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RESEARCH ARTICLE

Trade Balance Dynamics in Saudi Arabia: The Interplay of Oil Prices, Exchange Rate, and Financial Development

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Abstract

This study investigates the asymmetric effects of the real effective exchange rate (REER), oil prices, and financial development on Saudi Arabia's trade balance from 1980 to 2021, employing the Non-Linear Autoregressive Distributed Lag (NARDL) model. The results reveal the presence of long-run relationships and significant asymmetries. Specifically, negative shocks to REER adversely affect the trade balance, while positive shocks exhibit no statistically significant impact. Oil prices demonstrate both immediate and asymmetric effects on the trade balance in the short and long run, though the long-run impact gradually diminishes. Moreover, financial development exerts a significant yet negative influence on the trade balance. These findings underscore the dominant role of Saudi Arabia's position as a major oil exporter in shaping its trade dynamics and highlight the complex interplay of macroeconomic factors influencing external balances.

Keywords: Trade Balance, REER, Financial Development, Saudi Arabia, NARDL.

1. Introduction

The trade balance serves as a key indicator of a nation's economic strength, with net exports playing a crucial role in driving economic growth. A surplus trade balance reflects strong productive capacity and global competitiveness, while a deficit signals economic dependence and potential vulnerabilities. Understanding the determinants of trade balance dynamics is particularly important in oil-based economies, where fluctuations in oil prices significantly influence external sector performance. Among the many factors affecting the trade balance, the exchange rate plays a pivotal role, acting as a link between domestic and international markets. Most governments, particularly in developing countries, strive to maintain exchange rate stability to support trade competitiveness and reduce balance of payments imbalances. This is especially relevant for highly open economies with persistent trade deficits, where currency fluctuations can amplify external vulnerabilities.

In oil-producing economies such as Saudi Arabia, exchange rate fluctuations and oil price volatility are critical determinants of trade balance stability. Saudi Arabia's peg to the US dollar, combined with the dominance of oil exports, makes its trade balance highly sensitive to global macroeconomic conditions. A notable example occurred in 2008 when a sharp decline in oil prices led to falling export revenues, forcing the country to draw down its foreign reserves to sustain economic stability. This dependence underscores the need for a deeper understanding of the exchange rate-trade balance nexus in oil-driven economies.

The J-Curve hypothesis provides a theoretical foundation for analyzing exchange rate impacts on trade balance dynamics. This theory implies that currency depreciation initially worsens the trade balance due to higher import costs before leading to an improvement as exports become more competitive. However, empirical evidence on the exchange rate-trade balance relationship remains mixed, especially

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in economies with fixed exchange rate regimes and commodity-export dependence, such as Saudi Arabia. While several studies have analyzed exchange rate movements in oil-exporting countries (Helmi et al., 2023; Houfi, 2023; Mahmood et al., 2017) they often fail to account for the interplay between exchange rates, financial development, and oil price shocks, leaving a gap in understanding their collective influence on trade balance dynamics. Leading to the question of whether exchange rate policies can effectively manage trade balance fluctuations or if other factors—such as financial development and oil price movements—play a more dominant role.

The trade balance in oil-dependent economies is heavily influenced by oil price fluctuations, which directly impact export revenues and external competitiveness. Studies such as Alassaf (2024) and Helmi et al., (2023) confirm the significant impact of fluctuations in oil prices on trade dynamics. Alassaf (2024), using a panel NARDL model, found that positive oil price shocks enhance GCC countries' trade balance, while Helmi et al. (2023), using a time-varying VAR model, highlighted that oil price shocks have a greater impact than oil supply shocks on Saudi trade dynamics. In addition, financial development is increasingly recognized as an important factor influencing trade. Beck, (2002) argued that financial development enhances trade balance outcomes by facilitating capital mobility, credit access, and investment—especially in non-oil sectors. However, existing studies have largely examined exchange rate, oil prices, and financial development in isolation, failing to capture their interconnected effects on trade balance dynamics.

