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Understanding the Nexus between Oil Price Volatility and Trade Balance in GCC Countries: A Comparative Investigation of Panel Linear and Nonlinear ARDL Models

Ghazi Al-Assaf[1,2]*

[1]School of Business, The University of Jordan, Amman, Jordan, [2]Joaan Bin Jassim Academy for Defence Studies, Doha, Qatar.
*Email: g.alassaf@ju.edu.jo

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ABSTRACT

In this paper, we re-examine the relationship between oil price volatility and trade balance in oil exporting countries; namely GCC countries over the period 1989-2021. The empirical analysis employs a comparative approach, comparing the results obtained from a panel autoregressive distributed lag (ARDL) model with those from a nonlinear ARDL (NARDL) model. This research contributes to the literature by shedding light on the intricate linkages between energy markets and trade performance in major oil-exporting countries. The motivation stems from the importance of assessing how fluctuations in oil prices, a crucial factor for oil-exporting economies, affect their trade balance dynamics. Our empirical results depict that trade balances of GCC countries respond asymmetrically to changes in oil price although the positive oil price impacts showed greater effects on trade balance as opposed to the negative ones in the short run, the effect was reversed in the medium to long run. The findings reveal that the NARDL model provides a better fit to the data and offers richer insights into the relationship between oil price volatility and trade balances in the GCC region. Specifically, the empirical results indicate that positive oil price volatility has a greater effect on trade balances compared to negative volatility, and the speed of adjustment to equilibrium is faster in the NARDL model results. This asymmetric effect, with positive shocks exhibiting a larger influence, aligns with the expectations for oil-exporting countries. The results from the NARDL model highlight that policymakers need to account for these asymmetries when managing external trade positions in response to oil market fluctuations.

Keywords: Oil Price Volatility, Trade Balance, NARDL, GCC
JEL Classifications: C23, F14, Q43

1. INTRODUCTION

The economies of the Gulf Cooperation Council (GCC) countries which include Saudi Arabia, UAE, Qatar, Kuwait, Oman and Bahrain are one of the major oil-exporting economies with extensive dependence on the oil and gas sector. Oil revenues making the vast majority of their gross domestic product (GDP), public budgets, and foreign currencies. This extensive reliance on oil and gas as a major source of income and production as well as trade volume makes the GCC economies vulnerable to the volatility in global oil prices. Oil price fluctuations cause the oil-exporting economies to face a relatively complex and asymmetric facts, where a higher oil price can improve the trade balance by increasing export revenues (which should in turn improve the trade balance). It may lead to worsen the trade balance through import spending rise due to increased domestic income and consumption (after all, oil price has also affected domestic income and consumption), Korhonen and Ledyaeya (2010). On the other hand, decline in oil prices may result in worsening the trade balance as revenue from oil exports decreases but may also help improve the trade balance because of decreasing import demand. Farzanegan and Markwardt (2009).

This research paper exists to explore the GCC region's trade balance from different points of view and explain its sensitivity to volatile oil prices. By combining existing literature, empirical evidence, and theoretical frameworks, this paper will shed light on the fluctuations caused by the oil price on the GCC countries' trade balance, as well as provide specific insights on the dynamics specific to only the GCC. Therefore, the research comes as an attempt to answer the main following question: What is the impact of oil price volatility on the trade balance of GCC countries, and how do the ARDL and NARDL approaches differ in capturing the potential asymmetric effects of positive and negative changes in oil prices on the trade balance? By addressing this research question, the study can provide insights into the nature of the relationship between oil price volatility and the trade balance of GCC countries, as well as evaluate the relative performance of the ARDL and NARDL approaches in modeling this relationship accurately.

The current paper will be organized as follows: The next section outlines the theoretical background of the relationship between oil price volatility and trade balance. It will also provide a discussion of the review of the related literature. Section 3 present the general trends and evolution of oil prices along with the trade balance data for the 6 GCC economies. The models, data and methodological framework are discussed in section 4. Section 5 presents empirical results and discussions, while section 6 concludes.

