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The Nexus of Electricity Consumption, Financial Development, and Economic Growth in Turkey

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Abstract
The study revisits the nexus between electricity consumption and economic growth in Turkey, integrating financial development, capital, and labor as pivotal factors within an augmented production function framework spanning from 1971 to 2019. Employing the ARDL bounds testing approach, the research identifies long-run relationships among electricity consumption, economic growth, financial development, capital, and labor. Key findings indicate robust positive effects of electricity consumption, financial development, capital accumulation, and labor inputs on economic growth in Turkey. These results underscore the multifaceted contributions of energy infrastructure, financial sector development, and productive inputs to overall economic performance over the long term. The positive impact of electricity consumption on economic growth highlights the critical role of energy supply in driving economic activities, supporting industrial production, and enhancing overall productivity. As electricity consumption increases, it facilitates higher levels of output across various sectors, contributing to sustained economic expansion and development. Moreover, the study underscores the significance of financial development in bolstering economic growth. A well-developed financial sector facilitates efficient allocation of capital, encourages investment in productive activities, and fosters innovation and technological advancement—all crucial factors for enhancing economic performance and resilience. Additionally, capital accumulation and labor inputs emerge as significant determinants of economic growth in Turkey. Increased investment in physical capital, such as infrastructure and machinery, enhances productive capacity and efficiency, while a skilled and productive labor force further amplifies output and economic potential. The policy implications drawn from these findings are profound. To sustain economic growth momentum, Turkey should prioritize comprehensive energy policies aimed at enhancing electricity generation capacity, improving energy efficiency, and promoting renewable energy sources. Simultaneously, efforts to strengthen the financial sector through regulatory reforms, institutional capacity building, and financial inclusion initiatives can facilitate greater access to capital and investment opportunities, thereby fostering economic dynamism and resilience.
Keywords: Electricity Consumption, Economic Growth, Financial Development
JEL Codes: O40, Q43, G20

1. INTRODUCTION

In recent years, Turkey has experienced a significant annual growth rate of over 8% in electricity demand. This surge is fueled by various factors including technical advancements, social trends, and economic development. However, such rapid growth in demand raises considerable concerns about potential supply shortages in the near future if adequate measures to mitigate these challenges are not promptly implemented (ESMAP, 2009). Addressing these issues is crucial to ensuring a stable and sustainable electricity supply that can support Turkey's ongoing development and meet the needs of its growing population and industries. Turkey has undergone remarkable economic and social transformations, leading to a substantial increase in electricity demand. This growth is a reflection of Turkey's expanding industrial base, rising urbanization, and increasing standards of living across the country. As industries modernize and expand, the demand for electricity intensifies, driven by advancements in technology and production processes. Moreover, urbanization trends, with more people moving into cities and urban areas, contribute significantly to higher energy consumption for residential and commercial purposes.

The implications of such rapid growth in electricity demand are multifaceted. Firstly, there is a pressing need to ensure that the existing infrastructure can cope with the increased load without interruptions or shortages. This requires investments in upgrading and expanding the electricity generation, transmission, and distribution networks. Secondly, as Turkey aims for sustainable development, there is a growing emphasis on adopting cleaner and more efficient energy sources to meet the rising demand while minimizing environmental impact. Renewable energy sources such as wind, solar, and hydropower play an increasingly important role in Turkey's energy mix, contributing to both energy security and environmental sustainability. Moreover, the socio-economic benefits of ensuring reliable electricity supply cannot be overstated. Access to affordable and uninterrupted electricity is essential for supporting industrial productivity, attracting investments, and enhancing overall economic growth. It also improves living standards by providing essential services such as lighting, heating, and powering electronic devices in homes, schools, hospitals, and businesses. In addressing the challenges posed by rapid electricity demand growth, Turkey is also exploring energy efficiency measures and demand-side management strategies. These efforts aim to optimize energy use across sectors, reduce waste, and improve overall efficiency in electricity consumption. By adopting a comprehensive approach that combines

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infrastructure investments with sustainable energy policies, Turkey is working towards ensuring a resilient and sustainable energy future for its citizens and industries.

