Chapter 5

Estimation of the Relationship Between Financial Development Indicators - Renewable Energy Consumption - Economic Growth: 1990-2021 Period Türkiye

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Abstract

Energy, which is important in achieving sustainable growth and development goals, is present in every aspect of our lives in different forms. Likewise, financial development also plays an important role in achieving the sustainable economic growth targets of countries. In this context, this study investigates the relationship between renewable energy, financial development and economic growth in Türkiye in the period 1990-2021. As a result of the cointegration analysis test, the existence of a long-term relationship between the variables was obtained. According to the causality analysis findings, a bidirectional causality relationship was obtained between economic growth and money supply representing financial development. While a one-way causality relationship from economic growth and money supply to renewable energy consumption is obtained, a bidirectional relationship is obtained between private sector loans provided by banks representing financial development and renewable energy consumption.

1.Introduction

Economic growth is generally defined as the increase in the goods and services produced by a country compared to the previous year (Dinler, 1997). Therefore, economic growth is seen as one of the main macroeconomic variables affecting the welfare level of a country and one of the main driving forces of sustainable development. In this context, one of the main policies of all countries in the world is to achieve economic growth targets and to make it sustainable.

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Recently, the interaction between financial development, renewable energy consumption and economic growth has become an important focal point in realising global sustainable development goals. The increase in global energy demand and the increased attention to environmental factors have led to a growing interest in renewable energy consumption. While the widespread consumption of renewable energy contributes to environmental sustainability, it also provides significant advantages for economic growth. In this context, it is stated that financial development can support economic growth by contributing to the financing of renewable energy consumption projects (Apergis & Payne, 2010).

Renewable energy consumption is critical to ensure low carbon emissions and sustainable energy sources. By reducing dependence on fossil fuels, renewable energy sources strengthen energy security and support healthy economic growth in the long term. It is stated that this transformation is felt more clearly especially in developing countries. Various studies indicate that renewable energy investments can accelerate economic growth by transforming energy consumption (Sadorsky, 2009).

Financial development is expressed as a multidimensional concept. This concept is used to indicate the changes occurring in the financial system. Financial development indicators are important in determining the direction of the relationship between financial development and economic growth. It is stated that they vary from country to country. (Ertürkmen, 2023; Furstenberg and Fratianni, 1886). Financial development is particularly important in the increase in renewable energy consumption, which is supported by technological developments in energy production. Investments in renewable energy both increase energy efficiency and create long-term benefits for economic growth (Esen et al., 2024). In this context, this paper will examine the relationship between financial development, renewable energy consumption and economic growth, and also evaluate the contribution of this interaction to achieving sustainable development goals.

While the effects of financial development and energy consumption on economic growth are usually analysed separately in the literature, these variables will be analysed together as in Aslan and Yılmaz (2023). In this context, the aim of this study is to examine the relationship between financial development, renewable energy consumption and economic growth in Türkiye for the period 1990-2021 within the scope of Johansen Co-integration analysis and Toda Yamamoto causality analysis. Following the introductory section, studies on the relationship between financial development, renewable energy consumption and economic growth

are evaluated separately. Considering the literature, both the financial development-economic growth relationship and the energy consumption-economic growth relationship have been intensively addressed. There is a limited number of studies on the relationship between financial development-renewable energy consumption and economic growth in Türkiye. In addition, energy consumption is generally discussed in the studies and renewable energy variable is rarely used in the relationship between financial development-renewable energy consumption-economic growth. The study is expected to contribute to the literature in this respect. In the third part of the study, the data set, methodology and findings are evaluated. In the conclusion section, conclusions, policies and suggestions for future studies are made.

2.Energy Consumption-Financial Development and Economic Growth Relationship: Literature Review

When the literature is analysed, it is seen that the studies on financial development-economic growth relationship and energy consumption-economic growth relationship are intensive. In this section, some studies on financial development-economic growth, energy consumption-economic growth and financial development-energy consumption and economic growth relationship are summarised in Table 1, Table 2 and Table 3 respectively.

