# THE EFFECTS OF NATURAL RESOURCE CONSUMPTION ON GREEN FINANCE AND TRADE OPENNESS IN TÜRKİYE

## *TÜRKİYE'DE YEŞİL FİNANS VE TİCARİ AÇIKLIĞINDA DOĞAL KAYNAK KULLANIMININ ETKİLERİ*

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*Abstract*

The aim of this study is to examine the effects of natural resource consumption in Turkiye on green finance and trade openness using data from Türkiye, from 2003 to 2022. Regression and ARIMA analyses show that oil consumption has a positive effect on green finance, while natural gas consumption has a negative and significant effect. While oil plays a key role in financing processes, natural gas conflicts with green finance policies. Furthermore, while oil has no effect on the trade openness, natural gas reduces the deficit by lowering costs, counteracting its usual negative impacts. The findings emphasize the importance of domestic resource use and diversity in energy imports.

**Keywords:** Green Finance, Trade Openness, Natural Resources

*Özet*

Bu çalışmanın amacı, Türkiye'nin 2003-2022 yıllarına ilişkin verileri ile doğal kaynak kullanımının, yeşil finans ve ticaret açıklığı üzerindeki etkilerini incelemektir. Regresyon ve ARIMA analizleri, petrol tüketiminin yeşil finansı pozitif, doğal gaz tüketiminin ise negatif ve anlamlı etkilediğini göstermektedir. Petrol finansman süreçlerinde anahtar rol oynarken, doğal gaz yeşil finans politikalarıyla çelişmektedir. Ayrıca, petrolün ticaret açıklığına etkisi bulunmazken, doğal gazın negatif etkisi maliyetleri düşürerek açığı azaltmaktadır. Bulgular, yerli kaynak kullanımı ve enerji ithalatında çeşitliliğin önemini vurgulamaktadır.

**Anahtar Kelimeler:** Yeşil Finans, Ticaret Açıklığı, Doğal Kaynaklar

**ARAŞTIRMA MAKALESİ**

## 1. Introduction

Today, sustainability and environmental responsibility are becoming increasingly critical for the business world and financial systems. The effects of global warming pose serious risks to economic and social systems. According to the World Economic Forum (2024) report, climate change is one of the most significant global risks for the next decade. In this context, green finance is emerging as an important tool for reducing dependence on fossil fuels and promoting low-carbon investments (Bergman, 2018; Chuahan & Chavda, 2024).

Green finance encompasses financial mechanisms that support projects enhancing environmental sustainability and focus on areas such as renewable energy, energy efficiency, and environmental audits. It thus enables the reconciliation of economic growth with environmental concerns (Al-Mulali et al., 2015; Koczar et al., 2020). Trade openness shapes the flow of natural resources between countries, determining both economic growth and environmental impact. Appropriate trade openness policies and the integration of green finance practices are important for increasing energy efficiency in natural resource use and reducing the ecological footprint (He et al., 2019; Wu, 2022).

In Türkiye, the increase in renewable energy investments and changes in foreign trade volume directly impact natural gas and oil usage, supporting a sustainable energy transition. Investments encouraged by green finance accelerate the shift from fossil fuels to renewable energy sources in the energy sector, while addressing trade openness offers additional potential to optimize natural resource consumption (Ali et al., 2020; Aydin & Turan, 2020).

In this context, examining the effects of natural resource consumption, particularly oil and natural gas consumption, on green finance and trade openness in Turkiye is of significant importance. The main objective of this study is to analyze the impact of natural resource consumption (oil and natural gas consumption) on green finance and trade openness. In the literature, studies have generally associated green finance with environmental performance indicators (such as $CO_2$ emissions) (Wang et al., 2022; Zhang & Li, 2021). However, this study evaluates the relationship between trade openness and green finance from an energy-based perspective by incorporating energy consumption indicators (oil and natural gas) into the model. Using data for Türkiye for the period 2003–2023, the study aims to identify gaps in the existing literature and provide findings that can guide policymakers. Considering Türkiye's dependency on energy imports and its high level of foreign trade volume, examining the effects of energy

consumption on green finance and trade openness offers a unique perspective to the research. Accordingly, reliable data sources covering the relevant period were utilized. First, the theoretical foundations of green finance are discussed, followed by an examination of the relationships between trade openness and natural resource consumption. The subsequent sections present the methodology, empirical findings, conclusions, and policy recommendations.

## 2. Conceptual Framework and Literature Review

### 2.1. The Concept of Green Finance and Related Literature

Green finance is an important part of the global financial system (Koczar et al., 2020). The primary objective of this system is to channel global savings into areas where they can be utilized with the highest efficiency (Sachs et al., 2019). The emergence of green finance is a modern trend in ensuring state security within the context of globalization, a modern trend that aims to reduce poverty, control the use of natural resources, and increase the number of jobs (Cheberyako et al., 2021). Green finance supports the control of environmental pollution and the efficient use of resources by offering customer-focused financing opportunities to all businesses and sectors that embrace sustainable development (Gray, 2002). Green finance is a broad concept encompassing areas such as sustainable finance, environmental finance, carbon finance, and climate finance (Barua, 2020). Therefore, green finance acts as a bridge that enables businesses to access green financing.

At this point, there is still no single, universal definition of green finance. Industry players and international organizations have proposed definitions for certain green financial instruments and products, as well as various elements of sustainable finance (Berrou et al., 2019). Höhne et al. (2012) define green finance as broad-based financial investments directed toward sustainable development projects, environmentally friendly products, and policies that support a more sustainable economy. When considering usage and application areas, some sources view green finance as synonymous with sustainable finance (green bonds or green investments), while others argue that these concepts are distinctly different (Migliorelli & Dessertine, 2019; Wang & Zhi, 2016) Wang and Zhi (2016) describe green finance as an innovative financial mechanism focused on environmental protection and sustainable use of resources, while the World Bank Group defines green finance as an investment tool aimed at protecting natural resources and ensuring environmental security.

Green finance contributes to economic growth by supporting the financing of environmentally friendly industries and technologies, the development of new products, risk management practices, and the effectiveness of emissions trading. In this process, both environmental improvement and sustainable development are targeted through the promotion of green technologies and the development of efficient trading mechanisms (Soundarrajan & Vivek, 2016). Green financial instruments aim to support environmentally conscious projects and activities based on the principle of external resource utilization (Koval et al., 2022).

Studies in the literature related to the present study that address green finance and the findings are reviewed below.

Two studies stand out in examining the evolution of green finance research over time through bibliometric analysis. Miyan et al. (2024) analyzed the green finance literature for the period 1991–2023 and found that early research focused on concepts such as climate finance, ethical investment, and sustainability; however, the emphasis has increasingly shifted toward the concept of "green finance" itself. Similarly, Tao et al. (2022) showed that the environmental finance literature, which initially centered on corporate social responsibility and climate negotiations, has in recent years shifted toward themes such as climate finance, sustainable finance, climate risk, and green bonds. Both studies converge on the conclusion that the conceptual focus of the literature has progressively moved toward green finance instruments and market-based applications.

Studies evaluating the practical implementation of environmental finance policies investigate the interaction between policy design and financial market mechanisms. Li and Hu (2014) showed that since the 1980s, environmental finance policies in China have introduced new financial instruments such as green credit, green securities, and green insurance; however, weak implementation performance by financial institutions has limited the effectiveness of these policies. Approaching the issue from a macro-financial modeling perspective, Raberto et al. (2019) demonstrated that regulatory models that redirect banks' credit allocation toward green investments increase energy efficiency in the short run but reduce credit supply in the long run, thereby negatively affecting economic growth. Thus, both studies indicate that the effectiveness of green finance policies depends on institutional implementation capacity and macroeconomic balance.

