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THE NEXUS BETWEEN MACROECONOMIC INDICATORS AND ELECTRIC CONSUMPTION EFFECT ON ECONOMIC GROWTH IN TURKEY

Asst. Prof. Yasemin TELLİ ÜÇLER (Ph.D.)*

ABSTRACT

In this study, it is aimed to determine the relationship between the variables and to analyze the effect of independent variables on electricity consumption by using data on electricity consumption, economic growth, foreign direct investment, and general price level for the period 1996–2022 In the study, the cointegration relationship is analyzed using the Autoregressive Distributed Lag bounds test approach. The Fourier-Toda-Yamamoto causality test has been applied. Short- and long-term effects have been revealed. It is observed that energy consumption and economic growth have a positive relationship with the same direction in the short and long term. Inflation has a negative impact on energy consumption in the short and long term. In addition, the increase in foreign direct investments in the short term leads to a significant increase in energy consumption in the relevant period in Turkey. The study, which applies the Fourier-Toda-Yamamoto causality test, finds that there is no causality between electricity consumption, Gross Domestic Product and Foreign Direct Investment variables.

Key Words: *Energy Consumption, Economic Growth, ARDL, Turkey.*

Jel Codes*:C22, O40, Q43.*

1. INTRODUCTION

The industrial revolution initiated by Adam Smith in England reveals the importance of production factors in economic terms. The realization of production in a country shows that the level of development of that country has increased in terms of economic growth. Furthermore, unlike standard growth models, endogenous growth models argue that the level of technology, which is directly related to the amount of energy consumption, will also directly affect the components of economic growth (Karataş and Ergül, 2023). Therefore, economic growth indicators of the country depend on the effective and efficient use of production factors such as labor, capital, natural resources, entrepreneurship, and the development of technological levels. Economic growth is realized through production (Gövdere and

* Necmettin Erbakan University, Faculty Of Applied Sciences, Department of Logistics Management, E-mail: ytelliucleri@erbakan.edu.tr

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Can, 2016). It is known that energy is a fundamental factor for the functioning of production factors globally.

Fossil fuels are a major factor in economic growth. With the onset of the industrial revolution, the world's dependence on fossil fuels has gradually increased. The expanding use of fossil fuels such as natural gas, oil and coal has a significant impact on greenhouse gas emissions, particularly carbon dioxide. The greenhouse effect of carbon emissions causing global warming The occurrence of acid rain plays a major role in climate change, directly or indirectly causing many environmental problems. Droughts, famines, hurricanes and typhoons are caused by climate change.Climate change causes ecosystem degradation and various health problems, and affects food and water resources. On the other hand, the oil crises of the 1970's put the issue of energy security on the agenda and accelerated research into new energy sources. Later, with increasing sensitivity to environmental pollution, renewable energy sources began to take up more space in the energy table. By limiting the use of fossil fuels, the importance of renewable, clean energy sources has increased (Kahn vd. , 2021).

Turkey is one of the countries with the highest electricity demand.Turkey's energy resources are evaluated in two ways; fossil energy and renewable energy. Natural gas, coal, oil, and lignite are among the fossil energy resources of the country. Turkey is not a rich country in terms of resources other than coal and lignite. However, due to its geographical location, it has great potential in terms of renewable energy resources such as geothermal, hydroelectric, biomass, solar, and wind, i.e., green energy resources. In order to use renewable energy, it is necessary to allocate budgets, develop infrastructure, give importance to research and development activities, support projects, and provide financing. Although there have been new policies for sustainable and renewable energy in recent years, fossil fuels continue to be used at a high rate in the country because they are not at a sufficient level. This situation leads to foreign dependency on energy consumption and creates pressure on the budget balance (Kavas and Kaya, 2023). It is expected that the investments to be made for growth in Turkey will lead to an increase in electricity consumption. Electricity consumption is important for Turkey's current situation and future (Ertuğrul; 2011). In this context, the relationship between electricity consumption and economic growth gains importance. This study analyzes the relationship between electricity consumption and economic growth based on this important relationship.

In this study, it is aimed to determine the relationship between the variables and to analyze the effect of independent variables on electricity consumption by using data on electricity consumption, economic growth, foreign direct investment, and general price level for the period 1996–2022. The study consists of five sections: introduction, theoretical framework, literature review, econometric methodology and conclusion. The remainder of this paper is divided into four sections. Section 2 discusses the theoretical framework. Section 3 reviews the relevant (empirical) literature, while section

4 discusses the methods used in the study. Section 5 presents the results and policy implications of the study.

