Araştırma Makalesi / Research Article

ISSN: 2564-7504
JCS, Volume (6)1, 1 - 14
https://dergipark.org.tr/jcsci

Atıf Gösterimi:
Erdemir, N. A. (2022). Energy Dependence of Turkey: The Role of Renewable Energy Sources. *Başkent Üniversitesi Ticari Bilimler Fakültesi Dergisi*, (6)1, 1 – 14.

# Energy Dependence of Turkey: The Role of Renewable Energy Sources

*Türkiye'nin Enerji Bağımlılığı: Yenilenebilir Enerji Kaynaklarının Rolü*

Nuri Aytuğ ERDEMİR[1]

**Özet**

*Amaç: Türkiye'de ithal ürünler arasında enerji ithalatı ilk sırada yer almaktadır. Son yıllarda, tüm ithalatın %20'sinden fazlasını oluşturan enerji ithalatını en aza indirmek için Türkiye'de yenilenebilir enerji kapasitesi artırılmıştır. Bu makale, son yıllarda Türkiye'de kullanımı artan yenilenebilir enerji kaynaklarının Türkiye'nin enerji dışa bağımlılığını ne ölçüde etkilediğini araştırmaktadır.*

*Yöntem: Türkiye'de yenilenebilir enerji kaynakları, fosil enerji tüketimi ve gayri safi yurtiçi hasılanın net enerji ithalatı üzerindeki etkisi 1990-2018 yılları arasındaki veriler kullanılarak ampirik olarak analiz edilmiştir. Yukarıda belirtilen değişkenler arasındaki nedensel ilişki Toda-Yamamoto testi kullanılarak belirlenmiştir. Ayrıca değişkenler arasındaki etkileşimi belirlemek için Kantil regresyon kullanılmıştır.*

*Bulgular: Elde edilen bulgulara göre yenilenebilir enerji tüketimindeki artışın net enerji ithalatını azaltmadığı görülmüştür. Türkiye'de yenilenebilir enerji kaynakları kullanımının arttırılmasına yönelik olarak uygulanan politikalar enerji bağımlılığını azaltmada yetersiz kalmıştır ve fosil enerji kaynakları halen hakimiyetini korumaktadır.*

*Sonuç ve Katkılar: Yenilenebilir enerji kaynaklarının, enerji dışa bağımlılığını azaltma da etkisiz kalmasının en önemli nedeni enerji talebinin çok yüksek olmasıdır. Enerji talebinin yüksek oluşu, fosil yakıt tüketimini büyük oranlarda arttırdığından,*

[1] Arş. Gör., İzmir Bakırçay Üniversitesi, İktisadi ve İdari Bilimler Fakültesi, nuri.erdemir@bakircay.edu.tr , ORCID: 0000-0002-3614-9726

**Makale Geliş Tarihi / Received:** 24.01.2022 **Makale Kabul Tarihi / Accepted:** 09.03.2022

*yenilenebilir enerji tüketiminde meydana gelen artışlar, net enerji ithalatını düşürmede etkisiz kalmıştır.*

*Sınırlılıklar: Yenilenebilir enerji kaynakları verileri ayrı ayrı değil bir bütün olarak ele alınmıştır. Gelişimi çok yeni olan yenilenebilir enerji kaynakları kapasitelerinde her yıl, bir önceki yıla göre çok ciddi sıçramalar gerçekleşmiştir. Bu kaynakların önümüzdeki yıllarda Türkiye'nin enerji dışa bağımlılığını etkileyecek seviyeye gelmesi oldukça olasıdır.*

**Anahtar Kelimeler:** Enerji tüketimi, Yenilenebilir enerji, Enerji bağımlılığı, Toda-Yamamoto nedenselliği, Kantil regresyon.

**Jel Kodu:** P48, Q41, Q42

***Abstract***

*Purpose: Energy imports are ranked first among import products in Turkey. In recent years, renewable energy capacity in Turkey has increased to minimize energy imports which constitute more than 20% of all imports. This article investigates how renewable energy sources affect Turkey's foreign energy dependency.*

*Methodology: The effect of renewable energy sources, fossil energy consumption and gross domestic product on net energy imports in Turkey has been empirically analyzed using data between 1990 and 2018. The causal relationship between the variables mentioned above was determined using the Toda-Yamamoto test. In addition, quantile regression was used to determine the interaction between the variables.*

*Findings: According to the results, increasing renewable energy utilization did not result in a decline in net energy imports. Turkey's policies to increase the use of renewable energy sources have been insufficient in minimizing energy reliance, and fossil energy sources continue to dominate.*

*Implications: The very high energy demand is the most important reason why renewable energy sources are inefficient in reducing foreign energy dependency. Increased renewable energy consumption seemed to have no effect reducing net energy imports as high energy demand increased fossil fuel consumption dramatically.*