Studies examining the role of financial development in economic growth and the environment yield results consistent with the Environmental Kuznets Curve hypothesis. Li et al. (2015) used data from 102 countries for the period 1980–2010 and found that financial development supports economic growth up to a certain threshold, but that growth initially leads to environmental degradation; however, environmental improvement becomes possible at higher development levels. These findings emphasize that the environmental impact of growth varies by time and development stage.

Addressing the capital market dimension of green finance, Cheng et al. (2024) showed that green bond issuance in 12 Asian economies during 2015–2022 significantly increased resource efficiency both in the short and long term. However, the finding that GDP growth negatively affects resource efficiency through increased resource consumption suggests that the impact of green finance instruments must be evaluated in conjunction with the structure of the broader economy.

Research examining the relationship between renewable energy consumption and economic growth indicates that results vary depending on the country and type of energy source. For the United States, Yildirim et al. (2012) found that only biomass and waste-based energy have a positive and unidirectional causal effect on GDP. For Italy, Magazzino (2012) identified a long-term bidirectional causality between energy

consumption and economic growth. In OECD countries, Ohler and Fetters (2014) found a bidirectional relationship between electricity generated from renewable sources and economic growth. Önder and Polat (2018) showed that renewable energy positively affects economic growth, while non-renewable energy has a negative impact in 35 OECD countries. In the case of Greece, Karasimou et al. (2021) found that investments in renewable energy both enhance growth and support net-zero 2050 targets. For China, Hassan et al. (2023) found that renewable energy, technological development, and economic growth jointly support sustainable development goals. The green finance literature generally demonstrates that environmentally friendly investments play a significant role in enhancing energy efficiency, reducing carbon emissions, and supporting sustainable economic growth (Höhne et al., 2012; Soundarrajan & Vivek, 2016; Cheng et al., 2024). Studies conducted in various countries reveal that investments in renewable energy generally have positive effects on economic growth; however, the magnitude of this impact may vary depending on national policies, the depth of the financial system, and the structure of the energy sector (Ohler & Fetters, 2014; Önder & Polat, 2018; Karasimou et al., 2021). Furthermore, it is argued that the development of green finance is closely related not only to environmental indicators but also to financial

regulations and the level of trade openness (Li et al., 2015; Raberto et al., 2019). In this context, the effects of green finance are addressed in both environmental and economic dimensions, indicating that energy and trade policies are evaluated within a holistic sustainability framework.

## *2.2. The Concept of Trade Openness and Related Literature*

The fundamental differences in the resources and technological capabilities possessed by different countries lead to increased trade and significant trade openness between countries (Arawomo & Apanisile, 2018). This situation is also consistent with the standard approach of the Heckscher-Ohlin theory, which explains the basic ideas of international trade. According to this theory, a country exports products that it produces by intensively using the factors of production it has in abundance, while importing products that are scarce and therefore more costly to produce (Aydin & Turan, 2020).

The trade openness ratio, defined as the ratio of foreign trade to GDP, is a variable frequently used in international macroeconomic studies. This ratio is widely preferred as a practical indicator for measuring an economy's openness to the outside world, both in growth analyses and in research related to other macroeconomic issues (Fujii, 2019). In the literature, the focus on how open trade policies affect economic growth forms the basis for the uncertainty regarding the definition and measurement of trade openness (Frankel & Rose, 2002; Squalli & Wilson, 2011).

When examining the relationship between trade openness in the literature, Krueger (1978), associates an open economy with export-oriented policies, while, Pritchett (1996), Edwards (1998) and Harrison (1996), emphasize the neutrality between import and export incentives. Some researchers, such as Anderson and Neary (1992), have defined trade openness by measuring the extent to which tariffs and non-tariff barriers restrict trade, and have developed indices to measure this situation. This stems from the fact that concepts related to trade openness are addressed through both political processes and economic outcomes. At the same time, the literature examines trade openness in relation to a wide range of macroeconomic and political variables, including government size (Rodrik, 1998), government spending (Wagner & Weber, 1977), public expenditure dynamics (Peacock & Wiseman, 1967), sovereign debt defaults (Serfaty, 2024), economic growth (Levine & Renelt, 1992), real exchange rate dynamics (Garcia, 1999; Hau, 2002), and production volatility (Giovanni & Levchenko, 2009; Hau, 2002).

The literature examining the effects of trade openness on economic growth and public policy indicates that the degree of openness influences economic vulnerability, growth

dynamics, and sectoral structure. Rodrik (1998) argues that greater openness increases countries' exposure to global shocks, leading governments to expand public spending as a form of insurance mechanism against external risks. Studies focusing on the growth effects of openness emphasize that the relationship varies across time periods, sectors, and export composition. Dowrick & Golley (2004) find that trade openness contributed to economic convergence among less developed countries during the 1960s and 1970s, whereas after the 1980s the benefits of trade were largely concentrated among advanced economies. Likewise, Giovanni and Levchenko (2009) show that trade-induced specialization increases production volatility, and therefore, trade openness is positively associated with overall economic fluctuations. Examining the case of China, Hye et al. (2016) demonstrate that trade openness is positively related to economic growth in the long run, although the strength and direction of this effect vary across different time periods. Focusing on the qualitative dimensions of trade, Huchet-Bourdon et al. (2018) emphasize that export quality and product diversification play a decisive role in growth; countries specialized in lower-quality exports may experience negative growth effects from trade openness, whereas countries achieving higher export variety tend to grow faster.

Studies analyzing the environmental and structural implications of trade openness highlight that its effects differ according to country group and economic structure. Aydın and Turan (2020) find that the impacts of financial and trade openness on ecological footprints in BRICS countries are heterogeneous: while trade openness reduces environmental degradation in India and China, it increases pollution in South Africa, and energy intensity raises environmental pressure in most of these countries. Fatima et al. (2020) show that trade openness influences economic growth through human capital accumulation, and that low human capital levels may weaken or even reverse the positive growth effects of trade. In Pakistan, Khan et al. (2025) find that while exports and imports contribute positively to GDP growth, trade openness itself may exert a negative effect. Addressing the structural dimension, Taufik and Widiana (2025) show that trade openness positively affects the manufacturing sector's share in the economy in selected emerging countries, whereas GDP growth and exchange rate fluctuations tend to reduce this share.

The literature on trade openness reveals that the concept encompasses not only the volume of foreign trade but also its multidimensional effects on economic growth, public expenditure, production volatility, and environmental sustainability (Rodrik, 1998; Giovanni & Levchenko, 2009; Aydin & Turan, 2020). In general, studies indicate that

trade openness acts as a factor promoting economic growth; however, the magnitude and direction of this effect may vary depending on factors such as a country's export structure, production diversification, and energy dependency (Dowrick & Golley, 2004; Huchet-Bourdon et al., 2018; Fatima et al., 2020). In this context, trade openness is regarded as a key macroeconomic variable that shapes national economic performance, determines the level of external dependency, and may generate indirect impacts on energy consumption and environmental indicators.