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

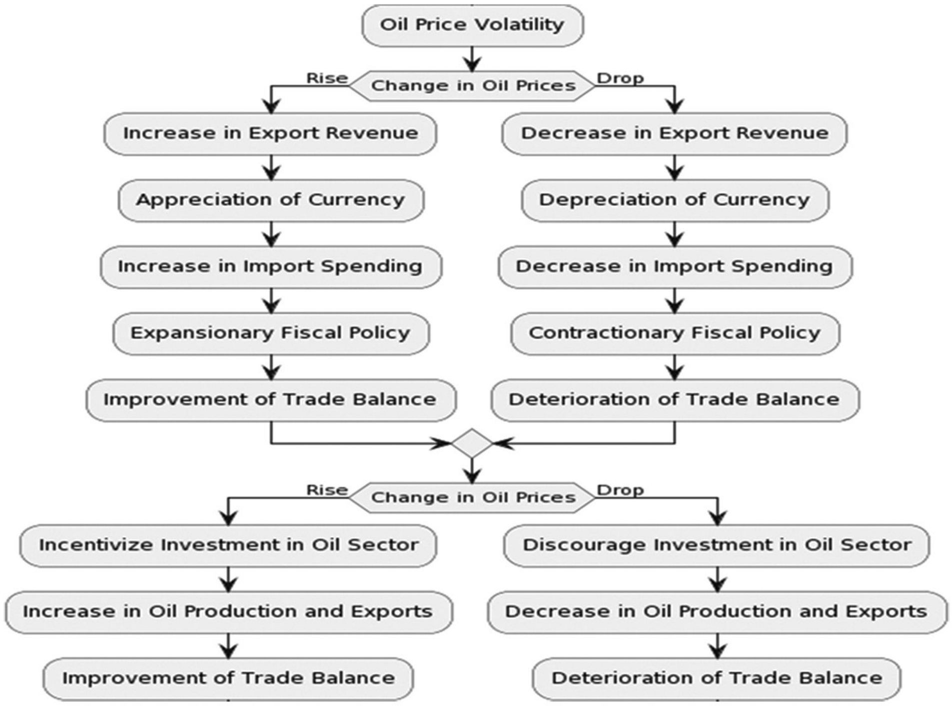
Understanding the impact of oil price volatility on trade balance requires a theoretical framework which should contribute all the major factors and mechanisms. The factor which affects the oil prices is the production costs relationship. With an increasing oil price, the production cost will also increase for goods and services such as fuel, power and others that use oil as an input. Such may result in the increase of the import cost for net importing countries, and thereby a trade-off mechanism would be triggered. Apart from the effects of oil price fluctuations on the trade balance as affected by the ties between oil prices and currency rates that are dynamic in nature, the appreciation of a currency can take place when the price of the oil is high. The exchange rate may depreciate making exports cheaper as well as the diminishing of competitiveness. However, again we need to consider the demand-side factors such as growing or shrinking of the demand also affect the change in oil price volatility that causes the change in the trade balance. Shedding light on one case of specific national economies, we can analyze situations where countries which are heavy dependable on oil imports might end up with low domestic demand for goods and services than before because of higher costs. Consequently, there will be a decline in their imports and a balance of trade may improve. In this context, the demand's response is another variable to consider. More oil-elastic countries are likely to suffer higher adverse effects from oil price volatility, because they will witness the changes in the prices causing unlike changes to their overall consumption, the ongoing trade balance, and certainly the global economy, Schubert and Turnovsky (2011).

