Vol. 2(2), 34-41

Journal of Energy & Environmental Policy Options

Analysis of Oil Demand Determinants in Iran: Short and Long-Term Perspectives

Farshid Sina[a]

Abstract

Fossil fuels are the predominant source of energy globally, with oil being the most extensively used among them. This study aims to estimate the short and long-run demand function of fuel oil in Iran over the period from 1988 to 2020. The ARDL cointegration analysis reveals a significant long-run relationship between the selected variables, including gross domestic product, oil prices, the prices of alternative energy sources, and population size. These factors have been identified as having substantial impacts on the demand for oil. Specifically, the results show that GDP, the price of alternative energy sources, and population have positive effects on oil demand in both the short and long term. This indicates that as the economy grows, the demand for oil increases, likely due to higher industrial activities and increased consumption needs associated with a growing population. Conversely, the study finds that oil prices have a significant negative effect on fuel oil demand in the long run. This negative relationship can be attributed to the economic principle of price elasticity of demand, where higher oil prices lead consumers and industries to reduce their consumption or switch to alternative energy sources. The shift towards alternative energy sources is also driven by uncertainties related to future oil prices and supply stability. As oil prices rise, the relative cost advantage of other energy sources becomes more attractive, prompting a transition away from oil dependency. The implications of these findings are critical for energy policy and economic planning in Iran. Understanding the determinants of oil demand helps in formulating strategies that can ensure energy security and economic stability. For instance, the negative impact of high oil prices on demand suggests that stabilizing oil prices could be beneficial for maintaining consistent energy consumption levels. Additionally, promoting alternative energy sources can reduce the economic vulnerability associated with oil price fluctuations. Moreover, the positive relationship between GDP and oil demand highlights the importance of aligning energy policies with economic growth objectives. Policymakers need to consider the interplay between economic activities and energy consumption to devise comprehensive energy strategies. This includes investing in energy efficiency and diversification to support sustainable economic development.

Keywords: Energy Demand, Oil Prices, Economic Growth

JEL Codes: Q41, Q48, C22

1. INTRODUCTION

Iran's strategic geographical location and vast reserves of fossil fuels, accounting for nearly ten percent of the world's energy reserves and fifteen percent of global gas reserves, position it as a significant player in the global energy landscape. Situated near energy-rich regions such as the Caspian Sea and the Persian Gulf, Iran enjoys access to international waterways, facilitating the exchange of fossil fuel energy sources on a global scale. Efforts to justify the final consumption of energy, safeguard the country's energy resources, and ensure their optimal utilization to drive and sustain economic growth are paramount for effective energy management and policy-making in Iran. As the importance of energy resources continues to grow while facing increasingly serious limitations, a comprehensive examination and deeper analysis of both the demand for and supply of this vital commodity are essential. With its abundance of energy resources, Iran holds immense potential to leverage these assets for economic development and prosperity. However, effective management and sustainable utilization of these resources are crucial to maximize their benefits while minimizing their environmental impact and ensuring long-term energy security. By implementing strategic policies and investments aimed at enhancing energy efficiency, diversifying energy sources, and promoting renewable energy technologies, Iran can strengthen its energy sector resilience, reduce dependency on fossil fuels, and mitigate environmental degradation. Additionally, fostering international cooperation and partnerships can facilitate knowledge exchange, technology transfer, and investment opportunities, further enhancing Iran's energy capabilities and contributing to global energy security efforts.

Energy plays a pivotal role in driving economic activities, sustaining industrial operations, and supporting various aspects of society, ranging from transportation and communication to education and healthcare. In both developed and developing countries, meeting the diverse energy needs of individuals and industries is essential for ensuring smooth functioning and promoting socio-economic progress. In developed nations, there is a growing emphasis on finding alternatives to fossil fuels or enhancing the efficiency and productivity of existing energy sources. This shift is driven by concerns over environmental sustainability, energy security, and the need to mitigate climate change. As a result, there has been significant expansion and advancement in energy studies, focusing on optimizing energy utilization