## 2.3. Natural Resources and Related Literature

Despite the environmental damage caused by fossil fuels, their continued dominance in global energy systems, along with population growth and technological advances, has brought global environmental issues to a critical point. Despite efforts to transition to renewable energy, the entrenched structure of the current energy system and the slow pace of the transition process are causing a drift away from sustainable development goals and keeping renewable energy as a backup source for now (Önal, 2020). This situation indicates that energy supply and fossil fuel consumption play a significant role in economic, financial, and trade dynamics.

Fossil fuels still account for a significant share of global energy consumption today. Economic growth and population increase have become key factors determining the use of these resources by increasing the demand for energy. In this context, coal is the second largest energy source, accounting for approximately 30% of the world's primary energy consumption (Zhou et al., 2022). Oil is not only a non-renewable primary energy source, but also plays a critical role in the global economy as a raw material, intermediate product, and source of power. Indicators of natural resource utilization, such as oil consumption and imports, can exert strong effects on a country's foreign trade balance and financial stability. Although alternative energy sources have partially replaced oil in heating, electricity, and power generation, oil's strategic importance continues (Bayraç, 2005). According to a report by the Republic of Türkiye Energy Market Regulatory Authority (2023), Türkiye imports crude oil and oil products, but exports refined oil derivatives (diesel, aviation fuels, gasoline, etc.) to various countries (the United States, the Netherlands, Romania, Italy, Spain, Lebanon, Germany, the United Kingdom, the Russian Federation, Ukraine, Slovenia, Malta, Singapore, Greece, Turkish Republic of Northern Cyprus (TRNC), and South Africa). This situation shows that part of the trade openness caused by oil imports is offset by oil product exports. However, the significant depreciation of the Turkish lira against the US dollar International Energy Agency (IEA) (2021) since 2015 will be a step towards increasing domestic production.

Although it is argued that renewable energy should replace fossil fuels, it is predicted that this dependence will continue in the coming years. This is due to the vital importance of fossil fuels for society, despite climate change, price increases, and security concerns (Brown et al., 2011). In contrast, renewable energy sources such as solar, wind, hydroelectric, geothermal, and biomass provide sustainability thanks to their renewable nature (Şahin & Şahin, 2024). Compared to traditional sources, renewable energy offers significant advantages in combating climate change by reducing greenhouse gas emissions (Ukoba et al., 2024).

Looking at Türkiye's energy consumption trends, it can be observed that oil and coal were prominent before 1980. Consumption increased rapidly with the introduction of natural gas in 1987. Natural gas has been used intensively in electricity production, especially since the 2000s. According to the IEA (2021: 137) report, given Türkiye's high dependence on natural gas imports and the resulting vulnerabilities in the balance of payments and energy security, its most important priority is to reduce the share of imported gas, particularly in electricity production, and increase the share of domestically produced energy sources. Although Türkiye is almost entirely dependent on external sources in this area, the discovery of 405 billion cubic meters of natural gas reserves in the Black Sea on August 21, 2020, has been a significant turning point. Furthermore, the activities carried out by the drilling ships Oruç Reis, Fatih, Yavuz, and Kanuni demonstrate that the country is mobilizing all its resources to ensure energy supply security (Dinçer & Ezan, 2021). In this context, Presidency of Strategy and Budget of the Republic of Türkiye (2019), in line with the Eleventh Development Plan (2019-2023), is pursuing a strategy of increasing the use of domestic resources, namely coal and renewable energy, by reducing the share of imported natural gas, especially in electricity production. Furthermore, efforts are being made to enhance natural gas supply security by expanding infrastructure through both pipelines and liquefied natural gas, and diversifying import sources.

The literature addressing the relationship between natural resources, energy use, trade, and sustainability emphasizes that resource dependence and energy composition play a critical role in shaping both economic and environmental outcomes. Önal (2020) highlights that although Türkiye has increased renewable energy investments, fossil fuels still dominate the energy mix, indicating that the country has yet to fully utilize its renewable potential to achieve sustainable development and reduce external energy dependence. Similarly, Wu (2022) shows that trade openness and green finance levels are strongly linked to natural resource use; coal consumption hinders green finance,

while gas and oil consumption shape trade openness, suggesting that a shift toward natural gas may support more sustainable trade patterns.

Studies examining the broader economic effects of resource dependence reveal differing outcomes. Gylfason (2006) argues that excessive reliance on natural resources can suppress savings, investment, and institutional quality, ultimately hindering economic growth. Das et al. (2013) find that economic growth increases natural gas consumption in Bangladesh, although the reverse effect does not hold. Topcu et al. (2020) show that the growth impact of natural resources and energy consumption varies by income group: natural resources are growth-enhancing in low- and middle-income countries but insignificant in high-income economies.

Other studies focus on the environmental consequences of energy and resource use. Khan and Kong (2020) find that energy consumption drives economic growth in major $CO_2$-emitting countries, but also significantly increases carbon emissions. Ulucak and Özcan (2020) demonstrate that non-renewable energy worsens environmental quality in OECD countries, while renewable energy reduces environmental degradation. Likewise, Wang et al. (2023) conclude that natural resources, clean energy, and human capital improve environmental quality in G-7 economies, while urbanization and imports intensify consumption-based carbon emissions. Finally, Magazzino (2024) finds that in China, electricity consumption and GDP increase ecological pressure, whereas trade and urbanization contribute to environmental improvement. The literature on natural resources and energy consumption highlights the decisive role of fossil fuels in economic growth and the trade balance. However, existing studies also suggest that excessive dependence on these resources may negatively affect environmental sustainability and long-term development (Gylfason, 2006; R. Khan & Kong, 2020; Ulucak & Ozcan, 2020). In the case of Türkiye, energy supply security and import dependency shape economic and environmental policy priorities, while investments in renewable energy emerge as a critical tool for reducing this dependency and supporting sustainable development (Önal, 2020; Dinçer & Ezan, 2021). In this context, examining the relationships between natural resource consumption, green finance, and trade openness reveals the determining role of energy consumption on economic and financial indicators.

## 3. Methodology

### 3.1. Research Model

The purpose of this study is to examine the effects of natural resource use, particularly natural gas and oil on trade openness and green finance. Due to insufficient data, coal

155

could not be included in the analysis. The study aims to reveal the gaps in the existing literature regarding the effects of natural resources on trade openness and green finance in the context of Türkiye and to guide future research. As shown in Figure 1, the research model represents the hypothetical causal relationships between variables with arrows.

**Figure 1:** Research Model
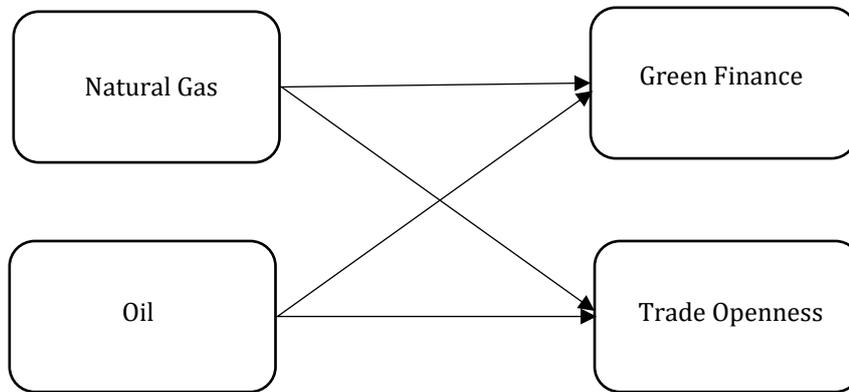
### 3.2. Variables

The independent variables of the study are natural resources, represented by the ratios of natural gas consumption to GDP and oil consumption to GDP. The dependent variables are defined as green finance (the ratio of investments in renewable energy sources to total energy investments) and trade openness (the ratio of trade volume to GDP). Through this framework, the study aims to analyze the potential effects of natural resource consumption on changes in green finance and trade openness.