Flowchart in Figure 1 summarizes the main effects channels through which the volatility of oil prices asymmetrically affects the trade balance of oil-exporting countries. The first effect channel is through export revenue; when the oil prices are increased, the export revenue grows and the trade balance becomes better, but if the oil prices are decreased, the export revenue tends to decrease and so does the trade balance. The second channel of impacts is through import spending, the rise in the price of oil can result in higher disposable income and import spending increases, thus further deterioration of trade balance. Then, a reduction in oil price results in lowering disposable income, and as a consequence, lowers the import expenditure which has a positive impact on the balance of trade. The other channel is through exchange rate movements, where an increase in oil prices will result in currency appreciation, making imports cheaper and exports unreasonably more expensive which has the tendency of worsening the trade balance. On the other hand, a decrease in oil prices will lead to currency depreciation, making imports more expensive and exports cheaper which can better the trade balance. However, the fiscal policy, is another effect channel of oil price volatility, which, with its increase, can be expanding fiscal policies that cause increasing imports and worsen trade balance and, with its decrease, can be contracting fiscal policies that result in reducing imports and improving trade balance. Though oil prices volatility may be an incentive to investment in the oil sector and consequently higher oil production and export can be observed, the trade balance will then improve. Although the decline in oil prices could lead to disincentive for investments in the oil sector with low oil production and exports contributed by the negatively affected trade balance.

Empirical findings demonstrate that oil price volatility can be a determining factor for the trade balances of countries, especially as a result of dealing with a global business cycle or oil market shocks. Yet, the extent of the influence of these conditions can vary greatly from country to country due to the different economic environments. Many studies showed a strong correlation between oil prices and trade balance, with diverse implications. Some cases have shown a negative relationship between oil price rises and trade balance while others have a positive or neutral impact. (See the early works of Backus and Crucini, 2000; Kilian; Bodenstein et al., 2011; Le and Chang, 2013; Rafiq et al. 2016).

Most recent studies have employed advanced econometric techniques, such as the Autoregressive Distributed Lag (ARDL) and Nonlinear ARDL (NARDL) models, to investigate this nexus. Allegret et al. (2014), in their study indicate the presence of cointegration among variables using panel techniques on GCC data from 1975 to 2010, drew conclusion of the asymmetric impact of oil prices shock, whereby the positive shocks were more influential to the trade balances as compared to negative ones. Similarly, by applying the same NARDL techniques, Nusair (2016) found out that GCC countries are also hit by trade imbalances' asymmetric impact of oil price volatility. Furthermore, Tiwari et al. (2015) utilizing a nonlinear estimation procedure observed strongly asymmetric influence that oil price shocks exerted on trade imbalances of selected oil wealth producing economies during 1980-2011. These earlier studies have broadened out

Figure 1: The effect channels of oil price volatility on trade balance of oil-exporting countries



Source: Author created by PlantUML based on the review of theoretical framework

our views, even though a need for recent analysis has emerged which deals with the time period of recent oil price volatility. Furthermore, the manner in which linear approaches and nonlinear approaches are compared during evaluations would reflect the relative performance of oil prices as a determinant of external trade positions.

Another study by Baek and Kwon (2019) investigates the effects of the changes in oil prices on the trade balances of six African countries. Using both ARDL and NARDL approaches for each country separately, the empirical results of the ARDL model with linearity show a poor result for relationship between oil prices and the trade balances. Nevertheless, the nonlinear ARDL models highlight more dynamic impacts caused by oil price volatility, especially on the oil trade balance of major oil exporting countries like Algeria, Egypt, and Nigeria. A more recent study by Alkhateeb and Mahmood (2020) also consider the asymmetrical effects of oil prices and real exchange rates on the trade balance of GCC countries. Their empirical country-specific results show significant and positive impact of an increase in oil prices on the trade balances in Oman, Saudi Arabia, and the UAE and a negative effect in Kuwait, while the oil prices reduction has positive effects on trade balance for Bahrain, Oman, Qatar, and the UAE.

