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Does Wind Energy Affect Economic Growth in Developing Countries?

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Abstract

Energy is of great importance for the sustainability of social and economic life. Energy consumption in the world has increased gradually depending on the economic development. Fossil fuels, which are frequently used in energy production, cause environmental degradation. Therefore, countries have turned their attention to renewable energy sources such as solar, wind and biomass. In this context, the relationship between economic growth and wind energy use was analyzed for 23 developing countries using the data of 2004-2016 and the Driscoll and Kraay estimator. The findings obtained as a result of the study prove that the increase in wind energy has a positive and significant effect on economic growth in the mentioned countries.

Keywords: Macro Economics, Economic Growth, Renewable Energy, Panel Data Analysis.

Özet

Sosyal ve ekonomik hayatın sürdürülebilmesi için enerji büyük önem taşımaktadır. Dünyada ise enerji tüketimi, ekonomik gelişmeye bağlı olarak giderek artmıştır. Enerji üretiminde sık kullanılan fosil yakıtların çevresel bozulmalara yol açmasından dolayı ise ülkeler dikkatlerini güneş, rüzgar ve biyokütle gibi yenilenebilir enerji kaynaklarına çevirmiştir. Bu kapsamda çalışmada, 23 gelişmekte olan ülke için 2004-2016 yılları arasında rüzgar enerjisinin ekonomik büyüme üzerindeki etkisi Driscoll ve Kraay Tahmincisi aracılığıyla tahmin edilmiştir. Çalışma sonucunda elde edilen bulgular, belirtilen ülkelerde rüzgar enerjisi artışının ekonomik büyüme üzerinde pozitif ve anlamlı bir etkiye sahip olduğunu kanıtlar niteliktedir.

Anahtar Kelimeler: Makro İktisat, Ekonomik Büyüme, Yenilenebilir Enerji, Panel Veri Analizi.

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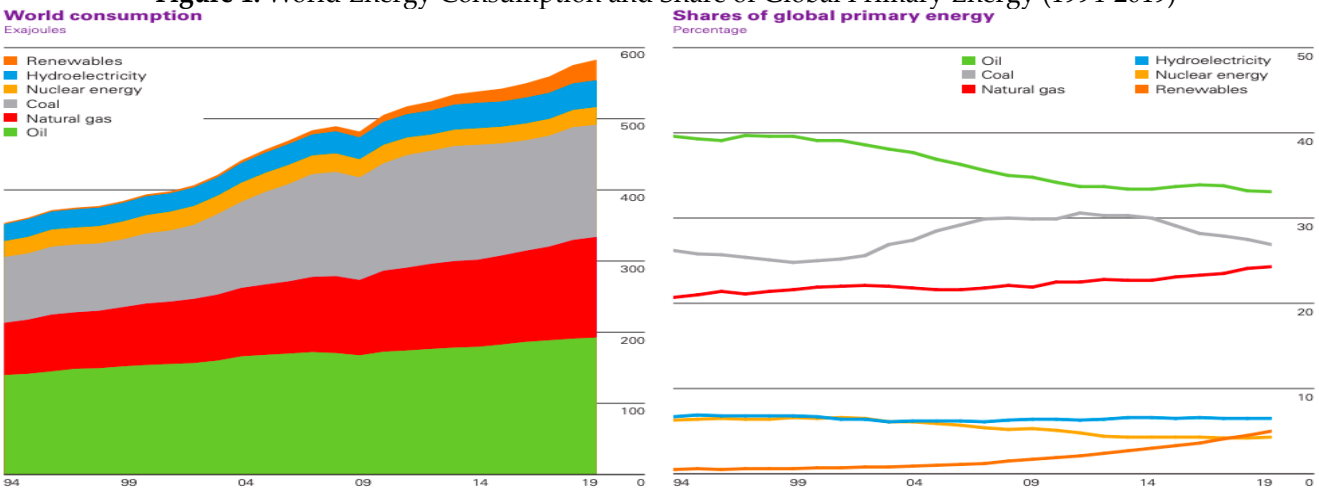
1 INTRODUCTION

Energy is one of the most important factors in building a sustainable future. In this context, there are many issues that are discussed about the future of energy resources. But three of these issues form the basis of energy discussions. The first of these issues is the limited reserves of fossil energy resources and the possibility that they will be exhausted at a later date. The second is that greenhouse gas emissions resulting from the use of fossil fuels increase, causing global warming and climate change. Finally, in economies that are dependent on foreign energy, in a possible energy crisis is the energy supply problem that will occur (Apergis and Danuletiu, 2014, p.578-579; Çalışkan, 2009, p.306; Gültekin and Uğur, 2019: 326).