*Limitations: The data on renewable energy resources were analyzed as a whole, not separately. Every year, the capacity of renewable energy resources has grown significantly in compared to the prior year. In the coming years, these resources may reach a point where they will have an impact on Turkey's reliance on foreign energy.*

**Keywords:** Energy consumption, Renewable energy, Energy dependency, Toda-Yamamato causality, Quantile regression.

**Jel Codes:** P48, Q41, Q42

## 1. Introduction

Energy is an essential component of human life and crucial in determining the welfare, social, political, and economic levels of countries. The most significant factors that increase the energy demand are; technological developments, rapid population growth, and rising living standards. The uneven distribution of fossil fuel reserves, such as oil, natural gas, and coal, which are today's most common energy resources, results in substantial differences in fossil fuel reserve richness between countries. Countries, having limited fossil fuel reserves and high dependency on energy, meet their energy demands through imports. Energy imports (over 20% of all import items) rank first in the import items of Turkey (TUIK, 2020). In 2018, approximately 39.67 million tons of oil equivalent (MTOE) of primary energy production were generated in Turkey, 22,79 MTOE of corresponds to renewable energy resources. The amount of energy imports was estimated to be 115.79 MTOE, while the amount of energy supply was calculated as 143.66 MTOE. (T.C. Enerji ve Tabii Kaynaklar Bakanlıgı, 2020). In other words, energy production in the country can only satisfy 24% of the overall energy supply. The rate of energy import dependency is 76%. The emergence of foreign energy dependence is due to a variety of factors, major of which is the lack of fossil fuel reserves.

The causes of Turkey's energy dependency can be listed as follows;

Turkey is still unable to benefit from nuclear energy in 2021. The first nuclear power plant in Turkey will be active in 2025. One of the most important reasons for Turkey's foreign dependence on energy is its late use of nuclear energy.

The 10 countries with the most nuclear power plants are given in Table 1.

*Table 1. Number of Active Nuclear Reactors* (IEA, 2019).

| Country | Number of Nuclear Power Plants |
|---|---|
| **USA** | 99 |
| **France** | 58 |
| **China** | 46 |
| **Japan** | 42 |
| **Russia** | 37 |
| **South Korea** | 24 |
| **India** | 22 |
| **Canada** | 19 |
| **Ukraine** | 15 |
| **England** | 15 |
| **Other** | 73 |

France, which lacks fossil fuel reserves, satisfies approximately 75% of electricity demand via nuclear energy (IEA, 2019). On the other hand, in Turkey, almost all of the electricity production was derived from imported natural gas (30.3%) and some from imported coal (37.2%), totaling 67.5% from fossil fuels (TUIK, 2020). The use of fossil fuels to generate electricity has environmental effects as well as increasing imports. According to the Global Carbon Budget 2019 report, Turkey is the 15th most polluting country in the world in 2018 with 430 million tons of carbon emissions. Another reason for Turkey's high foreign dependence on energy is the loss of energy. In the world,

residences are not only the most energy-consuming (about 40%) following the manufacturing sector, but also are areas where the most energy can be saved (Bingül, 2018). In recent years, many countries, especially Northern European countries, have included detailed regulations regarding energy efficiency and thermal insulation in their construction regulations (Kulaksızoğlu, 2006). A significant amount of energy is saved in residences as a result of these regulations. However, in Turkey, no suitable buildings for saving energy have yet been built. Building energy losses arise as a result of the lack of newly constructed buildings to fulfill energy efficiency standards, which is a result of rapid population growth and urbanization (Kaya and Öztürk, 2014). For example, Sweden is one of the most successful countries in residential energy-saving practices. The energy-savings achieved in Sweden's housing, compared with Turkey; It is seen that the same heating is achieved by consuming 2.8 times more fuel in a building in Istanbul, 3.6 times more in Ankara, and 6 times in Erzurum. (Kulaksızoğlu, 2006). For example, Germany is the country with the highest solar energy capacity in Europe. Although the sunshine duration of Germany is half of Turkey's (7.5 hours) (GEPA, 2020), solar energy capacities were calculated as 45 930 MW and 5995 MW for Germany and Turkey, respectively (IRENA, 2020). While Turkey has 81 GW the technical potential of wind energy, Germany has a technical potential of 12 GW of wind power (Öztürk and Çelik, 2006). However, the wind energy capacity of Germany is approximately 8 times higher than that of Turkey (IRENA, 2020). In the last 10-year period, investments of Turkey in renewable energy sources which increased capacity still remain behind many European countries. Turkey is ranked 18th among the countries of the European Union (EU) with 13.6% renewable energy usage, despite the fact that Turkey's renewable energy potential is quite high thanks to its geographical location. The average renewable energy usage of all EU countries is 17.89 % (Eurostat, 2020).

