumptions in the model. The null hypothesis is imposed using the robust variances obtained from the bootstrap operations in the Robust Hausman test. According to the Robust Hausman test results, it can be stated that the random effects model is more appropriate. Accordingly, the random effects estimation results of Han & Phillips (2010) are given in Table 5.

Table 5. Han and Phillips (2010) Estimation Results

Dependent Variable: LGDP		
Variables	**Coefficient**	**z-statistics**
LGDP (-1)	1.52	5.37***
LUrban	1.67	7.10***
LLabor	0.70	5.87***
LAccess	0.94	6.08***
CO2	0.10	6.24***
LPatent	0.03	1.52
Wald test	1323.9766***	
F-test	220.66***	
Robust Hausman Test	0.05 (0.99)	

Note: "*** indicates significance at the 1% level."

According to the estimation results of Han and Phillips (2010) expressed in Table 5, the relationship between urban population growth and economic growth in EAGLE countries is found to be statistically significant and positively correlated with each other. In that vein, urbanization plays an important role in the increase of national incomes of countries and constitutes one of the most important indicators of development. The fact that cities have features such as employment opportunities and market creation keeps them at the center of production (Tuna & Ceritli, 1997; Çalışkan & Öztürk, 2019; Gross & Ouyang, 2021).

The other variable whose effect on economic growth is examined in the study is labor. Table 5 also shows that labor affects economic growth statistically significantly and positively. The findings of the current study are consistent with Karaki (2023) and Paudel & Perera (2009). The fact that economies with high population rates have a high amount of labor also reduces the cost of labor. Thus, businesses increase their tendency to use cheaper labor, which leads to an increase in employment. As a result, the increasing labor force will inevitably contribute to economic growth (Becker et al., 1990).

In this study, there is also a statistically significant and positive relationship between access to electricity, which represents energy poverty, and economic growth. In other words, as access to electricity, which represents energy poverty, increases, economic growth is positively affected by it.

The results obtained from the study are also parallel to Öztürk & Çelik (2023) and Tatlı & Barak (2019). Access to electricity is the backbone of an economy's prosperity and progress, as well as an important indicator of socio-economic development. Technological developments increase the use of electrical energy resources and constitute one of the driving forces of economic growth (Alter & Syed, 2011; Manga, 2020).

Another variable whose effect on economic growth is examined is carbon emissions. A positive relationship is found between carbon emissions and economic growth, which is also statistically significant. Production in both developed and developing countries is carried out through fossil energy sources today. Fossil energy sources are considered by researchers as one of the main causes of carbon emissions. In this context, considering that the industrialization and production structure in EAGLE countries are dependent on fossil fuels, it is expected that the relationship between carbon emissions and economic growth is positive. While the results obtained do not coincide with Güllü & Yakışık (2017), they do coincide with Bayramoğlu & Yurtkur (2016). The last variable examined in the study is patent applications. It is found that patent applications have a positive effect on economic growth. However, the coefficient is also found to be statistically insignificant.

Concluding Remarks

While energy is at the center of both production and consumption in many countries around the world, it also forms the basis of many global problems such as climate change, food security, health, and education. Another concept that is discussed as much as the concept of energy today is energy poverty. Energy poverty, represented by access to energy and therefore electricity, constitutes one of the basic inputs of both economic growth and socio-economic development.

This study aims to empirically investigate the relationship between energy poverty and economic growth in EAGLE countries for the period 2000-2020 using the Han & Phillips (2010) method. In the study, energy poverty is represented by access to electricity, and the effects of the total labor force, patent applications, urbanization, and carbon emissions on economic growth are examined. The results obtained from the study findings show that there is a positive and significant relationship between energy poverty and economic growth. Access to electricity is the driving force of prosperity and progress in a country and is also an important indicator of socio-economic development. Especially thanks to technological developments, the increase in the use of electrical energy resources also increases economic growth. On the other hand, the effect of total labor force, urbanization, and carbon emissions on economic growth is found to be positive in the study, and the coefficients are statistically significant.

Although the energy conditions and development levels of countries are not the same, the aim of the energy policies implemented in each country is to increase the welfare level of the country by using the existing energy resources effectively and efficiently. Only in this way will sustainable growth be achieved and economic development will occur automatically. In this context, the study suggests some policies to policymakers:

- Policies to be adopted for renewable energy to ensure sustainable economic growth are of great importance for countries that use fossil fuels in mass production. Unlike fossil energy, renewable energy is local and unlimited, which will help to remove the obstacles to the energy access problem in these countries.
- Another thing to do to eliminate energy deprivation or minimize its effects is to ensure the efficiency of the energy used. Taking measures to ensure energy efficiency and innovation studies to be carried out in this area will help to transfer resources to more appropriate areas. Thus, economic growth will be positively affected by this situation.
- Implementing policies to eliminate inequalities in income distribution will also be one of the practices that will alleviate the effects of energy poverty. Income inequality is felt relatively more in developing countries. Fluctuating and high energy prices affect low-income individuals the most, especially poorer households where a larger portion of income is spent on food and energy. Policies to be implemented to reduce income inequality will also help to remove the obstacle to the development of these countries/regions.