Fossil energy sources such as coal, oil and natural gas constitute the majority of the energy used in the world today. In In this context, energy consumption according to its source and the shares of these resources in total energy consumption are expressed in Figure 1. In the light of the data obtained from Figure 1, oil is the most consumed energy source in the world. This is followed by coal, natural gas, hydroelectricity, nuclear energy and other renewable energy sources.

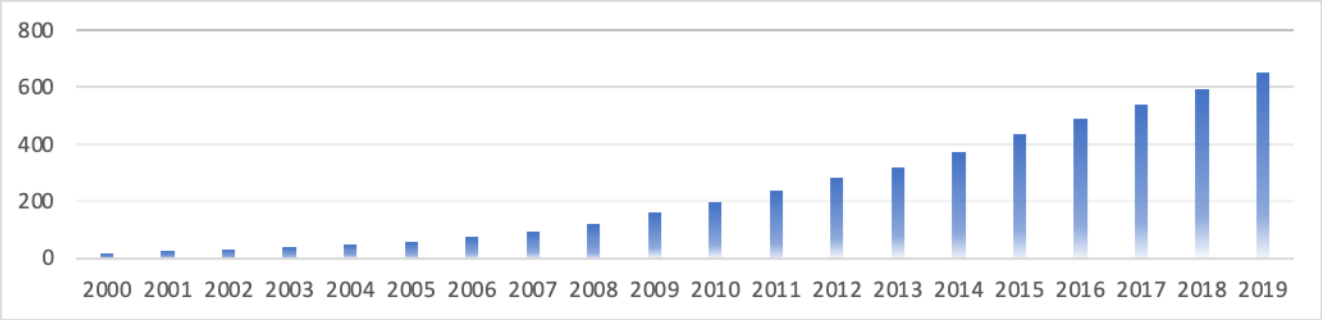
Figure 1: World Energy Consumption and Share of Global Primary Energy (1994-2019)



Source: BP Statistical Review of World Energy Outlook, 2020

In the period between 1994 and 2019, although the use of fossil energy sources is at the top, the consumption of renewable energy resources is increasing every year. So much so that, especially after the 2000s, with the developing technology and the increased awareness of these resources, the interest in renewable energy has increased. Increasing interest in renewable energy has brought with it more investment in this field. In this context, between 2010 and 2019, approximately 2.6 trillion dollars (excluding large-scale hydroelectric) renewable energy investments were made globally. Approximately 41% of this investment belongs to wind energy (Frankfurt School-UNEP Center / BNEF. 2019).

Wind energy is one of the fastest developing completely environmentally friendly energy sources. In addition, it is an energy source with low raw material cost. For example, the cost of electricity generated from wind energy is 50% of the cost of solar and nuclear energy, and approximately 25-30% of electricity produced from thermal power plants operating with natural gas, coal and oil (Hayli, 2001: 10).

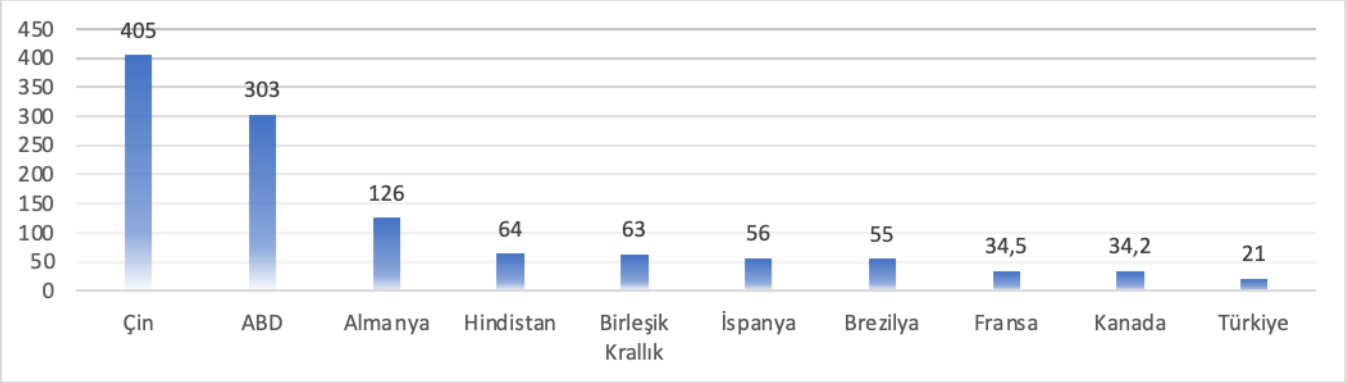


Source: Wind Energy İnternational, 2020 (https://library.wwindea.org/global-statistics/)