Recently, for the period of 1980-2015, GCC countries asymmetric effects were revisited by Rahma et al. (2021). Their findings emphasis that these countries are nonlinearly affected by fluctuations in oil prices. Thus, they suggested that it should be taken into consideration if the oil market is going to impact figures significantly. Also, Basher et al. (2022) used a nonlinear ARDL model and showed in asymmetric impacts of oil price volatility on trade balance for key oil-exporting economies during 1980-2019. Another approach applied by Mohaddes and Raissi (2022) to assess the impact of oil price shocks on the current account balances for GCC member countries, the study employed the global vector autoregressive (GVAR) models. It showed that the oil prices were substantially influencing the volume of external trade. Similar study is also done by Forson et al. (2022) for the case of selected sub-Sahara Africa countries.

The existing literature reveals crucial outcomes about the interaction between volatility of oil prices and trade balance, especially for oil-exporting countries. Different estimates come from the use of different econometric techniques and data sets, which is the reason for the diversity of the findings obtained. Though certain studies have demonstrated a significant impact of a volatile oil price on trade balances, others have produced insignificant or diverse outcomes. Nevertheless, there is a general view that the influence of oil abundance could be dependent on its degree of dependence on oil, the level of diversification of their economies, and the nature of the exchange rates adopted by these countries. However, the literature spotlights the criticality of acknowledging the existence of nonlinear effects and asymmetry in the relations, besides the requirement of local analysis. Despite the scientific value of the current studies, there remains an inconsistency in the literature about the management of panel data analysis, which requires the incorporation of advanced econometric models for the capture of the potential of the nonlinearities and asymmetries in the context of the GCC region.

Existing studies have either employed the ARDL or NARDL approach to detect asymmetric cointegration relationships among the variables or symmetric ones. Nevertheless, the empirical findings from both methodologies within the framework of a single methodology remain unorganized. In this case, a thorough investigation may advance our knowledge on the possible distinctions, as well as the similarities, of the outcomes between these two methods of modeling, where researchers and policymakers stand to gain from the findings. The purpose of this paper is to fill in the gap in the literature by conducting a comparative empirical analysis using the ARDL model together with the NARDL approach for a better understanding of the empirical outcomes of the effect of oil price fluctuations on trade balances in GCC countries.

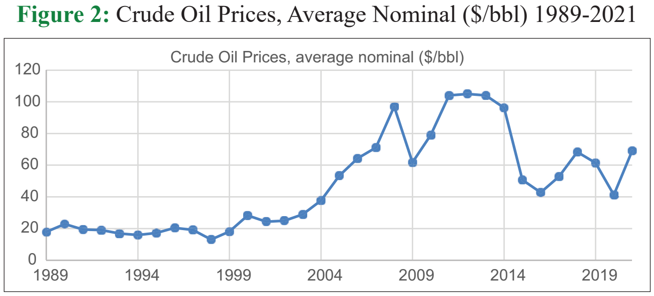
3. TRENDS IN OIL PRICES AND TRADE BALANCES OF GCC

The price of crude oil has had a huge volatility since the nineties up to 2021. According to data from the World Bank, the average nominal price per barrel was $17.84 in 1989. The prices still moderate themselves, staying between $13 and $22 per barrel during the 1990s. Nevertheless, crude oil prices exhibited a rising trend from the end of the 2000s, climbing above $53 per barrel during 2005 and almost hitting a maximum record of $97 per barrel in 2008. This impressive growth was due to a convergence of elements which included the world's demand for oil, the supply shortage, and geopolitical tensions in major producing regions.

The price spiked to exceed $100 per barrel in 2008 but then retreated in 2009 following the global economic crisis and was recorded at $61.76 per barrel. Then for the years of 2010 till 2013, the oil prices were again in fluctuations as they were between $79 and $105 per barrel. In the year 2014, the glut in supply and the drops in demand let this price to drop to $50.75 in 2015 as well as to $42.81 in the year 2016. The next year, the price has partially rebounded, averaging around $58 per barrel between 2017 and 2020, before it dropped to $41.26 in 2020, as a consequence of the COVID-19 pandemic. The latest numbers for the year 2021 show a cautious positive outlook, with the average price being $69.07 per barrel, as shown in Figure 2.