2. THEORETICAL FRAMEWORK

Different theoretical views exist on the relationship between economic growth and energy consumption. According to Yu and Hwang (1984), Cheng (1999), and Payne (2010), the "neutrality hypothesis" suggests that energy is minimal or neutral in economic growth and that there is no causal relationship between the variables. In other words, it is argued that the share of energy in national income is very low and cannot affect economic growth (Apaydın et al., 2019). According to Kraft and Kraft (1978), Cheng and Lai (1997), Hwang and Yoo (2014), with the oil crisis in the world, there is a positive relationship between energy use and gross domestic product (GDP) growth in the "Protectionism Hypothesis." In an economy with less energy dependence, energy consumption either has no impact on economic growth or has a very small impact. Economic growth and energy consumption are also called the "Growth Hypothesis." According to Stern (2000), Soytaş et al. (2001), Hove and Siu (2007), and Mucuk and Uysal (2009), energy consumption plays a role both directly and as a complementary factor of production. It is predicted that positive phenomena in energy consumption increase economic growth, while negative phenomena slow down growth. Although the Solow growth model mentions the relationship between technological development and economic growth, there is not much explanation about how economic growth is realized. Human capital, research and development activities, and technological development play an active role in determining a country's level of development. Today, the factors attributing the underdevelopment or overdevelopment of countries to the lack of financial and real capital have lost their validity. The inability to use technology and human capital inadequacy of knowledge accumulation can be seen as an inability to achieve the level of development (Mucuk and Uysal, 2009). The growth of economies does not depend on a single model. Endogenous growth models are also categorized among themselves. For example, technology, capital, and labor come to the fore in the Romer model. Energy enables the use of technology. Technology must be used to ensure the consumption of energy by transforming it. Countries can increase their level of development through technology in order to use energy efficiently. According to Hwang and Gum (1991), Glasure (2002), Öztürk and Uddin (2012), the "feedback" hypothesis also shows the relationship between electricity consumption and economic growth. (Apaydın et al., 2019; Rahman, 2020).

3. LITERATURE REVIEW

Increasing energy demand worldwide inadequate and unbalanced distribution of resources have led countries to different searches. Energy affects the social, cultural, and economic structures of countries. Although there are many studies on economic growth and energy consumption, there is no consensus on the subject (Çetin and Şeker, 2012). Although studies in the literature show that economic growth affects energy consumption, some studies show that energy consumption supports economic growth.

A summary of the methodology and results of some studies conducted in Turkey is presented below:

In the study by Karagöl et al. (2007), the correlation between economic development and electricity production in Turkey is analyzed using the bounds test approach using 1974-2004 data. In the study where the cointegration relationship was detected, it was observed that while a negative effect emerged in the long term, a positive effect emerged in the short term.

Erdal et al. (2008), explored the causal association between energy consumption and real Gross National Product (GNP), utilizing data from Turkey covering the period 1970-2006. The results of the Johansen cointegration and Pair-wise Granger causality tests revealed a discernible link between the two variables.

Mucuk and Uysal (2009), examined the correlation between energy consumption and economic growth in Turkey and conducted cointegration and Granger causality tests. Granger causality is found to be from energy consumption to economic growth and the variables are cointegrated.

Şahbaz and Yanar (2013), employing the Toda Yamamoto test, endeavored to establish the connection between overall energy consumption, sectoral energy consumption, and real gross domestic product (RGDP) in Turkey. They analyzed the data of six sectors between 1970-2010 and found no causality relationship between GDP and industrial and residential energy consumption. At the sectoral level, a one-way causality is observed, indicating a direction from GDP to energy consumption and from GDP to the transportation, agriculture, and cycling power plant sectors. It is predicted that Turkey's energy saving policies will not create a negative economic situation.

In the study by Yılmaz et al. (2016), sectoral energy consumption in Turkey was analyzed by decomposition method in the light of data for the period 1970-2013. It was found that energy consumption increased due to output and structural effect and decreased due to intensity effect.

In the study by Usta and Berber (2017), Toda-Yamamoto (1995) causality analysis was conducted using data from 1970-2012 in Turkey. A mutual causation was noted between energy consumption and economic growth within the transportation and industry sectors. No relationship was found between energy consumption and the farming and the residential industries.

In the study by Apaydın et al. (2019), the effects of energy consumption on economic growth in Turkey using data from 1965-2017 were analyzed using a nonlinear lagged autoregressive model. A linear relationship was found between renewable energy and economic growth.

Aydın (2020), analyzed the time and frequency dimension causality tests by taking the data between 1965 and 2017 in Turkey. Toda-Yamamoto (1995) and Breitung-Candelon (2006) causality tests were used. Although there is no causal relationship observed in the time dimension, the frequency dimension presents a different scenario. In this context, the growth hypothesis holds true, suggesting that the correlation direction from energy consumption to economic growth prevails in the long term.

Yurtkuran (2021), examined the correlation among economic growth, the utilization of primary energy resources, and logistics in Turkey spanning the period from 1974 to 2019. Bayer-Hanck method was used. It was found that the effect of primary energy resources and logistics on economic growth is positive, while the effect of economic growth and logistics on primary energy resources are positive and negative, respectively.