Figure 2: Global Installed Wind Energy Capacity (MW) between 2000-2019

Figure 2 shows the global installed power capacity of wind energy between 2000-2019. Accordingly, the installed power capacity, which was approximately 18 thousand MW in 2000, reached approximately 650 thousand MW by 2019. The most important factor in this increase in wind energy installed power capacity is the decrease in wind energy-based electricity generation costs. In wind energy, while the cost reduction in onshore wind has been 39% since 2010, there has been a 29% reduction in offshore wind (IRENA, 2020).

Figure 3 shows the top ten countries in wind energy generation as of 2019. Accordingly, China ranks first both in terms of the wind energy capacity used in 2015 and the capacity added in 2016. China ranks first in wind energy, as in other renewable energy sources. For many years, China has met its increasing energy need from fossil fuels in parallel with its economic development. In this context, China is trying to eliminate this problem, which gradually turns into energy security due to fossil fuel dependence, by turning to renewable energy sources (Turan, 2019). USA ranks second in wind energy production after China. Wind energy in the country provides more than 20% of the electricity production of 6 states (AWEA, 2020). Germany is third in the world in wind power generation, India fourth and the UK fifth. Turkey ranks tenth in the world.



Source: BP Statistical Review of World Energy Outlook, 2020

Figure 3: Top 10 Countries in Wind Energy Production as of 2019 (TWh)

2 LITERATURE REVIEW

Although there are many studies examining the relationship between renewable energy and economic growth in the economics literature, the number of studies examining the effects of wind energy on economic growth remains limited. At this point, this study is expected to fill the gap in the literature.

The effect of wind energy on economic growth is examined in the literature in two ways. The first of these examines the effect of wind energy on economic growth in theoretical terms. The first of the studies mentioned Koçaslan (2010), for the sustainable development objectives in Turkey conducted a study of the importance of wind energy. Accordingly, in addition to being a completely domestic, renewable and environmentally friendly

resource, wind energy is a resource that will meet the total final energy consumption; It has reached the conclusion that it will also contribute to the economic, environmental and social areas.

Pegels and Lütkenhorst (2014) compared wind power and solar energy in five different aspects, such as competitiveness, innovation, job creation, climate change mitigation and cost, within the framework of the German example. Accordingly, they concluded that wind energy meets these five substances better than solar energy.

Khan and Erdoğdu (2012), their study examined the economic benefits of wind energy for Turkey; In case of generating energy from wind instead of fossil fuels, a total of 56.7 million tons less carbon dioxide will be emitted. and that energy will be produced at around 56 million TL cheaper and stated that 112 thousand people will be provided with employment opportunities.

The second study examining the effect of wind energy on economic growth is empirical.For example, Gültekin and Uğur (2019) investigated the macroeconomic determinants of wind energy consumption for OECD countries with the help of panel data analysis for the years 2000-2015. In the study, government final consumption expenditures, government activity, energy use per capita and GDP per capita were used as determinants of wind energy. According to the analysis findings obtained, while public size is not a determinant in wind energy consumption in any country, government efficiency and energy use are the determinants of wind energy in some countries.

Koç and Apaydın (2020) analyzed the relationship between wind energy and economic growth with the data for the period 1991-2017, using panel data for G-20 countries. According to the results of the analysis, a significant and positive relationship was found between wind energy and economic growth.

Armeanu et al. (2017) measured the impact of renewable energy sources on economic growth in their study including the Panel Data Analysis they conducted for 28 EU Member States in the period between 2003-2014. In this study, they concluded that wind energy, which is one of the renewable energy resources, increased the economic growth by 4%.

Ohler and Fetters (2015) examined the causality relationship between electricity generation from renewable energy sources and GDP in their study using the Panel Error Correction model for the period 1990-2008 and 20 OECD countries. According to the study, it was stated that electricity obtained from biomass energy has a decreasing effect on GDP, while electricity obtained from wind energy and hydraulic energy has an increasing effect on GDP.