Investigating the causal relationship between electricity consumption and economic growth in Turkey is crucial given its implications for energy policy, economic planning, and sustainable development. Understanding how changes in electricity consumption affect economic growth and vice versa is essential for policymakers and researchers alike. Electricity consumption is not only a fundamental indicator of economic activity but also reflects the level of industrialization, technological advancement, and overall economic development within a country. In Turkey, where economic growth has been robust over the past few decades, the demand for electricity has surged, driven by industrial expansion, urbanization, and increasing household consumption. This growth in electricity demand poses challenges related to energy security, infrastructure development, and environmental sustainability. The ARDL bounds testing approach is particularly suited for this analysis as it allows for the examination of both short-run and long-run dynamics between electricity consumption and economic growth. By employing this method, researchers can identify whether changes in electricity consumption lead economic growth (Granger causality from electricity consumption to GDP), economic growth drives electricity consumption (Granger causality from GDP to electricity consumption), or if there exists bidirectional causality between the two variables. Moreover, the VECM Granger causality analysis complements the ARDL approach by capturing the short-term dynamics and feedback effects between electricity consumption and economic growth. This methodological combination enables a comprehensive understanding of how these variables interact over time, offering insights into policy interventions aimed at optimizing energy use while fostering sustainable economic development. This study not only contributes to the empirical literature on the energy-growth nexus but also provides actionable insights for policymakers in Turkey to formulate effective energy policies that support economic growth, enhance energy efficiency, and promote environmental sustainability amidst evolving global energy challenges.

2. REVIEW OF LITERATURE

The relationship between electricity consumption and economic growth has indeed been a subject of extensive research since the seminal work by Kraft and Kraft in 1978. Their pioneering study laid the foundation for numerous subsequent investigations into this critical nexus. Researchers have sought to understand whether increases in electricity consumption stimulate economic growth, whether economic growth drives higher electricity demand, or if there exists a bidirectional relationship between these variables. Ozturk (2010) and Payne (2010) are among the scholars who have contributed significantly to this field. Ozturk's comprehensive survey and analysis of the energy-growth nexus synthesized findings from various studies across different countries and regions, shedding light on the diverse factors influencing this relationship. Payne's work similarly explored the correlation between electricity consumption and economic growth, employing econometric techniques to discern causal links and dynamics. Over the years, the research has expanded to include considerations of energy efficiency, technological advancements, environmental impacts, and policy interventions. Studies often employ advanced econometric methods such as time series analysis, panel data models, and Granger causality tests to elucidate the intricate interactions between electricity consumption and economic activity.

The enduring interest in the relationship between electricity consumption and economic growth underscores its importance for energy policy, economic development strategies, and sustainability efforts globally. The evolving literature continues to refine our understanding of these dynamics, offering valuable insights for policymakers, researchers, and stakeholders seeking to navigate the complexities of energy use and economic progress. The aim of this study is to investigate the causal relationship between electricity consumption and economic growth in Turkey, utilizing the ARDL bounds testing approach of cointegration and VECM Granger causality analysis for the period from the early 1970s to the early 2020s. Since the late 1970s, researchers have extensively explored the relationship between electricity consumption and economic growth. Various literature surveys have delved into this topic in detail, revealing that the direction of causality remains a subject of debate. The empirical findings generally support four main hypotheses. The Growth Hypothesis suggests that causality runs from electricity consumption to economic growth. According to this view, increased electricity consumption drives economic growth. This implies that policies aimed at enhancing electricity supply can effectively stimulate economic development. The Feedback Hypothesis indicates a bidirectional causality between electricity consumption and economic growth. In this scenario, increased electricity consumption promotes economic growth, and in turn, economic growth leads to higher electricity consumption. This reciprocal relationship implies that policies promoting both energy exploration and economic growth are essential for sustainable development. The Conservation Hypothesis posits a unidirectional causality running from economic growth to electricity consumption. Under this hypothesis, economic growth drives electricity consumption. Consequently, energy conservation policies can be implemented without adversely affecting economic growth, as the demand for electricity is primarily a consequence of economic expansion. The Neutrality Hypothesis suggests the absence of a causal relationship between electricity consumption and economic growth. This hypothesis indicates that changes in electricity consumption do not significantly impact economic growth and vice versa. As a result, energy conservation policies can be pursued without fear of hindering economic progress. Understanding the causal relationship and direction of causality between electricity consumption and economic growth is crucial for policy formulation. The direction of causality influences the design and implementation of energy policies. For instance, if the growth hypothesis holds, expanding electricity infrastructure and supply would be a priority to foster economic growth. If the conservation hypothesis is supported, then energy efficiency and conservation measures can be prioritized without compromising economic development. This knowledge helps policymakers craft strategies that effectively balance energy use and economic objectives, ensuring sustainable growth and energy security for Turkey.