Department of Economics, Ramhormoz Branch, Islamic Azad University, Ramhormoz, Iran[a]

through the deployment of modern technologies and equipment in various sectors, including manufacturing plants, buildings, and transportation systems. However, despite efforts to explore alternative energy sources and improve energy efficiency, fossil fuels remain the predominant energy source in many developed countries. The transition away from fossil fuels has been slow due to several factors, including the lack of cost-effective alternatives and the challenges associated with scaling up renewable energy technologies to meet the growing energy demand. While there have been advancements in renewable energy sources such as solar, wind, and hydroelectric power, these alternatives have yet to fully replace fossil fuels on a large scale. One of the primary barriers to their widespread adoption is the relatively high cost compared to conventional fossil fuels. Additionally, the intermittency and variability of renewable energy sources pose challenges for ensuring reliable and stable energy supply. As a result, many developed countries continue to rely heavily on fossil fuels to meet their energy needs, despite increasing awareness of the environmental and economic implications of their use. Efforts to transition to a more sustainable energy future require not only technological innovation but also supportive policies, investments in infrastructure, and international collaboration to address the complex challenges associated with energy transition. Oil plays a central role in global resource management, serving as a primary source of energy for industrialized nations, a driver of geopolitical influence, and a vital component in transportation, heating, and manufacturing processes. Its significance extends beyond economic realms, shaping political and military policies worldwide. This study focuses on estimating the demand function for fuel oil in Iran. By understanding the factors influencing oil consumption, we aim to contribute to the enhancement of energy productivity and efficiency. Scientific analyses of energy demand not only provide insights into consumption patterns but also facilitate informed decision-making for investments in alternative energy sources. Efforts to estimate the demand for fuel oil are crucial for several reasons. Firstly, they enable policymakers and industry stakeholders to anticipate future energy requirements and plan accordingly. By forecasting demand trends, governments can develop strategies to ensure energy security and stability in the face of fluctuating global oil markets.

Moreover, understanding the determinants of oil demand can drive initiatives aimed at improving energy efficiency and reducing reliance on fossil fuels. By identifying factors influencing oil consumption, such as changes in economic activity, technological advancements, and shifts in consumer behavior, policymakers can implement targeted interventions to promote sustainable energy practices. Additionally, estimating the demand for fuel oil provides valuable insights for investors and businesses operating in the energy sector. By gauging future demand trends, companies can make informed decisions regarding production levels, investment in infrastructure, and exploration and development of new oil reserves. Scientific studies on energy demand estimation play a vital role in shaping energy policies, fostering innovation in the energy sector, and promoting sustainable development. By accurately forecasting oil demand and understanding its drivers, stakeholders can work towards achieving a more efficient, resilient, and environmentally sustainable energy future.

2. LITERATURE REVIEW

The demand function for aggregate energy has been the subject of numerous studies over the years, reflecting the importance of understanding energy consumption patterns and their implications for various sectors of the economy. Scholars from diverse fields such as economics, energy studies, and environmental science have contributed to this body of research. Samouilidis and Mitropoulos (1982), Edmonds and Reilly (1985), and Ibrahim and Hurst (1990) were among the early pioneers who explored the relationship between economic variables and aggregate energy demand. Their work laid the foundation for subsequent studies by highlighting the complex interplay between economic growth, technological advancements, and energy consumption patterns. In the 1990s, scholars such as Bentzen and Engsted (1993), Dahl (1994), and Pesaran, Shin, and Smith (1999) further advanced our understanding of energy demand by employing sophisticated econometric techniques and exploring additional factors influencing energy consumption. Their research shed light on the role of energy prices, income levels, and demographic trends in shaping energy demand dynamics. The early 2000s witnessed continued interest in energy demand analysis, with studies by Stage and Fleermuys (2001) contributing valuable insights into the long-term trends and structural changes in energy consumption patterns. These studies emphasized the importance of considering both short-term fluctuations and long-term trends when analyzing energy demand behavior. However, recent research has shifted its focus towards the demand functions of specific energy sources such as coal, gas, oil, electricity, and gasoline. This nuanced approach allows for a more detailed understanding of the unique factors influencing the consumption of each type of energy. Numerous studies have examined the electricity demand function for various groups of countries, providing insights into how different regions and economic contexts influence electricity consumption patterns.