Sakarya and Yıldırım (2017) used Monte Carlo Simulation (MCS) model in the evaluation of wind power plant (WPP) investments in their study. By simulating various combinations of input variables affecting the RES investment, determining the net present value (NPV) of the planned project, they concluded that RES investments are economically profitable if appropriate conditions are met.

Atay (2016) analyzed the relationship between wind energy and economic growth in G-7 and G-20 countries with a data set for 2003-2012. Accordingly, unit root tests, cointegration and causality tests applied with the help of panel data set using wind energy consumption and economic growth rates were used in the study. According to the results, a 1% increase in wind energy consumption increases economic growth by 6%

3 DATA SET AND METHODOLOGY

In econometrics-based empirical studies, three types of data are used: cross-section data, time series data and mixed data, which is a combination of these two data sets. If the same section unit is examined in a certain time period, such mixed data are called panel data (Gujarati, 1999). In other words, panel data includes the examination of countries, firms or household units at a certain time scale (Baltagi, 2001: 1). The general equation used in panel data analysis is expressed as follows:

$$Y_{it} = \alpha + X'_{it} + u_{it} \qquad i=1,,,,,N \qquad t=1,,,,,,T \qquad (1)$$

In equation no 1, i = 1,,, represents the data of N number of firms, households or countries, while t = 1,,,, T represents time. The term u_{it} error is assumed to be independent of all units (Sandalcılar, 2012: 8).

Static models established with the help of panel data set mostly use fixed effect and random effect models

(Çetin, 2013). In the fixed effects model, each unit that cannot be observed is assumed to be constant with respect to time, while in the random effect model, it is assumed that there are time varying effects around a certain probability distribution and that these effects are unrelated to the explanatory variables of the model (Baltagi, 2005).

Hausman (1978) test is used in the literature to choose between fixed and random effect models. In the Hausman (1978) test, the null hypothesis expressed as H_0 is set up to express the accuracy of the random effect model. As a result of this test, it is concluded that if the Chi-Square probability value is lower than 1%, the model to be used can be preferred as a fixed effect model (Baltagi, 2005). The variables belonging to the model created to examine the effect of wind energy on economic growth are given in Table 2.

Table 2: Variables Used in the Model

Variables	Defining Variables	Source	Expected Sign
GDP	Real GDP	World Bank-WDI	
WIND	Primary Use of Wind Energy	International Renewable Energy Agency- IRENA	+
GFC	Real Fixed Capital Investments	World Bank-WDI	+
LABOR	Labor	World Bank-WDI	+/-

In this study, besides the primary use of wind energy, the effects of real fixed capital investments and labor variables, which are among the important dynamics of growth, on economic growth were investigated. In this context, the study was examined for 23 developing countries using annual data for the period 2004-2016. Countries used in the study; Argentina, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Croatia, Egypt, Hungary, India, Iran, Mexico, Morocco, Peru, Philippines, Poland, Romania, Russia, South Africa, Sri Lanka, Turkey and Ukraine . These countries are determined by whether they use wind energy or not.

3.1. Empirical Findings

In this study, the effect of wind energy use on economic growth will be analyzed with the help of the model given below;

The model used in the analysis is expressed below.

$$LOGGDP_{it} = \alpha_i + \lambda_t + \beta_1 LOGWIND_{it} + \beta_2 LOGGFC_{it} + \beta_3 LOGLABOR_{it} + \varepsilon_{it} \quad (2)$$

In model number 2 i; t represents the country while t represents time. β, estimation coefficients, αi, country fixed effect, λt is the time constant and εit stands for error term. Descriptive test statistics of the variables used in the study are expressed in Table 3.