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Özet

Günümüzde sürdürülebilir ekonomik kalkınmanın sağlanmasında enerjiye erişim kritik bir rol oynamaktadır. Özellikle gelişmekte olan ülkelerde enerji, yalnızca üretimin ve sanayileşmenin temel girdisi değil, aynı zamanda yaşam kalitesinin artırılması, sağlık, eğitim ve istihdam gibi temel alanlarda ilerleme sağlanmasının da anahtarıdır. Ancak dünya genelinde milyonlarca insan hâlâ modern enerji hizmetlerinden yoksun yaşamaktadır. Bu durum, özellikle enerji altyapısının yeterince gelişmediği ve hızlı kentleşme ile nüfus artışının yaşandığı EAGLE (Emerging and Growth-Leading Economies) ülkelerinde daha da belirgindir. Bu bağlamda, çalışmada 2000–2020 dönemi için EAGLE ülkelerinde enerji yoksulluğunun ekonomik büyüme üzerindeki etkileri incelenmektedir. Enerji yoksulluğu kavramı, çalışmada doğrudan elektriğe erişim oranı üzerinden temsil edilmiştir.

Çalışmada, ülkeler arası farklılıkları ve veri setinin panel yapısını dikkate alan Han ve Phillips (2010) yöntemi kullanılmıştır. Ekonomik büyümeyi temsilen kişi başına düşen gayrisafi yurt içi hasıla (GSYİH) kullanılırken, temel bağımsız değişken olarak nüfusun elektriğe erişim oranı esas alınmıştır. Bunun yanı sıra toplam işgücü, kentleşme oranı, patent başvuru sayısı ve karbondioksit (CO_2) emisyonları gibi faktörler de modele dâhil edilerek ekonomik büyüme üzerindeki diğer potansiyel etkiler değerlendirilmiştir. Çalışmada kullanılan tüm değişkenler durağanlık açısından test edilerek, ampirik analizlerin güvenilirliği sağlanmıştır.

Elde edilen bulgular, elektriğe erişim ile ekonomik büyüme arasında pozitif ve istatistiksel olarak anlamlı bir ilişki olduğunu göstermektedir. Bu sonuç, enerji altyapısının iyileştirilmesinin ve elektrifikasyon oranlarının artırılmasının, üretim kapasitesini yükselttiğini, istihdamı teşvik ettiğini ve genel yaşam koşullarını iyileştirerek ekonomik performansa olumlu katkı sunduğunu ortaya koymaktadır. Ayrıca toplam işgücü ve kentleşme oranlarının da ekonomik büyümeye anlamlı ve pozitif etkilerde bulunduğu belirlenmiştir. Bu, şehirleşme ile birlikte gelen altyapı yatırımları, sanayi yoğunluğu ve hizmetlere erişimin artmasının, ekonomik canlılık üzerinde olumlu sonuçlar doğurduğu şeklinde yorumlanabilir.

Çalışmada, CO_2 emisyonlarının da ekonomik büyüme ile pozitif bir ilişki içinde olduğu görülmüştür. Bu durum, EAGLE ülkelerinde büyümenin önemli ölçüde enerji ve sanayi temelli bir yapıya sahip olduğunu ve bu büyümenin çevresel maliyetler doğurduğunu göstermektedir. Bu noktada, çevresel sürdürülebilirliğin sağlanabilmesi adına daha yeşil enerji stratejilerinin geliştirilmesi gerektiği ortaya çıkmaktadır. Diğer taraftan, patent başvuruları ekonomik büyüme üzerinde pozitif fakat istatistiksel olarak anlamlı olmayan bir etki göstermiştir. Bu bulgu, yenilikçiliğin henüz ekonomik yapı ile yeterince bütünleşmediğini ve teknoloji üretiminin büyüme üzerinde doğrudan bir etki yaratamadığını göstermektedir.

Sonuç olarak, EAGLE ülkelerinde enerjiye erişimin artırılması, yalnızca teknik bir altyapı yatırımı olarak değil, aynı zamanda kalkınmanın temel bir unsuru olarak değerlendirilmelidir. Elektriğe erişim oranlarının yükseltilmesi, ekonomik büyümenin hızlandırılması kadar, sosyal refahın artırılması ve bölgesel eşitsizliklerin azaltılması açısından da büyük önem taşımaktadır. Ancak bu süreçte, enerji kullanımının çevresel etkilerinin de dikkate alınması; karbon emisyonlarını azaltacak, yenilenebilir kaynakları destekleyecek politikaların uygulanması gereklidir. Ayrıca, inovasyonun ekonomik büyüme üzerindeki etkisinin artırılabilmesi için, Ar-Ge yatırımlarının artırılması ve yeniliklerin ticarileştirilmesini sağlayacak bir ekosistemin inşa edilmesi büyük önem taşımaktadır. Bu çalışma, enerji yoksulluğu ile ekonomik büyüme arasındaki ilişkiye dair kapsamlı ve somut kanıtlar sunarak, EAGLE ülkeleri için hem ekonomik hem sosyal kalkınma politikalarının enerji erişimi temelli olarak yeniden tasarlanması gerektiğini ortaya koymaktadır.