In the study by Bulut et al. (2022), the effect of electricity consumption on economic growth was investigated by considering the data of Turkey between 2005-2020. Asymmetric linkage between variables was analyzed with the Nonlinear Autoregressive Distributed Lag (NARDL model and Toda-Yamamoto test was used for causality. The evidence of the presence of co-integration among the data variables in the long term is found. In the Toda-Yamamoto causality results, directional linear effect from electricity consumption to growth is observed. This supports the NARDL model.

Kalfa (2022), analyzed the relationship between changes in GDP exports and Manufacturing Value Added with electricity consumption using data from 1995 to 2020 in Turkey. Using the Autoregressive Distributed Lag Bounds Test (ARDL) approach, the study found a causality relationship between electricity consumption to exports, from GDP to exports, from manufacturing value added to exports, and from GDP to manufacturing value added.

In the study by Eralp (2023), panel time series and spatial panel data analyzes were conducted by considering the data between 2004 and 2019 in Turkey. It was determined that a causal link exists from the industrial sector to electricity consumption, and the association between the variables follows an inverted U-shaped pattern. It was determined that the share of the services sector in electricity consumption increased after 2000.

In the study by Yeter (2023), the link between electricity consumption and productive sector in Turkey is analyzed by considering the data between January 2016 and February 2020. Engle and Granger (1987), Phillips and Oualiaris (1990), Hansen (1992) and Shin (1994) cointegration tests were conducted. It is observed that the tests confirm each other, there is a mutual connection in the long term and there is no significant connection in the short term. It is found that the power of electricity consumption on manufacturing industry is greater than the power of manufacturing industry on electricity consumption.

A summary of the methodology and results of some studies conducted in different countries is presented below:

Lise and Montfort (2007), examined the correlation between energy consumption and GDP, which is expected to increase in the future, using data for the period 1970-2003. According to the cointegration and vector error correction model results, causality shifts from GDP to energy consumption, and volatility function together in the long term.

Yuan et al. (2007), analyzed the correlation between China's real GDP and electricity consumption for the period 1978-2004. In the realm of cointegration theory, a unidirectional Granger causality from electricity consumption to real GDP has been identified in the case of China. The study also analyzed that real GDP and electricity consumption are cointegrated.

In Bozma et al.'s (2018), investigation, the correlation between energy consumption and economic growth in Brazil, Russia, India, China and South Africa (BRICS) and Mexico, Indonesia, Nigeria, and Turkey (MINT) countries was scrutinized through the application of the Westerlund (2008) cointegration test using data spanning from 1990 to 2014. The findings revealed a cointegrated relationship between economic growth and energy consumption in both BRICS and MINT countries.

In the study by Rahman (2020), economic growth and globalization are considered to affect the carbon dioxide (CO_2) emissions of the ten countries (China,USA, India,Japan, Germany,Canada, Brazil,South Korea,France, UK) that consume the most electricity. In the light of the data between 1971-2013, panel cointegration approach was used. It is found that there is a long- link between electricity consumption and economic variables. The positive results of CO_2 emissions of the ten countries with the highest electricity consumption are emphasized. A one-way causal relationship was detected, signifying a connection where economic growth influences electricity consumption, electricity consumption influences globalization, and globalization affects CO_2 emissions.

Hassan et al. (2022), analyzed the link between electricity consumption and economic growth in Portugal, France and Finland. Cointegration analysis was conducted. It is observed that electricity consumption affects Finland and Portugal in the long and short term, while it has a positive effect on economic growth in France in the long term.

This study aims to determine the relationship between variables and analyse the effect of independent variables on electricity consumption using data on electricity consumption, economic growth, Foreign Direct Investment, and general price levels for the period 1996–2022.The most important finding of the study is that there is a positive relationship between electricity consumption and economic growth in terms of macroeconomic indicators between 1996 and 2022.The limitations of the study are the selection of data on electricity consumption, economic growth, foreign direct investment, and general price levels between the specified periods and the inclusion of only Turkey.As a result of the literature review, the difference of this study from the other literatures and its contribution to the literature is that the measurement of the effect of gross domestic product on electricity consumption with selected macroeconomic variables between 1996-2022 in Turkey has been analyzed.

4. ECONOMETRIC METHODOLOGY

In order to test the relationship between energy consumption and growth, time series analysis is applied to the data on growth, electricity consumption, general level of prices and foreign direct investment for the period 1996-2022. Electricity consumption data for the period 1996-2022 are based on data from Turkish Statistical Institute (TurkStat) and Energy Market Regulatory Authority (EMRA). Growth data are taken from the Central Bank of the Republic of Turkey (CBRT) Electronic Data Distribution System (EDDS) as GDP growth rate, while general price level and foreign direct investment data are taken from the World Bank Database as growth rates. Using the package program, the ARDL Bounds Test approach determined the cointegration relationship, and then long- and short-term effects were tried to be revealed.