Figure 3 presents panels of 6 countries figures of trade balances including the volume of both exports and imports over the period 1989-2021. GCC's trade balances have been greatly affected by their role as principal oil exporters and their endeavor to lessen their dependency on oil which is their main source of income. Between the years of 1989 and the late 1990s, the GCC countries still enjoyed a considerable trade surplus since the supply of oil remained at a high level while the import was relatively slight.

Figure 2: Crude Oil Prices, Average Nominal ($/bbl) 1989-2021



Source: The World Bank Database

Nevertheless, with the changing oil prices and the domestic consumers' spending habits, their net positions exhibited great volatility.

The biggest part of the GCC countries' booming trade surpluses started at the beginning of 2000s, which was caused by a sharp rise in a price of oil and a robust demand for energy from around the world. Following this trend, in 2008, the GCC countries have reached the peak surplus at around $500 billion for all of them. Despite the global financial crisis of 2008-2009 and the murky crude oil market that followed, GCC countries still managed to maintain a rising trade surplus, albeit at a slower rate.

Recently, the GCC countries are still staking a positive trade balance, but individual countries have experienced relatively large fluctuations. The major oil and gas exporters namely Saudi Arabia and Qatar have consistently realized substantial trade surpluses as they persist in maintaining price competitiveness. This has made the trade balances of the United Arab Emirates, Kuwait, Oman, and Bahrain to fluctuate as they strive to achieve economic diversification and less dependency on hydrocarbon sources. Furthermore, the COVID-19 pandemic and associated supply chains disruption have impacted the trade balance of the GCC countries in 2020 and 2021.

Although the GCC countries have many similarities in their economic patterns as they are all key suppliers of oil, there are differences that are reflected in the trend of exports in the regional trade balance over the past thirty years. The two countries with the largest production and export of oil and gas in the region Saudi Arabia and Qatar have been the GCC countries with the biggest trade surpluses. The health of their trade balances has depended heavily on the grooming of global energy prices, improving during boom times and deteriorating during downturns. Oil exports still continue being the highest source of earnings for the United Arab Emirates; however, the trade balance of the country has been more moderated in the recent years, as it continues diversifying the economy and increasing the imports to benefit the non-oil sectors, i.e., tourism, financial services, and logistics.