Unlike previous research that has largely treated these factors in isolation, this study provides a more integrated approach to understanding their interconnected impact, offering new insights into the dynamics of trade balance fluctuations in an oil-dependent, fixed exchange rate economy. Using the NARDL (nonlinear autoregressive distributed lag) model developed by (Shin et al., 2014), the study analyzes both short- and long-term impacts while addressing potential asymmetries in exchange rate–trade balance interactions. Additionally, this research introduces a linearity test to assess whether exchange rate and oil price fluctuations exerts symmetric or asymmetric impact on Saudi trade dynamics, further distinguishing it from previous studies. By utilizing yearly data over the period (1980 – 2021), this study provides a comprehensive framework to understand how Saudi Arabia's trade balance responds to exchange rate changes, oil price fluctuations, and financial development under its pegged currency regime.

2. Literature Review

The J-curve phenomenon has been widely used as a theoretical framework to examine the impact of exchange rate movements on a country's trade balance. Magee, (1973) was among the first to investigate this concept in the context of the U.S. economy, noting that despite the devaluation of the U.S. dollar in 1971, the trade balance deteriorated in 1972. This paradoxical finding sparked extensive research into the lagged adjustment process of trade balances following currency devaluations. However, subsequent studies produced mixed results, largely due to variations in economic structures, trade dependencies, and methodological approaches employed across different countries.

Early empirical studies attempted to validate the J-curve hypothesis in multiple economies. Bahmani-Oskooee, (1985) employing quarterly data for the period (1973-1980) for countries such as Greece, India, Korea, and Thailand, found supporting evidence for the J-curve in most of these countries. Similarly, Yousefi & Wirjanto, (2003) examined Iran, Venezuela, and Saudi Arabia using cointegration analysis. Their findings suggested a responsive trade balance in Iran and Venezuela, while in Saudi Arabia, the effect was weaker due to structural trade rigidities. Similarly, Saqib (2013) studied the dynamics between Saudi exchange rate and trade balance using the Engle-Granger cointegration approach and found a significant long-run relationship but no short-run effect. Igue & Ogunleye, (2014) also found that currency depreciation positively influenced Nigeria's trade balance, reinforcing the argument that exchange rate adjustments can enhance competitiveness.

While these studies provided valuable insights, they largely relied on linear estimation techniques, which may oversimplify the relationship between exchange rates and trade balance dynamics. More recent studies have emphasized the importance of accounting for non-linearity in exchange rate effects, as neglecting such complexities may lead to model specification errors and misleading policy implications (Nusair, 2017; Bahmani-Oskooee & Aftab, 2017)). For example, Nusair (2017) compared linear (ARDL) and non-linear (NARDL) models for 16 European economies and found that while the linear ARDL model failed to support the J-curve, the NARDL model confirmed it in 12 countries. Similarly, Bahmani-Oskooee and Aftap (2017) applied the NARDL framework to industry-level trade data between Malaysia and the EU, finding that the non-linear model provided stronger empirical support for the J-curve, demonstrating that exchange rate fluctuations exhibit asymmetric effects across different industries.

Saudi Arabia's exchange rate dynamics have also been the focus of several recent studies, but findings remain inconclusive. Mahmood et al., (2017) analyzed the effects of currency devaluation policies on Saudi Arabia's trade balance (1970–2015) using the NARDL model. The study reported no long-run change in the trade balance following currency devaluation, while a short-term inverted J-curve effect was observed under revaluation policies. These findings support the argument that Saudi Arabia's exchange rate policies, particularly its pegged regime, limit the effectiveness of currency adjustments as a tool for trade balance improvement. The J-curve phenomenon continues to attract research interest, particularly in light of Saudi Arabia's economic development under Vision 2030. Barkat et al., (2024) examine the asymmetric impact of the nominal effective exchange rate (NEER) on GCC trade balances (2000:Q1–2017:Q4). Their results revealed a short-run negative impact of NEER increases but a long-run positive effect, suggesting that currency appreciation initially worsens the trade balance before leading to an improvement. Additionally, the study found that positive NEER changes had a greater impact than negative changes, reinforcing the role of exchange rate stability in sustaining trade balance equilibrium. A further study by Houfi (2023) investigated the relationship between the real exchange rate of the Saudi riyal and its trade balance with 13 partner countries using the NARDL model. The findings indicated a negative relationship between exchange rate fluctuations and trade balance adjustments, suggesting that Saudi Arabia's trade competitiveness is less sensitive to currency fluctuations.

