# The Relationship between Sustainable Growth and Renewable Energy in Turkiye's Perspective

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## Abstract

The goal of sustainable growth and development has been the main agenda of both developed and developing countries in recent years. In this regard, developed countries have started to include the concept of sustainability both in planning and in practice much earlier than developing countries. In particular, they focus on renewable energy and resource sustainability in achieving the goal of sustainable growth and development, with the use of resources, urbanization, investment, production and sustainability in many other areas. In this study, the relationship between sustainable growth and renewable energy for Turkiye was examined with 1998-2018 data. The concept of sustainability and the place of sustainable growth in industry and development plans, which are important road maps in reaching the given target, and its position within the targets have been examined. Data were obtained from the World Bank website.



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# Türkiye Açısından Sürdürülebilir Büyüme ve Yenilenebilir Enerji İlişkisi

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## Öz

Büyüme ve kalkınmanın sürdürülebilir olması hedefi son yıllarda hem gelişmiş hem de gelişmekte olan ülkelerin ana gündemini oluşturmaktadır. Bu hususta Gelişmiş ülkeler gelişmekte olan ülkelere nazaran çok daha önce hem planlamada hem de uygulamada sürüdürülebilirlik olgusuna yer vermeye başlamışlardır. Özellikle kaynak kullanımı, şehirleşme, yatırım, üretim ve daha bir çok alanda sürdürülebilirliğin sağlanması ile sürdürülebilir büyüme ve kalkınma hedefine ulaşmada yenilenebilir enerji ve kaynak sürdürülebilirliği konularına odaklanmaktadırlar. Bu çalışmada Türkiye açısından sürdürülebilir büyüme ve yenilenebilir enerji ilişkisi 1998-2018 verileri ile incelenmiştir. Verilen hedefine ulaşmada önemli yol haritaları olan sanayi ve kalkınma planlarında sürdürülebilirlik kavramı ve sürdürülebilir büyümenin yeri ve hedefler içerisindeki konumu incelenmiştir. Veriler Dünya Bankası internet sitesinden temin edilmiştir.

*Anahtar sözcükler: sürdürülebilirlik, ekonomik büyüme, sürdürülebilir büyüme.*


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## Introduction

Economic growth and development are among the main agenda items of both developing and developed countries. In addition to the realization of growth and development goals, the relationship and sustainability of these two phenomena also have an important place in the basic planning and policy practices of countries. Especially since the last 1970s, the regulation and maintenance of economic activities and social life has been discussed under the definition of "sustainability". Although the concept, which gained a place in the world public opinion on a global scale in the 1970s, has taken its place in Turkiye's development plans and economic policies with its framework in the last two development plans under the title of sustainability, attention has been paid in terms of resources, production and growth triangle from the first industrial plan in terms of meaning. are included in the considerations. In this context, sustainable growth, sustainability in resource use, especially sustainability in the field of energy, sustainable cities, and finally, sustainable growth and development, which is the intersection of all of them, are of great importance in terms of the continuity of being a producing country for policy implementations for Turkiye. The way to exist in the position of a country that produces and is not dependent on foreign sources and thus to become a global economic power will be possible by realizing the concept of sustainability at the level of economic growth in relation to all economic activities. As a matter of fact, when the economic growth trends and structures of developed countries are evaluated, it is noteworthy that the importance and application levels attributed to the sustainability phenomenon are great. Considering the urbanization structure especially in developed countries, it is seen that the policies implemented in terms of sustainability in growth started primarily at the level of regulations in terms of households. Based on all these issues, this study examines the place and importance given to the concept of sustainability in terms of meaning and concept in both the first industrial plans and the current development plans. Within the framework of this concept, the relationship between sustainability and growth is evaluated for Turkiye.

## Sustainable Growth Case for Turkiye

For Turkiye, we can say that the goals that are suitable for the meaning of the concept of sustainability began to come to the fore in the late 1970s. Although the 1990s did not include the concept of sustainability for Turkiye, it was the year when regulations and agreements that would be effective in the field of environment were realized. One of the important steps in this regard is the National Environmental Strategy and Action Plan (NEAP) (Bozlağan, 2010). The environmental standards and regulations of the European Union were taken into account in the content of the plan (1995-1998).