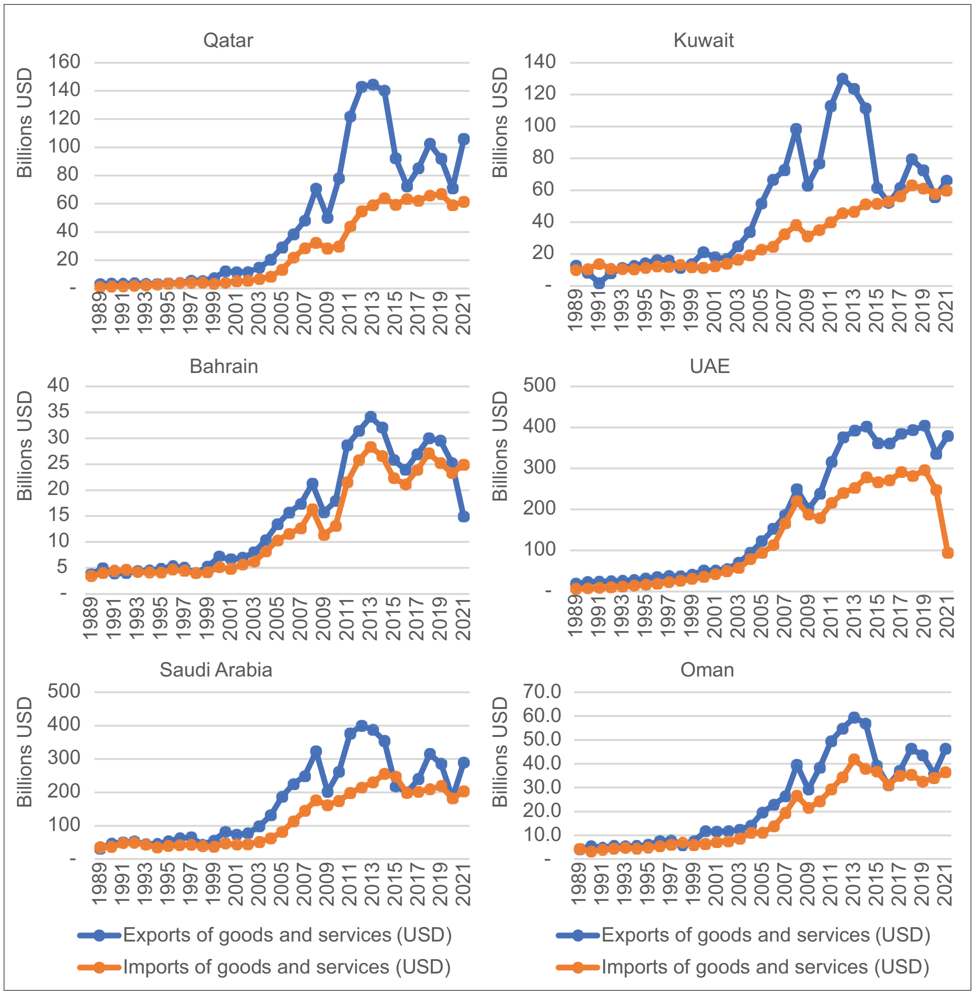
On the other hand, Kuwait, Oman, and Bahrain, with less oil and gas reserves and smaller outputs, have more sharp fluctuations in their trade balances, indicating higher volatility. In the past, the oil revenues used to make a big part of trade surplus for Kuwait, while Oman and Bahrain in some years could not keep trade balances positive, particularly during the years of low oil prices or of oversupplying the markets with goods and services.

4. MODELS, DATA AND METHODOLOGY

4.1. Data and Preliminary Analysis

This study examines the impact of oil price volatility on the trade balances of the GCC countries. The data set adopted for the empirical analysis covers annual observations for the period 1989-2021. The main component of the model is a trade balance, oil prices, and other macroeconomic variables such as GDP, exchange rates, and inflation rates. The GCC trade balance data is obtained

Figure 3: Trade balance of the GCC countries 1989-2021



Source: The World Bank Database

from corresponding national statistical agencies and central banks, while for the oil prices, the average price of a Brent barrel of crude oil per year, Brent crude oil serves as a key benchmark for pricing the crude oil produced in the Middle East, including several GCC countries. It is closely associated with the pricing and trading activities of crude oil in the region, the oil prices data obtained from the World Bank Commodity Price Data.

The stationarity of variables is an essential prior step to empirical analysis. Failure to address this issue may result in a type of regression analysis which will be misleading and hence not meaningful (spurious). Units root tests help to determine the order of integration of series in time. Various panel unit root tests will be considered for the purpose of the empirical analysis in this research. However, the selection of appropriate lag lengths for unit root tests involves the use of information criteria such as the Akaike Information Criterion (AIC) or the Schwarz Bayesian Information Criterion (SBIC). In addition, the test is conducted both with and without conditional autonomous trends, to determine whether the series has a possible conditional trend stationarity.

4.2. Methodological Framework

The impact of oil price volatility on trade balances of GCC countries is the main topic of this study which uses a comparable empirical approach and, for the sample, the ARDL model both in linear form and in nonlinear form, together with a panel data framework. This approach is devised to track the possible opposite influences of changes in oil prices on trade balances, on the other hand, with the help of cross-sectional time series method which exploits the advantages of panel data.