The econometric model of the study is established in Equation (1)

$$LogMWH_t = \beta_0 + \beta_1 Trend + \beta_2 LogGDP_t + \beta_3 LogFDI + \beta_4 LogINF_t + \varepsilon_t \quad (1)$$

In equation 4.1, MWH represents electricity consumption, the GDP variable represents gross domestic product, the FDI variable represents foreign direct investment, and the INF variable represents the inflation rate. The main objective of the study is to analyze the effect of the GDP variable on the MWH variable. For this purpose, FDI and INF variables were added to the model as control variables. The ARDL approach analyzes the stationarity of variables and the presence of co-integration among variables.

The stationarity of the variables is determined by applying the Augmented Dickey-Fuller (ADF) test. ARDL bounds test approach is used to examine the presence of cointegration among variables.

The results of data sets can be misleading. In time series stationarity tests, attention should be paid to the mean and variance of the series. If the mean and variance are conditional on the distance separating the two periods, the series is stationary. This is weak stationarity (Gujarati et all, 2012).

The results of non-stationary data sets can be misleading. In time series stationarity tests, the mean and variance of the series are important. If the mean and variance are conditional on the distance separating the two periods, it can be said to be stationary. This is defined as weak stationarity (Gujarati et all, 2012). For a time, series Y_t, it is as follows.

$$E(Y_t) = \mu \quad (2)$$

$$var(Y_t) = E(Y_t - \mu)^2 = \sigma^2 \quad (3)$$

$$Y_k = E[(Y_t - \mu)(Y_{t+k} - \mu)] \quad (4)$$

Here, Y_k represents the sequential common variance at lag k, i.e., the common variance of the difference between Y_t and Y_t+Y_k.

In the Augmented Dickey-Fuller (1981) unit root test, which is constructed by adding delayed values of the variable to the Dickey-Fuller (1979) unit root test, the unit root test can also be applied when there is an autocorrelation problem in the error terms.

No Trend and Intercept

- $\Delta Y_t = \alpha_1 Y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \varepsilon_t$ (5)

Intercept

- $\Delta Y_t = \mu + \alpha_1 Y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \varepsilon_t$ (6)

Trend and Intercept

- $\Delta Y_t = \mu + \alpha_1 Y_{t-1} + a_2 t + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \varepsilon_t$ (7)

Fourier Toda-Yamamoto causality test will also be used in this study. Equation (8) is the equation used in the Fourier Toda-Yamamoto causality test.

- $y_t = \alpha_0 + \gamma_1 sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 cos\left(\frac{2\pi kt}{T}\right)$ (8)

The test statistical values calculated with the help of these formulations are reported in the empirical findings section.

5. EMPRICAL FINDINGS

The data sets and descriptive statistics of the variables used in this study to investigate the relationship between electricity consumption and economic growth, foreign direct investment, and inflation are given in Table 1.

Table 1. Descriptive Statistics

	MWH	GDP	FDI	INF
Mean	8.199534	5.870006	1.358523	31.85204
Median	8.20249	6.001977	1.369137	13.12338
Maximum	8.517408	7.176432	3.623384	143.6397
Minimum	7.826673	4.02912	0.305387	5.446449
Std. Dev.	0.209643	0.769197	0.853456	35.55991
Skewness	-0.13287	-0.72954	0.853166	1.560145
Kurtosis	1.735418	2.978599	3.514168	4.742182
Jarque-Bera	1.94808	2.484265	3.705261	14.89997
Probability	0.377555	0.288768	0.156824	0.000581
Sum	229.587	164.3602	38.03866	891.8572
Sum Sq. Dev.	1.18665	15.97492	19.66647	34141.69

The null hypothesis of the ADF unit root test is "the series contains unit root". Therefore, when the probability values are below 1%, 5% and 10% significance levels, the null hypothesis is granted, and it is concluded that the series does not contain a unit root. The findings of the ADF unit root test are given in Table 2.

