International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2025, 15(2), 728-734.

Estimating the Effects of Oil Prices on Trade Balance in Saudi Arabia: Bounds Testing to Cointegration Approach

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Received: 10 November 2024 **Accepted:** 17 February 2025 **DOI:** https://doi.org/10.32479/ijeep.18453

ABSTRACT

The main objective of this study is to examine the effects of oil prices on the trade balance of the Kingdom of Saudi Arabia during the period 1980-2022. In this context, oil prices are analyzed to determine their impact on improving Saudi Arabia's trade balance in both the short and long term. This is achieved using the bounds testing to cointegration approach and the error correction model (ECM), which both measure short- and long-run equilibrium relationships between variables. The results of this study confirm a statistically significant positive relationship between oil prices and the trade balance in the short and long term. However, these findings confirm the country's reliance on the oil sector. The most important contribution of this study lies in its focus on the effects of oil prices on Saudi Arabia's trade balance, as the largest oil producer and net exporter. It also offers policy implications that address the negative effects of fluctuations in international oil prices on the trade balance.

Keywords: Trade Balance, Oil Price, Oil Fluctuation, Cointegration Analysis, Error Correction Model, Saudi Arabia

JEL Classifications: F14, Q41, Q43, P45, C32, O53

1. INTRODUCTION

The impact of changes in oil price has been a significant topic of research in applied studies because oil drives macroeconomic variations and shocks that affect the trade balance of both developing and developed countries. This is especially true for oil-exporting and oil-importing nations. The Kingdom Saudi Arabia, one of the largest oil exporters in the world, relies heavily on oil exports, which account for more than 40% of its export value. This dependence makes foreign trade, especially in crude oil and related industrial products, vital to its economy. From this standpoint, the main question of the study is: What is the impact of changes in oil prices on the Saudi economy? This study seeks to bridge the gap in the literature regarding the Saudi economy and the impact of oil price changes on its trade balance. Using annual time series data from 1980 to 2022, a cointegration framework is employed to examine the long-term impact.

1.1. The Concept of Oil Price

The price of oil represents the value of crude oil expressed in dollars during a specified period. The price elasticity of demand for oil is low in the short term due to the lack of alternatives, but becomes high in the long term because alternative energy sources may become available (Caldara et al., 2019; Kilian, 2022). Oil prices per barrel and required quantity in dollars are influenced by two key factors: Time, where alternative energy sources are not easily replaceable, and substitutive effects, where expensive fuel sources are replaced with cheaper alternative fuels.

1.2. The Concept of Trade Balance

Trade balance is defined as the difference between exports and imports over a certain period (Melvin and Norrbin, 2017). A trade surplus occurs when exports exceed imports, while a deficit arises in the opposite case. From a broader perspective, the trade balance encompasses visible trade, invisible trade, and trade in services.

Furthermore, international trade is crucial for developing and developed nations. Economically, it contributes to gross domestic product (GDP) growth, external account balances, and reciprocal linkages between economic sectors. The changing international prices of oil significantly affect national budgets and trade balances. The volume of oil exports also leads to a trade surplus or deficit. For oil-exporting countries, higher oil prices enhance the terms of trade by increasing real income (Ozigbu, 2023). In response to higher oil prices, firms and the households increase investment and spending, leading to a rise in the value of the local currency of the oil-exporting country and achieving a trade balance surplus. Thus, higher oil prices increase the net export of oil-exporting countries (Le and Chang, 2013).

Both empirical and theoretical evidence connect oil prices to the trade balance. This study seeks to test the impact of oil prices on Saudi Arabia's trade balance. Saudi Arabia is the largest economy in oil production and export within the Middle East. While the country imports both petroleum and non-petroleum products, the majority of its exports are oil-related.

The remainder of this paper is structured as follows: a review of the related literature is presented in Section 2, Section 3 delves into the methodology and sources of data, Section 4 discusses empirical findings, and Section 5 concludes the study with policy recommendations.

2. LITERATURE REVIEW

The literature provides evidence on the influence of oil prices on trade balances of oil importing and exporting countries (Kilian et al., 2009; Le and Chang, 2013; Nanovsky, 2019). Moreover, the literature highlights the need to investigate the asymmetry in the relationship between trade and oil prices (Rafiq et al., 2016; Baek and Kwon, 2019; Baek et al., 2019; Ahad and Anwer, 2019; Jibril et al., 2020).