Foreign dependence on energy has severe effects on the economy of countries. One of the main economic goals of countries is production, in which energy is an indispensable input. Production is costly due to the import of energy for countries like Turkey, which is foreign dependence on energy. Therefore, the prices of the products increase. As long as prices rise continuously, inflation will be inevitable. Increasing production costs have also a negative effect on national income as well.

Countries, that are dependent on foreign energy like Turkey, are extremely sensitive to fluctuations in energy prices and increases in exchange rates. Instability in energy-exporting countries, i.e., rising energy prices or falling in value of the national currency, increases the current account deficit. An increase in the current account deficit means an increase in foreign borrowing. During these periods, the need of country for hot money is on the rise. Hot money is generally provided from portfolio investments. Portfolio investments provide fast money entry to the country, but the sudden withdrawal of money from the country by investors can cause great economic difficulties in the country (Yildiz, 2017).

As the import and energy prices increase, and thereby the exchange rate increases, the foreign currency need problem arises for the countries that are foreign dependent on energy. The decrease in foreign currency reserves reduces the ability of a country to intervene in sudden economic crises and also its ability to compete in the global economy.

Another critical effect of energy import dependency is the employment problem. The country that imports energy passes on all employment in the acquisition, production, marketing, and other processes of energy to the country it imports.

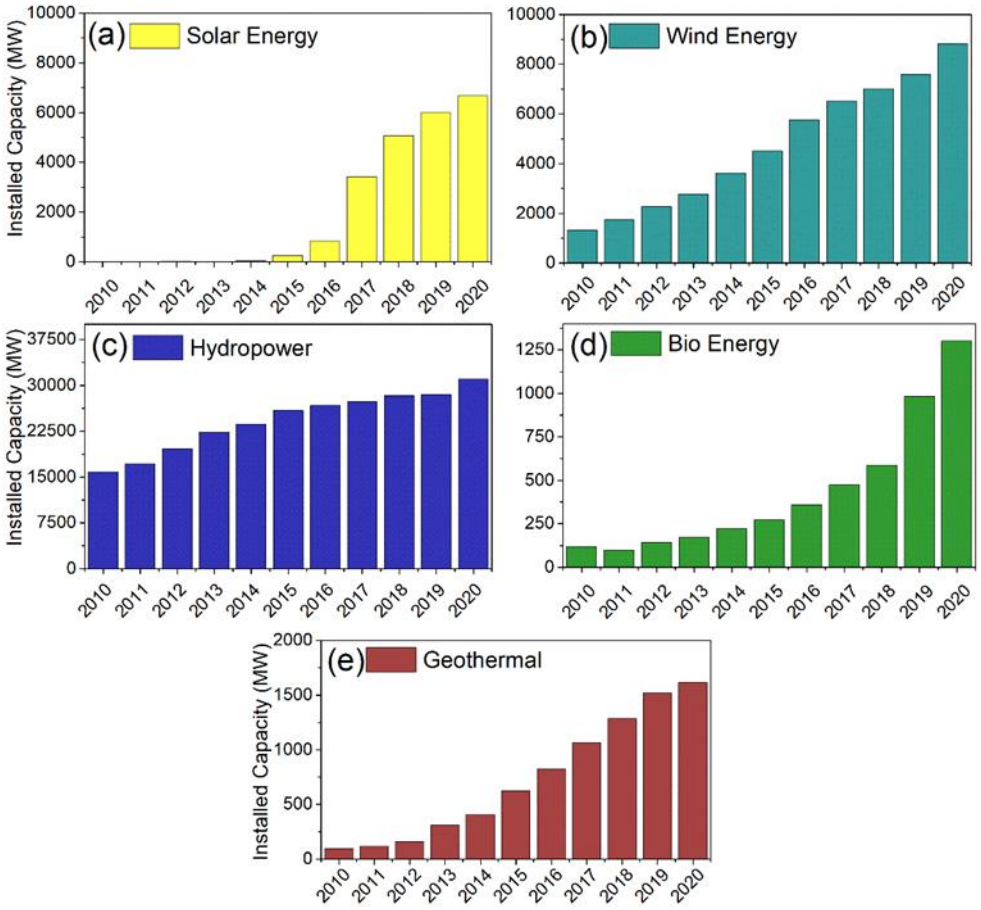
In a study carried out for Turkey, it is estimated that if the country uses its own resources to make renewable energy investments instead of imported energy resources, it will provide additional employment opportunities for approximately 3.6 million people. It is possible for the amount of employment to increase further by spreading these investments not only in the electricity sector but also in industries such as transportation and housing (Bingül, 2018).