Table 1. Some Studies on the Relationship between Financial Development and Economic Growth

Author-Year	**Country-Country Group/Period**	**Method**	**Result**
Gökdeniz et al. (2003)	Türkiye/1989-2002	EKK	Bank asset growth rate and Capital markets do not support economic growth and private bonds cannot explain economic growth. However, it is determined that money supply explains economic growth and inflation has a negative effect on economic growth.
Acaravcı et al. (2007)	Türkiye/1986-2006	Johansen Co-integration and Causality Analysis	In the study, no co-integration relationship was found between financial development and economic growth. However, a unidirectional causality relationship was obtained from financial development to economic growth.
Khan and Quayyum (2007)	Pakistan/1961-2005	ARDL bounds test analysis	A long-run relationship was found between economic growth and financial development.
Özcan and Arı (2011)	Türkiye/1998-2009	Time series analysis	A unidirectional causality is found between financial development and economic growth
Aydın et al.(2014)	Türkiye/1988-2012	Toda Yamamoto Causality Analysis	A unidirectional causality relationship was found from financial development to economic growth.
Bozuklu and Yılancı (2013)	14 Developing Countries/1988-2011	Panel Data Analysis	Empirical findings show that financial development increases economic growth.
Hayaloğlu (2015)	Fragile Five/1990-2012	Panel Data Analysis	The findings indicate that there is a positive relationship between financial development and economic growth.

Kılıç, et al. (2019)	Türkiye/1968-2017	Cointegration and Causality Analysis	A long-term cointegration relationship was found between economic growth and financial development indicators, and a causality relationship was found between financial development variables.
Eren, et al. (2021)	Selected Emerging Market Economies/2000-2018	Panel Data Analysis	At the end of the analysis, the effect of financial development on economic growth in emerging market economies was found to be statistically significant and positive.
Önder (2022)	Fragile Five/1990-2019	Panel Data Analysis	As a result of the analysis, the effect of financial development on economic growth is found to be significant. Increases in financial development reduce economic growth. It is emphasised that there are different findings in country-based coefficient results.
Çınar et al. (2023)	39 Africa, 34 Asia-Pacific, 41 Africa, 25 Middle East-Central Asia, 34 Western Hemisphere countries/1995-2020	Panel Data Analysis	A bidirectional causality relationship was found between economic growth and financial development.
Demirkale and Ebghaei (2023)	Türkiye/2008-2020	NARDL Analysis	Shocks to financial development are found to have a positive impact on economic growth
Gök and Biçer (2024)	MINT/1980-2021	Panel Data Analysis	Financial development is found to have a significant effect on economic growth.
Tekin et al.(2024)	Türkiye-G7 countries/1980-2019	Panel Data Analysis	Co-integration analysis revealed a cointegration relationship between variables in Türkiye, France and Italy. In addition, causality analysis revealed a bidirectional relationship between financial development and economic growth in the USA, while no finding was found among other countries

There are many studies in the literature on the relationship between energy, which constitutes one of the indispensable elements of production, and economic growth. Here, some studies on the relationship between energy consumption and economic growth are presented. Information on the studies is shown in Table 2.

Table 2. Some Studies on the Relationship between Energy Consumption and Economic Growth