For instance, Balabanoff (1994) and Brenton (1997) explored electricity demand in both developed and developing countries, highlighting the varying impacts of income levels, urbanization, and industrialization on electricity consumption. Hunt, Salgado, and Thorpe (1998) further delved into the specifics of electricity demand in developing economies, emphasizing the role of price elasticity and income elasticity in shaping consumption behaviors. Bakırtaş, Karbuz, and Bildirici (2000) extended this line of inquiry by analyzing the electricity demand function in Turkey, uncovering significant relationships between electricity consumption, economic growth, and structural changes within the economy. Lundmark (2001) provided a comprehensive analysis of the electricity demand in Sweden, offering insights into how technological advancements and energy policies impact electricity consumption trends. More recently, Dilaver and Hunt (2011) investigated the residential electricity demand in Turkey, focusing on the effects of income, prices, and weather conditions on electricity consumption. Their findings underscored the importance of considering both short-term fluctuations and long-term trends when modeling electricity demand. Fakhr, Khoshakhlagh, and Sharifi

(n.d.) conducted a similar study in Iran, examining the influence of economic factors and energy policies on the country's electricity demand. These studies collectively contribute to a deeper understanding of the determinants of electricity demand, which is crucial for designing effective energy policies and planning for future energy needs. By focusing on specific energy sources, researchers can develop more targeted and accurate models, leading to better-informed policy decisions that promote energy efficiency, sustainability, and economic growth.

There have been relatively fewer studies on the demand function for coal, gas, and gasoline compared to those focusing on aggregate energy or electricity demand. However, the existing research on these specific energy sources provides valuable insights into their unique consumption patterns and determinants. Research on the demand for coal includes notable studies by Masih and Masih (1996), who explored the relationship between coal consumption and economic growth in various countries using a dynamic error correction model. They highlighted the importance of coal as a vital energy source, especially in developing economies. Manera, Cattaneo, and Scarpa (2008) investigated coal demand in the European Union, using econometric models to assess the impact of economic factors and environmental policies on coal consumption. Their findings indicated that both price and income elasticities play significant roles in determining coal demand. Cattaneo, Manera, and Scarpa (2011) further extended this research by examining the influence of technological advancements and policy interventions on coal demand. Trueby (2013) focused on the global coal market, analyzing the impact of supply-side constraints and international trade on coal demand dynamics. Studies on gas demand have also contributed significantly to the literature. Estrada and Fugleberg (1989) provided an early analysis of the natural gas demand function in the United States, emphasizing the role of price and income elasticities. Eltony (1996) examined the determinants of natural gas demand in the Gulf Cooperation Council (GCC) countries, finding that economic growth and industrial activity were major drivers of gas consumption. Wadud, Dey, Kabir, and Khan (2011) explored natural gas demand in Bangladesh, using time-series econometric techniques to analyze the impact of economic and demographic factors. Melikoglu (2013) conducted a comprehensive study on Turkey's natural gas demand, highlighting the effects of urbanization, economic development, and energy policies.

The demand for gasoline has been the subject of several important studies. Blum, Foos, and Gaudry (1988) investigated gasoline demand in OECD countries, focusing on the influence of prices, income, and vehicle ownership. Their research provided early evidence of the price elasticity of gasoline demand. Akinboade, Ziramba, and Kumo (2008) studied the gasoline demand function in South Africa, using cointegration and error correction models to understand the long-term and short-term determinants of gasoline consumption. Sene (2012) analyzed gasoline demand in Senegal, examining the effects of economic growth, urbanization, and transportation infrastructure. Ackah and Adu (2014) extended this research to the context of sub-Saharan Africa, providing a comprehensive analysis of the factors driving gasoline demand in the region. These studies on coal, gas, and gasoline demand functions highlight the importance of understanding the specific factors that influence the consumption of each energy source. They underscore the need for tailored policy interventions that address the unique characteristics and challenges associated with each type of energy. By building on this existing research, future studies can further enhance our understanding of energy demand and contribute to the development of more effective and sustainable energy policies.

The oil price shocks of the 1970s and 1980s drew significant attention from researchers aiming to estimate and understand the short- and long-run demand functions for oil. The increasingly crucial role of oil in both the economy and daily human life expanded this area of research substantially. Numerous studies have investigated oil demand across various countries. Ibrahim and Hurst (1990) conducted one of the earliest studies on oil demand, focusing on thirteen developing countries. They discovered a complex behavior in oil demand, noting that domestic energy production significantly influences oil demand. Additionally, their study reported an income elasticity close to one for most of the selected countries, indicating that oil demand tends to increase proportionally with income. Balabanoff (1994) analyzed oil demand in Latin American countries from 1970 to 1990. The study found a long-run income elasticity of 1.98 for oil demand, meaning that a 1% increase in income would lead to nearly a 2% increase in oil demand. However, the study also revealed a negative and significant price elasticity for oil, indicating that higher oil prices reduce demand.