Mili (2019) conducted an analysis of trade balance and crude oil reserves in South Africa, using the ARDL model to demonstrate a long-term relationship between oil prices and the trade balance. This study showed that macroeconomic indicators such as oil price, exchange rate, interest rate, domestic income, and inflation share a single cointegration vector with trade balance. The findings showed that price fluctuations in the oil market have a direct, heavy, and adverse effect on the trade balance.

Jawadi and Fitit (2019) investigated the impact of oil price fluctuations on Saudi Arabia's economic growth to assess its reliance on the crude oil sector. The results validate the oil industry's role in the nation's economic expansion but also demonstrate the nonlinearity and threshold effects in the relationship between oil and Saudi Arabia's economy, since the influence in oil price varies by regime based on market conditions. Saudi Arabia's economic growth is positively and significantly impacted by changes in oil price, confirming its reliance on the oil industry.

Al-Zahrani (2022) examined the effects of oil price fluctuations on Saudi Arabia's GDP between 1990 and 2020. The co-integration model indicates a long-run relationship among economic growth, world oil prices, oil price fluctuations, and the price index. While variations in world oil prices show a significant and positive effect on economic growth in Saudi Arabia, the absolute oil price and the general price levels show no statistically significant effects.

Almutairi (2020) analyzed the impact of oil price shocks on Saudi Arabia's economic growth and unemployment from 1999 to 2015, using a bivariate structural VAR model to estimate the dynamic impacts of oil price and credit shocks. The results showed that oil price shocks play a significant role in the fluctuations of economic growth in Saudi Arabia. This indicates that although oil and its revenues are good for the economy in terms of improving infrastructure and other aspects of development, oil constitutes a serious obstacle and threat to sustainable growth in the long term due to the intrinsic volatility of oil price shocks.

Alhwij (2020) examined the effects of oil price fluctuations on Libya's trade balance from 1988 to 2018. Gregory and Hansen's cointegration technique was used to test the long-term equilibrium relationship. Furthermore, the error correction model was used to estimate the short-term dynamic. The results confirmed the existence of a long-run equilibrium relationship between variables and indicated positive effects in oil fluctuations on both the oil and overall trade balances in the short and long terms. The impact of oil price fluctuations on the non-oil trade balance was significantly negative.

Balli et al. (2021) analyzed oil price shocks on trade balances in Russia and China between 1993 and 2018. The study found that oil demand shocks had a greater net positive effect on Russia's trade balance than on China's, while oil supply shocks negatively impacted China's trade balance.

Alkhateeb and Mahmood (2020) examined the impact of oil prices on the trade balances of Gulf countries. Their findings showed that exchange rates and oil prices positively impacted the trade balance. However, country-specific findings indicated that rising oil prices had a negative impact on Kuwait's trade balance but a positive impact on Oman, Saudi Arabia, and the United Arab Emirates. The trade balances of Bahrain, Oman, Qatar and the UAE were positively correlated to declining oil prices. Outside of Saudi Arabia, the effects of oil prices of trade balance were asymmetric.

Faheem et al. (2020) investigated the impact of oil price fluctuations on the trade balances of selected GCC countries from 1980 to 2017. They adopted both linear and nonlinear ARDL models and found that oil prices having an asymmetrical effect over trade balance. Furthermore, they assessed how the real effective exchange rate moderated the oil-trade balance relationship. These results showed that oil prices have a negative impact on the trade balances of Saudi Arabia and Kuwait but a positive influence within UAE. At the lowest value of the real effective exchange rate, the marginal effect of oil prices was positive for Kuwait but negative for both Saudi Arabia and the UAE.

Elneel and Almulihin (2022) studied the relationship between oil price shocks and economic growth of Saudi Arabia between 1969 and 2019. Using both ARDL and VECM, they found that non-oil exports stimulated economic growth in the short and long term, which is consistent with the objectives of Vision 2030. However, long-term economic growth was negatively affected by significant oil price shocks, foreign direct investment (FDI), and local investment. FDI had a negative and significant long-term effect on economic growth, which hindered the achievement of Vision 2030 goals.