Author-Year	**Country-Country Group/Period**	**Method**	**Result**
Sarı et al.(2001)	Türkiye/1960-1995	Johansen Co-integration Test	A long-run cointegration relationship was found between the variables considered.
Paul and Bhattachar (2004)	India/1950-1996	Engle Granger Co-integration Analysis	It is determined that there is a mutual relationship between the variables
Erdal et al. (2008)	Türkiye/1970-2006	Johansen Co-integration Analysis	It was found that there is a bidirectional cointegration relationship between the variables in question.
Güvenek and Alptekin (2010)	25 OECD Countries/1980-2005.	Panel Co-Integration Analysis.	Empirical results indicate the existence of a bidirectional causality relationship between energy consumption and economic growth.
Apergis and Payne (2010)	9 South American Countries/1980-2005	Panel Data Analysis	The results show a unidirectional causality relationship from economic growth to energy consumption.
Polat (2017)	Türkiye/1960-2015	Gregory Hansen Co-integration Analysis	Relationship The existence of a long-run relationship between these variables was obtained.
Kızılkaya (2018)	Türkiye/1960-2015	Co-integration and causality analysis	There is no cointegration and causality relationship between the variables.
Alper (2018)	Türkiye/1990-2017	Bayer Hank Co-integration and Toda Yamamoto Causality Analysis	A long-run relationship was found between renewable energy and economic growth. In addition, according to the causality analysis results, a unidirectional relationship was found from economic growth to renewable energy consumption.

Uslu (2018)	21 Developing Countries/1990-2014	Panel Data Analysis	The findings indicate that there is a long-run relationship between energy consumption and economic growth. The study also emphasises that there is a bidirectional causality between energy consumption and economic growth.
Yanıktepe et al.(2021)	Yanıktepe et al.(2021)	Granger Causality Analysis	The findings indicate that there is a positive relationship between the variables.
Özen and Levent (2022)	Selected OECD countries/2000-2019	Panel Data Analysis	In the study, the existence of a long-run relationship between energy consumption and economic growth was found. In addition, the existence of a unidirectional causality between economic growth and energy consumption was determined.
Bozkaya and Aytekin (2023)	Bozkaya and Aytekin (2023)	Panel Data Analysis	It was found that there was no significant relationship between energy consumption and economic growth.
Şimşek (2024)	Türkiye/1990-2020	Toda Yamamoto Causality Analysis	It was found that there was no causality relationship between the variables.

It is observed that energy consumption, GDP and financial development indicators are used in many studies analysing the relationship between financial development and economic growth or energy consumption and economic growth. There is a large literature on both issues. However, there is no common consensus. It can be said that the differences in the methods, country-country groups, periods and variables used are effective in this.

Table 3 summarises the studies on the relationship between Financial Development-Energy Consumption and Economic Growth. As can be understood from the literature review, it is seen that the number of studies dealing with the three issues together and the studies using renewable energy consumption as a variable are limited. It is seen that energy consumption is used intensively in these studies. It is foreseen that the study will contribute to the literature in this respect

Table 3. Some Studies on the Relationship between Financial Development, Energy Consumption and Economic Growth

Author-Year	**Country-Country Group/Period**	**Method**	**Result**
Shahbaz et al. (2013)	China/1971-2011	ARDL Test and Co-integration Analysis	It is found that there is a positive relationship between the variables analysed and economic growth.
Salman and Atya (2014)	Algeria, Tunisia, Egypt/1980-2010	Granger Causality and ECM Analysis	It is emphasised that financial development and energy consumption contribute positively to growth in Algeria and Tunisia, but have a negative impact in Egypt.
Sidique and Majeed (2015)	Five South Asian Countries/1980-2010	Panel Data Analysis	They found that financial development, energy consumption and trade positively affect economic growth
Doğan and Değer (2016)	India /1970-2013	Causality and Co-integration Analysis	As a result of causality analysis, they found that there is a causality relationship from economic growth to energy consumption, while there is no causality relationship from energy consumption to economic growth. They also found a causal relationship from economic growth to financial development.
Boz et al. (2017)	ASEAN Countries/1985-2013	Panel Data Analysis	The findings showed that there is a unidirectional causality from economic growth to energy consumption and financial development.
Burakov and Freidin (2017)	Russia/1990-2014	VECM Analysis and Granger Causality Test	There was no causality relationship between financial development and renewable energy consumption.
Yılmaz and Şen (2018)	Türkiye/1980-2014	ARDL analysis	It was found that there is a long-run relationship between the variables.
Şahin (2018)	Emerging Market Economies/1990-2014	Panel Data Analysis	Co-integration relationship was found between the variables. In addition, a causality from financial development to economic growth was found in India, Argentina, Malaysia and Mexico.