Theoretical and empirical research in recent years suggests that financial development plays a significant role in economic development. Stiglitz (2000) emphasizes the critical function of financial markets, describing them as the "brain" of the entire economic system, central to decision-making and resource allocation. According to Stiglitz, if financial markets fail, it can lead to reduced sectoral profits and impaired performance of the entire economic system. Despite the recognized importance of financial development, research on this topic within the context of Turkey remains relatively limited.

The pivotal role of financial markets in resource allocation and economic decision-making highlights their importance in fostering economic growth. Financial development facilitates efficient capital distribution, supports entrepreneurial activities, and enables technological advancements. These processes collectively drive economic expansion and development. However, the specific dynamics and impacts of financial development in Turkey have not been extensively explored, leaving a gap in the literature that needs to be addressed. Understanding the relationship between financial development and economic growth in Turkey is essential for formulating effective economic policies. It is crucial to investigate how financial markets in Turkey contribute to resource allocation, investment decisions, and overall economic performance. Addressing this gap can provide valuable insights for policymakers to enhance the financial sector's role in supporting sustainable economic growth and development in Turkey.

For example, Afşar (2008) examined the relationship between economic growth and financial development in Turkey from 1990 to 2006. The empirical evidence from this study revealed a bidirectional causality between financial development and economic growth, indicating that improvements in financial markets can stimulate economic growth and vice versa. Similarly, Ardor et al. (2007) explored this relationship by applying multivariate cointegration and VEM models. Their results confirmed both the cointegration and feedback effect between financial development and economic growth, reinforcing the notion that these two variables are closely interconnected and mutually reinforcing.

These studies highlight the importance of financial development in Turkey's economic growth. They suggest that policies aimed at strengthening financial markets can have a positive impact on the economy, and that economic growth can further enhance financial development. This bidirectional relationship underscores the need for a balanced approach in policy formulation, where both financial market improvements and economic growth initiatives are given equal emphasis to achieve sustainable development.

Halicioglu (2007) tested the supply-side and demand-side hypotheses by applying the VECM Granger causality approach. The results confirmed the presence of cointegration using the bounds testing approach. The causality results supported the supply-side hypothesis in Turkey, indicating that financial development drives economic growth. On the contrary, Ardic and Damar (2007) found that financial development impedes economic growth. They argued that domestic credit in Turkey is often used to finance government expenditures, which can crowd out private investment and hinder economic growth. These contrasting findings highlight the complexity of the relationship between financial development and economic growth in Turkey. While Halicioglu's study suggests that a well-functioning financial sector can stimulate economic activity, Ardic and Damar's research indicates that the allocation of financial resources is crucial. If financial development primarily serves government spending rather than productive investment, it can have a detrimental effect on economic growth. This underscores the importance of effective financial regulation and prudent fiscal policies to ensure that financial development contributes positively to the economy.

Ozturk (2008) applied the VAR model to examine the causal relationship between economic growth and financial development in Turkey and found no significant relationship between the two variables. Soytaş and Küçükkaya (2011) also investigated this relationship, creating a financial development index, but similarly found no long-run relationship between economic growth and financial development. In contrast, Karahan and Yılgör (2011) utilized VAR and Granger causality tests, reporting a feedback effect between financial development and economic growth, suggesting that the two variables influence each other. Zortuk and Çelik (2012), however, noted unidirectional causality running from economic growth to bank credit, indicating that economic growth drives financial development rather than the other way around. Mercan and Peker (2013) found that financial development contributes positively to economic growth, aligning with the view that a developed financial sector can support economic expansion. On the other hand, Ayadi et al. (2013) reported a negative relationship between financial development and economic growth, suggesting that financial development may hinder economic growth under certain conditions. Given the critical role of financial development in economic growth, it is plausible to consider its significant impact on energy demand.