Helmi et al. (2023) analyzed how oil price shocks affected Saudi Arabia's external balance from 1991 to 2021. The results highlighted the importance of understanding the source of such shocks to better assess their effects on the economy and the degree of influence they exert over time. The results indicated that, except for Saudi Arabia, global oil production shocks negatively and significantly affect trade balance, often surpassing the impact of Saudi Arabia's oil production shocks, which were negligible for most of the period.

Alfalih (2023) investigated the relationship between oil prices, GDP, foreign direct investment, trade openness, and unemployment rates in Saudi Arabia from 1991 to 2019. The study applied an ARDL model and tested for co-integration using bounds testing. The results indicated the presence of a significant long-run relationship among the variables. Oil price has a positive effect above $41.2 per barrel; below this threshold, it seems to enhance the adverse situation of the labor market in Saudi Arabia.

Recently, Alassaf (2024) revisited the link between trade balance and oil price volatility nexus in the Gulf Cooperation Council from 1989 to 2021. The study employed a comparative approach using both panel ARDL and non-linear ARDL models. These results showed that oil price changes do not create symmetric trade balance responses in GCC countries. Although short-term responses to positive oil price changes were higher than those of negative price changes, long- to medium-term responses were the reverse. Thus, the NARDL model better explains the data and more precisely addresses the oil price volatilities associated with trade balances in the GCC region.

In context of Saudi Arabia, most of the previous studies analyzed the impact of oil price on selected macroeconomic variables such as GDP, exchange rate, economic growth, personal consumption, and unemployment, but they did not include the trade balance variable (Elneel and AlMulhim, 2022; Almutairi, 2020; Alkhateeb and Mahmood, 2020; Algahtani, 2016; Dibooğlu and Aleisa, 2008; Mahmood and Zamil, 2019). The current study thus contributes to the literature by considering the effects of changes in oil prices on Saudi Arabia's trade balance from 1980 to 2022. A key contribution of this study is its examination of the relationship between oil prices and the trade balance, using a robust econometric method and a 43-year time series approach to assess both short- and long-term effects.

3. METHODOLOGY AND DATA DESCRIPTION

This section aims to examine the impact of oil prices on the trade balance in Saudi Arabia during the period 1980-2022. Thus, the model variables, data sources, and procedures to verify whether a long-run equilibrium relationship exists are presented, and both a short-term and long-term relationship are estimated using the ARDL approach.

3.1. Model Specification

This work is grounded in principles of economic theory and previous studies, where a traded balance variable, including average oil prices, was adopted as a dependent variable. Data were obtained from the Saudi Central Bureau of Statistics, and the standard econometric model can be formulated as follows:

$$BT = b_0 + b_1 P_t + u_t \quad (1)$$

Where:
BT: trade balance,
P_t: average oil prices,
b_0: constant term,
b_1: regression coefficient,
u_t: random error term (residuals).
Theoretically, it is expected that b_0, $b_1 > 0$.

3.2. Stationarity Tests

Regression models reveal the extent of stability of a series of study variables. Unit root tests are used to examine the characteristics of the time series for all variables and ensure their stability, and the condition of stability is considered a basic condition for time series analysis that is used to reach logical results and determine the degree of integration of the variables (Johansen, 1991). Two commonly used unit root tests for testing stability in time series data are the augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. If the original series is stationary at the level, it is considered integrated at level I(0). However, if taking the first difference is necessary to achieve stability, it is classified as integrated of order one, or I(1) (Bashir and Ibrahim, 2023).