Another important issue is the fact that every development in foreign policy is very sensitive for countries with energy dependence. The economy of the energy-dependent country faces serious problems, if the energy-exporting country limits the amount of energy it exports or boosts its price. Therefore, the energy-dependent country has to obey the energy-imported country in foreign policy. In order to avoid this situation, it is very important to create resource diversity by importing from many different countries instead of a single country. The amount of energy Turkey imports from Russia exceeds the amount it produces.

To eliminate the negative effects of Turkey's energy import on the economy, especially in recent years, renewable energy capacities have been increased and foreign dependency has been aimed to be reduced.

Figure 1 shows various renewable energy capacities (hydro energy, solar energy, wind energy, bioenergy, and geothermal energy) in Turkey in the last 10-years.

*Figure 1. Energy Capacity (MW) of (a) Solar Energy, (b) Wind Energy, (c) Hydropower, (d) Bio-Energy, and (e) Geothermal Energy between 2010-2020 years in Turkey (IRENA, 2020)*




In the 2010-2020 period, the solar energy, wind energy, hydropower energy, bio-energy, and geothermal energy capacities of Turkey have increased approximately 1000, 5,7, 1.8, 8.3, and 16.1 times, respectively. As can be seen from the graphs, there have been serious spikes in renewable energy capacities in the country. In the empirical analysis of this study, it was analyzed whether these spikes had an impact on energy imports.

## 2. Literature Review

In this part of the study, empirical studies on energy from an economic perspective, the relationships between energy dependency, energy demand, and economic growth are included.

One of the first studies in literature, conducted by Kraft, A. and Kraft, J. (1978), examined the relationship between economic development and energy consumption. The study was conducted for the United States of America (USA) and examines the causality relationship between the data between 1947-1974 and the variables of GDP and Energy Consumption. A causality from GDP to energy consumption was established.

Aslani et al. (2014) investigated the dependence of energy supply for Finland by using a causal cycle diagram and defining energy demand and energy dependence. According to the findings, energy consumption will increase by 7%, and dependence on foreign energy will increase by 1-7% in 2020.

Altinay (2007), using data from 1980 to 2005 for Turkey, chosen the oil imports as the dependent variables, and GDP and nominal oil prices as explanatory variables. Both nominal GDP and oil prices had an effect on the amount of oil imported.

The causes and degree of the commitment of Turkey's foreign dependence on energy were investigated by Bilginoglu and Dumrul (2012). The ratio of energy imports to energy production was specified as the dependent variable, while GNP, the amount of energy used in houses, and energy efficiency as explanatory variables. There is a positive relationship between energy dependence and explanatory variables, and energy efficiency strongly supports energy dependence, according to a study conducted using data from 1960 to 2008 and Johansen-Juselius cointegration analysis.

Korkmaz and Develi (2012), with the data between 1960-2009 for Turkey, analyzed energy consumption, energy production, and GDP variables via Granger causality tests and vector error correction mechanism. It was concluded that there is a long-term relationship between the variables, and there is a bidirectional causality relationship between energy consumption and GDP. Economic growth will increase energy dependency.

Demir (2013) examined the characteristics and direction of the relationship between industrial production, current account deficit, and energy import variables using cointegration, error correction model, and Granger causality test. The direction of causality was found unidirectional from the industrial production index and energy imports to the current account deficit. The current account deficit problem of the country will grow as the energy dependency arising from the economic growth and increasing energy demand increases.

Bayraç and Çıldır (2017) investigated the effects of renewable energy usage on economic growth in the short and long term for EU countries. As a result of the empirical analysis in which the data were used between 2006 and 2015, there is a long-term co-integrated relationship between renewable energy use and GDP per capita. Additionally, it has been found that increasing the usage of renewable energy has a positive effect on economic growth by increasing GDP per capita in both the short and long term.

Efeoglu and Pehlivan (2018) applied Johansen cointegration, impulse response analysis, Granger and Toda- Yamamoto Causality tests to variables such as final energy consumption, economic growth, and current account deficit with data between 1987-2016 in Turkey. The existence of long-term relationships between these three variables was demonstrated. It was shown that there is unidirectional causality from GDP to current account deficit, from energy consumption to GDP and current account deficit, as well as a causality from current account deficit and energy consumption to GDP.

Özcan and Öztürk (2019) examined the relationship between energy consumption and economic growth for 17 developing countries. The bootstrap panel causality test was used in the study using data between 1990 and 2016. The neutrality hypothesis was determined in all markets except Poland. There is no causality running from renewable energy demand to economic growth.

Ayla and Karıs (2019) investigated the relationship between current account deficit and energy import variables with the ARDL boundary test and the Toda-Yamamoto causality test, using the data between 1984-2015. A cointegration relationship between variables was revealed as a result of the analysis in which the control variables of net foreign direct investment inflows and crude oil import prices per barrel were also added to the ARDL limit test. While a unidirectional negative causality relationship was determined from the current account deficit to foreign investments, no statistically significant relationship could be found between the other variables in which the causality effect was examined. According to the authors, the reverse negative causality relationship represents financial fragility in developing countries.