Despite these advancements, most studies overlook the role that financial development and oil prices play in shaping the exchange rate-trade balance nexus. Financial development influences trade by enhancing capital mobility, credit access, and investment decisions, which in turn affect how exchange rate fluctuations impact trade balance. Ahad, (2017) found that financial development and exchange rate significantly influenced the trade balance of Pakistan in the long run. Belen, (2016), demonstrates how financial development affects Turkey's trade balance using the NARDL model, showing a negative but significant relation among the two.

Studies such as Alassaf, (2024) and Helmi et al., (2023) confirm that oil prices play a dominant role in shaping trade dynamics in oil-exporting economies. Alassaf, (2024) examine the asymmetric effect of oil price on trade balance of GCC countries usning panel NARDL technique and found that the positive aspect of oil price volatility directly and positively affects the trade balance of GCC countries. Helmi et al., (2023) applied a time-varying vector autoregressive (TV-VAR) model to assess the evolving impact of oil price and supply shocks on Saudi Arabia's trade balance. Their findings indicated that oil price shocks have a far greater effect than both global and domestic oil supply shocks, underscoring the dominant role of oil prices in shaping trade outcomes.

Given that exchange rate fluctuations affect the valuation of oil revenues and influence non-oil trade competitiveness, it is crucial to jointly examine the effects of oil price shocks and exchange rate movements on trade balance. Moreover, financial development plays an additional role by moderating trade responses to both exchange rate and oil price shocks through its impact on capital flows, credit access, and investment. Despite the interconnection between these three factors, existing research has largely examined them in isolation.

To address this gap, this study incorporates oil prices, financial development, and exchange rate movements within a unified framework, utilizing the NARDL model (Shin et al., 2014) to capture potential asymmetries in their effects on Saudi Arabia's trade balance. This approach provides a more comprehensive understanding of trade balance determinants in an economy where oil exports dominate external trade, financial sector reforms are ongoing, and exchange rate stability is a key policy concern.

In sum, we can present our hypothises as follows:

H1: The real effective exchange rate (REER) has an asymmetric impact on the trade balance, meaning that positive and negative changes in REER influence trade balance differently

H2: Financial development positively affects the trade balance by enhancing capital flows and export-oriented investments, provided credit expansion does not excessively increase imports.

H3: Higher oil prices improve Saudi Arabia's trade balance by increasing export revenues.

H4: Oil Price has an asymmetric effect on trade balance.

3. Data Description

To examine our hypothesis we use annual data from 1980 to 2021. The trade balance (TB) function is estimated using the real effective exchange rate (REER), financial development (FD), oil price (OP), and GDP per capita (GDPC), expressed as follows:

$$BTt = f(REER, FD, OP, GDPC), t = 1980, \ldots, 2021$$

Trade Balance (TB) in period t is measured as the ratio of exports to imports. Real Effective Exchange Rate (REER) measures the average change in a country's exchange rate relative to a basket of currencies, accounting for inflation differences. It reflects the overall competitiveness of a country's exports. An increase in REER indicates currency appreciation, which, according to the J-curve hypothesis, is expected to have a negative effect on the trade balance in the short run. Financial Development (FD) is represented by an aggregate index comprising nine sub-indices that assess the depth, access, and efficiency of financial institutions and markets. FD can enhance the trade balance by improving export capacity, particularly when currency depreciation increases export competitiveness. However, it may also deteriorate the trade balance by facilitating credit expansion, leading to increased demand for imports. The oil price represents the average price of crude oil in U.S. dollars. Given that oil is Saudi Arabia's primary export commodity, an increase in oil prices is expected to positively impact the trade balance by increasing export revenues. GDP per capita (GDPC) reflects the level of economic development and consumer purchasing power, which may influence trade patterns through demand for imports and exports. Data for all variables for the period 1980–2021 were sourced from the World Development Indicators (WDI) database.

The data descriptive statistics are demonstrated in Table 1:

Table 1. *Descriptive statistics*

	MIN	Median	Mean	1st Qu	3rdQu	Max
TB	0.9062	1.5738	1.6785	1.1856	1.994	2.8896
GDPC	9.887	10.043	10.121	9.991	10.144	10.952
REER	4.546	4.772	4.856	4.671	4.855	5.509
OP	2.57	3.438	3.558	2.956	4.122	4.654
FD	0.1567	0.3648	0.3677	0.313	0.4432	0.5195

