

Analysis of The Relationship between Renewable Energy and Foreign Direct Investments for Turkey*

Yenilenebilir Enerji ile Doğrudan Yabancı Yatırımlar Arasındaki İlişkinin Türkiye İçin Analizi

Şerife Merve KOŞAROĞLU^a, Halil İbrahim KAYA^b

^a Dr. Öğr. Üyesi, Sivas Cumhuriyet Üniversitesi, Sosyal Bilimler Meslek Yüksekokulu, Finans Bankacılık ve Sigortacılık Böl., mervekosaroglu@gmail.com, 0000-0002-2563-5753

^b Dr. Öğr. Üyesi, Sivas Cumhuriyet Üniversitesi, İktisadi ve İdari Bilimler Fakültesi, İktisat Bölümü, halilkaya@cumhuriyet.edu.tr, 0000-0001-8331-0853
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ÖZ

Doğrudan yabancı yatırımlar ülkelerin büyüme ve gelişme süreçlerinde avantaj sağlamaktadır. Son 50 yılda küreselleşme süreci ile birlikte doğrudan yabancı yatırımların artması, ülke ekonomileri üzerinde özellikle ekonomik büyüme ve istihdam olanakları üzerinde bazı etkiler yaratmıştır. Bu etkiler arasında doğrudan yabancı yatırımların enerji sektörü üzerinde etkileri olduğu bilinmektedir. Enerji sektörünün yükselen bir alanı olan yenilenebilir enerji sektörü de doğrudan yabancı yatırımlardan olumlu veya olumsuz etkilenmektedir. Bu nedenle çalışmanın amacı, 1990-2019 verileri ile Türkiye'deki yenilenebilir enerji tüketimi, doğrudan yabancı yatırımlar ve GSYİH arasındaki ilişkiyi incelemektir. Bu çalışmada Banerjee vd. (2017) Fourier ADL eşbütünlük testi analizi kullanılmıştır. Analiz sonuçlarına göre, Türkiye'de doğrudan yabancı yatırımlar, yenilenebilir enerji tüketimi ve GSYİH arasında eşbütünlük ilişkisi yoktur. Türkiye'de doğrudan yabancı yatırımların temiz enerji alanlarını ve kullanımını destekleyecek şekilde gerçekleştirilmesi durumunda yenilenebilir enerji tüketiminin artacağı düşünülmektedir.

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ABSTRACT

Foreign direct investments provide advantages in the growth and development processes of countries. The increase in foreign direct investments with the globalization process in the last 50 years has created some effects on the economies of countries, especially on economic growth and employment opportunities. Among these effects, it is known that foreign direct investments have effects on the energy sector. The renewable energy sector, which is a rising area of the energy sector, is also positively or negatively affected by foreign direct investments. For this reason, the aim of the study is to examine the relationship between 1990-2019 data and renewable energy consumption in Turkey, foreign direct investments and GDP. In this study, Banerjee et al. (2017) Fourier ADL cointegration test analysis was used. According to the results of the analysis, there is no cointegration relationship between foreign direct investments, renewable energy consumption and GDP in Turkey. It is thought that renewable energy consumption will increase if foreign direct investments in Turkey are realized in a way that supports clean energy areas and usage.

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1. INTRODUCTION

Energy plays an important role in the economic growth and development of countries. This situation, which has a large share in the increase in energy consumption, makes access to affordable, clean and reliable energy a strategic issue today (Emodi and Boo, 2015:580). As a matter of fact, the continuous increase in energy consumption brings with it the unstable price formations of fossil fuels and climate change problems due to global warming. These developments, which confront the world economy with serious difficulties, increase the importance of the

transition to alternative energy sources, especially renewable energy (hereafter, RE) sources (Ibrahiem, 2015:314). Expanding the use of RE is seen as one of the most appropriate options for reducing greenhouse gasses. On the other hand, it is thought that a country that prioritizes RE production reflects its vision for sustainable growth. However, attracting more foreign direct investment (hereafter, FDI) is one of the priorities of the countries that attach importance to sustainable growth (Parab et al., 2020:479).

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With the increase in FDI, the total production level of the country receiving the investment will increase and this will cause an increase in the energy demand in the country. On the other hand, it is possible for increased FDI to cause high energy demand and environmental problems in the host country (Ahmad et al., 2019:22221). These factors are very important in ensuring sustainability in the path that countries follow to realize their economic growth.