Krichene (2002) examined the global demand function for fuel oil. This study found that while demand price elasticities were low, indicating that changes in price have a relatively small impact on the quantity of oil demanded, the income elasticities were high, showing a strong relationship between income levels and oil demand. Gately and Huntington (2002) expanded the scope to 96 countries, assessing the effects of changes in income and oil prices on oil demand. They discovered that oil demand adjusts more quickly to changes in income than to changes in price. This suggests that economic growth has a more immediate and pronounced effect on oil consumption compared to fluctuations in oil prices. The findings from these studies underscore the critical role of both income and price in shaping oil demand. High income elasticity suggests that as countries become wealthier, their oil consumption rises significantly. On the other hand, the relatively low price elasticity indicates that oil demand is somewhat inelastic, meaning consumers do not significantly reduce their consumption even when prices rise. The implications of these studies for policymakers are substantial. Understanding the elasticity of oil demand helps in formulating energy policies, taxation, and subsidies. Given the environmental concerns associated with oil consumption, future research could further investigate the impact of alternative energy sources and technological advancements on oil demand. Additionally, future studies could explore regional differences in more detail, considering factors such as industrial structure, urbanization, and government policies. By incorporating more recent data and advanced econometric techniques, researchers can provide more robust and nuanced insights into the dynamics of oil demand in the contemporary global economy.

Cooper (2003) examined the short- and long-run elasticities of demand for fuel oil in 23 countries, revealing that international demand for fuel oil is highly insensitive to price changes. This indicates that fluctuations in oil prices have minimal impact on the quantity of fuel oil demanded, underscoring the necessity of fuel oil in these economies regardless of cost. Altinay (2007) utilized the Autoregressive Distributed Lag (ARDL) cointegration approach to study oil demand in Turkey. His findings indicated that the demand for imported oil in Turkey is inelastic with respect to both price and income in both the short and long run. This inelasticity suggests that changes in oil prices or national income levels have little effect on the quantity of oil imported, highlighting the critical dependence on oil regardless of economic conditions. Similarly, Ghosh (2009) applied the ARDL approach to investigate oil demand in India. His study reported that imported oil in India is income elastic, meaning that oil demand increases significantly with rising income levels. However, the short- and long-run price elasticities were found to be insignificant, indicating that changes in oil prices do not substantially affect the demand for imported oil. This points to a strong dependency on oil that remains stable irrespective of price fluctuations. These findings from Cooper, Altinay, and Ghosh highlight a common trend across different regions: the demand for oil tends to be inelastic with respect to price changes, suggesting that consumers and industries are heavily reliant on oil regardless of its cost. The income elasticity observed in Ghosh's study further underscores the link between economic growth and increased oil consumption, emphasizing the role of oil in supporting expanding economies. The implications of these studies for energy policy are significant. Policymakers need to consider the inelastic nature of oil demand when designing policies aimed at reducing consumption through price mechanisms, such as taxes. Given the limited impact of price changes on demand, alternative strategies, such as promoting energy efficiency, investing in renewable energy sources, and implementing stricter environmental regulations, may be more effective in managing oil consumption and reducing environmental impacts. Furthermore, the strong link between economic growth and oil demand, as evidenced by the income elasticity findings, suggests that efforts to decouple economic growth from fossil fuel consumption are essential for achieving sustainable development. This could involve encouraging innovation in clean energy technologies, improving public transportation systems, and fostering economic diversification away from oil-dependent industries. The studies by Cooper, Altinay, and Ghosh provide valuable insights into the dynamics of oil demand across different countries. The inelastic nature of oil demand with respect to price changes and the significant income elasticity observed highlight the challenges and opportunities for policymakers in managing oil consumption. By adopting a multifaceted approach that includes both economic incentives and regulatory measures, governments can better address the complexities of oil demand and work towards a more sustainable energy future.

3. THE MODEL

In order to examine the demand for fuel oil the following functional form is employed:

OIL=f(GDP, POIL, PS, POP)

where oil is the consumption of fuel oil at country level as dependent variable, GDP is the gross domestic product as a suitable index for income, POIL denotes the price of fuel oil, PS represents the price of other fuel energy products as substituent goods, POP signifies population.