### 3.3. Data Set and Method

The study uses data from the period 2003-2022. Initially, coal from natural resources was also planned to be included in the analysis; however, since the coal dataset is only available from 2020 onwards, it was excluded from the scope. The data used in the research were compiled from the Turkish Statistical Institute, the Ministry of Energy and Natural Resources, the International Energy Agency (IEA), and the World Bank Integrated Trade Solution (WITS) databases. Data for oil consumption (thousand tons) and natural gas consumption (converted from $sm^3$ to thousand tons) were obtained from the International Energy Agency (IEA). The green finance variable (the ratio of renewable energy investments to total energy investments) was compiled from the International Energy Agency (IEA), the World Bank, and the Ministry of Energy and Natural Resources (ETKB), and calculated as percentage (%) values. The trade openness variable was calculated using data from the Turkish Statistical Institute (TÜİK) and the World Bank's World Integrated Trade Solution (WITS) database, based on the formula

(Exports+Imports)/GDP. Considering Türkiye's high dependency on energy imports, fossil fuel-based energy structure, and trade-driven economic model, these indicators demonstrate that natural gas, oil, green finance, and trade openness are highly representative and meaningful variables within the national context. The data obtained were analyzed using multiple regression and the ARIMA (Autoregressive Integrated Moving Average) (0,0,0) models with SPSS (Statistical Package for the Social Sciences).

### 3.4. Hypotheses

The following hypotheses have been developed to determine the effect of the use of natural resources, such as natural gas and oil, on trade openness and green finance. Accordingly, the validity of these assumptions will be empirically tested in the context of the Turkish economy through the analyses conducted in this study.

H1$_a$: Natural gas consumption has an impact on green finance. (This hypothesis reflects the possible relationship indicating that natural resource consumption may increase or decrease the demand for natural gas through the use of green finance instruments, such as investments in renewable energy.)

H1$_b$: Oil consumption has an impact on green finance. (This hypothesis is based on the assumption that natural resource consumption may reduce dependence on oil through green finance practices or influence it through different dynamics.)

H2$_a$: Natural gas consumption has an effect on trade openness. (This hypothesis suggests that natural gas consumption may have an influence on a country's trade openness.)

H2$_b$: Oil consumption has an effect on trade openness. (This hypothesis reflects the idea that oil consumption, through increases or decreases in international trade activities, may alter the level of trade openness.)

### 4. Findings

In the regression analysis performed, the Enter method was used to include the independent variables (natural gas and oil) in the model. This method demonstrates that all variables are included in the models simultaneously in order to directly test the hypotheses. Within the scope of the study, two separate models were established to determine the effects of green finance and trade openness on natural gas and oil consumption. Green finance was determined as the dependent variable in the first model, while trade openness was determined as the dependent variable in the second model. Accordingly, the summary of both models is given in Table 1.

**Table 1:** Model Summary

| Model | R | R² | Adjusted R² | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | 0,595 | 0,354 | 0,278 | 23,31623 | 1,811 |
| 2 | 0,614 | 0,376 | 0,303 | 6,88547178 | 0,951 |

Predictors: (Constant) Natural Gas, Oil
Dependent Variable: (Model 1): Green Finance
Dependent Variable: (Model 2): Trade Openness

The $R^2$ value for Model 1 was found to be 0,354, indicating that the oil and the natural gas independent variables explain approximately 35,4% of the total variance in the green finance variable. In Model 2, the $R^2$ value is 0,376, which indicates that the model has moderate explanatory power. The Durbin-Watson statistic for Model 1 is calculated as 1,811, indicating that there is no significant autocorrelation among the residuals. Therefore, one of the basic assumptions of Model 1 is satisfied. The value in Model 2 is 0,951, which is significantly lower than 2, and therefore interpreted as indicating positive autocorrelation in the model's residuals.

Table 2 shows the ANOVA test results for both models.

**Table 2:** Anova

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 5.070,905 | 2 | 2.535,452 | 4,664 | ,024 |
| | Residual | 9.241,992 | 17 | 543,647 | | |
| | Total | 14.312,897 | 19 | | | |
| 2 | Regression | 486,671 | 2 | 243,335 | 5,133 | ,018 |
| | Residual | 805,965 | 17 | 47,410 | | |
| | Total | 1.292,636 | 19 | | | |

Dependent Variable: (Model 1): Green Finance
Dependent Variable: (Model 2): Trade Openness
Predictors: (Constant) Natural Gas, Oil

The p-values in Models 1 and 2 are less than 0,05, making them statistically significant. This result indicates that at least one of the independent variables has a significant effect on the dependent variables.

Table 3 shows the regression coefficients for Model 1 and Model 2.

When examining the regression coefficients of Model 1, it is observed that the effects of the independent variables on green finance are statistically significant. (p<0,05) The oil variable has a positive and significant effect on green finance (B=0,548, p<0,05), while the natural gas variable has a significant but negative effect (B=−0,619, p<0,05). These results reveal that both independent variables play an important role in explaining green finance. Based on these results, hypotheses H1$_a$ (natural gas consumption has an effect

on green finance) and H1$_b$ (oil consumption has an effect on green finance) are supported.

**Table 3:** Coefficients

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 149,932 | 46,536 | | 3,222 | 0,005 |
| | Oil | 0,001 | 0,001 | 0,548 | 2,460 | 0,025 |
| | Natural Gas | -0,007 | 0,003 | -0,619 | -2,777 | 0,013 |
| 2 | (Constant) | 88,482 | 13,742 | | 6,439 | 0,000 |
| | Oil | 0,000 | 0,000 | 0,177 | 0,809 | 0,430 |
| | Natural Gas | -0,002 | 0,001 | -0,680 | -3,103 | 0,006 |

Dependent Variable: (Model 1): Green Finance
Dependent Variable: (Model 2): Trade Openness

According to the regression coefficients of Model 2, oil consumption does not have a statistically significant effect on the trade openness ($p>0,05$). In contrast, the natural gas variable has a statistically significant and negative effect on the trade openness ($B=-0,177$, $p<0,05$). Based on these findings, hypothesis H2$_a$ (natural gas consumption has an effect on trade openness) is supported, while hypothesis H2$_b$ (oil consumption has an effect on trade openness) is not supported.

Table 4 presents the results of residual statistics for the models.