3.3. Cointegration Test

This study employed the bounds test according to the regression with distributed lags (ARDL) methodology, which was proposed by Pesaran and Shin (1995) and developed by Pesaran et al. (1999). The choice of this methodology is due to several advantages, the most important of which follow (Ibrahim and Bashir, 2020):

a. It can combine variables that are at least stationary at level I(0) or first differencing I(1). It is not necessary for all variables to be stable at the same level, but enough time series variables can be integrated of order I(0) or I(1) or combination of the both.
b. The ARDL procedure provides a system to determine both the short- and long-term relationships between the dependent and independent variables as well as measures the influence of each on the dependent variable.
c. The estimators produced from this model are unbiased and efficient, and the methodology helps resolve issues related to omitting variables and multicollinearity. Accordingly, the impact of oil prices on the trade balance in Saudi Arabia from1980 to 2022 can be measured in the short and long term using the ARDL model as follows:

$$\Delta B_t = b_0 + \sum\nolimits_{i=0}^{r} b_{1i} \Delta P_{t-1} + \lambda BT - 1 + \lambda 2Pt - 1 + \varepsilon t \quad (2)$$

Where:
Δ = first difference of the variable;
b_0= constant term;
r = number of optimal time delays; short-run coefficients of the dynamic relationship;
b_1, b_2 = long-run coefficients through which cointegration can be known;
t = time;
εt = random error term.

If cointegration between the variables of interest is suggested by the bounds test, the short-run relationship can be estimated using an error correction model with the following equation:

$$\Delta BT_t = b_0 + \sum_{i=0}^{r} b_{1i}\Delta BT_{t-1} + \sum_{i=0}^{r} b_{2i}\Delta P_{t-i} + yECT_{t-1} + \varepsilon t \quad (3)$$

Where ECT represents the error correction term that is added to the model, and (y) represents the percentage of deviation corrected in period t-1 to t. This means the speed of error correction of the dependent variable in the short-run moves toward its equilibrium value in the long-run (Bashir and Ibrahim, 2023).

3.4. Estimation Steps

The ARDL approach follows a three-step procedure. The order of integration of the studied variables is determined, and the stationarity of the times series data is confirmed through unit root tests, The presence of a cointegration relationship is then tested using the bounds testing approach, Finally, the ARDL model is estimated to obtain further short- and long-term coefficients.

3.5. Descriptive Statistics

Statistical analysis was conducted in the early stages of the study to describe and analyze the data pertaining to the study variables over the considered period. This included the arithmetic mean, standard deviation, and range to show the largest and smallest values, as well as using the skewness coefficient to determine the distribution shape of the data, as shown in Figures 1 and 2.

3.5.1. Trade balance

In (Figure 1), the average trade balance is (275908.5), with a standard deviation of (268423.8). The highest amount recorded was (874170.6), while the lowest was (3898.4). The skewness test for the trade balance data indicates a non-normal distribution, since the skewness coefficient reached (0.929). Non-normality was shown using the Jarque–Bera test, where the test value reached (6.46), with a significance level of (0.039), which is lower than the test significance level of (0.05).

3.5.2. Average oil prices

Figure 2 shows that the average variable in oil prices during 1980-2022 reached (62.59), with a standard deviation of (28.20), a maximum of (110.22), and a minimum of (11.58). The skewness test also indicates that the data of the average oil price variable series is distributed normally, with a skewness coefficient of (0.09), which is also supported by the Jarque-Bera test, where the test value was (1.47) with a level of moral significance level of (0.477), which greater than the significance level (0.05).

3.6. Results of the Unit Root Test

The ADF test as well as the unit root tests were conducted to identify the characteristics of the time series for all model variables within the study period, determine their level of stationary, and establish the extent to which each variable was integrated. As can be seen from Table 1, all variables are not stationary at level. Therefore, the unit root tests were repeated, and the results showed that the variables became stationary after first differences at the 5% significance level. Thus, the time series of these variables are integrated at the first order (1), making them suitable for applying the cointegration test among time series.

3.7. Optimal Lag Selection

Table 2 shows that the optimal number of lag periods, upon which all the criteria used are agreed upon and which have the lowest values for all the criteria, is one lag period, which is used to estimate the study model.