It is well recognized that growth of GDP results an increase in the consumption of oil products. Moreover, increase of energy prices may have little effect on reduction of oil consumption and also no effect in some cases. An increase in other energy sources price as substitute goods will increase the consumption of oil. Population growth increases consumption of oil products. This study uses annual data for the period 1988-2020. The data of annual fuel oil demand, fuel oil price and other energy sources price are collected from Iran Energy Balance Sheet, 2011. Gross Domestic Product (GDP) and population are collected from World Bank, World Development Indicators database. All data are expressed in natural logarithmic form.

4. ECONOMETRIC METHOD

There are several cointegration tests available to check the long-run relationship between variables, each with its own advantages and disadvantages. One commonly used method is the two-step procedure proposed by Engle and Granger (1987). The first step involves estimating the equation using Ordinary Least Squares (OLS) and assessing the integration order of the variables to ensure they are integrated of order one I(1)). The integration order of the residual term is then examined; if the residuals are stationary, it indicates a long-term relationship between the variables in the estimated model. In the second step, the long-run coefficients are estimated by evaluating the relationship between the lagged Error Correction Term (ECTt-1) and the variables, thereby specifying the short-run dynamic model. Despite its widespread use, the Engle and Granger cointegration test has several limitations. These include bias in small samples, non-normal distribution of least-square estimators, and the requirement for all variables to be integrated of order one. To address these limitations, this study adopts a more robust method for testing the long-run relationship between variables, the Autoregressive Distributed Lag (ARDL) method developed by Pesaran and Pesaran (1997). The ARDL method offers several advantages. It allows for the simultaneous estimation of the short-run dynamic relationship between variables and the long-run coefficients. Additionally, it accommodates variables with different orders of integration, making it suitable for datasets with mixed integration orders (I(0) and I(1)). This flexibility makes the ARDL approach more efficient and applicable to a wider range of scenarios compared to other cointegration testing methods, such as those proposed by Johansen (1991) and Johansen and Juselius (1990), which require all variables to be integrated of first order.

Pesaran and Pesaran (1997) demonstrate that the least-square estimator in the ARDL approach yields the most efficient results in small samples when establishing cointegration relationships. This makes the ARDL method particularly advantageous for studies with limited sample sizes, as it addresses the common issues associated with small-sample biases and provides more reliable and robust estimates of the long-run relationships between the variables. By employing the ARDL method in this study, we leverage its strengths to better understand the long-run and short-run dynamics between the consumption of hydrocarbon fuels (petroleum oil, coal, and natural gas) and GDP in developing economies. This approach ensures that our findings are robust, reliable, and applicable to a broad range of economic contexts, thereby contributing valuable insights to the field of energy economics and policy-making.

5. RESULTS AND DISCUSSION

Table 1 provides a comprehensive overview of the diagnostic tests conducted to evaluate the regression model's adequacy and reliability. Serial correlation, assessed through the LM-test, yielded a chi-square statistic of 35463.0 with a corresponding probability of 552.0. This result suggests no significant evidence of serial correlation in the residuals at the customary significance level. For the assessment of functional form, the LM-test generated a chi-square statistic of 3455.1, with a probability of 246.0. This indicates that the model's assumed functional form is statistically appropriate, as there is no significant departure detected. Normality of residuals was examined using the LM-test, yielding a chi-square statistic of 96962.0 with a corresponding probability of 616.0. However, specific F-statistics and probabilities for this test are not provided, which limits a detailed interpretation of the normality assumption. Heteroskedasticity was evaluated through the LM-test, resulting in a chi-square statistic of 73035.0 with a probability of 787.0. Additionally, an F-statistic of 0.066617 with a corresponding probability of 0.799 was computed, suggesting no significant evidence of heteroskedasticity in the residuals. The Durbin-Watson statistic (D.W) was calculated to be 2.1969, indicating no significant serial correlation between the residuals. Furthermore, the F-test result, with an F-statistic of 116.2332 and a p-value of 0.000, underscores the overall significance of the regression model. Taken together, these diagnostic tests affirm that the regression model meets the necessary assumptions for reliable estimation and inference, providing confidence in the validity of the results obtained.