**Table 4:** Residuals Statistics

| | | Minimum | Maximum | Mean | Standart Deviation | N |
|---|---|---|---|---|---|---|
| Model 1 | Predicted Value | 18,7696 | 73,6322 | 48,4325 | 16,33676 | 20 |
| | Residual | -34,37721 | 35,15112 | 0,00000 | 22,05495 | 20 |
| | Std. Predicted Value | -1,816 | 1,543 | 0,000 | 1,000 | 20 |
| | Std. Residual | -1,474 | 1,508 | 0,000 | 0,946 | 20 |
| Model 2 | Predicted Value | 37,4161 | 55,4496 | 44,898 | 5,06105 | 20 |
| | Residual | -11,870043 | 20,378875 | 0,00000 | 6,513 | 20 |
| | Std. Predicted Value | -1,478 | 2,085 | 0 | 1 | 20 |
| | Std. Residual | -1,724 | 2,96 | 0 | 0,946 | 20 |

Dependent Variable: (Model 1): Green Finance
Dependent Variable: (Model 2): Trade Openness

The residual statistics obtained from the analysis demonstrate that the residuals successfully meet the fundamental assumptions of regression models. Furthermore, the standard deviation of the residuals is consistent with the standard error measures used to evaluate the goodness-of-fit of the models. All findings support the hypotheses initially proposed in the study and demonstrate that the model successfully reveals the relationships between the variables examined. Following the evaluation of the basic results of the regression analysis, the analysis was continued using the ARIMA

(Autoregressive Integrated Moving Average) model to make forward-looking predictions, taking into account the time series characteristics of the variables.

The ARIMA model is a method frequently used to forecast future needs in areas such as domestic consumption, exports, and the economy in general (Badmus & Ariyo, 2011). This model provides decision-makers with an important roadmap. It is used in many studies due to its ability to predict future trends, enabling appropriate measures to be taken.

The ARIMA model is traditionally expressed as ARIMA (p, d, q). Each letter in this notation represents a fundamental function of the model. The p parameter indicates the level of the autoregressive (AR) component, which determines the model's dependence on its past values. The d parameter is the integration (I) level, which indicates how many differences are required to make the time series stationary. Finally, the q parameter indicates the level of the moving average (MA) component, which expresses how much the model takes into account past prediction errors. These three fundamental components enable the ARIMA model to make meaningful predictions from complex time series data (Arslan & Ertuğrul, 2022; Reisen, 1994). Table 5 provides the ARIMA model description.

**Table 5:** Model Description

| | | | Model Type |
|---|---|---|---|
| Model ID | Green Finance | Model_1 | ARIMA(0,0,0) |
| | Trade Openness | Model_2 | ARIMA(0,0,0) |

The ARIMA (0,0,0) model was used for both dependent variables in the study. The ARIMA (0,0,0) model is a simple time series model used in regression analysis, indicating that the current data are a completely random process. Table 6 contains the model fit.

Model fit statistics enable the comparative performance of different models to be evaluated in time series analysis. The findings obtained reflect the performance distribution of the entire model group rather than the suitability of a single model. According to the results of the table, a clear heterogeneity was observed in the performance of the models. Indeed, the stationary $R^2$ values range from 0,354 to 0,376, indicating that the explanatory power varies within a relatively narrow band (Gujarati & Porter, 2009). When examining the error metrics, it was determined that the model with the best performance had a Root Mean Square Error (RMSE) value of 6.885 and an

Average Percentage Error (MAPE) value of 9,277%, which are considered "high accuracy" thresholds in the literature (Wahyudi, 2017: 233). However, the RMSE value of the weakest model rose to 23,316 and its MAPE value rose to 67,240%, indicating a significant deterioration in forecasting performance. Normalized Bayesian Information Criterion (BIC) values, which take model complexity into account, also support the performance difference. According to the BIC, it is argued that the smaller the BIC value, the better the performance of ARIMA models (Soni et al., 2014: 184). While the BIC value of the best model is 4,308, which is within the acceptable range in the literature, the worst model has a value of 6,748.

**Table 6:** Model Fit

| Fit Statistic | Mean | SE | Min. | Max. | Percentile | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Stationary $R^2$ | 0,365 | 0,016 | 0,354 | 0,376 | 0,354 | 0,354 | 0,354 | 0,365 | 0,376 | 0,376 | 0,376 |
| $R^2$ | 0,365 | 0,016 | 0,354 | 0,376 | 0,354 | 0,354 | 0,354 | 0,365 | 0,376 | 0,376 | 0,376 |
| RMSE | 15,101 | 11,618 | 6,885 | 23,316 | 6,885 | 6,885 | 6,885 | 15,101 | 23,316 | 23,316 | 23,316 |
| MAPE | 38,259 | 40,987 | 9,277 | 67,240 | 9,277 | 9,277 | 9,277 | 38,259 | 67,240 | 67,240 | 67,240 |
| MaxAPE | 175,894 | 203,456 | 32,028 | 319,759 | 32,028 | 32,028 | 32,028 | 175,894 | 319,759 | 319,759 | 319,759 |
| MAE | 11,074 | 9,598 | 4,288 | 17,861 | 4,288 | 4,288 | 4,288 | 11,074 | 17,861 | 17,861 | 17,861 |
| MaxAE | 27,765 | 10,446 | 20,379 | 35,151 | 20,379 | 20,379 | 20,379 | 27,765 | 35,151 | 35,151 | 35,151 |
| Normalized BIC | 5,528 | 1,725 | 4,308 | 6,748 | 4,308 | 4,308 | 4,308 | 5,528 | 6,748 | 6,748 | 6,748 |

According to the results obtained, the RMSE of the trade openness model was calculated as 6,885 and the MAPE as 9,277%. In contrast, the RMSE value of the other model was 23,316 and the MAPE value was 67,240%. These findings indicate that the trade balance model has significantly stronger forecasting performance, thus making it the model with the highest predictive accuracy among the two models.

The residuals of the ARIMA model were examined to verify the model's assumptions and assess its suitability, and the results are summarized in Table 7.

According to Table 7, it has been observed that the autocorrelation values (mean) at each lag level (Lag 1-19) are close to zero. This finding indicates that there is no systematic pattern or autocorrelation remaining in the error terms (residuals) that the model cannot predict. The findings support the validity and reliability of the established ARIMA model. Table 8 shows a summary of the partial autocorrelation function.