In the literature, energy consumption is generally considered as a whole in empirical analysis. However, within the scope of this study, energy consumption is divided into two categories: fossil energy and renewable energy. Although there are many studies in the literature that deal with the issue of renewable energy both theoretically and practically in different formats, there are few studies that look at it from the perspective of energy dependency. Therefore, the influence of renewable energy on energy dependency is addressed and discussed in this report.

## 3. Data, Methodology, and Results

The sources in this study, which examine the relationship between net energy imports, GDP, fossil fuel consumption, and renewable energy consumption, are given in Table 2. Data were taken annually.

*Table 2. Variables, Data Period and Source of Data*

| Variable Name | Data Period | Source of Data |
|---|---|---|
| **Net Energy Import (ly)** | 1990-2018 | World Bank |
| **GDP (lgdp)** | 1990-2018 | World Bank |
| **Fossil Fuel (lfuel)** | 1990-2018 | MENR, National Balance Table |
| **Renewable Energy (lenergy)** | 1990-2018 | MENR, National Balance Table |

While net energy import is selected as the dependent variable, GDP, fossil fuel consumption and renewable energy consumption are the independent variables.

Net energy imports play a critical role in the current account balance of Turkey, as in many countries. In recent years, energy imports have accounted for 20% of total imports, ranking first among import items of Turkey. For this reason, it is important to understand the factors that influence net energy imports. Countries provide their energy needs from a variety of sources, including fossil fuels, renewable energy, and nuclear power sources. Since Turkey has still not benefited from nuclear energy, fossil fuels, and renewable energy variables have been included in the study.

### 3.1. Unit Root Tests

In this study, applied unit root tests are Extended Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski -Phillips -Schmidt-Shin (KPSS) unit root tests.

The ADF unit root test was performed after taking the logarithms of the variables, after taking the first differences of the series, it is clear that they are stationary. Table 3 displays the results of the ADF unit root tests.

*Table 3. ADF Unit Root Test*

| ADF | Level (ADF-t Statistics) | | | | First-Difference (ADF-t Statistics) | | | |
|---|---|---|---|---|---|---|---|---|
| **Variables** | **T-Statistics** | **%1** | **%5** | **%10** | **T- Statistics** | **%1** | **%5** | **%10** |
| **Net Energy Import** | -1.42 | -3.69 | -2.97 | -2.62 | -5.42 | -3.69 | -2.98 | -2.63 |
| **Renewable Energy** | -0.81 | -3.69 | -2.97 | -2.62 | -6.62 | -3.69 | -2.98 | -2.63 |

Another unit root test applied in the study is the PP unit root test. When the first differences of the series are taken, it is observed that they are stationary. The results of the PP unit root test are shown in Table 4.

*Table 4. PP Unit Root Test Results*

| PP | Level (PP-t Statistics) | | | | First Difference (PP-t Statistics) | | | |
|---|---|---|---|---|---|---|---|---|
| **Variables** | **T-Statistics** | **%1** | **%5** | **%10** | **T- Statistics** | **%1** | **%5** | **%10** |
| **Net Energy Import** | -1.69 | -3.69 | -2.97 | -2.62 | -5.35 | -3.69 | -2.98 | -2.63 |
| **GDP** | 1.71 | -3.69 | -2.97 | -2.62 | -5.44 | -3.69 | -2.98 | -2.63 |
| **Fossil fuel** | -0.49 | -3.69 | -2.97 | -2.62 | -4.59 | -3.69 | -2.98 | -2.63 |
| **Renewable energy** | -0.61 | -3.69 | -2.97 | -2.62 | -6.62 | -3.69 | -2.98 | -2.63 |

KPSS unit root test results are shown in Table 5. In the KPSS unit root test, it is stationary because the critical value of 5% in the first difference value for all variables is greater than the LM statistic value. Thus, results supporting each other were obtained in all unit root tests.

*Table 5. KPSS Unit Root Tests*

| PP | Level (PP-t Statistics) | | | | First Difference (PP-t Statistics) | | | |
|---|---|---|---|---|---|---|---|---|
| **Variables** | **LM- Statistics** | **%1** | **%5** | **%10** | **LM- Statistics** | **%1** | **%5** | **%10** |
| **Net Energy Import** | 0.61 | 0.74 | 0.46 | 0.35 | 0.22 | 0.74 | 0.46 | 0.35 |
| **GDP** | 0.69 | 0.74 | 0.46 | 0.35 | 0.23 | 0.74 | 0.46 | 0.35 |
| **Fossil fuel** | 0.69 | 0.74 | 0.46 | 0.35 | 0.05 | 0.74 | 0.46 | 0.35 |
| **Renewable energy** | 0.61 | 0.74 | 0.46 | 0.35 | 0.14 | 0.74 | 0.46 | 0.35 |

### 3.2. Toda-Yamamoto Causality Test

In the current study, the Toda-Yamamoto causality test (1995), a version of Granger non-causality which is valid regardless of whether a series is I(0), I(1), or I(2), not-cointegrated, or cointegrated in any arbitrary order, was used to investigate the causal relationship between net energy import, GDP, fossil fuel, and renewable energy.