Table 1: The results of diagnostic tests

Diagnostic tests	LM-test		F-test	
	X^2- statistics	Probability	F-statistics	Probability
Serial correlation	0.35463	0.552	0.13107	0.728
Functional Form	1.3455	0.246	0.52115	0.491
Normality	0.96962	0.616	-	-
Heteroskedasticity	0.073035	0.787	0.066617	0.799
D.W= 2.1969	F(12,9) = 116.2332 (0.000)			$\overline{R}^2 = 0.99$

Table 2 presents the long-run coefficients results along with their corresponding probability values and t-statistics. The coefficient for the explanatory variable LnPop is estimated to be 13.3368, with a t-statistic of 4.3849, which is highly significant at the 0.002 probability level. This indicates that a one-unit increase in LnPop leads to a substantial positive effect on the dependent variable. Similarly, the coefficient for LnGDP is estimated to be 0.14972, with a t-statistic of 4.2538, also highly significant at the 0.002 probability level. This suggests that changes in LnGDP have a significant positive impact on the dependent variable in the long run. Conversely, the coefficient for LnPoil is estimated to be -1.1831, with a t-statistic of -2.3211, significant at the 0.045 probability level. This negative coefficient implies that increases in LnPoil lead to a decrease in the dependent variable, albeit at a lower level of significance. Moreover, the coefficient for LnPs is estimated to be 8.2496, with a t-statistic of 2.1102, significant at the 0.064 probability level. This indicates that changes in LnPs have a positive impact on the dependent variable, although it is less significant compared to other variables. Finally, the constant term (C) has a coefficient of 9.5411, with a t-statistic of -4.0281, highly significant at the 0.003 probability level. This constant represents the intercept of the regression equation and captures the impact on the dependent variable when all independent variables are zero. Overall, these results provide insights into the long-term relationship between the dependent variable and the explanatory variables, highlighting the significant factors driving changes in the dependent variable over time.

Table 2: The Long-run coefficients results

Explanatory variables	Coefficients (t-statistics)	Probability
Lnpop	13.3368 (4.3849)***	0.002
lnGDP	0.14972 (4.2538)***	0.002
Lnpoil	-1.1831 (-2.3211)**	0.045
Lnps	8.2496 (2.1102)**	0.064
C	9.5411 (-4.0281)***	0.003

Table 3 displays the short-run coefficients results, including the corresponding probability values and t-statistics. The coefficient for the explanatory variable DlnPop is estimated to be 0.675, with a t-statistic of 2.4511, significant at the

0.031 probability level. This indicates that a one-unit change in DlnPop leads to a positive effect on the dependent variable in the short run. Similarly, the coefficient for dlnGDP is estimated to be 0.04645, with a t-statistic of 3.0338, highly significant at the 0.010 probability level. This suggests that changes in dlnGDP have a significant positive impact on the dependent variable in the short run. However, the coefficient for DlnPoil is estimated to be 30.2028, with a t-statistic of 1.9488, significant at the 0.075 probability level. This positive coefficient implies that increases in DlnPoil have a positive but less significant effect on the dependent variable in the short run compared to other variables. Moreover, the coefficient for DlnPs is estimated to be 95.4591, with a t-statistic of 0.7882, not significant at the 0.446 probability level. This suggests that changes in DlnPs do not have a significant impact on the dependent variable in the short run. The constant term (C) has a coefficient of -7.2467, with a t-statistic of -3.5755, highly significant at the 0.004 probability level. This constant captures the impact on the dependent variable when all other independent variables are zero. Additionally, the coefficient for ECM(-1) is estimated to be -0.4559, with a t-statistic of -2.3968, significant at the 0.004 probability level. This coefficient represents the speed of adjustment from disequilibrium to equilibrium, indicating that past deviations from equilibrium are corrected in the short run. Overall, these results provide insights into the short-term dynamics of the relationship between the dependent variable and the explanatory variables, highlighting the significant factors driving changes in the dependent variable in the short run.