Demirci (2019)	Türkiye/1980-2016	Johansen Co-Integration and VECM Causality Analysis	It was found that there is a long-run relationship between the variables.
Tutgun (2019)	Türkiye/1961-2014	ARDL Analysis	Financial development and energy consumption have been found to increase economic growth.
Gürsucu (2021)	Türkiye/1960-2015	Toda Yamamoto Causality Analysis	It was not found any causality between financial development and energy consumption. However, it is among the findings that there is a unidirectional causality from financial development to economic growth.
Yılmaz (2021)	G-7 Countries/1980-2018	Panel Causality Analysis	A causality relationship was found from financial development to renewable energy consumption and from renewable energy consumption to financial development. In addition, the findings emphasise that there is a causality from renewable energy consumption to economic growth.
Uslu (2022)	Türkiye/1960-2019	VECM Causality Analysis	According to the causality analysis, a unidirectional causality relationship was found from economic growth to energy consumption and financial development. In addition, it is also found that there is a bidirectional causality between energy consumption and financial development.
Aslan and Yavuz (2023)	BRICS-MINT/2001-2019	Panel Data Analysis	It was found that there is a cointegration relationship between the variables. It is also concluded that there is a unidirectional causality relationship from financial development to economic growth and a unidirectional causality relationship from financial development to renewable energy.
Şahin (2023)	Türkiye/1990-2020	ARDL Analysis	A significant relationship was found between financial development and renewable energy consumption.

As a general assessment, with the globalisation process, it is important to identify the issues of financial development-economic growth and energy consumption and the relations between these issues. In both time series and panel data analyses, it has been found that there is an interaction between financial development and growth, energy consumption and growth or between financial development and energy consumption and growth.

3.Empirical Findings

3.1.Data Set

In this study, the relationship between financial development indicators, renewable energy consumption and economic growth in Türkiye is analysed using the data set for the period 1990-2021. When the variables are evaluated, GDP per capita (LGDP-2015 US$) is used as the dependent variable, domestic loans provided by banks to the private sector (% GDP) (LK) and broad money supply (LPA), renewable energy consumption (% total energy consumption) (LYEN) variables are used as independent variables. Aslan and Yavuz (2023) study was utilised in determining the model. In this study, a model was constructed as follows and the logarithmic forms of the variables were used.

$$LGDP_t = \beta_0 + \beta_1 LYEN_t + \beta_2 LK_t + \beta_3 LPA_t + \varepsilon_t \quad (1)$$

In Equation 1, 'β' represents both the coefficient and the elasticity coefficients of the variable and 'ε_t' represents the error term of the model. Descriptive statistics of the variables are presented in Table 4

Table 4. Descriptive Statistics

	LGDP	LK	LYEN	LPA
Mean	8.9690	3.3792	2.7815	3.7237
Median	8.9560	3.236	2.6905	3.7149
Maximum	9.5067	4.2612	3.1945	4.2711
Minimum	8.5673	2.6398	2.4336	3.1671
St. deviation	0.2965	0.5874	0.2578	0.2890
Jargue -Bera	2.6369	3.6620	3.0743	1.1092
Jargue –Bera probability	0.2675	0.1602	0.2149	0.5742

In Table 4, economic growth, financial development and renewable energy variables are analysed. According to the Jargue-Bera probability values, the variables are normally distributed.