Numerous studies have empirically explored the potential linkages between financial development and energy consumption. For instance, Love and Zicchino (2006) noted that financial development affects real variables, such as real interest rates, which can drive investment. This, in turn, positively influences economic growth, generates employment opportunities, and raises income levels. Increased income leads to higher consumer spending, particularly on durable goods such as automobiles, air-conditioners, homes, and refrigerators, which in turn boosts energy consumption (Mankiw & Scarth, 2008; Sadorsky, 2010). This sequence of financial development leading to higher energy consumption underscores the necessity of expanding the analytical framework from a simple bivariate to a multivariate approach. Karanfil (2009) advocated for incorporating additional parameters such as liquid liabilities, stock market capitalization, and domestic credit to the private sector as a percentage of GDP to better understand this dynamic. By considering these variables, the interplay between financial development and energy consumption can be comprehensively analyzed, providing deeper insights into how financial growth translates into increased energy demands. This multivariate framework can reveal the complex interdependencies and feedback mechanisms between financial markets, economic growth, and energy usage. It highlights the need for policies that address not only the financial and economic aspects but also the energy implications of financial development. This holistic approach can help in designing more sustainable and balanced growth strategies that take into account the critical linkages between financial development and energy consumption.

Dan and Lijun (2009) explored the relationship between financial development and primary energy consumption in China, discovering unidirectional Granger causality from energy consumption to financial development. This implies that changes in energy consumption directly influence financial development in the country. Sadorsky (2010), in his study of 22 emerging economies over the period 1990–2006, identified a positive but modest link between energy consumption and economic growth. He examined various indicators of financial development, such as bank deposits as a share of GDP, foreign direct investment (FDI), stock market capitalization as a share of GDP, total stock market value traded over GDP, and the stock market turnover ratio. These indicators provided a comprehensive view of how financial development interacts with energy consumption in these emerging economies. Further, Sadorsky (2011) extended his analysis to nine Central and Eastern European economies, examining the relationship between financial development and energy consumption. He found that financial development indeed stimulates energy demand. For this analysis, he utilized measures such as liquid liabilities to GDP, stock market capitalization, deposit money bank assets to GDP, and financial system deposits to GDP. This study highlighted that as financial systems develop, there is a corresponding increase in energy consumption, underscoring the interconnectedness of financial markets and energy usage in these economies.

In Tunisia, Shahbaz and Lean (2012) explored the dynamics of energy demand, revealing that financial development leads to higher energy consumption. This is attributed to increased economic activities that accompany financial development, thereby boosting overall energy usage. In Malaysia, Tang and Tan (2012) examined the relationship between financial development and energy consumption, incorporating foreign direct investment (FDI) and relative energy prices into their analysis. Their research indicated that there is a bidirectional causality between financial development and energy consumption, both in the short and long term. This means that not only does financial development drive energy demand, but energy consumption also stimulates financial development. Islam et al. (2013) expanded this analysis in the Malaysian context, suggesting that economic growth, financial development, and population growth all contribute to increased energy demand. They found a feedback effect between energy consumption and financial development in the long run, reinforcing the idea that these two factors are interdependent. This interdependence highlights the complex relationship between financial development and energy consumption, where improvements in financial markets lead to greater energy use, which in turn supports further financial development.

Recent studies have continued to explore the complex relationship between financial development and energy consumption. Çoban and Topcu (2013), using a system GMM model, examined this relationship across the EU 27 countries from 1990 to 2011. Their findings indicate a strong influence of financial development on energy consumption in the older EU member states, regardless of whether this development arises from the banking sector or the stock market. However, for the newer EU members, the impact of financial development on energy consumption varies depending on the measurement method. When using the bank index, the relationship is inverted U-shaped, while the stock index shows an insignificant relationship. In China, Shahbaz et al. (2013) explored the causal direction between financial development and energy consumption within a production function framework. They found evidence of cointegration between the two variables, indicating a long-term equilibrium relationship. Moreover, their results show that energy consumption Granger causes financial development, suggesting that increased energy use can drive financial market development in China. Similarly, Shahbaz et al. (2013) also studied Indonesia and found that financial development Granger causes energy consumption. This suggests that in Indonesia, as financial markets develop, there is a corresponding increase in energy consumption, likely due to enhanced economic activities and investments spurred by financial development.