Table 2. Augmented Dickey-Fuller Unit Root Test Results

At The Level

	None		Intercept		Trend And Intercept	
	T-statistic	***Prob.***	***T-statistic***	***Prob.***	***T-statistic***	***Prob.***
MWH	8.251130	1.0000	-1.345616	0.5933	-2.229400	0.4555
GDP	-1.435408	0.5488	1.154823	0.9998	-0.588463	0.4522
FDI	-2.667581	0.0936	-2.619611	0.2753	-0.899653	0.3170
INF	-1.658707	0.4390	-0.426397	0.9805	-1.235924	0.1928

First Difference

	None		Intercept		Trend And Intercept	
	T-statistic	***Prob.***	***T-statistic***	***Prob.***	***T-statistic***	***Prob.***
MWH(-1)	-2.087122	0.0376	-4.688679	0.0010	-4.697347	0.0047
GDP (-1)	-6.756246	0.0000	-7.072347	0.0000	-6.687098	0.0000
FDI (-1)	-4.669616	0.0011	-4.612894	0.0059	-4.754403	0.0000
INF (-1)	-5.434060	0.0002	-6.017684	0.0002	-5.571873	0.0000

In table 2, all variables have unit root. For this reason, when the first-order differences of all data are taken, it is observed that all data are stationary in the models with No Trend and Intercept, Intercept and Trend and ARDL Bounds Test.

ARDL Bounds Test provides the opportunity to analyze stationary data sets at different degrees. The study shows that the variables are stationary at different degrees, provided that they are not greater than I (1). Therefore, the ARDL bounds test method should search for the cointegration relationship. Based on the Akaike information criteria, the appropriate ARDL model is estimated as ARDL (4,4,4,4,4).

Table 3. Cointegration Test (F Bound Test)

$LogMWH_t = \beta_0 + \beta_1 Trend + \beta_2 LogGDP_t + \beta_3 LogFDI + \beta_4 LogINF_t + \varepsilon_t$		
F Statistics	**3,162489**	
Appropriate ARDL Model	4,4,4,4,4	
Significance Levels	**Critical Value**	
	I (0) Bound	**I(1) Bound**
10%	1.98	2.37

5%	2.18	2.56
2,5%	2.37	2.79
1%	2.51	3.15
Diagnostics Tests	**Statistics (Probability Value)**	
Normality Test (Jarque-Bera)	**0,746835 (0,688378)**	
Breusch-Godfrey Serial Correlation LM Test	**0,530230 (0,6967)**	
Breusch-Pagan-Godfrey Variance Test	**0,285344 (0,9645)**	
Ramsey Reset Test	**0,016029 (0,9108)**	

Table 3 presents the results of the ARDL bounds test used to determine whether there is a cointegration relationship. The results show that there is evidence of cointegration if the F-statistic value is above the critical values and no cointegration if the F-statistic value is below the critical values. Since the F-statistic value (3.162489) is above all critical values, the null hypothesis stating that there is no cointegration in the model is accepted and cointegration is observed between the variables.

According to Ramsey Reset Test The null hypothesis "error terms are normally distributed" cannot be rejected when the probability value is greater than 0.05 significance level. It is concluded that the error terms satisfy the normal distribution condition.

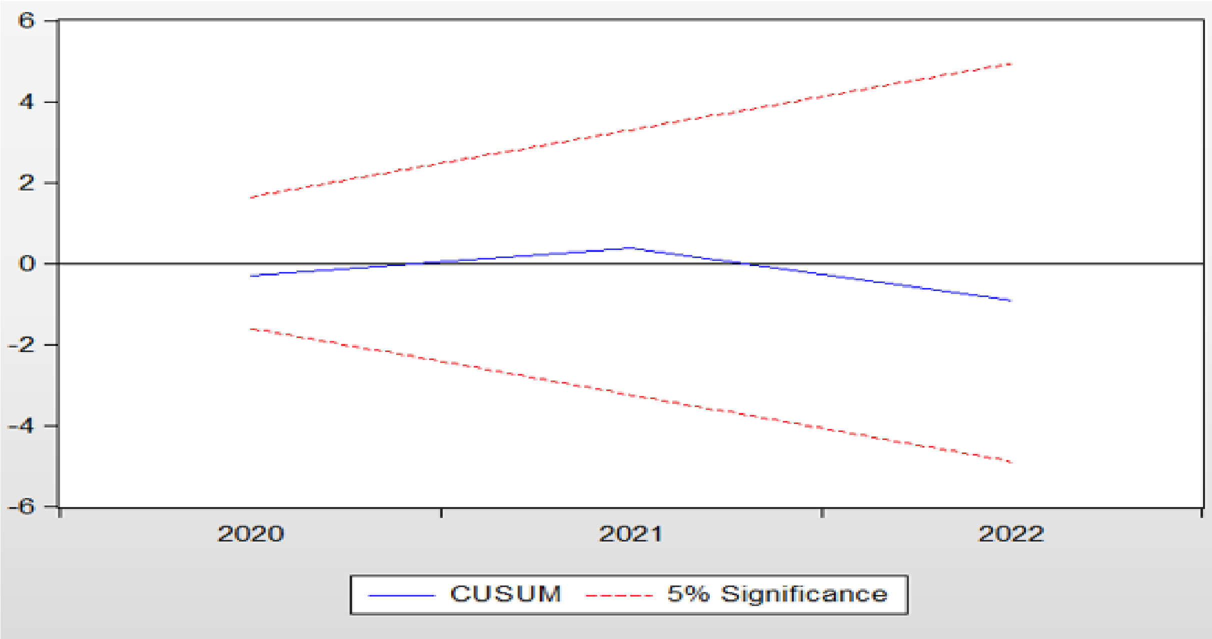
Breusch-Godfrey Serial Correlation LM Test Results shows that the probability value tests the null hypothesis "There is no autocorrelation" and cannot be accepted even at 10% statistical significance level. With this result, it is concluded that there is no autocorrelation problem in the analyzed model.