3.2 Methodology and Evaluation of Findings

3.2.1 Unit Root Test and Results

Time series analysis, which is one of the econometric analyses, is a method based on the values of variables over a time interval and the comparison of these values for different variables. Before statistical analysis of a time series, it should be investigated whether it is stationary or not. On the contrary, t and F tests and R2 value may give biased results in studies with non-stationary results (Zabun, 2015). In this case, the problem of spurious regression occurs (Granger and Newbold, 1974). Therefore, it is important to investigate the stationarity of a series in the model to be analysed. A Yt series,

Average : $E(Y_t) = \mu$

Constant Variance : $var(Y_t) = E(Y_t - \mu)^2 = \sigma^2$ (2)

Constant Covariance : $\gamma_k = E[(Y_t - \mu)(Y_{t+k} - \mu)]$

A time series is said to be stationary if it has the above characteristics (Gujarati, 1999). In this study, Augmented Dickey-Fuller (ADF) (1979-1981) and Phillips- Perron (PP) (1988) unit root tests were used to determine the stationarity levels of the variables. While ADF unit root test is considered as a parametric test, PP unit root test is considered as a nonparametric test (Alpagut, 2023). The unit root test results of the variables in the study are shown in Tables 5 and 6.

Table 5. ADF Unit Root Test Results

	Level				**First Difference**			
	Fixed	Prob.	Fixed and Trend	Prob	Fixed	Prob.	Fixed and Trend	Prob
LGDP	-0.5548	0.9860	-2.4673	0.3407	-5.4406	0.0001	-5.4658	0.0006
LYEN	-1.6197	0.4600	-2.4341	0.3561	-6.4368	0.0000	-6.7859	0.0000
LK	-0.2123	0.9267	2.4489	0.3482	-4.2736	0.0002	-4.2167	0.0001
LPA	-0.5677	0.8634	-2.4707	0.3545	-8.3324	0.0000	-8.1843	0.0000

Note: Critical values for the model with constant are calculated as -3.66 at 1%, -2.96 at 5% and -2.61 at 10%. For the model with constant and trend, critical values are calculated as -4.29 at 1%, -3.56 at 5% and -3.21 at 10%.

Table 6. PP Unit Root Test Result

	Level				First Diffrence			
	Fixed	Prob.	Fixed and Trend	Prob	Fixed	Prob.	Fixed and Trend	Prob
LGDP	-1.7952	0.9996	-2.3734	0.3852	-5.9755	0.0000	-7.2043	0.0000
LYEN	-1.1702	0.6744	-2.2901	0.4266	-7.1200	0.0000	-8.0794	0.0000
LK	-0.3109	0.9122	-1.7311	0.7129	-4.2303	0.0002	-4.1664	0.0013
LPA	-0.8865	0.7790	-2.3890	0.8788	-9.9750	0.0001	-9.9983	0.0000

When the stationarity analyses of the series used in the study are evaluated, it is seen that all variables are not stationary at level according to both ADF and PP unit root tests. With the ADF and PP unit root test applied to the first differences, it is seen that all series become stationary in the first difference. In more technical terms, it is understood that the series are I(1). In order to perform Johansen cointegration test based on VAR analysis, the condition that the series are stationary (I(1)) of the same order is met.

3.2.2. Johansen Co-integration Test and Results

Johansen cointegration test was used to determine the long-run relationship between the series used in the study. In the studies of Johansen (1988) and Johansen- Juselius (1990), Johansen (1988) and Johansen-Juselius (1990) introduced the trace statistic and the max eigenvalue statistic to determine the number of cointegration vectors and their significance levels (Sipahi, 2021).

In the Johansen cointegration test, it is stated that it is important to determine the appropriate lag length (Eryer and Eryer, 2023). The appropriate lag length of the VAR model is shown in Table 7.

Table 7. Determination of Lag Length

Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	49.43057	NA	5.69e-07	-3.028704	-2.841878	-2.968937
1	156.9178	179.1455*	1.29e-09*	-9.127857*	-8.193728*	-8.829020*
2	171.7528	20.76890	1.49e-09	-9.050185	-7.368748	-8.512279

Note: LR: Likelihood Ratio FPE: Final Prediction Error AIC: Akaike Information Criteria SC: Schwarz İnformation Criteria HQ: Hannan Quinn

According to FPE, AIC, SIC and HQ information criteria in Table 7, where the VAR model of the variables is installed and the appropriate lag length is shown, the lag length is determined as 1 for the model in question.