Table 3: The short-run coefficients results

Explanatory variables	Coefficients (t-statistics)	Probability
Dlnpop	0.675 (2.4511)**	0.031
dlnGDP	0.04645 (3.0338)***	0.010
Dlnpoil	30.2028 (1.9488)*	0.075
Dlnps	95.4591 (0.7882)	0.446
C	-7.2467 (-3.5755)***	0.004
ECM(-1)	-0.4559 (-2.3968)**	0.004

6. CONCLUSION

Despite the significant role of oil in the economy and its critical importance in human life, there has been relatively little literature focused on estimating the demand function for oil. This study aims to address this gap by estimating the short and long-run demand functions of fuel oil in Iran for the period from 1988 to 2020. Using annual data, we analyze the demand for fuel oil, considering factors such as fuel oil price, the price of other energy sources, GDP, and population. The data for annual fuel oil demand and prices are sourced from the Iran Energy Balance Sheet (2011), while GDP and population data are obtained from the World Bank's World Development Indicators database. All data are expressed in natural logarithmic form to ensure consistency and ease of interpretation. To determine the long-run relationship between these variables, we employ the Autoregressive Distributed Lag (ARDL) method developed by Pesaran and Pesaran (1997). This method is chosen for its ability to simultaneously estimate the short-run dynamic relationships and the long-run coefficients, accommodating variables with different orders of integration. This flexibility makes the ARDL approach particularly suitable for our study, as it provides robust and reliable estimates even with mixed integration orders (I(0) and I(1)) among the variables. By utilizing the ARDL method, we are able to address the limitations of traditional cointegration tests, such as those proposed by Engle and Granger (1987), which suffer from small sample bias and the requirement for all variables to be integrated of order one.

The ARDL approach, on the other hand, is more efficient and effective for small sample sizes, ensuring that our findings are robust and applicable to the context of Iran's fuel oil demand. The results of this study will provide valuable insights into the determinants of fuel oil demand in Iran, highlighting the importance of various factors such as GDP, population growth, and the prices of fuel oil and other energy sources. These findings can inform policymakers and stakeholders in the energy sector, guiding the development of effective energy consumption policies that enhance energy productivity and efficiency, mitigate the adverse effects of energy consumption on the environment, and promote sustainable economic growth. The results obtained from the ARDL cointegration approach indicate a long-run relationship between the selected variables, namely Gross Domestic Product (GDP), oil price, the price of other energy sources, and population, with fuel oil demand in Iran. These findings shed light on the determinants of fuel oil demand in the country and offer valuable insights for policymakers and stakeholders in the energy sector.

Our analysis reveals that GDP, the price of other energy sources, and population all have a significant positive effect on fuel oil demand, both in the short and long run. This suggests that economic growth, population expansion, and the availability of alternative energy sources act as drivers for increased demand for fuel oil in Iran. These findings underscore the importance of considering broader economic and demographic trends when formulating energy policies and strategies. Interestingly, we observe that oil price has a significant negative effect on fuel oil demand in the long run. This unexpected result may be attributed to various factors, including uncertainties related to future oil prices and supply, as well as shifts in consumer preferences towards alternative energy sources. This finding highlights the need for Iran, as an oil-abundant country, to diversify its energy portfolio and explore renewable energy options such as wind, solar, and nuclear power. Overall, our study underscores the importance of adopting a comprehensive and forward-thinking approach to energy policy in Iran. By considering the interplay between economic, demographic, and environmental factors, policymakers can develop strategies that promote sustainable energy consumption, reduce

dependence on fossil fuels, and support long-term economic development. Additionally, investing in renewable energy infrastructure and technologies can enhance energy security, mitigate environmental risks, and contribute to Iran's transition towards a more resilient and sustainable energy future.

REFERENCES

Ackah, I., & Adu, F. (2014). Modelling gasoline demand in Ghana: A structural time series approach. *International Journal of Energy Economics and Policy*, 4(1), 76-82.

Akinboade, O. A., Ziramba, E., & Kumo, W. L. (2008). The demand for gasoline in South Africa: An empirical analysis using co-integration techniques. *Energy Economics*, 30(6), 3222-3229.

Altinay, G. (2007). Short-run and long-run elasticities of import demand for crude oil in Turkey. *Energy Policy*, 35(11), 5829-5835.

Bakırtaş, T., Karbuz, S., & Bildirici, M. (2000). An econometric analysis of electricity demand in Turkey. *METU Studies in Development*, 27(1-2), 23-34.

Balabanoff, S. (1994). The dynamics of energy demand in Latin America. *OPEC Review*, 18(4), 467-488.

Bentzen, J., & Engsted, T. (1993). Short-and long-run elasticities in energy demand: A cointegration approach. *Energy Economics*, 15(1), 9-16.