In the Breusch-Pagan-Godfrey varying variance test, if the probability value is greater than 0.05 statistical significance level, the null hypothesis is that there is no varying variance problem. Since the null hypothesis cannot be accepted even at 10% statistical significance level, it is revealed that there is no problem of heteroscedasticity in the error term.

The Ramsey Reset test is used to establish whether the mathematical form of the model is correctly chosen. Test results greater than 0.05 statistical significance level cannot reject the null hypothesis "the mathematical form of the model is correctly chosen". The probability values show that the null hypothesis cannot be accepted even at 10% statistical significance level. This supports the conclusion that the exponential variables added to the model have no effect on the dependent variable and that the econometric model is correctly established.

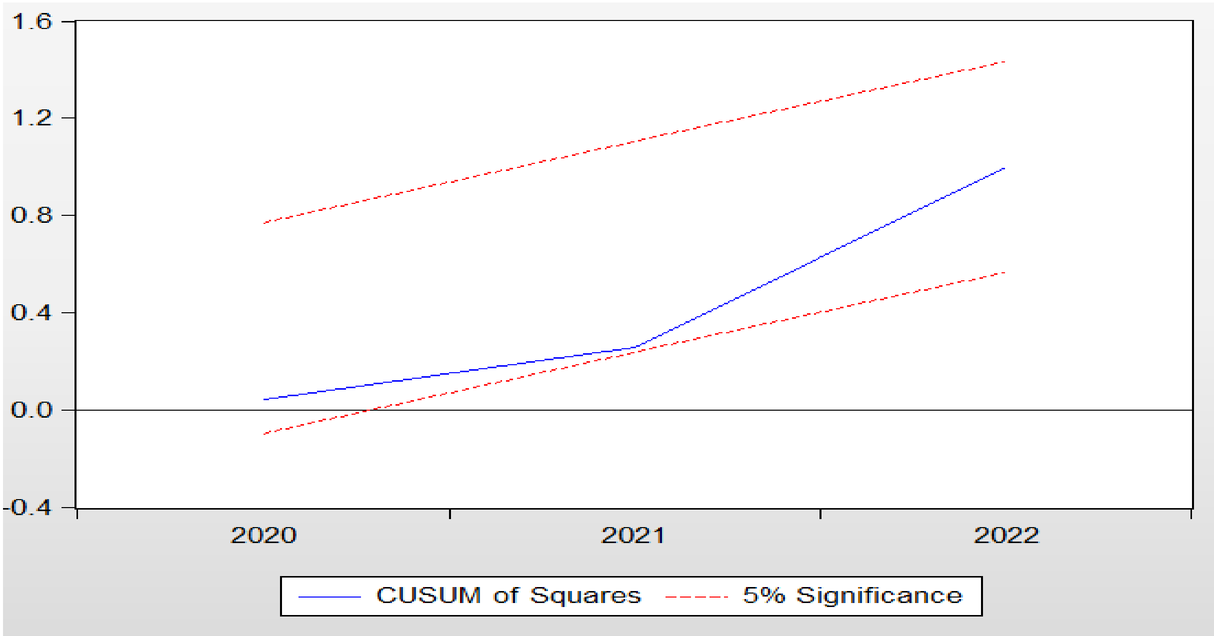
Finally, the CUSUM and CUSUMSQ tests conducted to determine the stability of the long-term coefficients are presented in Graphs 1 and 2.

Graph 1. CUSUM Test



Graph 1 shows that the ratio of the sum of error terms to the standard deviation in the CUSUM test remains within the 5% critical values and does not deviate.

Graph 2. CUSUMSQ Test



Graph 2 shows that the variance of the sum of squares of error terms in the more sensitive CUSUMSQ test does not exceed the 5% critical value. This shows that the forecast results are stable.

In the model where cointegration is observed, short- and long-term estimations can be made. The calculated long-term relationship is given in Table 4.