The descriptive statistics in Table 1 provide insights of the distribution, central tendency, and variability of our study variables. The trade balance (TB) exhibits a moderate range, with a mean of 1.6785 and a median of 1.5738, suggesting relatively stable trade performance. GDP per capita (GDPC) remains consistent, with a mean of 10.121 and a narrow interquartile range, reflecting steady economic conditions. REER reveals minimal variation, with a mean of 4.856 and a median of 4.772, indicating that monetary policies have maintained exchange rate stability. Oil prices (OP), with a mean of 3.558 and a wider range from 2.57 to 4.654, demonstrate expected fluctuations due to global energy market dynamics. Financial development (FD) shows variation, with a mean of 0.3677 and a maximum of 0.5195, suggesting progress in the financial sector, potentially due to ongoing reforms aimed at improving financial infrastructure and access to capital. These indicators collectively provide a comprehensive picture of Saudi Arabia's economic landscape, reflecting stability in key areas while highlighting the influence of external factors such as oil price fluctuations and financial market development.

4. Methodology

In this study, we use the NARDL model to examine the asymmetric relationship between the trade balance and the independent variables, including REER, oil prices (OP), financial development (FD), and GDP per capita (GDPC). The model offers several advantages, such as its suitability for testing cointegration with small sample sizes (e.g., 37 observations in this study, covering 1980–2021), and its ability to capture non-linear relationships by considering both positive and negative shocks in REER and OP.

For the estimation process, we used R software due to its robust econometric capabilities and flexibility in model specification. However, the use of R software and the specific packages available influenced our decision to run two separate models: one for REER and the other for oil prices. This was necessary because R's current estimation tools did not support the simultaneous decomposition of both REER and oil prices into positive and negative shocks within a single model framework. Therefore, to explore the hypotheses related to the asymmetric effects of

REER and oil prices, two separate regressions were conducted (equations 2 and 3).

This approach ensures that the distinct effects of REER and oil prices are captured in isolation, providing clearer insights into their individual impacts on the trade balance. The limitation of not being able to decompose both variables simultaneously is acknowledged and could be addressed in future research by exploring other econometric techniques or software that allow for greater flexibility in this regard.

To examine hypotheses (H1-H3) The trade balance model using the NARDL approach can be specified as:

$$\Delta TB_t = \alpha_0 + \alpha_1 TB_{t-1} + \theta^+ REER^+_{t-1} + \theta^- REER^-_{t-1} + \alpha_2 OP_{t-1} + \alpha_3 FD_{t-1} + \alpha_4 GDPC_{t-1} + \sum_{i=1}^{p-1} \partial_{1i}\, \Delta TB_{t-i} + \sum_{i=0}^{q} (\pi_i^+ \sum_{i=0}^{q} (\pi_i^+\, \Delta REER^+_{t-i} + \pi_i^- \Delta REER^-_{t-i}) + \sum_{i=1}^{p-1} \partial_{2i}\, \Delta OP_{t-i} + \sum_{i=1}^{p-1} \partial_{3i}\, \Delta FD_{t-i} \sum_{i=1}^{p-1} \partial_{4i}\, \Delta GDPC_{t-i} + e_t \qquad (2)$$

The equation captures the effects of both exchange rate depreciation and appreciation.

To examine (H4) Hypothesis we use the equation where OP is decomposed to positive and negative shocks:

$$\Delta TB_t = \alpha_0 + \alpha_1 TB_{t-1} + \theta^+ OP^+_{t-1} + \theta^- OP^-_{t-1} + \alpha_2 REER_{t-1} + \alpha_3 FD_{t-1} + \alpha_4 GDPC_{t-1} + \sum_{i=1}^{p-1} \partial_{1i}\, \Delta TB_{t-i} + \sum_{i=0}^{q} (\pi_i^+\, \Delta OP^+_{t-i} + \pi_i^- \Delta OP^-_{t-i}) + \sum_{i=1}^{p-1} \partial_{2i}\, \Delta REER_{t-i} + \sum_{i=1}^{p-1} \partial_{3i}\, \Delta FD_{t-i} \sum_{i=1}^{p-1} \partial_{4i}\, \Delta GDPC_{t-i} + e_t \qquad (3)$$

Long-run (LR) effects are represented by θ^+, θ^-, α_1, α_2, α_3, α_4 while short-run (SR) effects are measured by ∂_{1i}, π_i^+, π_i^-,∂_{2i} ,∂_{3i}, ∂_{4i} where i indicates lag periods.