At this point, the relationship between FDI and environmental quality comes to the fore. The positive relationship between FDI and environmental pollution is explained by the pollution haven hypothesis. Accordingly, developing countries adopt flexible policies regarding environmental standards to attract more FDI in order to grow faster (Mike, 2020:108). Therefore, environmental pollution tends to shift from developed countries with strict environmental regulations to developing countries with weak environmental regulations through FDI. FDI towards countries with weak environmental regulations generally tend towards sectors with high pollution levels (Ari, 2021:123).

The fact that FDI change the RE consumption positively or negatively creates motivation in the research of the subject. The aim of this study is to investigate the relationship between 1990-2019 data and RE consumption, FDI and GDP in Turkey. Banerjee et al. (2017) Fourier ADL cointegration test was applied. The findings show that there is no cointegration relationship between FDI, RE consumption and GDP in Turkey.

2. LITERATURE REVIEW

There are many studies in the economics literature investigating the determinants of economic growth. Some of these studies have focused on the relationship between growth and energy consumption. Studies investigating the relationship between growth and energy consumption are based on the pioneering work of Kraft and Kraft (1978). In this study, the existence of a one-way causality relationship from GNP to energy consumption was determined by using data from 1947-1974 in the USA. Later, following Kraft and Kraft (1978), different studies were brought to the literature (Akarca and Long, 1980; Yu and Hwang, 1984; Abosedra and Baghestani, 1989; Hwang and Gum, 1991).

Other studies have focused on the relationship between growth and FDI. There is a large theoretical and empirical literature on the relationship between growth and FDI (De Mello, 1997; Borensztein et al., 1998; De Mello, 1999; Ericsson and Irandoust, 2001; Karimi and Yusop, 2009). FDI is generally seen as an important dynamic for growth. FDI inflows provide new investments, advanced technologies and management advantages to the host country. These advantages contribute to economic growth by increasing the level of productivity. Therefore, investigating the relationship between FDI and growth

has become popular in the relevant literature (Acaravci et al., 2015:1051).

In the current literature, there are few studies focusing on the relationship between FDI and energy consumption (Long, 2020). In some studies in this area, it has been suggested that FDI can reduce energy consumption by promoting energy-efficient technologies. In other studies, it has been claimed that FDI can increase energy consumption as new foreign firms become active in the host country (Polat, 2018:33). These different views make it important to investigate the relationship between FDI and energy consumption. Thus, findings on the direction of the relationship between two different determinants of growth will be guiding for economic policies.

One of the studies in the current literature belongs to Ibrahiem (2015). Ibrahiem (2015) examined the relationship between renewable electricity consumption, FDI and economic growth in Egypt for the years 1980-2011 using ARDL method. The analysis findings showed the existence of a long-term relationship between the variables. It has been found that renewable electricity consumption and FDI positively affect economic growth. In the Granger causality test, it was determined that there is a bidirectional causality relationship between economic growth and renewable electricity consumption. In addition, a unidirectional causality relationship from FDI to economic growth is accepted. Ekwueme et al. (2021) analyzed the data of South Africa for the period 1970-2014 and the relationship between FDI, RE consumption, economic growth and financial development using ARDL method. ARDL results showed a significant positive relationship between renewable energy, economic growth, financial development and carbon emissions in the long run. In the short run, he found a positive relationship between growth, financial development and carbon emissions, and a negative relationship between RE consumption and carbon emissions. The Granger causality test proved that there is a bidirectional causality relationship between RE and economic growth. Kang et al. (2021) investigated the relationship between GDP, FDI, renewable energy, trade openness, carbon emissions, and population in selected South Asian countries for the years 1990-2019 using DOLS and FMOLS methods. The results showed that there is a negative relationship between FDI and RE in South Asian countries. They also found a strong and positive relationship between GDP and RE use. FMOLS and DOLS findings were reported to be almost the same. Polat (2018) investigated the effect of FDI on renewable and non- RE consumption in 85 developed and developing countries for the years 2002-2014 using a dynamic panel data method. The results of the analysis empirically show that FDI encourage energy saving in developed countries, but have no effect on energy demand in developing countries. Parab et al. (2020) investigated the relationship between FDI and RE consumption of 43 countries for the period 2005-2017.

As a result, it has been determined that there is a one-way causality and a long-term relationship from RE consumption to FDI inflows.