Log-Likelihood (LL), Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Quinn information criterion (HQIC) and Schwarz' Bayesian Information Criterion (SBIC) information criteria were used to determine lag length selection.

*Table 6. Lag Length Criteria*

| Lag | LL | LR | df | p | FPE | AIC | HQIC | SBIC |
|---|---|---|---|---|---|---|---|---|
| **0** | 79.62 | - | - | - | 2.8e-08 | -6.05 | -5.99 | -5.85 |
| **1** | 158.13 | 157.02 | 16 | 0.00 | 1.9e-10 | -11.05 | -10.78 | -10.07 |
| **2** | 169.52 | 22.77 | 16 | 0.12 | 3.1e-10 | -10.68 | -10.19 | -8.93 |
| **3** | 191.38 | 43.72 | 16 | 0.00 | 2.7e-10 | -11.15 | -10.45 | -8.61 |
| **4** | 245.61 | 108.46 * | 16 | 0.00 | 2.6e-11* | -14.21* | -13.29* | -10.89* |

All the information criteria show that the 4th lag length is optimal. Later, LM (Lagrange-Multiplier) test was performed to examine the presence of autocorrelation, and the results were summarized in Table 7.

*Table 7. LM Test*

| Lag | Chi2 | df | Prob>chi2 |
|---|---|---|---|
| **1** | 18.30 | 16 | 0.31 |
| **2** | 14.39 | 16 | 0.57 |

Since probe values are low at two lag lengths, there is no autocorrelation, and the model is stable.

*Table 8. Toda-Yamamoto Causality Test Results*

| Variables | Causality Direction | M-Wald Statistics |
|---|---|---|
| **ly and lgdp** | lgdp is the Toda-Yamamoto cause of ly. | 23.97 (0.0001) * |
| | ly is the Toda-Yamamoto cause of lgdp. | 16.87 (0.0020) * |
| **ly and lfuel** | lfuel is the Toda-Yamamoto cause of ly. | 82.49 (0.000) * |
| | ly is the Toda-Yamamoto cause of lfuel. | 65.17 (0.0000) * |

| | | |
|---|---|---|
| **ly and lenergy** | lenergy is the Toda-Yamamoto cause of ly. | 53.60 (0.000) * |
| | ly is the Toda-Yamamoto cause of lenergy | 157.38 (0.0000) * |
| **lgdp and lfuel** | lfuel is the Toda-Yamamoto cause of ly. | 31.18 (0.000) * |
| | ly is the Toda-Yamamoto cause of lfuel. | 89.61 (0.000) * |
| **Lgdp and lenergy** | lenergy is the Toda-Yamamoto not cause of lgdp. | 7.30 (0.1208) |
| | lgdp is the Toda-Yamamoto cause of lenergy. | 66.42 (0.0000) * |
| **Lfuel and lenergy** | lfuel is the Toda-Yamamoto cause of lenergy. | 61.93 (0.0000) * |
| | lenergy is the Toda-Yamamoto cause of lfuel. | 240.70 (0.0000) * |

Note: Values in parentheses are p values; * and ** indicate the level of statistical significance with a p-value at 1% and 5%, respectively.

In summary, the Toda-Yamamoto causality tests revealed a bidirectional causality relationship between net energy import as a dependent variable and GDP, renewable energy, fossil fuel as the independent variables. There is also a bidirectional causality between GDP and fossil fuel consumption, as well as between renewable energy consumption and fossil fuel consumption. While there is causality from GDP to renewable energy consumption, a causality from renewable energy consumption to GDP has not been found

### 3.3. Quantile Regression

The relationship between net energy imports and renewable energy, GDP, and fossil fuel consumption was investigated utilizing a quantile regression model, one of the alternative regression techniques. Quantile regression, developed by Koenker and Basset (1978), is used to explain the relationship between variables like many other regression models. The quantile regression is generally used in the absence of a normal distribution. In the study, quantile regression was used to obtain estimation results that were more robust to outliers.

Estimation results of the quantile regression are given in Table 9. For quantile point 0.2, a 1% increase in renewable energy production enhances net energy imports by 0.27%. A 1% increase in GDP leads to a 0.35% rise in net energy imports, while a 1% increase in fossil fuel consumption causes a 0.63% increment in net energy imports. When the quantile regression results are examined, it is observed that the coefficients obtained for all other quantiles (e.g., 0.2-0.8) are positive, close, and statistically significant.