However, the fact that the concept of sustainability is an officially targeted phenomenon for Turkiye is declared in the introduction that the Tenth Five-Year Development Plan has been prepared in a structure that focuses on sustainability, when the Development plans reflecting the Development Goals are evaluated for the first time, and it is stated in the introduction that the sustainability in living spaces, sustainability in the environment, sustainability in development and growth are especially emphasized. emphasis has been placed. While the

urbanization process is being handled, the issues of urbanization and settlement in a sustainable structure are also mentioned in this area. In the plan, which emphasized not consumption-oriented growth, but sustainable consumption and efficient use of resources, and sustainable resource use, the necessity of planning for sustainable development was highlighted. It was emphasized that especially the development policies have developed in the direction of sustainable development, and that with the increase in the share of the industrial sector in GDP, important developments will be achieved in line with the goal of sustainable growth. The tenth plan, which refers to the possibility of achieving the sustainable growth target by increasing the employment, capital stock and total factor productivity (TFV), which are the production sources of growth, which was emphasized in the previous plan, is also an important road map in terms of achieving the target by increasing domestic savings (TC. CSSB, 2013). Tenth Five-Year Development Plan has a target map in harmony with the UN's global economic goals on sustainable development.

The eleventh five-year development plan has also been prepared in harmony with the UN sustainable development goals. Sustainable environment, sustainable living spaces, sustainable growth and sustainable development are the main targets in the plan. For all these, the need for sustainable policy coordination at the international level is emphasized. Among the current situations that hinder sustainability, the issue of income inequality and the policy practices that should be followed in this regard are also referred to. Arrangements in which urban development is accepted as one of the basic steps for the goals in this direction, and which means starting from the individual life at the point of policy effectiveness for sustainability, are among the highlights of the plan. Again, the importance of access to finance in order to achieve the goals in this area and the practices in this regard are among the important issues in the plan. Another point that draws attention in the plan when evaluated in terms of UN targets is that Turkiye's ODA (Official Development Assistance)/GNP ratio reached 1.1 percent according to the preliminary data for 2018. With this ratio, Turkiye has become one of the seven countries that have achieved the goal of a 0.7 percent ODA/GNP ratio, which is one of the United Nations' (UN) sustainable development goals. At the point of achieving all these stated goals, horizontal policies that are aimed to be implemented especially in the field of manufacturing industry are included in the plan. Among these policy implementations, Human Resources → R&D and Innovation → Critical Technologies issues draw attention (TC. CSSB, 2019).

Table 1: Literatur Review

| Authors | Year | Analysis | Results |
|---|---|---|---|
| Bayraç And Çildir | 2017 | ADF and PP Fisher unit root tests, cointegration tests, OGT and HOGT | lLong-term co-integrated relationship is found between the amount of energy produced from renewable resources and GDP per capita, and the increase in renewable energy production positively affects economic growth. |

| | | | |
|---|---|---|---|
| Alper | 2018 | Bayer-Hanck cointegration test and Toda-Yamamoto causality | A unidirectional causality has been identified economic growth ⟶ renewable energy use. |
| Acaravcı, Erdoğan | 2018 | dynamic panel data methods | There is a long-term relationship between non-stationary variables and that renewable energy production has a negative effect on environmental pollution. In addition, it has been determined that per capita income has a positive effect on environmental pollution. |
| Usupbeyli | 2018 | ARDL | As the share of electricity production in total electricity production increased, an increase in GDP value and an increase in growth were detected. |
| Erdoğan, Dücan, Şentürk, Şentürk | 2018 | Johansen Cointegration Test and VECM causality | It has been determined that in the long run, economic growth is the cause of renewable energy production and the two variables are cointegrated. |
| Apaydın, Güngör, Taşdoğan | 2019 | nonlinear distributed lag autoregressive model | The effect of negative shocks is bigger than the effect of positive shocks in renewable energy consumption. |
| Temiz Dinç And Akdoğan | 2019 | Johansen–Juselius co-integration test, Granger causality, the vector error correction model, impulse-response functions and variance decomposition | They exist in a causality that is controlled by both short- and long-term energy consumptions, where we interview a person for a short period of time between both short and tall. |
| Ünüvar And Keskinkılıç | 2020 | ADF and PP Fisher unit root tests, Kao and Johansen Fisher panel cointegration tests, FMOLS and DOLS test | A positive relationship is found between the renewable energy production and economic growth. |
| Öymen, Ömeroğlu | 2020 | in-depth interview | The importance of sustainability provided by renewable energy sources has been revealed. |
| Koyuncu and Bayraç | 2020 | ARDL and VECM Causality Test | The neutrality hypothesis is valid in the short run between renewable energy and |