Δ represents the first difference of the variable, and e_t denotes the error term.

Partial sums of positive and negative changes in REER are calculated as:

$$REER_t^+ = \sum_{i=1}^{t} REEr_t^+ = \sum_{i=1}^{t} \max(\Delta x_i, 0) \qquad (4)$$

$$REER_t^- = \sum_{i=1}^{t} REER_t^- = \sum_{i=1}^{t} \min(\Delta x_i, 0) \qquad (5)$$

Partial sums of positive and negative changes in OP are calculated as:

$$OP_t^+ = \sum_{i=1}^{t} OP_t^+ = \sum_{i=1}^{t} \max(\Delta x_i, 0) \qquad (6)$$

$$OP_t^- = \sum_{i=1}^{t} OP_t^- = \sum_{i=1}^{t} \min(\Delta x_i, 0) \qquad (7)$$

Steps to Test Cointegration and Non-Linear Relationships:

- Model Estimation: Use ordinary least squares (OLS) to estimate the NARDL model.
- Cointegration Testing: Test the null hypothesis of no cointegration among variables:

$$\alpha_1 = \theta^+ = \theta^- = \alpha_2 = \alpha_3 = \alpha_4 = 0$$

- Non-Linearity Testing: Using the Wald test, assess the null hypotheses of linear relationships in the short and long run:

Long-run linearity:

$$\theta^+/\alpha_1 = \theta^-/\alpha_1$$

Short-run linearity:

$$\Sigma_{i=0}^{q} \pi_i^+ = \Sigma_{i=0}^{q} \pi_i^-$$

5. Results

5.1 Models Robustness

5.1.1 Unit Root Test

Before employing the NARDL model, it is essential to ensure that the variables are integrated at level 0 or 1 (I(0) or I(1). If any variable is integrated of order 2 (I(2)), the F-statistic used for testing cointegration becomes invalid. Additionally, time series stationarity tests are necessary to verify the stability of the variables and confirm the model's applicability. The null hypothesis of the stationarity test is that the time series is non-stationary.

Table 2. *Unit root test*

Variable	ADF-unit root test		Phillips Perron	
Integrated at	level	1st-difference	level	At 1st-difference
TB	-3.961**	5.9439***	-13.5	-31.8**
GDPC	-6.166***	3.7172**	-6.27	-35.98**
REER	-2.0577	-3.9669**	3.428	-22.08**
OP	-2.3609	-5.092***	-7.7	-38.68**
FD	-3.1929	-4.1307**	11.36	-31.028**

Note: ****, **, and * indicate that the value is significant at the 1%, 5%, and 10% levels, respectively.*

Using Augmented Dickey–Fuller (ADF), we found that the variables: trade balance, and GDP per capital (GDPC) are integrated from order I(0), while exchange rate, oil price and financial development are stationary at firs difference . Therefore, we confirmed that our variables are not stationary after their second differentiation, such information allows us to apply the NARDL model procedure.

5.1.2 Diagnostic Tests

To ensure the robustness of our estimated NARDL models, we conduct several diagnostic tests to verify that the residuals are normally distributed, uncorrelated, and homoscedastic. These tests include the Jarque-Bera (JB) test for normality, the LM test for autocorrelation, and the ARCH test for heteroscedasticity. Table 3 summarizes the results. The p-values for the JB, LM, and ARCH tests are all above conventional significance levels (10%), confirming that the residuals satisfy these assumptions.

Table 3. *Diagnostic tests*

	P - value		
Test	JB	LM	ARCH
NARDL with $^{+}_{-}$REER	0.6188	0.428	0.507
NARDL with $^{+}_{-}$OP	0.1867777	0.4229147	0.6840653

Additionally, we apply the CUSUM of Squares test to assess the stability of our NARDL models over time. Figure 1 presents the results of the CUSUM of Squares test, which assesses the stability of our NARDL models over time. The test results suggest that the NARDL model with $^{+}_{-}$OP exhibits greater stability compared to the NARDL model with $^{+}_{-}$REER, as its cumulative sum of squared residuals remains within the critical bounds for a longer period.