3. THE MODEL

We use Cobb-Douglas production function by assuming marginal contribution of energy, capital and labor in production, production function in period *t* is given below:

$$Y(t) = A(t)K(t)^{\beta} L(t)^{1-\beta} \qquad 0 < \beta < 1 \qquad (1)$$

Where Y is domestic output, A is technological progress, K is capital and labor is L in time period t.

We extend the Cobb-Douglas production function by assuming that technology can be determined by level of financial development. Financial development contributes to economic growth by enhancing capitalization in an economy. This shows that financial development transfers the incentives of producers towards goods with increasing returns to scale. The intersectoral specialization and therefore the structure of trade flows are determined by the relative level of financial intermediation (Goldsmith, 1969; King & Levine, 1993; Rajan & Zingales, 1998; Rajan & Zingales, 2003; Wurgler, 2000).

$$\ln Y_t = \varphi_1 + \varphi_2 \ln E_t + \varphi_3 \ln F_t + \varphi_4 \ln K_t + \varphi_5 \ln L_t + \mu_t \qquad (2)$$

Where, $\varphi_1 = \log \phi$ is constant term, $\ln Y_t$ is log of real GDP per capita, $\ln E_t$ is log of electricity consumption per capita, $\ln F_t$ is real domestic credit to private sector per capita, $\ln K_t$ is real capital stock per capita, $\ln L_t$ is labor force participation per capita and u_i is error term assumed to be constant.

A higher value of financial development indicators signifies a robust banking sector capable of providing funds for investment (Minier, 2009; Shahbaz, Shamim, & Aamir, 2010). There are two main theoretical arguments supporting the idea that increased financial market activities stimulate investment and economic growth.

First, the level effect highlights the positive impact of financial markets on both the quantity and quality of investments. Financial development necessitates advanced accounting and reporting standards, which in turn improve investor confidence (Shahbaz, 2009) and attract foreign investment, often characterized by its risk-averse nature.

Second, the efficiency effect suggests that financial development enhances liquidity and enables better asset allocation to suitable ventures. This improvement in financial market efficiency boosts investment behavior, sustains strong economic growth, and consequently increases energy consumption. The expected relationship between financial development and energy consumption is therefore positive.

4. RESULTS AND DISCUSSIONS

Table 1 presents the ARDL cointegration test results across various estimated models, each characterized by different lag lengths and corresponding F-statistics. The first model with lag lengths of 2, 2, 1, 2, and 2 shows an F-statistic of 13.220, which is significant at the 1 percent level. The second model, with lag lengths of 2, 2, 2, 2, and 2, has an F-statistic of 7.495, also significant at the 1 percent level. The third model, characterized by lag lengths of 3, 2, 2, 2, and 1, presents an F-statistic of 4.925, which is significant at the 10 percent level. Another model with lag lengths of 2, 2, 2, 2, and 2 shows an F-statistic of 6.598, significant at the 5 percent level. Lastly, the model with lag lengths of 3, 2, 2, 1, and 1 reports an F-statistic of 15.404, which is significant at the 1 percent level. The critical values for the bounds test, given T=40, are as follows: at the 1 percent significance level, the lower bound I(0) is 6.053 and the upper bound I(1) is 7.458; at the 5 percent significance level, the lower bound I(0) is 4.450 and the upper bound I(1) is 5.560; and at the 10 percent significance level, the lower bound I(0) is 3.740 and the upper bound I(1) is 4.780. These values are used to determine the presence of cointegration by comparing the F-statistics of the models to these critical bounds. If the F-statistic exceeds the upper bound, it indicates cointegration at the corresponding significance level.

Table 1: ARDL cointegration test

Estimated Models	Lag length	F-statistics
$F_Y(Y/E,F,K,L)$	2, 2, 1, 2, 2	13.220*
$F_E(E/Y,F,K,L)$	2, 2, 2, 2, 2	7.495*
$F_F(F/Y,E,K,L)$	3, 2, 2, 2, 1	4.925***
$F_K(K/Y,E,F,L)$	2, 2, 2, 2, 2	6.598**
$F_L(L/Y,E,F,K)$	3, 2, 2, 1, 1	15.404*
Significant level	Critical values (T= 40)	
	Lower bounds *I*(0)	Upper bounds *I*(1)
1 per cent level	6.053	7.458
5 per cent level	4.450	5.560
10 per cent level	3.740	4.780

Table 2: Johansen cointegration test

Hypothesis	Trace Statistic	Maximum Eigen Value
$R = 0$	111.4499*	53.2014*
$R \leq 1$	58.2484*	38.2158*
$R \leq 2$	20.0325	12.1168
$R \leq 3$	7.9156	7.26725
$R \leq 4$	0.6484	0.6484

Note: * indicates significance at 1% level.