| | | | |
|---|---|---|---|
| | | | economic growth, and the feedback hypothesis is valid in the long run. |
| Zhang, Gul, Saleem, Shabbir, Bilal and Abbasi | 2021 | a fixed-effect test and panel vector error correction model (PVECM) test | It has been determined that geothermal, hydro and wind renewable energy sources have positive and significant effects on economic development among the economies of SAARC countries, and hydroelectric renewable energy source has more impact and impact on economic growth compared to the other two renewable energy sources. |
| Örk Özel and Ekiz | 2021 | Johansen cointegration test and Granger causality test | A unidirectional causality relationship from renewable energy consumption and carbon dioxide emissions to economic growth has been determined. |
| Çetinbakış, Şahin Kutlu | 2022 | ARDL | In the long run, the effect of final consumption expenditure, foreign direct investments and renewable energy consumption on economic growth is positive, while the effect of carbon dioxide emissions on economic growth is negative. In the short run, final consumption expenditure, foreign direct investments and renewable energy consumption have a positive effect on economic growth. Carbon dioxide emissions have a negative effect on economic growth. |

## Method

In this study, causality relationships for renewable energy consumption and GDP for Turkiye are tested with 1990-2018 data. The data are obtained from the World Bank website and short-term relationships are determined. The dependent variable in the analysis is renewable energy consumption. The independent variable is GDP per capita.

In the econometric analysis used in the study, time series analysis was used to explain the relationship between renewable energy consumption and GDP variables. In time series analysis, in order to determine a meaningful result between the variables, it should be found that the series do not contain a unit root. That is, the series must be stationary. Augmented Dickey Fuller unit root test (ADF), Philips Perron (PP) and Kwiatkowski-Philips-Schmidt-Shin (KPSS) unit root tests were carried out in order to solve the autocorrelation process of time series data and to examine whether they are stationary or not.

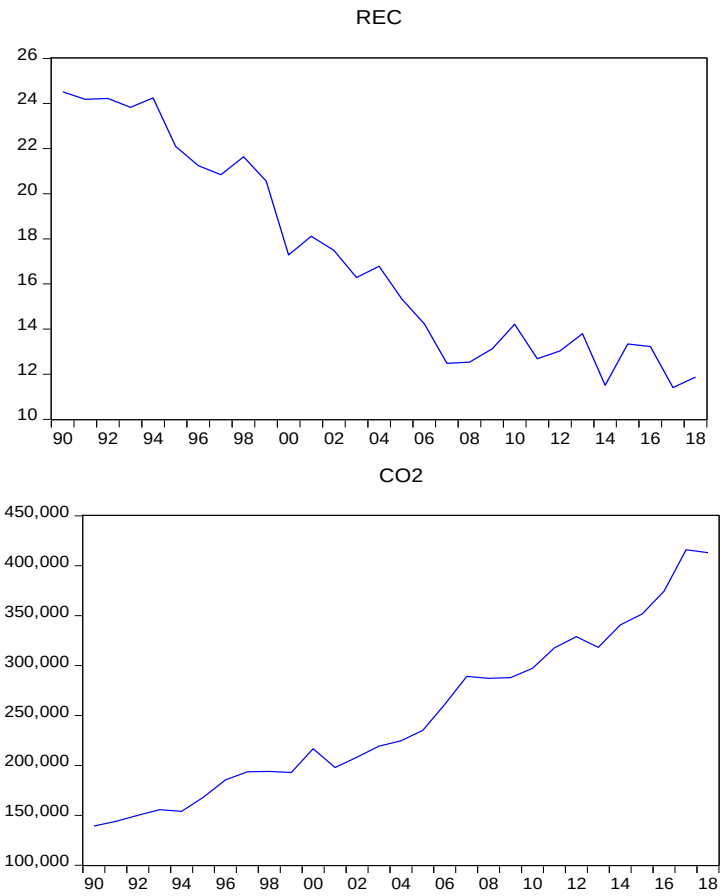
H0 = There is a unit root

H1 = No unit root. The series is stationary.

## Findings

Graph view of times in levels of series settings included in the econometric model.