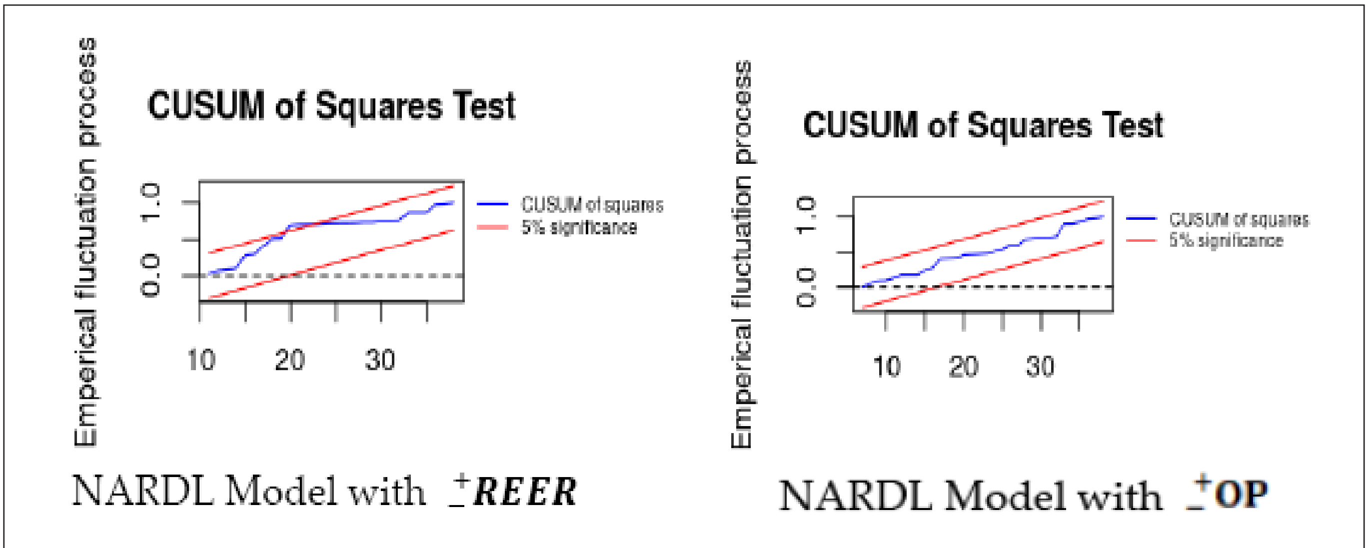

Figure 1. *CUSUM of suares Test*

5.1.3 Cointegration

We examine the presence of cointegration in three models: the ARDL model, the NARDL model where REER is decomposed into positive and negative changes, and the NARDL model where OP is separated into positive and negative shocks. The optimal lag length chosen according to Akaike's Information Criterion (AIC).

To assess cointegration the F-bound test is used for the ARDL model to determine if there is a long-run relationship among the variables. While the Pesaran, Shin, and Smith (2001) cointegration test is used for the NARDL models to confirm the presence of a long-run cointegration relationship. The Bounds F-test result for the ARDL model suggests that there is no strong evidence of cointegration at conventional significance levels. This implies that while the short-run dynamics are well captured, the long-run relationship between the trade balance and its determinants remains uncertain. However, for the NARDL models, the F-statistics are significantly higher, indicating the presence of long-run cointegration. These results suggest that incorporating asymmetries in REER and OP improves the identification of long-run relationships between the variables.

Table 4. *F-Bound test for Cointegration*

Model	F (P-Value)	Indicate cointegration
ARDL	2.5713(.3134)	NO
NARDL $^{+}_{-}$REER	29.24(1.9e-12)	Yes
NARDL $^{+}_{-}$OP	38.1(9.19e-14)	Yes

5.2 NARDL Models

Table (5) summarizes the results of NARDL models of trade balance. The findings from the NARDL at the two case (NARDL with $^{+}_{-}$REER) and (NARDL with $^{+}_{-}$OP) estimation suggest a significant long-run and short-run relationship between the trade balance (TB) and its key determinants. The findings of the two models will be discussed below:

5.2.1 NARDL with Asymmetric REER Effect

The findings of Wald-test suggest a significant long-run and short-run relationship between TB and its key determinants. The adjusted R^2 of 0.8885 indicates that the model explains approximately 89% of the variation in TB , signifying a strong fit. The error correction term (TB(-1) = -0.696) is negative and highly significant, indicating a strong adjustment process toward long-run equilibrium. This coefficient suggests that approximately 69.6% of any deviation from the long-run TB equilibrium is corrected within one period, highlighting a relatively fast speed of adjustment.