Table 2 presents the results of the Johansen cointegration test, which includes both the Trace Statistic and the Maximum Eigen Value for different hypotheses regarding the number of cointegrating relationships (denoted as RRR). For the hypothesis R=0R = 0R=0, the Trace Statistic is 111.4499 and the Maximum Eigen Value is 53.2014, both significant at the 1% level, indicating the presence of at least one cointegrating relationship. For the hypothesis R≤1R \leq 1R≤1, the Trace Statistic is 58.2484 and the Maximum Eigen Value is 38.2158, also significant at the 1% level, suggesting at least two cointegrating relationships. For R≤2R \leq 2R≤2, the Trace Statistic is 20.0325 and the Maximum Eigen Value is 12.1168, which are not significant at the 1% level, indicating no additional cointegrating relationships beyond the first two. For R≤3R \leq 3R≤3, the Trace Statistic is 7.9156 and the Maximum Eigen Value is 7.26725, while for R≤4R \leq 4R≤4, both the Trace Statistic and Maximum Eigen Value are 0.6484. These values are also not significant at the 1% level, further confirming that there are no additional cointegrating relationships beyond the first two identified. The note clarifies that the asterisk (*) indicates significance at the 1% level.

Table 3 provides the results of the long-run and short-run analysis with the dependent variable represented by the variable. In the long-run results, the coefficient for the constant is -0.4288 with a T-Statistic of -0.4773, which is not significant. The coefficient for the variable is 0.1184 with a T-Statistic of 3.2845, significant at the 1% level (indicated by *). The coefficient for the next variable is 0.1633 with a T-Statistic of 9.0790, also significant at the 1% level. The coefficient for another variable is 0.0611 with a T-Statistic of 2.7099, significant at the 5% level (indicated by **). Lastly, the coefficient for the final variable in the long-run is 0.1274 with a T-Statistic of 4.6745, again significant at the 1% level. In the short-run results, the coefficient for the constant is -0.0010 with a T-Statistic of -0.1039, which is not significant. The coefficient for the first variable is 0.1881 with a T-Statistic of 1.8672, significant at the 10% level (indicated by ***). The coefficient for the second variable is 0.1071 with a T-Statistic of 5.0872, significant at the 1% level. The coefficient for the third variable is 0.1349 with a T-Statistic of 5.0243, also significant at the 1% level. The coefficient for the fourth variable is 0.0592 with a T-Statistic of 0.5189, which is not significant. The coefficient for the final variable in the short-run is -0.3417 with a T-Statistic of -2.5857, significant at the 5% level.

Table 3: Long-run and short-run analysis

Dependent Variable = $\ln Y_t$		
	Long-Run Results	
Variable	Coefficient	T-Statistic
Constant	-0.4288	-0.4773
$\ln E_t$	0.1184	3.2845*
$\ln F_t$	0.1633	9.0790*
$\ln K_t$	0.0611	2.7099**
$\ln L_t$	0.1274	4.6745*
	Short-Run Results	
Variable	Coefficient	T-Statistic
Constant	-0.0010	-0.1039
$\Delta \ln E_t$	0.1881	1.8672***
$\Delta \ln F_t$	0.1071	5.0872*
$\Delta \ln K_t$	0.1349	5.0243*
$\Delta \ln L_t$	0.0592	0.5189
ECM_{t-1}	-0.3417	-2.5857**

5. CONCLUSIONS

This paper investigates the causal relationship between electricity consumption and economic growth in Turkey, utilizing the ARDL bounds testing approach to cointegration and vector error-correction models (VECM). The period under study spans from 1971 to 2019, offering a comprehensive analysis over several decades. Understanding the dynamics between electricity consumption and economic growth is vital for policymakers, as it influences decisions on energy policy, infrastructure investment, and sustainable development strategies. The ARDL bounds testing approach is particularly suitable for this analysis due to its flexibility in handling variables that are integrated of different orders, i.e., I(0) or I(1), making it robust for empirical analysis in the context of time series data. The VECM Granger causality framework provides insights into both the short-run and long-run relationships between the variables. In the short run, fluctuations in electricity consumption can impact economic activity, and vice versa, providing crucial information for short-term policy adjustments.