The classical ARDL model is a common technique employed in the analysis of cointegration in the field of panel data analysis, and was developed by Pesaran et al. (1999). The linear panel ARDL model contains an assumption of a symmetrical adjustment process where the ups and downs of oil prices alter trade balances by equally much.

This study utilizes also the nonlinear panel ARDL approach (NARDL) proposed by Shin et al. (2014). The NARDL is an extension of the original linear ARDL model. It is NARDL approach which makes it possible to come-up with partial sum decomposition of oil price variations into positive and negative variations components that can help in statistical analysis of asymmetric effects. To investigate the effect of oil price volatility on trade balances using panel data, we extend the model of Baek and Kwon (2019) as follows:

$$TB_{it} = \alpha_i + \beta_1 OPV_{it} + \beta_2 GDP_{it} + \beta_2 ER_{it} + \beta_2 INF_{it} + \varepsilon_{it} \quad (1)$$

Where:

- TB_{it} stands for the trade balance of country i at time t, expressed as a ratio of GDP.
- OPV_{it} represents the oil price volatility variable (Brent), calculated as the standard deviation of oil prices.
- GPD_{it} is the growth rate of Gross Domestic Product of country i at time t
- ER_{it} is the real effective exchange rate index, accounting for changes in the relative value of domestic currency against trading partners' currencies.
- INF_{it} is the inflation rate, capturing the effect of price changes on the competitiveness of domestic goods in international markets.
- α_i represents the country-specific fixed effects, capturing time-invariant unobserved heterogeneity across countries.
- ε_{it} is the error term, assumed to be IID.

The main methodology for this study is based on the application of a comparative ARDL panel data model using two different methods, linear and nonlinear autoregressive distributed lag (ARDL), to investigate the empirical findings. This technique is utilized in conductive study of how the changing of oil price makes countries with trade deficit or trade surplus.

The linear ARDL model can be specified as follows:

$$TB_{it} = \alpha_i + \sum_{j=1}^{p} \beta_{ij} TB_{i,t-j} + \sum_{j=0}^{q_1} \gamma_{1ij} OPV_{i,t-j} + \sum_{j=0}^{q_2} \gamma_{2ij} GDP_{i,t-j} + \sum_{j=0}^{q_3} \gamma_{3ij} ER_{i,t-j} + \sum_{j=0}^{q_4} \gamma_{4ij} INF_{i,t-j} + \mu_i + \epsilon_{it} \quad (2)$$

The NARDL model can be represented as:

$$TB_{it} = \alpha_i + \sum_{j=1}^{p} \beta_{ij} TB_{i,t-j} + \sum_{j=0}^{q_1} \gamma_{1ij}^{+} OVP_{i,t-j}^{+} + \sum_{j=0}^{q_1} \gamma_{1ij}^{-} OPV_{i,t-j}^{-} + \sum_{j=0}^{q_2} \gamma_{2ij} GDP_{i,t-j} + \sum_{j=0}^{q_3} \gamma_{3ij} ER_{i,t-j} + \sum_{j=0}^{q_4} \gamma_{4ij} INF_{i,t-j} + \mu_i + \epsilon_{it} \quad (3)$$

Where:

$$OPV_{i,t}^{+} = \sum_{j=1}^{t}{}" \, OPV_{i,j}^{+} = \sum_{j=1}^{t} max(" \, OPV_{i,j}, 0)$$

The NARDL model (equation 3) is an extension of the ARDL model (equation 2) that allows for the investigation of potential asymmetric effects of oil price volatility on trade balances. It decomposes the oil price volatility variable into positive and negative partial sum components (OPV^{+} and OPV^{-}), enabling the identification of potential asymmetries in the impact of positive and negative changes in oil price volatility on trade balances.