**Table 7:** Residual ACF Summary

| Lag | Mean | SE | Minimum | Maximum | Percentile | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Lag 1 | 0,109 | 0,099 | 0,039 | 0,180 | 0,039 | 0,039 | 0,039 | 0,109 | 0,180 | 0,180 | 0,180 |
| Lag 2 | -0,102 | 0,237 | -0,270 | 0,065 | -0,270 | -0,270 | -0,270 | -0,102 | 0,065 | 0,065 | 0,065 |
| Lag 3 | 0,020 | 0,035 | -0,005 | 0,045 | -0,005 | -0,005 | -0,005 | 0,020 | 0,045 | 0,045 | 0,045 |
| Lag 4 | -0,163 | 0,042 | -0,193 | -0,133 | -0,193 | -0,193 | -0,193 | -0,163 | -0,133 | -0,133 | -0,133 |
| Lag 5 | -0,074 | 0,207 | -0,220 | 0,072 | -0,220 | -0,220 | -0,220 | -0,074 | 0,072 | 0,072 | 0,072 |
| Lag 6 | -0,037 | 0,099 | -0,107 | 0,033 | -0,107 | -0,107 | -0,107 | -0,037 | 0,033 | 0,033 | 0,033 |
| Lag 7 | -0,057 | 0,056 | -0,097 | -0,017 | -0,097 | -0,097 | -0,097 | -0,057 | -0,017 | -0,017 | -0,017 |
| Lag 8 | 0,125 | 0,202 | -0,018 | 0,268 | -0,018 | -0,018 | -0,018 | 0,125 | 0,268 | 0,268 | 0,268 |
| Lag 9 | -0,085 | 0,188 | -0,218 | 0,048 | -0,218 | -0,218 | -0,218 | -0,085 | 0,048 | 0,048 | 0,048 |
| Lag 10 | -0,074 | 0,043 | -0,104 | -0,043 | -0,104 | -0,104 | -0,104 | -0,074 | -0,043 | -0,043 | -0,043 |
| Lag 11 | 0,049 | 0,046 | 0,017 | 0,082 | 0,017 | 0,017 | 0,017 | 0,049 | 0,082 | 0,082 | 0,082 |
| Lag 12 | 0,013 | 0,006 | 0,009 | 0,017 | 0,009 | 0,009 | 0,009 | 0,013 | 0,017 | 0,017 | 0,017 |
| Lag 13 | 0,081 | 0,272 | -0,111 | 0,274 | -0,111 | -0,111 | -0,111 | 0,081 | 0,274 | 0,274 | 0,274 |
| Lag 14 | 0,169 | 0,066 | 0,122 | 0,215 | 0,122 | 0,122 | 0,122 | 0,169 | 0,215 | 0,215 | 0,215 |
| Lag 15 | -0,042 | 0,074 | -0,094 | 0,011 | -0,094 | -0,094 | -0,094 | -0,042 | 0,011 | 0,011 | 0,011 |
| Lag 16 | -0,078 | 0,023 | -0,095 | -0,062 | -0,095 | -0,095 | -0,095 | -0,078 | -0,062 | -0,062 | -0,062 |
| Lag 17 | -0,120 | 0,051 | -0,156 | -0,084 | -0,156 | -0,156 | -0,156 | -0,120 | -0,084 | -0,084 | -0,084 |
| Lag 18 | -0,087 | 0,011 | -0,095 | -0,079 | -0,095 | -0,095 | -0,095 | -0,087 | -0,079 | -0,079 | -0,079 |
| Lag 19 | -0,148 | 0,215 | -0,300 | 0,005 | -0,300 | -0,300 | -0,300 | -0,148 | 0,005 | 0,005 | 0,005 |

The Partial Autocorrelation Function (PACF) was examined to determine the autoregressive structures in the series. According to the analysis results, the average partial autocorrelation values of the lags between Lag 1 and Lag 19 were very close to zero, and no statistically significant relationship was observed between these lags. This finding indicates that the model successfully captured the autoregressive components and eliminated the serial dependencies in the series (Unhapipat, 2018: 8). Therefore, it can be concluded that there is no significant autocorrelation remaining in the residuals of the relevant model and that the modeling process was carried out appropriately (Box & Jenkins, 1976). Table 9 shows the model statistics.

**Table 8:** Residual PACF Summary

| Lag | Mean | SE | Minimum | Maximum | Percentile | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Lag 1 | 0,109 | 0,099 | 0,039 | 0,180 | 0,039 | 0,039 | 0,039 | 0,109 | 0,180 | 0,180 | 0,180 |
| Lag 2 | -0,119 | 0,216 | -0,272 | 0,034 | -0,272 | -0,272 | -0,272 | -0,119 | 0,034 | 0,034 | 0,034 |
| Lag 3 | 0,025 | 0,006 | 0,021 | 0,029 | 0,021 | 0,021 | 0,021 | 0,025 | 0,029 | 0,029 | 0,029 |
| Lag 4 | -0,221 | 0,096 | -0,289 | -0,153 | -0,289 | -0,289 | -0,289 | -0,221 | -0,153 | -0,153 | -0,153 |
| Lag 5 | -0,032 | 0,217 | -0,185 | 0,121 | -0,185 | -0,185 | -0,185 | -0,032 | 0,121 | 0,121 | 0,121 |
| Lag 6 | -0,100 | 0,311 | -0,320 | 0,120 | -0,320 | -0,320 | -0,320 | -0,100 | 0,120 | 0,120 | 0,120 |
| Lag 7 | 0,020 | 0,163 | -0,095 | 0,135 | -0,095 | -0,095 | -0,095 | 0,020 | 0,135 | 0,135 | 0,135 |
| Lag 8 | 0,027 | 0,024 | 0,010 | 0,044 | 0,010 | 0,010 | 0,010 | 0,027 | 0,044 | 0,044 | 0,044 |
| Lag 9 | -0,107 | 0,149 | -0,213 | -0,001 | -0,213 | -0,213 | -0,213 | -0,107 | -0,001 | -0,001 | -0,001 |
| Lag 10 | -0,051 | 0,031 | -0,073 | -0,029 | -0,073 | -0,073 | -0,073 | -0,051 | -0,029 | -0,029 | -0,029 |
| Lag 11 | -0,008 | 0,192 | -0,144 | 0,127 | -0,144 | -0,144 | -0,144 | -0,008 | 0,127 | 0,127 | 0,127 |
| Lag 12 | 0,015 | 0,120 | -0,070 | 0,100 | -0,070 | -0,070 | -0,070 | 0,015 | 0,100 | 0,100 | 0,100 |
| Lag 13 | 0,004 | 0,146 | -0,100 | 0,107 | -0,100 | -0,100 | -0,100 | 0,004 | 0,107 | 0,107 | 0,107 |
| Lag 14 | 0,269 | 0,015 | 0,258 | 0,280 | 0,258 | 0,258 | 0,258 | 0,269 | 0,280 | 0,280 | 0,280 |
| Lag 15 | -0,118 | 0,015 | -0,129 | -0,108 | -0,129 | -0,129 | -0,129 | -0,118 | -0,108 | -0,108 | -0,108 |
| Lag 16 | 0,001 | 0,077 | -0,053 | 0,056 | -0,053 | -0,053 | -0,053 | 0,001 | 0,056 | 0,056 | 0,056 |
| Lag 17 | -0,119 | 0,036 | -0,145 | -0,093 | -0,145 | -0,145 | -0,145 | -0,119 | -0,093 | -0,093 | -0,093 |
| Lag 18 | -0,054 | 0,015 | -0,064 | -0,043 | -0,064 | -0,064 | -0,064 | -0,054 | -0,043 | -0,043 | -0,043 |
| Lag 19 | -0,093 | 0,080 | -0,150 | -0,037 | -0,150 | -0,150 | -0,150 | -0,093 | -0,037 | -0,037 | -0,037 |

**Table 9:** Model Statistics

| Model | Number of Predictors | Model Fit Statistics | | | | | | | | Ljung-Box Q (18) | | | Number of Outliers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Stationary R² | R² | RMSE | MAPE | MAE | MaxAPE | MaxAE | Normalized BIC | Statistics | DF | Sig. | |
| Green Finance-Model_1 | 2 | 0,354 | 0,354 | 23,316 | 67,240 | 17,861 | 319,759 | 35,151 | 6,748 | 20,351 | 18 | 0,313 | 0 |
| Trade Openness-Model_2 | 2 | 0,376 | 0,376 | 6,885 | 9,277 | 4,288 | 32,028 | 20,379 | 4,308 | 11,892 | 18 | 0,853 | 0 |

When green finance and trade openness models are evaluated comparatively, both models are found to have a moderate level of explanatory power. The green finance model explains 35,4% of the changes in the series with $R^2 = 0,354$, while the trade openness model offers a higher explanatory power (37,6%) with $R^2 = 0,376$. The Ljung–Box Q test results also show that the error terms are randomly distributed in both models, with a significance of 0,313 for the green finance model and a significance of 0,853 for the trade openness model, indicating no autocorrelation between the residuals in either case. These findings demonstrate that both models are statistically valid, but also show that the trade openness model has a relatively higher explanatory power. With significant differences in RMSE, MAPE, MAE, and Normalized BIC values, the analysis shows that the trade openness model performs better than the green finance model.