One of the studies for Turkey was conducted by Arı (2021). Arı (2021) could not find a relationship between RE and FDI for the years 1984-2019 in Turkey. Bölük et al. (2022) investigated the relationship between economic growth, FDI and energy consumption in Turkey for the period 1987-2015 using NARDL method. The results showed that FDI inflows are important on energy consumption and economic growth. In addition, it has been determined that non-RE resources are more effective on growth than renewable resources. In this study, the relationship between RE consumption, FDI and GDP is investigated with evidence from the Fourier field. In this respect, it is expected that the study will contribute to the literature.

3. ECONOMETRIC ANALYSIS OF DATA

In this study, the relationship between the data of 1990-2019 in Turkey and RE consumption, FDI and GDP was investigated. Banerjee et al. (2017) Fourier ADL cointegration test was applied. The model used in the analysis and given in equation 1 was created by considering the studies of Arı (2021) and Polat (2018). The natural logarithm of GDP was taken from the variables and included in the analysis. The established model is shown in equation 1.

$$REC_t = \beta_0 + \beta_1 FDI_t + \beta_2 LNGDP_t + \varepsilon_t \quad (1)$$

In equation 1, β_0 represents the constant term, β_1 and β_2 coefficients, and ε_t represents the error correction term. The explanation of the variables used in the analysis is given in Table 1.

Table 1. Variables Used in Analysis

Variables	Definition of Variables	Data Source
REC_t (Dependent Variable)	Renewable energy consumption (% of total final energy consumption)	World Bank
FDI_t (Independent Variable)	Foreign direct investment (% of GDP)	
$LNGDP_t$ (Independent Variable)	GDP (current US\$)	

Descriptive statistics of the variables used in the analysis are given in Table 2. RE consumption in Turkey is a minimum of 11,400, a maximum of 24,510, and an average of 17,005. The minimum, maximum and average values of FDI are 0.009, 0.750 and 0.239, respectively. The minimum, maximum and average values of GDP are 25,596, 27,587 and 26,714, respectively. As can be seen from the descriptive statistics, the difference between the minimum and maximum values of RE consumption is large. This can be explained by the increase in RE investments. The minimum and maximum value of FDI are quite low. It is thought that the inability to attract enough FDI in Turkey, which has a high economic growth performance, constitutes a disadvantage.

Table 2. Descriptive Statistics

	REC	FDI	LNGDP
Mean	17.00588	0.239548	26.71409
Median	15.81500	0.224670	26.84354
Maximum	24.51078	0.750837	27.58789
Minimum	11.40000	0.009955	25.59610
Std. Dev.	4.535992	0.178956	0.711852

Since the spurious regression problem will arise if the variables used in econometric analysis are not stationary, it is necessary to examine the stationarity of the data before starting the analysis. Various unit root tests are used to examine stationarity. In this study, Fourier KPSS (KKPSS) unit root test was performed and the results are given in Table 3.

Table 3. FKPSS Unit Root Test Results

π_t^{REC}	Frequency (k)	FKPSS
Fixed Model	1	0.366***
Fixed and Trend Model	1	0.500***
π_t^{FDI}	Frequency (k)	FKPSS
Fixed Model	1	0.249**
Fixed and Trend Model	4	0.069**
π_t^{LNGDP}	Frequency (k)	FKPSS
Fixed Model	1	0.362***
Fixed and Trend Model	1	0.056**

Note: In the FKPSS test, the critical values at 1%, 5%, and 10% significance levels are 0.26, 0.17, and 0.13 for the fixed model for k=1, and 0.07, 0.05, and 0.04 for the constant and trend model, respectively. The critical values at the 1%, 5% and 10% significance level are 0.72, 0.45 and 0.34 for the fixed model for k=4, respectively. ***, **, * values indicate that the alternative hypothesis is accepted at 1%, 5% and 10% significance levels, respectively.

Since the FKPSS test statistic is larger than the table value, the alternative hypothesis is accepted. In other words, the variables used in the analysis for the FKPSS test constant and constant trend models have unit roots. Two unit root test results are in the direction of accepting the existence of a unit root.