Table 4. Long Term Coefficients

Variable	Coefficient	Standard Error	t-Statistic	Probability Value
C	-29.36053	15.25462	-1.924697	0.1499
MWH (-1)	-0.544262	0.436221	-1.247674	0.3007
GDP (-1)	1.751213	0.602430	2.906916	0.0622
FDI (-1)	10.95685	5.258414	2.083680	0.1285
INF (-1)	-1.361075	0.417204	-3.262377	0.0470
D(MWH(-1))	-0.830191	0.567392	-1.463170	0.2396
D(MWH(-2))	-1.095647	0.541348	-2.023925	0.1361
D(MWH(-3))	-0.627535	0.529057	-1.186139	0.3209
D(GDP)	0.797714	0.180228	4.426131	0.0214
D(GDP(-1))	-0.237921	0.305154	-0.779673	0.4924
D(GDP(-2))	0.699408	0.265036	2.638912	0.0777
D(GDP(-3))	0.661399	0.402686	1.642470	0.1990
D(FDI)	5.826544	3.064899	1.901056	0.1535
D(FDI(-1))	-4.714052	2.150791	-2.191776	0.1161
D(FDI(-2))	-4.241226	2.996981	-1.415166	0.2520
D(FDI(-3))	-0.805814	1.237667	-0.651075	0.5614
D(INF)	-0.798585	0.210434	-3.794939	0.0321
D(INF (-1))	-0.252599	0.187060	-1.350361	0.2697
D(INF (-2))	-0.362913	0.149948	-2.480262	0.0941
D(INF (-3))	-0.176421	0.113736	-1.551143	0.2187

According to the data in Table 4, the effect of growth on the dependent variable electricity consumption in the current period is positive and significant at 10% significance level. Since the data is significant, it can be interpreted, and it is observed that a 1% change in growth causes a 1.75% change in the same direction in electricity consumption.

When the lag of growth data is analyzed, it is observed that there is a significant and positive correlation between electricity consumption in one period and an insignificant and negative correlation in the other period. The impact of foreign direct investments and the change in the general level of prices on electricity consumption is insignificant in the long term.

The short-term relationship between variables is examined employing the ARDL error correction model. The model is as in Equation (9)

$$\Delta LogMWH = c + \sum_{i=1}^{k} \beta_i \Delta LogGDP_{t-i} + \sum_{i=1}^{k} \alpha_i \Delta LogFDI_{t-i} + \sum_{i=1}^{k} \alpha_i \Delta LogINF_{t-i} + \tau_i CointEq_{t-1} + \varepsilon_t \quad (9)$$

In Equation 9, "c" represents the constant term in the model, and CointEq represents the error correction term. The number of lagged variables in the model is denoted as "k" and the number of lags as "i."

Table 5. Short Term Coefficients

Variable	Coefficient	Standard Error	t-Statistic	Probability Value
D(MWH(-1))	-0.830191	0.170734	-4.862487	0.0166
D(MWH(-2))	-1.095647	0.188286	-5.819045	0.0101
D(MWH(-3))	-0.627535	0.232093	-2.703805	0.0735
D(GDP)	0.797714	0.095124	8.386013	0.0036
D(GDP(-1))	-0.237921	0.116696	-2.038799	0.1342
D(GDP(-2))	0.699408	0.104503	6.692683	0.0068
D(GDP(-3))	0.661399	0.169308	3.906480	0.0298
D(FDI)	5.826544	0.878460	6.632680	0.0070
D(FDI(-1))	-4.714052	0.810620	-5.815368	0.0101
D(FDI(-2))	-4.241226	1.121793	-3.780755	0.0324
D(FDI(-3))	-0.805814	0.557488	-1.445437	0.2441
D(INF)	-0.798585	0.113580	-7.031009	0.0059
D(INF(-1))	-0.252599	0.062548	-4.038476	0.0273
D(INF(-2))	-0.362913	0.062246	-5.830336	0.0101
D(INF(-3))	-0.176421	0.0553119	-3.321206	0.0450
CointEq(-1)	-0.544262	0.089602	-6.074184	0.0090

Short term coefficients are shown in Table 5. Hence, in the error correction model, the coefficient of CointEq (-1), which is called the error correction coefficient, is expected to be significant and negative (-). A significant and negative error correction coefficient implies that the deviation from the long-term relationship of the variables will be rebalanced in subsequent periods. When the value in table 5 is analyzed, it is seen that the coefficient of CointEq (-1) is (-)0.544262 and it is statistically consistent even at 1% significance level. Therefore, it is observed that when deviations from the long-term equilibrium occur. According to the Cointegration Coefficient of-0.544, deviations from the long term equilibrium are rebalanced within approximately two year.

Table 6. Fourier Toda-Yamamoto Casuality Test Results

	Lag	Freq.	Wald Stat.	Prob.	Results
MWH→GDP	2	1	4,291	0,117	There is no casuality
GDP→MWH	1	1	0,252	0,616	There is no casuality
MWH→INF	1	1	2,814	0,093	There is casuality
INF→MWH	1	1	2,604	0,107	There is no casuality
MWH→DI	1	3	0,065	0,798	There is no casuality
DI→MWH	1	3	0,061	0,805	There is no casuality

According to the results of the Fourier-Toda-Yamamoto causality test, electricity consumption causes inflation. At the 10% level, with a negligible difference, it can be interpreted that inflation causes electricity consumption. According to the results of the Fourier-Toda Yamamoto causality test, no causal relationship was detected between electricity consumption, GDP, and foreign direct investment variables.