3.8. Bounds Testing Estimation

The *F* statistic was estimated by a bounds test to determine whether average oil prices and the trade balance have a long-term complementary relationship. The estimation results from Table 3 show an F statistics value of (4.180), which is compared to the critical value at the 5% significance level. Since the F statistic exceeds the upper critical value of (3.67), the null hypothesis rejected, and the alternative hypothesis is accepted. This indicates

Figure 1: Trade balance

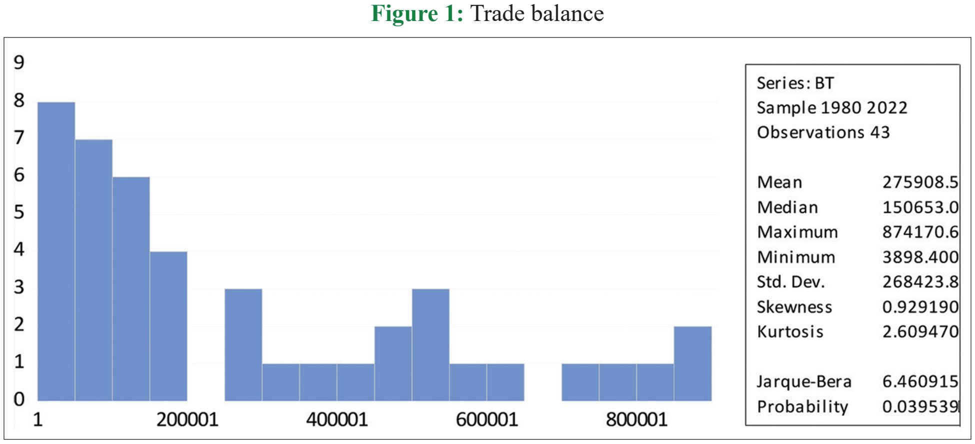


Figure 2: Average oil price

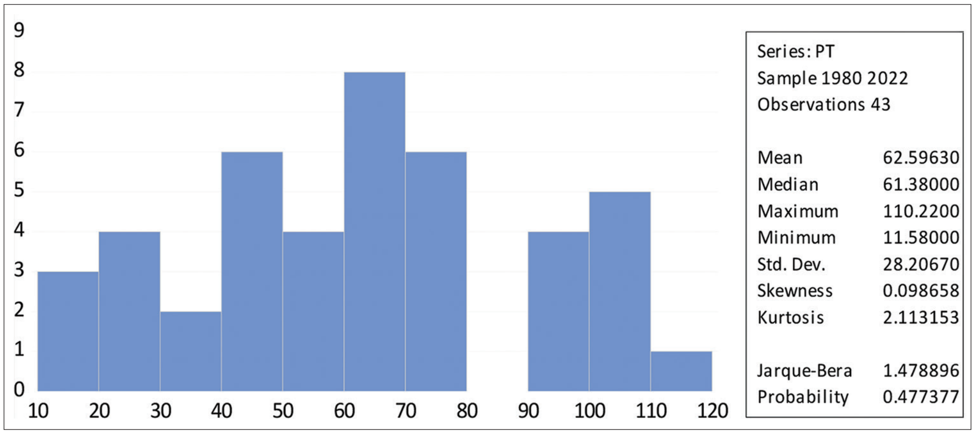


Table 1: Results of the unit root test

Variable	Intercept			Trend and intercept		
	ADF	P-value	Stationary order	ADF	P-value	Stationary
BT	−5.701	0.0000	I (1)	−5.659	0.0002	I (1)
Pt	−6.522	0.0000	I (1)	−6.491	0.0000	I (1)

Source: Output of E-views

Table 2: Criteria for selecting the optimal lag

Lag	LR	FPE	AIC	SC	O-H
0	8.986939	9.036043	8.957313	26.61757	NA
1	6.622530*	6.868046*	6.474398*	2.226119*	22.39057*
2	6.824748	7.16847	6.617362	2.575575	1.089925
3	6.830052	7.271981	6.563414	2.452808	8.518129

Source: Output of E-views

Table 3: Results of the bounds testing to cointegration

Significance (%)	I (0) Bound	I (1) Bound	F
10	2.37	3.2	4,180
5	2.79	3.67	
2.5	3.15	4.08	

Source: Output of E-views

Table 4: Estimation results of the long-run

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LOG (BT[−1])	0.824321	0.288456	3.68485	0.0009
LOG (PT)	1.062916	0.288456	3.68485	0
LOG (PT[−1])	−1.424298	0.294759	−4.832073	0
C	3.773159	1.413093	2.670143	0.0123
Adjusted R-squared=0.78			R-squared=0.80	

Source: Output of E-views

Table 5: Estimation results of the short-run

Variable	Coefficient	Std. error	t-statistic	Prob.
DLOG (PT)	1.052916	0.252688	4.206436	0.0002
CointEq(−1)	−0.175679	0.056082	-3.132536	0.0039
Adjusted R-squared=053			R-squared=0.55	

Source: Output of E-views

a cointegration and a long-run equilibrium relationship between oil prices and the trade balance.