*Table 9. Quantile Regression Estimation Results*

| **Dependent Variable: Log (Net Energy Import)** | | | | |
|---|---|---|---|---|
| **Independent Variable: Log (Renewable Energy)** | | | | |
| **Quantile** | **Coefficient** | **Standard error** | **t-statistics** | **Probability** |
| 0.2 | 0.277675 | 0.046949 | 5.914438 | 0.0000 |
| 0.4 | 0.296300 | 0.054982 | 5.389051 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| Median | 0.181141 | 0.074987 | 2.415631 | 0.0227 |
| 0.6 | 0.144483 | 0.082528 | 1.750723 | 0.0913 |
| 0.8 | 0.136260 | 0.074855 | 1.820321 | 0.0798 |
| **Dependent Variable: Log (Net Energy Import)** | | | | |
| **Independent Variable: Log (GDP)** | | | | |
| **Quantile** | **Coefficient** | **Standard error** | **t-statistics** | **Probability** |
| 0.2 | 0.356891 | 0.034454 | 10.35844 | 0.0000 |
| 0.4 | 0.345247 | 0.042529 | 8.117914 | 0.0000 |
| Median | 0.338695 | 0.047663 | 7.106085 | 0.0000 |
| 0.6 | 0.335397 | 0.051909 | 6.461303 | 0.0000 |
| 0.8 | 0.309622 | 0.094870 | 3.263659 | 0.0030 |
| **Dependent Variable: Log (Net Energy Import)** | | | | |
| **Independent Variable: Log (Fossil Fuel)** | | | | |
| **Quantile** | **Coefficient** | **Standard error** | **t-statistics** | **Probability** |
| 0.2 | 0.635297 | 0.052960 | 11.99583 | 0.0000 |
| 0.4 | 0.635094 | 0.064730 | 9.811434 | 0.0000 |
| Median | 0.610128 | 0.068754 | 8.874122 | 0.0000 |
| 0.6 | 0.622328 | 0.071302 | 8.728042 | 0.0000 |
| 0.8 | 0.587886 | 0.124618 | 4.717512 | 0.0001 |

## 4. Conclusions

Foreign dependence on energy is one of the most serious problems for the Turkish economy. Energy demand has increased day by day as a result of the rise in oil prices following the 1970s oil crisis, rising energy demand due to outward-looking industrialization, and widespread use of natural gas in residences. Although fossil fuel reserves are limited, approximately 76% of annual energy consumption is satisfied with fossil fuels, which is one of the reasons for foreign dependence.

In the literature, energy consumption has been generally evaluated as a whole in empirical analysis. However, within the scope of this study, energy consumption is divided into two categories: fossil energy and renewable energy. Although there are many theoretical and empirical studies on renewable energy, those examining this issue from the perspective of energy dependence are quite limited. Therefore, in this study, the effect of renewable energy on energy dependency is discussed. As a result of the empirical study, it is seen that the fossil fuel consumption variable has the largest impact on net energy imports. GDP and fossil fuel consumption are expected to increase net energy imports. However, contrary to expectations, the coefficients of renewable energy consumption and net energy imports are positive as a result of the quantile regression, indicating that as renewable energy consumption increases, so do net energy imports. The high demand for energy can be shown as one of the significant factors explaining this situation. It can be said that the increase in renewable energy consumption and production has been inadequate in reducing net energy imports, as the high demand for energy has increased fossil fuel consumption significantly. In Turkey, policies aimed at increasing the use of renewable energy resources have been ineffective in reducing energy dependency, and fossil

energy resources continue to be dominant. So, the capacity of renewable energy sources should be expanded even further, and the dominance of fossil fuels should be broken. As mentioned in several sections of the study, it is critical for Turkey, which has a large renewable energy potential, to use the potential to minimize its foreign dependency on energy. According to the projections made by the Ministry of Energy and Natural Resources, oil, natural gas, and coal have a lifespan of 51, 53, and 114 years, respectively. Minimizing the use of these fossil fuels, which are imported in massive quantities, cause climate change via carbon dioxide emissions, and have no future, should be the main priority of Turkey as it is for every country. Turkey, which is expected to start benefiting from nuclear energy in 2025, should construct nuclear power facilities after obtaining the technology from Russia and Japan. It is very important for Turkey to make **(i)** short, **(ii)** medium, and **(iii)** long-term plans for energy utilization. For example, **(i)** it can be aimed to diversify the resources in terms of imports in the short term, **(ii)** increase the renewable energy capacities and nuclear energy usage in the medium term, and **(iii)** meet the entire energy demand from completely renewable energy in the long term. To achieve these goals, it is extremely important to follow technological developments, encourage science, increase R&D investments, and train well-equipped personnel.