Table 3: Descriptive test statistics for variables

Variables	Mean	Standard deviation	Minimum	Maximum
GDP	8.731003	0.677523	6.804615	9.620793
WIND	5.023556	2.498339	0	12.03605
GFC	24.92718	1.389702	22.42275	29.11586
LABOR	16.84755	1.445668	14.41239	20.48374

Before performing panel regression analysis, it is necessary to determine the appropriate model in the study. In this context, first of all, in order to determine which of the fixed and random effects models to be used in the study, it was decided according to the result of Hausman test, which is frequently used in the literature. According to the results of the Hausman Test given in Table 4, it was seen that the most suitable method in this study was the fixed effects model. Following the determination that the appropriate model was the Fixed Effects Model in the study, the modified Wald Test for heteroskedasticity problem that could cause errors and deviations in the estimation results, the Wooldridge autocorrelation test for the autocorrelation problem, and the Pesaran

(2004) CD test to determine the presence of cross-sectional independence were used in the study. According to the obtained test results, it was determined that all three heteroskedasticity, autocorrelation and cross-sectional independence problems exist in the model. According to the test findings, Driscoll and Kraay (1998) Standard Errors and Fixed Effects Regression, which are used in the presence of all three of these problems and eliminate these problems, were applied as the final model and the estimated results obtained are given in Table 4.

Table 4: Fixed Effects Model Results with Driscoll and Kraay Standard Errors

Variables	Coefficients
Logwind	0.0254*** (0.00)
Loggfc	0.445*** (0.00)
Loglabor	-0.246* (0.056)
R^2	0.84
Sample Number	299
F-statistic (W)	576.88
Hausman Test statistic	16.86
Modified Wald Test statistic	9184(0.00)
Wooldridge Test statistic	67.31 (0.00)
Pesaran Cross-sectional Independence Test Statistic	4.785 (0.00)

Note: : ( ) refers to the probability values of the variables. and *** p <0.01, ** p <0.05, * p <0.1 represent significance levels

Table 4 shows Driscoll and Kraay estimator results.. According to Fixed Effects Model Results with Driscoll and Kraay Standard Errors , R^2 value is estimated as 0.84. In other words, the power of independent variables to explain the dependent variable is 0.84. The F statistic shows that the model is generally significant. The coefficients of all variables were found to be statistically significant. According to the estimation results, the increase in wind energy positively increases the GDP in accordance with the expectations. In other words, a 1% increase in the use of wind energy increases the GDP by 0.02. Likewise, fixed capital investments have a positive effect on GDP as expected. A 1% increase in fixed capital investments increases GDP by 0.44. On the other hand, the labor variable negatively affects the GDP and a 1% increase in the said coefficient decreases the GDP by 0.24.

4 CONCLUSION

One of the dynamics of a sustainable economy that is thought to change the economic structure of the future is wind energy. Unlike the fossil-based energy resources that are widely used in the world, countries have turned to alternative energy sources in recent years. Wind energy, which is one of these alternatives, increases its importance day by day.

In the study, the effect of wind energy on economic growth between 2004-2016 for 23 developing countries was estimated by means of Driscoll and Kraay estimator. In addition to the primary use of wind energy, labor and real fixed capital investments are also used in the model to measure the relationship between the use of wind energy and economic growth, as they are the dynamics of growth.

In the study, the coefficient for the primary use of wind energy was found to be statistically significant and positive. The demand for renewable energy has increased in recent years and wind energy, which is among the renewable energy sources, is technologically more advantageous than its alternatives, the installation phase is completed in a short time, it can be considered as a factor that increases economic growth due to social and economic contributions in the region where it is established. In addition, wind energy will reduce foreign dependency in energy and thus the decrease in energy import costs will cause an increase in GDP. Labor force, which is another variable considered, constitutes the dynamics of growth. The increase in the labor force in a growing

economy is an issue in the economics literature. If productivity in the labor force is low and the wages correspond to a relatively small proportion of the production cost of the firm that will invest in the country, the abundant workforce in that country will not create an opportunity for the investing firm. In this context, 1% increase in labor force in the study reduces economic growth by 0.24%.The last variable used in the study is real fixed capital investments. Like other variables, this variable was found statistically positive and significant in the study. In summary, the study concludes that the use of wind energy and fixed capital investments increase economic growth, while the labor force reduces economic growth.

The rapid increase of the population in developing countries, and the supply of energy used as input in the increasing production process, at high rates, from fossil-based energy sources make these countries highly dependent on foreign countries. This foreign dependency constitutes one of the biggest obstacles to the development of countries. The current account deficit, which is largely given when importing energy, prevents countries from making new investments and causes a restriction on research and development expenditures to be allocated to this field. In order to minimize this negative situation and solve the energy deficit problem, developing countries should form their energy policies in favor of using renewable energy, just like developed countries. Wind energy, on the other hand, is a good alternative for developing countries due to the fact that its installation and maintenance costs are less than other energy sources and the time it can pay off is very short.

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