**Graph 1:** Times in Levels of Series Settings Included in the Econometric Model



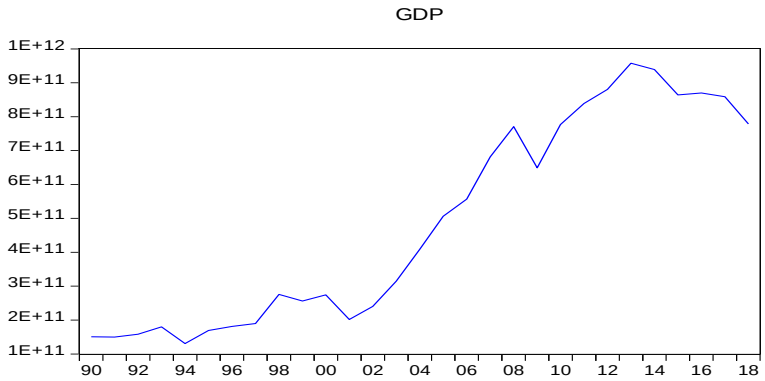



Table 2: Unit Root Test Results Applied to Variables

| LNGDP | ADF | | PP | | KPSS | |
|---|---|---|---|---|---|---|
| | Fixed | Fixed and Trending | Fixed | Fixed and Trending | Fixed | Fixed and Trending |
| Test Statistic | -0.96 | -1.61 | -0.95 | -1.75 | 0.64 | 0.10 |
| %1 | -3.68 | -4.32 | -3.68 | -4.32 | 0.73 | 0.21 |
| %5 | -2.97 | -3.58 | -2.97 | -3.58 | 0.46 | 0.14 |
| %10 | -2.62 | -3.22 | -2.62 | -3.22 | 0.34 | 0.11 |
| Renewable Energy Consumption | ADF | | PP | | KPSS | |
| | Fixed | Fixed and Trending | Fixed | Fixed and Trending | Fixed | Fixed and Trending |
| Test Statistic | -1.55 | -2.09 | -1.18 | -2.01 | 0.65 | 0.15 |
| %1 | -3.71 | -4.32 | -3.68 | -4.32 | 0.73 | 0.21 |
| %5 | -2.98 | -3.58 | -2.97 | -3.58 | 0.46 | 0.14 |
| %10 | -2.62 | -3.22 | -2.62 | -3.22 | 0.34 | 0.11 |

* The existence of a unit root at the 5% significance level cannot be denied.
* The lag lengths were determined based on the Akaike information criterion.

According to the unit root test results, all variables have a unit root process at the level. After it was understood that there were no stationary variables at the level of the variables, the unit root test was applied to the first differences of the variables.

Table 3: Unit Root Test Applied to First Differences of Variables

| LNGDP | ADF | PP | KPSS | |
|---|---|---|---|---|
| | None | None | Fixed | Fixed and Trending |
| Test Statistic | -4.93 | -4.96 | 0.13 | 0.10 |
| %1 | -2.65 | -2.65 | 0.73 | 0.21 |
| %5 | -1.95 | -1.95 | 0.46 | 0.14 |
| %10 | -1.60 | -1.60 | 0.34 | 0.11 |

| Renewable Energy Consumption | ADF | PP | KPSS | |
|---|---|---|---|---|
| | None | None | Fixed | Fixed and Trending |
| Test Statistic | -5.69 | -5.69 | 0.08 | 0.08 |
| %1 | -2.65 | -2.65 | 0.73 | 0.21 |
| %5 | -1.95 | -1.95 | 0.46 | 0.14 |
| %10 | -1.60 | -1.60 | 0.34 | 0.11 |

* It shows that the existence of a unit root is rejected at the 5% significance level.
* The lag lengths were determined based on the Akaike information criterion.

The existence of a unit root for the first differences of the variables is rejected at the 5% significance level and it has been determined that all the variables used in the analysis are stationary at the first difference.

VAR was applied to the data and the appropriate lag length was determined for this first. The VAR model is estimated with this delay. The order of the VAR model was found to be 1.