In the long run, the results reveal an asymmetric impact of REER on TB. The long-run asymmetry test (W-stat = 5.901, $p < 0.05$) confirms that the effects of exchange rate changes differ in the long run, reinforcing the importance of distinguishing between appreciation and depreciation effects. The coefficient of positive REER changes ($REER^{+}$ = 2.524) is positive but not significant. However, the coefficient of negative REER changes ($REER^{-}$ = -1.699) is statistically significant, indicating that currency depreciation improves TB over time. In economic logic, this means that a depreciation makes exports more competitive and imports more expensive. Additionally, the lagged negative REER coefficient ($REER^{-}$(-1) = 0.7302) suggests a partial reversal effect, implying that the impact of depreciation diminishes over time. TB is more responsive to currency depreciation than appreciation, supporting the J-curve hypothesis.

On the other hand, oil prices (OP = 1.0937 and lagged OP(-1) = -0.4818) have a significant effect. The positive and significant coefficient in the current period suggests that higher oil prices improve the trade balance, which is expected for oil-exporting economies. However, the negative and significant lagged coefficient implies a reversal effect, where the initial gains from higher oil prices may decline over time,, possibly due to delayed adjustments in non-oil sectors. Another important variable is financial development. Financial Development (FD) has a negative and significant effect (-1.6325)**, implying that financial sector expansion may increase imports, leading to a trade deficit. Regarding economic growth (GDP per capita, GDPC), the coefficients (-0.8128 and lagged -0.8669) are negative but not significant, indicating that GDPC does not have a strong influence on TB in the long run. Finally, The trend variable (-0.0588)* suggests a slight deterioration in the trade balance over time.

The short-run asymmetry W-statistic (2.859, $p > 0.05$) suggests that short-run effects of exchange rate changes may not be significantly asymmetric. The coefficient of $REER^{+}$ (1.7) is positive but not significant, suggesting that exchange rate appreciation has limited effects on the trade balance in the short term. However, the coefficient of $REER^{-}$ (-1.756) is significant, confirming that depreciation leads to an improvement in the trade balance.

As in the long run, oil prices (OP = 1.0937 and lagged OP(-1) = -0.4818) remain significant in the short run, reinforcing the strong influence of oil price fluctuations on the trade balance. Financial development exhibits a significant lagged effect (FD(-1) = -2.478), suggesting that changes in financial development take time to influence the trade balance.

5.2.2 NARDL with Asymmetric OP Effect

To examine whether the trade balance (TB) reacts differently to increases and decreases in oil prices, we decompose oil price (OP) into positive (OP^{+}) and negative (OP^{-}) shocks. As stated earlier, the F-Bound test confirms the existence of a long-run cointe-gration relationship among the model variables. Additionally, the R^2 value (0.893) indicates a high explanatory power. Diagnostic tests confirm that the residuals are normally distributed, homoscedastic, and free from autocorrelation. TB (-1) is negative and highly significant (-0.6559*)**, confirming that the model exhibits a stable adjustment process toward long-run equilibrium. Wald statistics of short and long run asymmetry (12.91 and 30.01, respectively) confirm significant short-run and long-run asymmetry.

The coefficient of the long run estimation is shown in Table 6. The significant and positive coefficient of the positive shocks of OP indicates that a rise in oil prices significantly improves Saudi Arabia's trade balance, highlighting the country's strong reliance on oil exports. However, the lagged effect of positive oil price shocks (OP^{+}_{-1} = -1.372**) is negative, suggesting that the initial improvement weakens over time. This could be attributed to rising oil revenues fueling higher imports, increased government spending, or capital outflows. On the other hand, negative oil price shocks (OP^{-} = 0.8953**) do not deteriorate TB as expected. Unlike many oil-dependent economies that experience immediate deficits when oil prices decline, Saudi Arabia's trade balance still improves. This resilience may stem from economic buffers such as sovereign wealth funds, fiscal adjustments, or reduced import demand during downturns.

REER is negative and significant (-0.70), confirming that currency appreciation worsens TB. A stronger currency makes exports less competitive while increasing imports, ultimately leading to a trade deficit. Similarly, GDPC is negatively associated with TB (-2.26**), indicating that higher income levels drive greater demand for imports, further worsening the trade position. Additionally, financial development has a strong negative impact (-5.0259**), suggesting that an expanding financial sector facilitates higher capital outflows and import-driven consumption, which negatively affects Saudi TB.