After determining the appropriate lag length, the results of the Johansen co-integration test, which is used to determine the long-term relationship between the variables, are shown in Table 8.

Table 8. Johansen Co-integration Results

Hypothesis	**Trace İst.**	**0.05 Critical Value**	**Prob. Value**	**Max. Eigen Value İst.**	**0.05 Critical Value**	**Prob. Value**
r=0*	62.0865	54.0790	0.0082	30.7432	28.5880	0.0261
r≤1	31.3433	35.1927	0.1228	18.569	22.299	0.1532
r≤2	12.774	20.2618	0.3821	7.7572	15.892	0.5769

According to the trace statistic and maximum eigenvalue statistic in Table 8, there is one cointegration vector in the model. According to the estimation results, it was found that there is a long-run cointegration relationship between the variables used in the model. Because the null hypothesis stating that there is no long-run relationship between the variables used in the model (r = 0) is rejected at 5% significance level according to both trace and maximum eigenvalue statistics.

3.2.3. Toda Yamamoto Causality Test and Results

In Toda Yamamoto causality analysis, it is stated that the series are analysed with level values. It is stated that this test has two important advantages over other causality tests. The first one is that it can be applied even if the series have different stationarity conditions. Secondly, it is known as not looking for a cointegration relationship between variables (Meçik & Koyuncu, 2020).

In order to perform Toda Yamamoto causality analysis, the extended VAR model with (k+dmax) lags should be determined as a priority. Here, k indicates the lag length of the model, while dmax indicates the highest degree of integration of the series. It is emphasised that the lag length of the WALD test is determined by summing these two values. Determination of these two values allows the model to be estimated accurately, preventing data loss and enabling more successful results to be obtained at the level level (Toda and Yamamoto, 1995; Okur and Çiçek, 2023). The model of the Toda and Yamamoto test is established as follows:

$$Y_t = \beta_0 + \sum_{i=t}^{k} \beta_{1i} Y_{t-1} + \sum_{j=k+1}^{k+d_{\max}} \beta_{2j} Y_{t-j} + \sum_{i=1}^{k} a_{1i} X_{t-1} + \sum_{j=k+1}^{k+d_{\max}} a_{2j} X_{t-j} + \varepsilon_{1t} \quad (3)$$

$$X_t = c_0 + \sum_{i=t}^{k} c_{1i} X_{t-1} + \sum_{j=k+1}^{k+d_{\max}} c_{2j} X_{t-j} + \sum_{i=1}^{k} d_{1i} Y_{t-1} + \sum_{j=k+1}^{k+d_{\max}} d_{2j} Y_{t-j} + \varepsilon_{2t} \quad (4)$$

In Equation 4, the null hypothesis is that X is not the Granger cause of Y, while the alternative hypothesis is that X is the cause of Y. In Equation 5, while the null hypothesis is that Y is not the Granger cause of X, the alternative hypothesis is that Y is the Granger cause of X.

It was found that there is a long-run relationship between the variables. Toda Yamamoto causality analysis was used to determine the direction of this relationship. In the empirical findings, dmax was determined as 1 for the maximum degree of integration when LGDP, LYEN, LK and LPA variables are considered. The appropriate lag length of the VAR model was determined as 1. By adding the maximum degree of cointegration of the variables to the appropriate lag length of the VAR model (k+dmax= 1+1=2), the second order VAR model analysis was performed. As a result of the findings obtained, the study continued with Toda Yamamoto causality analysis.