The ARIMA (0,0,0) model parameter analysis for constructing the classical regression equation, (y = a + bx), is provided in Table 10.

**Table 10:** ARIMA Model Parameters

| | | | | | Estimate | SE | t | Sig. |
|---|---|---|---|---|---|---|---|---|
| Green Finance-Model_1 | Green Finance | No Transformation | Constant | | 149,932 | 46,536 | 3,222 | 0,005 |
| | Oil | No Transformation | Numerator | Lag 0 | 0,001 | 0,001 | 2,460 | 0,025 |
| | Natural Gas | No Transformation | Numerator | Lag 0 | -0,007 | 0,003 | -2,777 | 0,013 |
| Trade Openness -Model_2 | Trade Openness | No Transformation | Constant | | 88,482 | 13,742 | 6,439 | 0,000 |
| | Oil | No Transformation | Numerator | Lag 0 | 0,000 | 0,000 | 0,809 | 0,430 |
| | Natural Gas | No Transformation | Numerator | Lag 0 | -0,002 | 0,001 | -3,103 | 0,006 |

In the regression analysis conducted within the green finance model, the significance levels of the natural gas (p=0,013) and oil (p=0,025) variables were found to be below the statistically accepted 5% significance level (p<0,05). This result indicates that these variables are statistically significant in terms of the model and have an effect on green finance. Hypotheses $H1_a$ and $H1_b$ are supported. The regression models established based on the coefficients are as follows:

Green Finance = 149,932 + 0,001*Oil – 0,007*Natural gas

According to the analysis results, a 1-ton increase in oil consumption leads to a 0,001-unit increase in the green finance ratio (p<0,05). Contrary to expectations, despite this positive correlation, it has been determined that a 1-ton increase in natural gas consumption causes a 0,007-unit decrease in the green finance ratio (p<0,05). Therefore,

the results show that oil and natural gas consumption have statistically significant and different effects on green finance practices.

$$\text{Trade openness} = 88{,}482 + 0{,}000 * \text{Oil} - 0{,}002 * \text{Natural gas}$$

There is no statistically significant relationship between oil consumption and the trade openness ($p>0{,}05$). A 1-ton increase in natural gas consumption causes a 0,002-unit decrease in the trade openness ratio. This negative relationship indicates that as natural gas consumption increases, the economy's openness to the outside world decreases relatively. Therefore, hypothesis $H2_a$ is supported, while hypothesis $H2_b$ is not supported. These findings reveal that while natural gas consumption has an effect on trade openness, oil consumption does not have a statistically significant effect on trade openness.

The values showing whether any direct relationship remains in the residuals are given in Table 11.

**Table 11:** Residual ACF

| Model | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Green Finance-Model_1 | ACF | 0,039 | -0,270 | -0,005 | -0,193 | 0,072 | -0,107 | -0,017 | 0,268 | -0,218 | -0,104 | 0,017 | 0,009 | 0,274 | 0,122 | -0,094 | -0,062 | -0,156 | -0,079 | 0,005 |
| | SE | 0,224 | 0,224 | 0,240 | 0,240 | 0,247 | 0,248 | 0,251 | 0,251 | 0,265 | 0,274 | 0,275 | 0,276 | 0,276 | 0,289 | 0,291 | 0,293 | 0,294 | 0,298 | 0,299 |
| Trade Openness-Model_2 | ACF | 0,180 | 0,065 | 0,045 | -0,133 | -0,220 | 0,033 | -0,097 | -0,018 | 0,048 | -0,043 | 0,082 | 0,017 | -0,111 | 0,215 | 0,011 | -0,095 | -0,084 | -0,095 | -0,300 |
| | SE | 0,224 | 0,231 | 0,232 | 0,232 | 0,236 | 0,246 | 0,246 | 0,248 | 0,248 | 0,249 | 0,249 | 0,250 | 0,250 | 0,253 | 0,262 | 0,262 | 0,264 | 0,265 | 0,267 |

The mean values for all delays were observed to be very close to zero. This means that the models did not leave any systematic pattern or relationship even in the part they could not predict; in other words, the residuals are randomly distributed. Table 12 shows the partial autocorrelation results for the residuals.

**Table 12:** Residual PACF

| Model | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Green Finance Model_1 | PACF | 0,039 | -0,272 | 0,021 | -0,289 | 0,121 | -0,320 | 0,135 | 0,044 | -0,213 | 0,029 | -0,144 | 0,100 | 0,107 | 0,258 | -0,129 | 0,056 | -0,093 | -0,064 | -0,037 |
| | SE | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 |

| Trade Openness-Model_2 | PACF | 0,180 | 0,034 | 0,029 | -0,153 | -0,185 | 0,120 | -0,095 | 0,010 | -0,001 | -0,073 | 0,127 | -0,070 | -0,100 | 0,280 | -0,108 | -0,053 | -0,145 | -0,043 | -0,150 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | SE | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 | 0,224 |

The autocorrelation in the residuals (error terms) and the partial autocorrelation in the residuals (error terms) demonstrate that both the green finance and trade openness models are statistically valid and reliable. The model successfully explains the data and has transformed the error terms into a random process.

Figure 2 shows the changes over time in the green finance and trade openness series, respectively. The graphs display the observed values of their own series over a 20-period span.

**Figure 2:** Green Finance and Trade Openness Series Graph
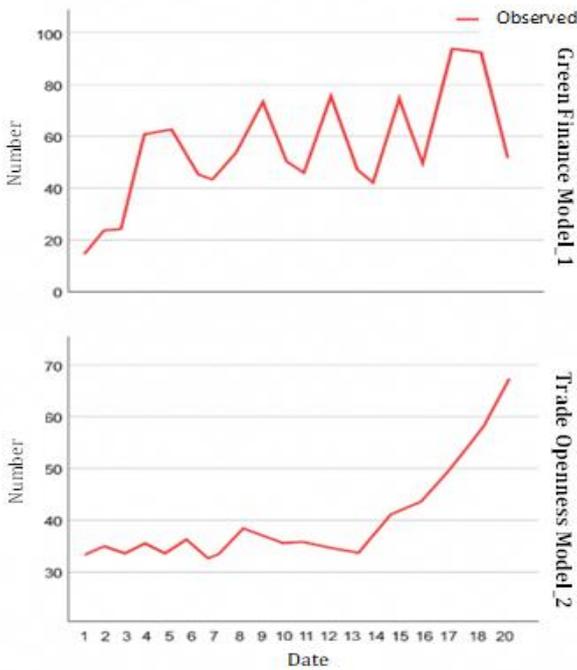
The green finance series demonstrates a highly volatile and fluctuating structure. Values move within a wide range between 10 and 100, exhibiting sharp declines and increases. The significant increase observed particularly in recent periods clearly highlights the series' high volatility. This fluctuating structure can make the series more difficult to predict. The trade openness series has a more stable and regular structure compared to the green finance series. Values fluctuate within a narrower range between 30 and 70. The graph shows a steady upward trend, which became particularly apparent after the 14th period. The series' fluctuations are less severe and its movement is smoother.

In conclusion, the ARIMA (0,0,0) model analysis reveals statistically significant relationships between green finance, trade openness, and natural resource consumption.