The short-run coefficients of the model indicate a highly significant and immediate effect of both positive and negative oil price shocks, though their impacts differ. Positive oil price shocks (OP^{+} = 1.3358**) strongly improve the trade balance in the short run; however, the lagged effect (OP^{+}_{-1} = -0.8999**) is negative, suggesting that the initial boost is followed by a correction, likely due to increased imports or capital outflows. Negative oil price shocks (OP^{-} = 0.5872**) also remain significant, indicating that TB responds to both increases and decreases in OP, potentially reflecting the role of economic buffers or fiscal adjustments in mitigating adverse effects. Additionally, REER appreciation (-0.46) has a negative impact on TB, confirming that a stronger currency reduces export competitiveness while increasing import demand, leading to a trade deficit. Moreover, the significant negative effects of GDPC and FD align with the findings from the NARDL model with REER asymmetry, reinforcing the robustness of these relationships.

Table 6. *NARDL models*

Variables	NARDL with $^{+}_{-}$REER	NARDL with $^{+}_{-}$OP
Const	17.48***	
REER	-	-0.70**
$Reer^{+}$	2.524013	-
$Reer^{-}$	-1.699**	-
$Reer^{-}$ (-1)	0.7302	-
OP	1.0937***	
OP(-1)	-0.4818***	
OP^{+}	-	2.0366***
OP^{+}-1	-	-1.372***
OP^{-}	-	0.8953***
GDPC	-0.8128	-2.26133***
GDPC(-1)	-0.8669	-
FD	-1.6325*	-5.0259***
FD(-1)	-2.02017***	-
trend	-0.0588*	-
Short run dynamic		
TB(-1)	-0.696***	-0.6559***
Const		19.6874***
Reer		-0.46**
$Reer^{+}$	1.7	-
$Reer^{-}$	-1.756**	-

$Reer^{-}$ (-1)	0.730	-
OP	1.0937***	-
OP-1	-0.4818***	-
OP^{+}		1.3358***
OP^{+}-1		-0.8999***
OP^{-}		0.5872***
GDPC	-0.8128	-1.4832***
GDPC(-1)	-0.8669	-
FD	-1.632	-3.296***
FD-1	-2.478**	-
Trend	-0.0588	-
$W\text{-stats}_{SR}$	2.859	12.91***
$W\text{-stats}_{LR}$	5.901**	30.03***
R2	0.9199	0.8929,
Adjusted R2	0.8885	0.8694

Note: ****, **, and * indicate that the value is significant at the 1%, 5%, and 10% levels, respectively.*

6. Conclusions

This study investigate the impact of REER, oil prices, financial development, and GDP per capita on the trade balance in Saudi Arabia using the NARDL model. The findings indicate that exchange rate movements and oil price fluctuations exhibit significant asymmetric effects on the trade balance in the long run. Specifically, REER depreciation and appreciation affect the trade balance differently over the long term, highlighting the importance of exchange rate policies. However, no significant short-run asymmetry is found for REER. In contrast, oil price increases and decreases show distinct effects in both the short and long run, reflecting Saudi Arabia's dependence on oil revenues and the transmission of global price shocks into the domestic economy.

Additionally, the results show a negative impact of financial development on the trade balance. This suggests that, rather than enhancing export competitiveness, financial development may encourage increased imports, potentially due to easier access to foreign financing or a growing domestic market for foreign goods. This negative effect emphasizes the need for targeted policies to improve the efficiency of the financial sector and reduce the economy's reliance on imports, fostering a more balanced trade position. GDP per capita, while significant as a control variable, does not show the same direct relationship with the trade balance, but it indirectly influences demand for imports.

While the study provides valuable insights into the trade balance dynamics in Saudi Arabia, it has certain limitations. A key constraint is the inability to simultaneously decompose both REER and oil prices into positive and negative shocks. This limitation arises due to the specific estimation approach used in R software, which does not support multiple asymmetric decompositions within the same model framework. Future research could explore alternative econometric techniques or software that allow for greater flexibility in capturing multiple sources of asymmetry. Additionally, extending the analysis to other GCC countries would offer a broader regional perspective on the interplay between exchange rates, oil prices, and trade dynamics.

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