Table 9. Toda Yamamoto Causality Results

Dependent Variable LGDP	**Wald st.**	**Prob. Value**
LPA	7.4973	0.0235**
LK	0.8679	0.6479
LYEN	1.6108	0.4469
Dependent Variable LPA	**Wald st.**	**Prob. Value**
LGSYH	8.0159	0.0182
LK	2.4674	0.2912
LYEN	0.1607	0.9228
Dependent Variable LK	**Wald st.**	**Prob. Value**
LGSYH	0.1097	0.9466
LPA	2.4924	0.2876
LYEN	4.6614	0.0972***
Dependent Variable LYEN	**Wald st.**	**Prob. Value**
LGSYH	12.085	0.0024**
LPA	10.4773	0.0053**
LK	0.9570	0.0069**

Note: Test results are obtained from VAR(1+1) at level. **, %5 and ***, %10 indicate critical values.

Causality findings are presented in Table 9. When the test results are analysed, bidirectional causality was found between economic growth and money supply, which represents financial development, at 5% significance level. The results also show that there is a unidirectional causality relationship from economic growth to renewable energy consumption. In this period, the protectionism hypothesis was found to be valid for Türkiye. According to this hypothesis, economic growth is considered as a factor supporting energy consumption (Alper, 2018). In addition, while a unidirectional causality relationship was obtained from money supply to renewable energy consumption at 5% significance level, a bidirectional causality relationship was obtained between the other variable representing financial development, private sector loans provided by banks, and renewable energy consumption at 5% and 10% significance levels. The causality findings obtained are in line with the studies of Apergis and Payne (2010), Alper (2018), Yılmaz and Şen (2018), Yılmaz (2021), Uslu (2022), Aslan and Yavuz (2023) in the literature.

Conclusion

Sustainable economic growth and development are among the main macro objectives of countries. Recently, one of the factors whose impact on economic growth has attracted the most attention is the energy factor. Because energy is seen as one of the basic inputs for the realisation of economic growth. The need for energy continues to increase for both developed and developing countries. In this context, energy and especially renewable energy is one of the issues that need to be addressed today.

Progress in financial markets, diversification of financial instruments in the country and increasing accessibility of these financial instruments are considered as financial development. Thanks to financial development, economic units can utilise their existing savings with the help of different financial instruments. These financial instruments are actively traded in financial markets and offer many choices to investors. In fact, developments in the financial system contribute to the utilisation of savings as investment and the use of resources in more productive areas (Erim and Türk, 2005). With the globalisation process, studies on financial development have also started to gain importance and be discussed. It is an expected phenomenon that the level of financial development increases in parallel with economic development. In particular, its relationship with economic growth, which is one of the macroeconomic factors, has been evaluated in many research topics. Energy is one of these subjects. The integration of clean energy resources into economic activities has become more and more widespread day

by day. Financial development factors such as financial markets, investment methods, and the amount of funds in financial markets are important in the financing of renewable energy investments such as wind, solar and geothermal (Sadorosky, 2010).

In this context, in this study, the relationship between renewable energy consumption, financial development indicators and economic growth is tested using the data set for the period 1990-2021 for Türkiye. In the empirical part of the study, ADF and PP unit root tests were applied to the variables. As a result of the ADF and PP unit root test, it was observed that all variables used in the model became stationary in the first difference. Johansen cointegration test was used to determine the long-run relationship between the variables. In addition, Toda Yamamaoto Causality analysis was used to determine the direction of the relationship between the variables. According to the causality analysis findings, bidirectional causality was found between economic growth and money supply, which represents financial development. While a unidirectional causality relationship was found from economic growth and money supply to renewable energy consumption, a bidirectional causality relationship was found between private sector loans provided by banks, another variable representing financial development, and renewable energy consumption. The findings obtained are consistent with the literature.

The interaction between financial development -renewable energy consumption-economic growth both ensures environmental sustainability and increases economic welfare. In this respect, effective policies should be developed for the efficient functioning of this relationship and innovative and environmentally friendly investments should be supported.

Geographically, Türkiye is a country rich in renewable energy resources. Türkiye can transform its energy resources into renewable energy resources for a sustainable growth and environment. In addition, more investments should be made in renewable energy resources and it can be suggested to support projects for this purpose. In conclusion, country-country group comparisons can be made and policy recommendations can be developed through analyses to be made with different structural break techniques.

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