Table 4: The Order of VAR Model

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | 3.547552 | NA | 0.003057 | -0.114633 | -0.018646 | -0.086091 |
| 1 | 47.27519 | 77.73802* | 0.000161* | -3.057421* | -2.769458* | -2.971795* |
| 2 | 49.83836 | 4.177012 | 0.000181 | -2.950989 | -2.471050 | -2.808278 |

Table 5: Remains of the 1st order vector autoregressive model

| Component | Jarque-Bera | df | Prob. |
|---|---|---|---|
| 1 | 1.135630 | 2 | 0.5668 |
| 2 | 0.234494 | 2 | 0.8894 |
| Joint | 1.370124 | 4 | 0.8494 |

H0 = Residues are normally distributed. H1 = Residues are not normally distributed. Since 0.8494>0.05, H0 is accepted, the residues are normally distributed in the model. The normal distribution of the model is important for constructing F statistics and confidence intervals. If the model is determined at which order, it is expected that there will be no autocorrelation at that order. At this point, the results of the LM tests are examined.

H0 = No autocorrelation.
H1 = There is autocorrelation.

Table 6: LM Test

| Lag | LRE*stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 4.229796 | 4 | 0.3758 | 1.085364 | 4,42.0 | 0.3760 |
| 2 | 3.796179 | 4 | 0.4343 | 0.969123 | 4,.42.0 | 0.4345 |

Since the probability value at the 1st order is 0.3760>0.05, H0 is accepted. There is no autocorrelation in the model. In order to establish a VAR model, there should be no problem of varying variance in the model.

H0 = There is constant variance.
H1 = There is varying variance.

Table 7: Variable Variance Control

| Joint test | | |
|---|---|---|
| Chi-sq | df | Prob. |
| 8.076833 | 12 | 0.7791 |

Since the probability value is 0.7791>0.05, H0 is accepted. The model has constant variance. In order to ensure the stationarity and stability condition of the VAR model, the model must be in the unit circle and the inverses of all AR roots must be less than 1.

Figure 1: Inverse Roots of AR Characteristic Polynomial

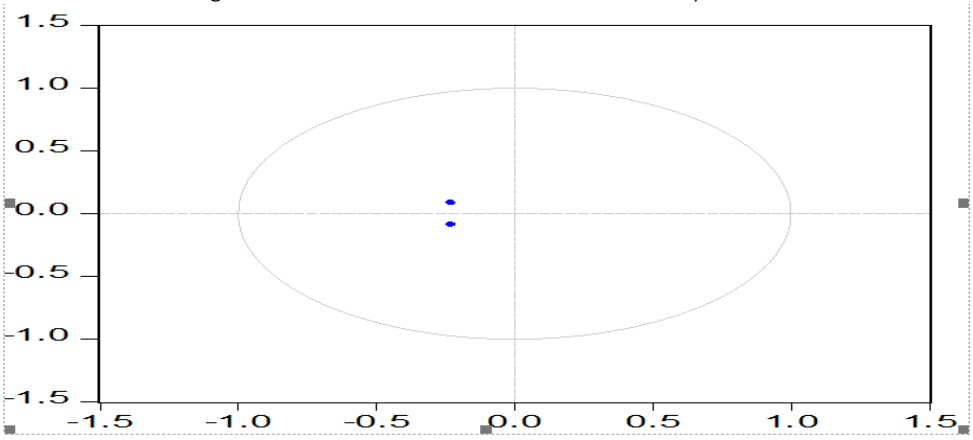



Table 8: Root and Modulus

| Root | Modulus |
|---|---|
| -0.227333-0.087490i | 0.243587 |
| -0.227333+0.087490i | 0.243587 |

As can be seen in the figure and table, the model is in the unit circle and the inverses of all AR roots are less than 1. The VAR model satisfies all the conditions. Therefore, it was decided that this model could be used. By performing variance decomposition, the order of the series is determined. The order of the series is determined from the most internal to the less internal.

Table 9: Variance decomposition

| Variance decomposition REC | | | |
|---|---|---|---|
| Dönem | S.E. | REC | GDP |
| 1 | 0.078311 | 100.0000 | 0.0000 |
| Variance decomposition GDP | | | |
| 1 | 0.168274 | 3.056940 | 96.94306 |

REC → GDP

Table 10: Error Correction Model

| Variable | Coefficient Value | Standard Error | t-Statistic Value | Probability Value |
|---|---|---|---|---|
| ΔLNGDP | 0.148777 | 0.078477 | 1.895788 | 0.0696 |
| Error Term | -0.668796 | 0.190918 | -3.503053 | 0.0018 |

When the table is examined, the error correction coefficient was negative (-0.668796) and statistically significant (0.0018<0.05) as expected. According to these results, it can be said that the error correction mechanism works. According to the results of the error correction model, it can be said that an imbalance in the renewable energy consumption and GDP variables in the short run may be balanced in the long run. When the table is interpreted by looking at the error correction model, it is seen that 1 unit deviation will be corrected by 66% in the next period. It is calculated that the effects of the shock will disappear after 1/0.66 = 1.51 ie approximately 2 periods.