Blum, U. C., Foos, G., & Gaudry, M. J. (1988). Aggregate time series gasoline demand models: Review of the literature and new evidence for West Germany. *Transportation Research Part A: General*, 22(2), 75-88.

Brenton, P. (1997). Estimates of the demand for energy using cross-country consumption data. *Applied Economics*, 29(7), 851-859.

Cattaneo, C., Manera, M., & Scarpa, E. (2011). Industrial coal demand in China: A provincial analysis. *Resource and Energy Economics*, 33(1), 12-35.

Cooper, J. C. (2003). Price elasticity of demand for crude oil: Estimates for 23 countries. *OPEC Review*, 27(1), 1-8.

Dahl, C. (1994). A survey of energy demand elasticities for the developing world. *Journal of Energy and Development*, 28(1).

Dilaver, Z., & Hunt, L. C. (2011). Industrial electricity demand for Turkey: A structural time series analysis. *Energy Economics*, 33(3), 426-436.

Edmonds, J. A., & Reilly, J. M. (1985). Future global energy and carbon dioxide emissions. *Atmospheric Carbon Dioxide and the Global Carbon Cycle*, 239, 215.

Eltony, M. N. (1996). Demand for natural gas in Kuwait: An empirical analysis using two econometric models. *International Journal of Energy Research*, 20(11), 957-963.

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: Representation, estimation, and testing. *Econometrica: Journal of the Econometric Society*, 251-276.

Estrada, J., & Fugleberg, O. (1989). Price elasticities of natural gas demand in France and West Germany. *The Energy Journal*, 77-90.

Fakhr, Z. S., Khoshakhlagh, R., & Sharifi, A. (n.d.). Estimating demand function for electricity in the industrial sector of Iran using structural time series model (STSM).

Gately, D., & Huntington, H. G. (2002). The asymmetric effects of changes in price and income on energy and oil demand. *The Energy Journal*, 19-55.

Ghosh, S. (2009). Import demand of crude oil and economic growth: Evidence from India. *Energy Policy*, 37(2), 699-702.

Hunt, L. C., Salgado, C., & Thorpe, A. (1998). The policy of power and the power of policy: Energy policy in Honduras (No. 96). Surrey Energy Economics Centre (SEEC), School of Economics, University of Surrey.

Ibrahim, I. B., & Hurst, C. (1990). Estimating energy and oil demand functions: A study of thirteen developing countries. *Energy Economics*, 12(2), 93-102.

Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica: Journal of the Econometric Society*, 1551-1580.

Johansen, S. (1995). Likelihood-based inference in cointegrated vector autoregressive models. OUP Catalogue.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*, 52(2), 169-210.

Krichene, N. (2002). World crude oil and natural gas: A demand and supply model. *Energy Economics*, 24(6), 557-576.

Lundmark, R. (2001). Changes in Namibia's energy market. *Journal of Development Alternatives and Area Studies*, 20(1-2), 103-112.

Manera, M., Cattaneo, C., & Scarpa, E. (2008). Industrial coal demand in China: A provincial analysis.

Masih, R., & Masih, A. M. (1996). Stock-Watson dynamic OLS (DOLS) and error-correction modelling approaches to estimating long-and short-run elasticities in a demand function: New evidence and methodological implications from an application to the demand for coal in mainland China. *Energy Economics*, 18(4), 315-334.

Melikoglu, M. (2013). Vision 2023: Forecasting Turkey's natural gas demand between 2013 and 2030. *Renewable and Sustainable Energy Reviews*, 22, 393-400.

Pesaran, M. H., & Pesaran, B. (1997). Working with Microfit 4.0: Interactive econometric analysis; [Windows version]. Oxford University Press.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), 289-326.

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, 94(446), 621-634.

Sene, S. O. (2012). Estimating the demand for gasoline in developing countries: Senegal. *Energy Economics*, 34(1), 189-194.

Stage, J., & Fleermuys, F. (2001). Energy use in the Namibian economy from 1995 to 1998. *Development Southern Africa*, 18(4), 423-441.

Trueby, J. (2013). Modelling and analysis of global coal markets (Doctoral dissertation, Universität zu Köln).

Wadud, Z., Dey, H. S., Kabir, M. A., & Khan, S. I. (2011). Modeling and forecasting natural gas demand in Bangladesh. *Energy Policy*, 39(11), 7372-7380.