6. CONCLUSION

This study investigates the relationship between electricity consumption and economic growth, foreign direct investment, and inflation. The econometric results of the study show that in the short term, growth has a positive relationship with energy consumption in the same direction. Inflation, on the other hand, has a negative impact on energy consumption in the short term with all its lags. In addition, the increase in foreign direct investments in the short term leads to a significant increase in energy consumption in the relevant period. A 1% increase in FDI leads to a 5% increase in energy consumption in the short term. Similar effects are valid for the long term, but a 1% change in growth leads to a 0.79% increase in energy consumption. Although the positive effect becomes insignificant in the first lag, a positive effect is observed again in the second lag. A similar pattern is observed for inflation, but inflation has a negative effect on energy consumption in both the short and long term. Fourier-Toda-Yamamoto causality test results show that electricity consumption causes inflation. At the 10% level, with a negligible difference, it can be stated that inflation causes electricity consumption. According to the results of Fourier-Toda Yamamoto causality test, it is observed that there is no causality relationship between electricity consumption, GDP and foreign direct investment variables.

In this regard, it is necessary to develop anti-inflationary policies, that is, to implement policies that decrease demand in the short term and raise supply in the long term. Demand can be reduced through tax increases and expenditure cuts. Reducing demand can reduce inflation. In the long term, Inflation is determined by the monetary base. The money demand in the economy determines inflation; since the quantity of money shapes the general level of prices, an increase in the money supply directs investment and consumption expenditures. It may have a positive effect on prices. The sustainability of Turkey's economic growth should be supported by foreign direct investment, and Turkey should enter a rapid process of change and transformation for the use of renewable energy resources.

Recent studies that support the finding that growth has a positive impact on energy consumption in Turkey are analyzed using different methods. Kazanasmaz et al (2023), concluded that electricity consumption has a positive effect on economic growth by using Granger causality, vector error correction model and Johansen cointegration tests with data from 1967-2017. Similarly, Kavas and Kaya (2023), emphasised that economic growth performance should also be increased in order to increase renewable energy, using the ARDL bounds test method with data from 1982-2021. The study by Kızılkaya (2023), covers the period 1965-2021. The study, which used the Bayer-Hanc cointegration test, concluded that increases in energy consumption also increase economic growth. Örnek and Kabak (2023), assessed the relationship between economic growth and energy consumption with Granger causality and Johansen cointegration tests using data between 1990 and 2020. A causal relationship was found between energy consumption and economic growth. The study by Bulut et al. (2022), analyzed the period 2005-2020 using the NARDL model and tested for causality using the Toda-Yamamoto test. It indicates that there is a positive relationship between and electricity consumption and economic growth. Similar results have been found in recent studies on this topic worldwide. In the study by Liu et al. (2023), the relationship between economic growth and energy consumption was analyzed using data for the years 2005-2016 in Beijing. Unidirectional causality is found in the Granger causality analysis.The study by Samour et al. (2023), analyzed the impact of electricity consumption from renewable and non-renewable sources in the BRICS-T countries, using data between 1990 and 2018. The Dumitrescu-Hurlin panel causality was carried out using the ARDL model. It is found that renewable electricity has a positive effect on electricity consumption, economic growth and industrialisation. Espoir et al. (2023), analyzed the impact of renewable and Using data from 1980 to 2018, the growth of non-renewable electricity consumption in 51 African countries. The co-integration analysis found positive effects of renewable and non-renewable electricity consumption on growth. Simionescu (2023), applied panel data models based on the Cobb-Douglas function in 23 European Union Member States over the period 1990-2020. The consumption of renewable energy has a positive effect on economic growth. In the study by Usman (2021), cointegration and error term bounds testing approaches were analyzed using data from selected South Asian countries for the years 1990-2018. The impact of economic performance on electricity consumption is assessed. A positive effect was found.

The major finding of the study is that there is a positive relationship between electricity consumption and economic growth in terms of macroeconomic indicators between 1996 and 2022. For the sustainability of economic growth, renewable energy resources should be emphasised. Investments in this area will reduce Turkey's need for fossil energy resources. This will minimise external energy dependence and ensure sustainable economic growth. The limitations of this study are the selection of data on electricity consumption, economic growth, foreign direct investment and general price levels for the period 1996-2022 and the inclusion of only Turkey. In future studies, macroeconomic indicators can be evaluated using different analyzes, different criteria and different countries and cities, and the issue can be explored in depth.

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