Table 11: Co-integrated Relationship in the Long Run

| Variable | Tau statistic | Probability Value | Z statistic | Probability Value |
|---|---|---|---|---|
| LNREC | -3.562949 | 0.0500 | -18.30503 | 0.0313 |
| LNGDP | -3.449532 | 0.0625 | -17.41627 | 0.0414 |

| Variable | Chi-sq | df | Probability Value |
|---|---|---|---|
| LNGDP | 2.392981 | 2 | 0.3023 |
| LNREC | 5.925418 | 2 | 0.0517 |

As a result of the test performed to determine the cointegrated relationship in the long run, the probability value of 0.0414 shows that there is a significant relationship between renewable energy and economic growth. In the error correction model, it was observed that there was a long-term relationship between the variables.

In the Wald test performed to test the coefficients, the statistical value of 0.0696 F shows that there is a significant relationship between renewable energy and economic growth in the short run at 10% confidence level.

Error correction models are also examined in the created model. The error correction model is used in time series analysis to eliminate the imbalance between the short and long run relationship and to test the short and long run causality between the variables with cointegration relationship. The error correction coefficient of the model is expected to be negative and statistically significant.

## Conlusion

Today, concerns about the sustainability of production resources are increasing day by day. Especially in the global environment where countries are concerned about sustainable economic growth, the use of renewable energy sources comes to the fore. For this reason, developing countries, especially developed countries, include sustainability and renewable energy issues in their development plans and organize their policies accordingly.

As a matter of fact, empirical studies also reveal the relationship between sustainable economic growth and renewable energy. Based on the importance of the subject and especially the importance attributed to the subject in the last two development plans, in this study, the relationship between sustainable growth and renewable energy for Turkiye has been examined for the period 1998-2018.

Sustainable economic stability, which is also mentioned in the development plans, is possible with policy implementations that will be structured to suit the interests of resource conservation. In order to carry out the processes called green production with renewable energy systems, necessary infrastructure investments and technological support applications should be provided.

According to the unit root test results in the study, the existence of a unit root with null hypothesis for the levels of all variables could not be rejected. For this reason, it has been determined that all variables have unit root processes at the level. Since the variables are not stationary at the level, their first differences are taken. The existence of a unit root, which is the null hypothesis for the first differences, was rejected at the 5% significance level. As a result of the analysis, it was determined that all variables were stationary at the first difference. By determining the appropriate lag length, the order of the VAR model is found to be 1. Since the probability value in the 1st order is 0.3760>0.05, H0 cannot be rejected and it has been determined that there is no autocorrelation in the model. Since the probability value is 0.7791>0.05, H0 could not be rejected again, and constant variance was determined in the model. In addition, it has been determined that the model is in the unit circle and the inverses of all AR roots are less than 1. According to all these results, it has been determined that the VAR model meets all the conditions. By decomposing the variance, the order of the series was determined as REC → GDP. The error correction coefficient was negative (-0.668796) and statistically significant (0.0018<0.05). According to the results of the error correction model, it has been determined that an imbalance in the renewable energy consumption and GDP variables in the short run may be balanced in the long run.

When the table is interpreted by looking at the error correction model, it is seen that 1 unit deviation will be corrected by 66% in the next period. It has been calculated that the effects of the shock will disappear after 1/0.66 = 1.51 ie approximately 2 periods. As a result of the test performed to determine the cointegrated relationship in the long run, the probability value of 0.0414 shows that there is a significant relationship between renewable energy and economic growth. In the Wald test performed to test the coefficients, the statistical value of 0.0696 F shows that there is a significant relationship between renewable energy and economic growth in the short run at 10% confidence level. There are significant relationships between renewable energy consumption and GDP in Turkiye between 1998 and 2018, both in the long run and in the short run. In addition, a 1% unit increase in renewable energy consumption increases GDP by about 0.15%.

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