---

**Research and Publication Ethics Statement**

The author declare that ethical rules are followed in all preparation processes of this study. In case of detection of a contrary situation, Journal of Commercial Sciences has no responsibility and all responsibility belongs to the author of the study.

---

**References**


Altinay, G. (2007). Short-run and long-run elasticities of import demand for crude oil in Turkey. *Energy Policy*, 35(11), 5829-5835.

Aslani, A., Helo, P., & Naaranoja, M. (2014). Role of renewable energy policies in energy dependency in Finland: System dynamics approach. *Applied energy*, 113, 758-765.

Ayla, D., & Karış, Ç. (2019). Türkiye'de Enerji İthalatı ve Cari Açık Üzerine Bir Değerlendirme. *Adıyaman Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, (32), 380-412.

Bayraç, H. N., & Çildir, M. (2017). AB YENİLENEBİLİR ENERJİ POLİTİKALARININ EKONOMİK BÜYÜME ÜZERİNDEKİ ETKİSİ. Uluslararası Yönetim İktisat ve İşletme Dergisi, 13(13), 201-212.

Bilginoğlu, M. A. (2012), "Türkiye'nin Enerji Sorunları ve Çözüm Arayışları", *Erciyes Üniversitesi Stratejik Araştırmalar Merkezi (ERUSAM)*, Sunum Metni, Kayseri: ERÜ Basın Yayın.

Bingül, A. (2018). Enerji bağımlılığının Türkiye ekonomisine etkisi (*Master's thesis, Sosyal Bilimler Enstitüsü*).

Demir, M. (2013). Enerji ithalati cari açik ilişkisi, Var analizi ile Türkiye üzerine bir inceleme. *Akademik Araştırmalar ve Çalışmalar Dergisi (AKAD),* 5(9), 2-27.

Efeoğlu, R., & Pehlivan, C. (2017). Türkiye'de enerji tüketimi ve cari açığın ekonomik büyüme üzerine etkisi. *Politik Ekonomik Kuram,* 2(1), 103-123.

EUROSTAT. (2020). Energy statistics. *The statistical office of the European Union*, https://ec.europa.eu/eurostat/data/database

IEA. (2019). Nuclear energy data, *International Energy Agency*, https://www.iea.org/fuels-and-technologies/nuclear (Erişim Tarihi: 12.11.2021)

IRENA. (2020). Solar energy data. *International Renewable Energy Agency*, https://www.irena.org/solar

IRENA. (2020). Wind energy data. *International Renewable Energy Agency*, https://www.irena.org/wind

Kaya, H., & Öztürk, E. (2014). Performance of distributed turbo coded system with selected best relay. *In 2014 22nd Signal Processing and Communications Applications Conference (SIU)* (pp. 678-681).

Korkmaz, Ö., & Develi, A. (2012). Türkiye'de birincil enerji kullanimi, üretimi ve Gayri Safi Yurt İçi Hasila (Gsyih) arasindaki ilişki. *Dokuz Eylül Üniversitesi İktisadi İdari Bilimler Fakültesi Dergisi*, 27(2), 1-25.

Kulaksızoğlu, Z. (2006). Isı Yalıtım Sektör Araştırması. *İstatistik Şubesi. Ankara*.

Kraft, J., & Kraft, A. (1978). On the relationship between energy and GNP. *The Journal of Energy and Development,* 401-403.

Ozcan, B., & Ozturk, I. (2019). Renewable energy consumption-economic growth nexus in emerging countries: A bootstrap panel causality test. Renewable and Sustainable Energy Reviews, 104, 30-37.

Öztürk, İ., & Çelik, A. (2006). Dünya'da ve Türkiye'de Rüzgâr Enerjisi Kullanım Durumu ve Geleceğe Yönelik Beklentiler. *Atatürk Üniversitesi Ziraat Fakültesi Dergisi,* 37(2), 267-274.

T.C. Enerji ve Tabii Kaynaklar Bakanlığı (Çevrimiçi), Türkiye elektrik enerjisi. https://enerji.gov.tr/bilgi-merkezi-enerji-elektrik (Erişim Tarihi: 21.03.2020).

T.C. Enerji ve Tabii Kaynaklar Bakanlığı (Çevrimiçi). *Yenilenebilir Enerji Genel Müdürlüğü, Güneş Enerjisi Potansiyel Atlası (GEPA),* https://gepa.enerji.gov.tr/MyCalculator/

TÜİK. Çevre ve Enerji-Enerji İstatistikleri, 1990-2018. *Türkiye İstatistik Kurumu*, https://data.tuik.gov.tr/Kategori/GetKategori?p=Cevre-ve-Enerji-103 (Erişim Tarihi: 26.03.2020).

Yildiz, T. (2017). Türkiyenin enerji bağımlılığı (Master's thesis, Sosyal Bilimler Enstitüsü).