In the long run, the cointegration relationship indicates whether electricity consumption and economic growth move together over time, reflecting their interdependence and the stability of their relationship. The empirical findings from this study are expected to contribute significantly to the literature on energy economics and development studies. By identifying the direction of causality, whether unidirectional or bidirectional, the study will shed light on whether Turkey's economic growth drives electricity consumption or if increasing electricity consumption stimulates economic growth. This has profound implications for energy conservation policies, investment in energy infrastructure, and strategies to ensure sustainable economic growth. Moreover, the study's results can inform the development of energy policies aimed at improving energy efficiency and reducing dependency on non-renewable energy sources. By understanding the relationship between electricity consumption and economic growth, Turkey can better plan for future energy needs, balance economic development with environmental sustainability, and enhance its energy security. The study reconsiders the relationship between electricity consumption and economic growth by incorporating financial development, capital, and labor force as important factors of production. This approach provides a more comprehensive analysis by acknowledging the multifaceted nature of economic growth and the various elements that contribute to it. The results reveal a long-run relationship among electricity consumption, economic growth, financial development, capital, and labor force, indicating that these variables move together over time and are interdependent.

This long-run equilibrium suggests that changes in one variable are associated with changes in the others, reflecting their interconnectedness in Turkey's economy. Furthermore, the findings indicate that electricity consumption, financial development, capital, and labor force positively affect economic growth. This implies that increasing electricity consumption can stimulate economic activity, while advancements in financial development enhance the economy's ability to allocate resources efficiently, supporting investment and growth. Similarly, the accumulation of capital and an expanding labor force contribute positively to economic productivity and output. The inclusion of financial development as a factor highlights its critical role in facilitating economic growth by improving access to financial services, fostering investment, and encouraging innovation.

Capital accumulation, represented by investments in physical infrastructure and technology, boosts production capacity and efficiency. The labor force, as a fundamental component of production, drives economic activity through its contributions to labor productivity and overall economic output. In conclusion, this study underscores the importance of considering a broader set of variables when analyzing the relationship between electricity consumption and economic growth. By integrating financial development, capital, and labor force into the analysis, the study provides a more nuanced understanding of the factors driving economic growth in Turkey. The positive effects of these variables on economic growth highlight the need for policies that promote energy consumption, financial sector development, capital investment, and labor market expansion to sustain and enhance economic growth. The main finding from this study is that there is evidence of bidirectional causality, indicating mutual interdependence between energy consumption and economic growth in Turkey. Several factors contribute to this result. First, changes in lifestyles and improved living standards in Turkey have increased the demand for energy. As people enjoy better living conditions, their consumption of energy-intensive appliances and services rises. Second, economic growth drives expansion in the commercial and industrial sectors, where electricity is a fundamental input. As these sectors grow, their energy requirements increase, leading to higher overall electricity consumption. Third, Turkey has experienced rapid electrification in both the household/commercial sector and the industrial sector. The widespread adoption of electrical appliances, such as televisions, refrigerators, washing machines, and air conditioners, has significantly boosted electricity usage. The results from this study support the view that energy is a limiting factor to economic growth. Consequently, policies aimed at increasing investment in the energy sector, particularly in electricity supply, are likely to stimulate economic growth in Turkey. By ensuring a stable and sufficient energy supply, these policies can support the expanding needs of various sectors and contribute to sustained economic development. In conclusion, the bidirectional causality between energy consumption and economic growth underscores the importance of energy as a driver of economic activity. Policies focused on enhancing energy infrastructure and supply can create a positive feedback loop, where increased energy availability fuels economic growth, which in turn boosts energy demand, leading to further economic expansion. This interdependence highlights the need for a balanced and forward-looking energy policy to support Turkey's long-term economic objectives.

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