## 5. Conclusions and Recommendations

The findings of this study reveal the complex relationships between green finance, trade openness, and natural resources (natural gas and oil) in the Turkish economy. According to the analysis results, oil consumption was found to have a significant and positive effect on green finance, while natural gas consumption was found to have a statistically significant and negative effect on green finance. Furthermore, it was found that oil consumption does not have a statistically significant effect on trade openness, while the natural gas variable has a statistically significant and negative effect on trade openness. These findings reveal that oil and natural gas exhibit different dynamics in their relationships with green finance and trade openness.

The positive impact of oil consumption on green finance can be explained by the continued dominance of fossil fuels in the global energy system and the slow pace of the transition process, as noted by researchers such as Sachs and Du Toit (2015) and Önal (2020). This is consistent with what Sachs et al. (2019) state, that financial institutions are more interested in fossil fuel projects than green projects because the former are seen as more attractive. This unexpected result suggests that green finance practices have not yet had a transformative impact on the oil sector or that existing financing mechanisms are also directed towards oil-related projects.

The negative impact of natural gas consumption on green finance is related to its environmental effects and the focus of green finance on areas such as climate and carbon finance, sustainable banking, and renewable energy, which are the main objectives of green finance (Miyan et al., 2024; Tao et al., 2022). The fundamental purpose of green finance is to enhance environmental sustainability (Al-Mulali et al., 2015; Hdom & Fuinhas, 2020). Therefore, natural gas, as a fossil fuel, does not fully serve emission reduction targets, but causes financing sources to stay away from this area. Additionally, it creates a negative impact due to the increase in natural gas consumption, which conflicts with environmental goals. In future policies, green finance instruments (green bonds, loans, etc.) could be directed towards projects aimed at more efficient use of natural gas. This could create a mechanism to accelerate the transition to renewable energy sources (Karasimou et al., 2021; Önder & Polat, 2018) and cleaner energy technologies (Hassan et al., 2023).

It has been concluded that petroleum consumption does not have a statistically significant effect on trade openness. Traditionally, it is known that oil imports significantly increase the trade openness (Bayraç, 2005). This situation suggests that the structural dynamics of Türkiye's oil imports or fluctuations in import volumes do not affect the trade openness indicator as clearly as natural gas does. However, it shows that this is balanced by Türkiye being a significant exporter of oil products, as well as having a high share in oil imports. According to a report by Energy Market Regulatory Authority (EMRA) (2023) Turkiye imports crude oil and oil products, while exporting processed oil derivatives (diesel, aviation fuels, gasoline, etc.) to various countries using its refinery capacity. This situation shows that part of the trade openness caused by oil imports is offset by oil product exports. However, the significant depreciation of the Turkish lira against the US dollar since 2015 will be a step towards increasing domestic production, according to the IEA (2021).

The negative and significant impact of natural gas on the trade openness gains meaning when combined with studies examining the economic effects of natural resources, such as those by Das et al. (2013) and Gylfason (2006). Gylfason (2006) noted that excessive dependence on natural resources can negatively affect economic growth. Türkiye's heavy dependence on natural gas imports may be an indicator that increasing natural gas consumption is widening the trade openness through imports, but the negative impact of natural gas on the trade openness highlights the importance of Türkiye's energy supply security strategies. According to a report prepared by IEA (2021) report states: " Given the high import dependency on natural gas and the resulting balance of payments and energy security vulnerabilities, Türkiye's most important priority regarding natural gas is to reduce the share of imported gas, particularly in electricity generation, and increase the share of domestically produced energy sources. It also seeks to increase natural gas supply security by expanding infrastructure through both pipelines and liquefied natural gas and diversifying import sources." Presidency of the Republic of Türkiye's Strategy and Budget Office (2019) in line with the Eleventh Development Plan (2019-2023) is to reduce the share of imported natural gas in electricity production and increase the use of domestic resources, namely coal and renewable energy. More effective use of domestic resources, such as natural gas discoveries in the Black Sea (Dinçer & Ezan, 2021), can positively impact the trade balance by reducing import dependency. In this context, policies aimed at increasing energy efficiency (Cheng et al, 2024) and diversifying energy sources (Ulucak & Ozcan, 2020), are vital for a sustainable trade structure. Rodrik (1998) argues that the potential effects of foreign trade on macroeconomic variables can be determined. Wu (2022)

stated that gas and oil consumption strongly determine the trade openness. The findings in the current study support the idea that domestic sources should be prioritized in natural gas consumption.

The examination of natural resource, green finance, and trade openness variables in this study supports the role of green finance and appropriate international trade policies in reducing countries' environmental footprints and improving overall environmental quality, as emphasized by Aydin and Turan (2020) and He et al. (2019). This situation strengthens the approach of analyzing the complex interactions between energy consumption and macroeconomic variables such as trade openness, as well as its influence on green financial systems. In conclusion, this study makes a significant contribution to the international literature on complex environmental and economic transformation by empirically revealing the effects of energy consumption trends in Türkiye on green finance and trade openness.

This study presents an analysis covering the period 2003-2022. For future research, including data across different time periods, could yield new findings. Furthermore, examining natural gas and oil consumption by sector (industry, housing, transportation, etc.) could provide a more in-depth understanding of the impacts on green finance and trade openness. The direct impacts of green finance instruments (green bonds, sustainable banking, etc.) in Türkiye on trade openness and energy consumption could be examined using econometric models.

The empirical findings clearly demonstrate the determining and guiding influence of energy consumption trends on financial and trade indicators. These critical results provide in-depth and practice-oriented policy implications, particularly for Türkiye's current energy policies and long-term sustainable finance strategies. In this context, the recommendations presented are based on robust scientific evidence and aim to offer a roadmap for effective policy implementation.

To support the development of green finance in Türkiye and reduce dependence on fossil fuels, policies should focus on accelerating the transition to renewable energy sources and cleaner energy technologies that facilitate energy transformation (Hassan et al., 2023). In the long term, the transition to renewable energy should be tied to clear and measurable requirements (such as hydrogen compatibility and methane leakage reduction). For this purpose, it is recommended to promote green finance instruments—such as green bonds and loans—directed toward natural gas infrastructure. Banks and financial institutions should be encouraged to develop environmentally friendly

products and services and to facilitate financing for sustainable projects. These incentives should be supported through macroprudential tools, such as adjusting credit risk weights in favor of green projects (green factoring) and establishing green portfolio targets by the Central Bank and the Banking Regulation and Supervision Agency.

At the same time, sectors with high carbon emissions should be subject to regulatory restrictions to ensure the adoption of environmentally sustainable practices. These restrictions should be structured through a phased Carbon Pricing Mechanism (aligned with the EU Carbon Border Adjustment Mechanism—CBAM) and the establishment of a transparent Emissions Trading System (ETS). It is also important for Türkiye to adjust its international trade policies in a way that increases the export of environmentally friendly products and services and facilitates access to green finance.

The findings obtained within the scope of the analysis have been evaluated within certain methodological and data-related limitations. First, since the analysis is based on annual data from the 2003–2023 period, short-term fluctuations or structural breaks could not be reflected in the model. Second, although coal consumption was initially planned to be included in the analysis, reliable data were only available for the period after 2020; therefore, this variable was excluded. Additionally, the indicators used in the study were derived from macro-level national and international databases (TÜİK, ETKB, IEA, World Bank (WITS)), limiting the ability to capture sectoral differences and regional dynamics in detail. Nonetheless, the reliable and comparable nature of the data provided by these institutions supports the coherence and generalizability of the findings.

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