Considering the previously presented results of the stability test and confirmation of a long-run equilibrium relationship between the dependent and independent variables, the ARDL model is estimated for the long- and short-run effects, as well as the error correction vector parameter (ECM), according to the equation described earlier and based on the number of slowdown periods specified according to the selection criteria. All estimates for the model are computed using E-views12 program, and the tables below show the estimates for modeling the effect of oil prices on the trade balance in Saudi Arabia from 1980 to 2022, with their short- and long-term effects according to ARDL.

The results of the long-run estimation in Table 4 show a statistically significant relationship between oil prices and the trade balance. The value of the oil price coefficient is (1.0629) with a probability value of (0.0009), which is less than the level of significance at (0.05). This indicates that a 1% change in oil prices increases the trade balance by 1.06%. The estimation results also reveal a positive relationship between the change in the trade balance in the previous year and the change in the trade balance in the current year, where the coefficient is (0.824) with a probability value of (0.0000). The coefficient of determination is (0.78), meaning that the oil price variable explains 78% of the changes in the trade balance, while the remaining 22% could be attributed to other variables not included in the model. This result indicates the fitness of the ARDL model in explaining the impact of oil prices on the trade balance of Saudi Arabia in the long-run. These results are similar to those reported by Alfalih (2023), Jawadi and Fitit (2019), and Faheem et al. (2020).

The results of the short-term estimation in Table 5 shows a statistically significant relationship between oil prices and the trade balance, where the oil price coefficient is (1.0529) with a probability value of (0.0002), which is less than the level of significance of (0.05). This means that a 1% change in oil prices increases the trade balance by 1.05%. The value of the error

Table 6: Diagnostic tests results

Statistics	F-statistics	P-value
Serial correlation	2.378	0.1118
Heteroskedasticity	1.904	0.1509
Normality test	1.665	0.434

Source: Output of E-views

Figure 3: CUSUM test

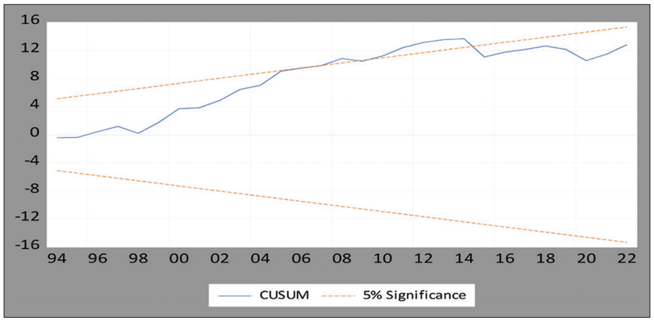
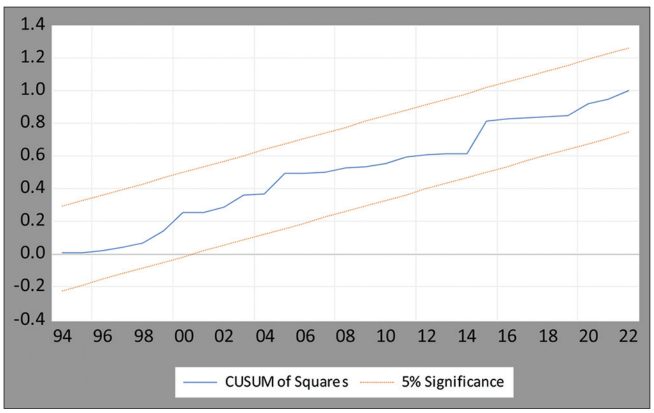


Figure 4: CUSUM of squares test



correction factor (CointEq[−1] [0.17567−]) reached a probability value of (0.0039), which is less than the level of significance of (0.05). It its negative sign confirms the existence of a long-term equilibrium relationship between oil prices and the trade balance. The speed of correction is (−0.17567), indicating that 17.6% of the deviations in the trade balance from its long-term equilibrium value in the previous period are corrected in the current period. The coefficient of determination is (0.53), indicating that the variable oil prices in the short-term explain changes in the trade balance by 53%, while 47% of these changes can be attributed to other variables not included in the model.