It is generally accepted that economic data is affected by structural breaks. Since structural breaks are neglected in traditional cointegration tests, it causes the true null hypothesis to be rejected incorrectly. In order to eliminate this deficiency, cointegration tests including structural break have been developed. Banerjee et al. (2017) developed a new cointegration test based on the Autoregressive Distribution Latency (ADL) model that allows unknown forms of nonlinear breaks estimated by a Fourier function. The Fourier ADL test allows smooth transitions rather than hard structural breaks and works well in the presence of unknown breaks in the series. Banerjee et al. The regression proposed in the cointegration test developed by (2017) is given in equation 2 (Hepsağ, 2022:189):

$$\Delta y_t = \alpha + \gamma_1 \sin \sin \left(\frac{2\pi kt}{T} \right) + \gamma_2 \cos \cos \left(\frac{2\pi kt}{T} \right) + \delta y_{t-1} + \psi' x_{t-1} + \theta' \Delta x_t + \varepsilon_t \quad (2)$$

In equation 2, k is the number of frequencies, T is the total number of observations, t is the deterministic

trend, π is the pi number, \sin and \cos are trigonometric terms expressing the other deterministic components in the regressions. In determining the appropriate frequency number, taking into account the information criteria, the least residual squares sum of the predicted models is taken as a basis. Depending on the k frequency number determined here, different opinions have been proposed in the significance of trigonometric terms in the $F(k)$ test. Banerjee et al. (2017) suggested information criteria for determining the appropriate number of k frequencies. The model in which the appropriate frequency number is determined is taken into account in testing the cointegration. In determining the significance of trigonometric terms, the critical values of the $F(k)$ test were tabulated. In the Fourier ADL cointegration test, the null hypothesis is that there is no cointegration ($\delta = 0$), and the alternative hypothesis is that there is cointegration ($\delta < 0$) (Hepsağ, 2022:190-191).

The most important feature that distinguishes the Fourier ADL test from other methods is that the low-frequency components of the Fourier expansion are included in the model. Thus, there is no need to predetermine the number and duration of structural breaks (Yurtkuran, 2021:68). In this study, the Fourier ADL test was used because of its advantages over traditional cointegration tests. Fourier ADL cointegration test results are given in Table 4.

Table 4. Fourier ADL Test Results

Test Statistics	-3.746
Frequency	1.000
AIC	3.028

Test results obtained in Table 4, Banerjee et al. (2017) was compared with the critical values of the table found in the study. The null hypothesis shows that there is no cointegration relationship between the variables. The alternative hypothesis shows that there is a cointegration relationship between the variables. Accordingly, our table value is -4.96, -4.32 and -3.98 for 1%, 5% and 10%, respectively. According to the test statistical value and table values obtained from the analysis, the null hypothesis is accepted at all significance levels. That is, there is no cointegration between the variables.

4. CONCLUSION

Economic growth comes first among the economic performance indicators of countries. The positive course of other macroeconomic variables together with economic growth will have an important place in the formation of a strong economic structure. In providing this structure, foreign investments provide various advantages to the host country. Therefore, FDI play an important role in ensuring sustainable growth in the global economic order. In addition, FDI lead to developments that protect the environment for the use of clean energy.

The Turkish economy is one of the developing countries with a certain growth performance. The desired development in FDI could not be achieved until the post-2000 period. Investments after 2000, on the other hand, were realized in the form of purchasing or becoming a partner rather than making new investments. This situation causes the expected benefit from FDI not to be obtained (Bal and Göz, 2010:459). In the field of renewable energy, investments made by the government in line with sustainable environmental policies have come to the fore. Therefore, it seems that the connection between FDI and RE consumption has not been fully established. The result obtained from the analysis seems to support this situation. The analysis results are consistent with the results obtained by Arı (2021), Polat (2018) and Ibrahiem (2015) for developing countries. FDI do not have a positive or negative effect on Turkey's environmental quality. For this reason, policies that encourage FDI under current conditions will not affect RE consumption. The fact that FDI are made through privatization in Turkey and the sectors that FDI are directed to can be shown as the reason for this result. When Turkey's growth potential is evaluated, while policies to attract FDI are implemented, steps should be taken to increase RE investments. Measures should be taken to encourage foreign investors to use clean energy.