3.9. Stability and Diagnostic Tests

The validity of the model is assessed by ensuring that the model meets several standard criteria necessary for sound statistical inference. The most important of these criteria includes verifying the assumptions regarding the error limits. Specifically, the error limits should be independent, uniformly distributed, and normally distributed, in addition to being able to test the structural stability of the coefficients. Table 6 shows that the residuals are independent from each other, based on the Breusch-Godfrey serial correlation LM test, where the value of the F-statistic is (2.378) at a significance level of (0.1118), which is >5%. To ensure homogeneity, the Breusch-Pagan-Godfrey test was used, and the results show no statistical evidence to reject the null hypothesis. The test value is (0.1509), which is greater than the 5% significance level, confirming there is no issue with variance. Normality was also verified using the Jarque-Bera test, with a test value of (1.665) and probability of (0.434), which is greater than the 5% significance level. This suggests the residuals follow a normal distribution at a 5% significance level.

As shown in Figures 3 and 4, the cumulative sum of residuals (CUSUM) and CUSUM of squares tests were used. The CUSUM test falls within the critical limits at a significance level 5%, which indicates stability and consistency in the model estimates between the long- and short-term results. This means the estimated coefficients are structurally stable during the study period. To evaluate the model's predictive ability, the Theil equality coefficient was used. The value of the Theil coefficient is (0.078), which is close to zero, indicating the model has strong predictive accuracy. Furthermore, (Figure 4) shows a slight deviation from the maximum limits during the 2012-2016 period, which can be explained by the trade balance declining as a result of the drop in oil prices during that time.

4. CONCLUSION AND POLICY RECOMMENDATIONS

This study examined the effects of oil prices on trade balance in Saudi Arabia from 1980 to 2022. In summary, the findings of the study are as follows:

a. Unit root tests indicate that oil prices and the trade balance did not prove stable at their levels but were found to be stable after first differencing.
b. The bounds testing approach confirmed a cointegration relationship between oil prices and trade balance in Saudi Arabia. In this study, a statistically significant positive relationship between oil prices and trade balance both in the short- and long-run were found in Saudi Arabia.
c. The study demonstrated that oil price plays a significant role in explaining changes in the trade balance, with the coefficient of determination at 78% in the long-run and 53% in the short-run
d. The error correction factor revealed that deviations from the long-run equilibrium are corrected annually by 17.6% to reach equilibrium.

This study contributes to the literature by illuminating the complex relationships that prevail between oil markets and trade performance in Saudi Arabia. The need for an analysis arises from the importance of oil price, a critical determinant for an oil-exporting economy such as Saudi Arabia, which affects the trade balance dynamics of the country.

Hence, the present study provides some recommendations based on these findings:

a. Invest in technology and innovations in the oil sector to maximize efficiency and minimize production costs to enhance Saudi Arabia's competitiveness in international markets.
b. To further advance economic diversification and reduce dependence on oil exports, increase investments in promising

and attractive sectors, including industry, agriculture and tourism.

c. As Saudi policymakers work to diversify the economy and reduce oil dependence, both internally and externally, they should strengthen economic ties with emerging markets such as China, Southeast Asia, and Africa. This would help mitigate the impacts of oil price fluctuations and promote sustainable economic growth.
d. Invest financial surpluses resulting from high oil prices into sustainable development projects such as education, training, health, infrastructure, and research and innovation.
e. Strengthen trade activities to ensure the stability of the trade balance in the event of oil price fluctuations. Regular analysis of global oil markets and price forecasts should be conducted to develop proactive strategies that align with potential changes.

5. FUNDING STATEMENT

This work was supported and funded by the Deanship of Scientific Research at Imam Mohammad Ibn Saud Islamic University (IMSIU) (grant number IMSIU-DDRSP2503).

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