REFERENCES

- Abosedra, S. and Baghestani, H. (1989). New evidence on the causal relationship between United States energy consumption and gross national product. *The Journal of Energy and Development*, 14(2), 285-292.
- Acaravci, A., Erdogan, S. and Akalin, G. (2015). The electricity consumption, real income, trade openness and foreign direct investment: The empirical evidence from Turkey. *International Journal of Energy Economics and Policy*, 5(4), 1050-1057.
- Ahmad, M., Zhao, Z. Y., Rehman, A., Shahzad, M. and Li, H. (2019). Revealing long- and short-run empirical interactions among foreign direct investment, renewable power generation, and CO2 emissions in China. *Environmental Science and Pollution Research*, 26, 22220–22245.
- Akarca, A. T. and Long, T. V. (1980). On the relationship between energy and GNP: A reexamination. *The Journal of Energy and Development*, 5(2), 326-331.
- Arı, A. (2021). Yenilenebilir enerji ve doğrudan yabancı yatırımlar: Türkiye örneği. *KMÜ Sosyal ve Ekonomik Araştırmalar Dergisi*, 23(40), 122-131.
- Bal, H. and Göz, D. (2010). Doğrudan yabancı sermaye yatırımları ve Türkiye. *Ç.Ü. Sosyal Bilimler Enstitüsü Dergisi*, 19(2), 450-467.
- Banerjee, P., Arčabic, V. and Lee, H. (2017). Fourier ADL cointegration test to approximate smooth breaks with

- new evidence from crude oil market. *Economic Modelling*, 67, 114-124.
- Borensztein, E., De Gregorio, J. and Lee, J. W. (1998). How does foreign direct investment affect economic growth?. *Journal of International Economics*, 45, 115-135.
- Bölük, G., Çağlar, A. E. and Mert, M. (2022). Do renewable energy and foreign direct investment promote economic growth in Turkey? An evidence through a nonlinear and asymmetric analysis approach. *Journal of Yasar University*, 17(66), 415-436.
- De Mello, L. R. (1997). Foreign direct investment in developing countries and growth: A selective survey. *Journal of Development Studies*, 34(1), 1-34.
- De Mello, L. R. (1999). Foreign direct investment-led growth: Evidence from time series and panel data. *Oxford Economic Papers*, 51, 133 – 151.
- Ekwueme, D. C., Zoaka, J. D. and Alola, A. A. (2021). Carbon emission effect of renewable energy utilization, fiscal development, and foreign direct investment in South Africa. *Environmental Science and Pollution Research*, 28(31), 41821-41833.
- Emodi, N. V. and Boo, K. J. (2015). Sustainable energy development in Nigeria: Overcoming energy poverty. *International Journal of Energy Economics and Policy*, 5(2), 580-597.
- Ericsson, J. and Irlandoust, M. (2001). On the causality between foreign direct investment and output: A comparative study. *International Trade Journal*, 15(1), 122-132.
- Hepsağ, A. (2022). Ekonometrik zaman serileri analizlerinde güncel yöntemler. Der Yayınları, İstanbul.
- Hwang, D. B. K. and Gum, B. (1991). The causal relationship between energy and GNP: The case of Taiwan. *Journal of Energy Development*, 16(2), 219-226.
- Ibrahiem, D. M. (2015). Renewable electricity consumption, foreign direct investment and economic growth in Egypt: An ARDL approach. *Procedia Economics and Finance*, 30, 313-323.
- Kang, X., Khan, F. U., Ullah, R., Arif, M., Rehman, S. U. and Ullah, F. (2021). Does foreign direct investment influence renewable energy consumption? Empirical evidence from South Asian countries. *Energies*, 14, 1-15.
- Karimi, M. S. and Yusop, Z. (2009). FDI and Economic Growth in Malaysia. MPRA, 14999.
- Kraft, J. and Kraft, A. (1978). On the relationship between energy and GNP. *Journal of Energy and Development*, 3 (2), 401-403.
- Long, N. T. (2020). Do foreign direct investment, energy consumption and urbanization enhance economic growth in six ASEAN countries?. *Journal of Asian Finance, Economics and Business*, 7(12), 33-42.
- Mike, F. (2020). Kirlilik sığınağı hipotezi Türkiye için geçerli mi? ARDL sınır testi yaklaşımından bulgular. *Doğuş Üniversitesi Dergisi*, 21(2), 107-121.
- Polat, B. (2018). The influence of FDI on energy consumption in developing and developed countries: A dynamic panel data approach. *Journal of Yasar University*, 13(49), 33-42.
- Parab, N., Naik, R. and Reddy, Y. V. (2020). Renewable energy, foreign direct investment and sustainable development: An empirical evidence. *International Journal of Energy Economics and Policy*, 10(5), 479-484.
- Yu, E. S. and Hwang, B. K. (1984). The relationship between energy and GNP. *Energy Economics*, 6(3), 186-190.
- Yurtkuran, S. (2021). Türkiye’de kirlilik sığınağı hipotezi geçerli mi? Fourier eşbütünleşme ve nedensellik yöntemlerinden kanıtlar. *Akademik Araştırmalar ve Çalışmalar Dergisi*, 13(24), 61-77.