This methodological framework, combining linear and nonlinear ARDL models with panel data estimation techniques, offers a robust and comprehensive approach to investigating the impact of oil price volatility on trade balances. The comparative analysis of linear and nonlinear models will provide valuable insights into the nature of the relationship, accounting for potential asymmetries and nonlinearities, while the panel data estimation techniques will ensure cross-sectional heterogeneity and dependence are properly addressed. In both models, the optimal lag orders are determined using information criteria such as the Akaike Information Criterion (AIC) or the Schwarz Bayesian Criterion (SBC).

5. EMPIRICAL RESULTS AND DISCUSSION

This section will present and discuss the empirical analysis, including unit root tests, cointegration tests, and the estimation of the ARDL and NARDL models. The analysis will be based on conducting a comparative investigation between the results obtained in the two models and will focus on the short-run and long-run effects of oil price volatility on trade balance, as well as the potential asymmetric impacts captured by the NARDL model.

The LLC and IPS tests are implemented to test the null hypothesis about a unit root (non-stationarity) in the panel data series. The empirical results shown in Table 1 indicate that some of the series are stationary at a level while others are at first difference. Regarding trade balance, LLC test reject the null hypothesis at 1% significance level and, therefore, the trade balance series is stationary at the level, while IPS test cannot reject the null hypothesis at 1% significance level and, therefore, the trade balance series is non-stationary at the level. The null hypothesis in both tests, would not be rejected at conventional significance level, as oil price volatility in levels is non-stationary, according to both tests. On the other hand, after the first difference (ΔOil Price Volatility) and running both tests, both of them show a strong rejection to the alternative hypothesis at the 1% level, and so, we have a stationary at first difference. The results also show that GDP growth is revealed to be a stationary one in level with the null hypothesis being rejected at 1% significance level in the two tests. PLS (levels with LLC test), but the IPS test rejects the null at the 5% level shows the exchange rate variable is non-stationary. The first difference test (ΔExchange Rate) with a 1% level of significance, the null hypothesis is rejected in both tests, indicating that the exchange rate series is stationary at the difference, and hence it is I(1), while the inflation rate is found to be I(0).

These mixed results, with some variables being stationary at level (I(0)) and others being stationary at first difference (I(1)), show the presence of different levels of integration in the panel data. In such a situation, however, the Autoregressive Distributed Lag (ARDL) model, proposed by Pesaran et al. (2001), becomes an appropriate estimation technique for determining the long-run and the short-run relationships of the variables, irrespective of their order of integration typically, I(0) or I(1). The ARDL model can be applied to variables with either integrated I(0) or integrated I(1), thus it is highly robust technique for cointegration analysis. The ARDL model involves the estimation of the error correction model, which takes into short-run dynamics and long-run equilibrium relationship among the variables. In addition, it enables cointegration testing via bounds testing, without any pre-requisite step for the order of integration among the variables.

Table 2 presents the results of two widely used panel cointegration tests. In addition, the study employed the residual cointegration tests, the Pedroni Residual Cointegration Test, and the Kao Residual Cointegration Test. The data was made up of 6 countries and was generated over 32 years. In the Pedroni test results, five out of the seven statistics (Panel v-Statistic, Panel rho-statistic, Panel PP-statistics, Panel ADF-statistics and Group PP-statistics), are statistically significant at the two different levels of 1% or 5% show the presence of cointegration among variables in the panel data. Also, the Group ADF-Statistic is likewise signification at the 1% level, so as, it still represents the cointegration relationship.

The Kao Residual Cointegration Test result also suggests cointegration. The method asserts the same autoregressive coefficient for all cross-sections (countries), and the ADF statistic is highly significant in the 1% level. On the base of the data specific test statistic founds to be highly significant thus the null hypothesis of no cointegration can be rejected. This renders the mean assumption that variables in the panel data, with a six-country dimensions and a 32-year coverage, are expressed as a long-run equilibrium relationship.

Table 1: Panel unit root tests

Variable	LLC Test		IPS Test		Outcomes
	Statistic	P-value	Statistic	P-value	
Trade Balance	−0.134	0.002***	−0.331	0.370	I (1)
Δ Trade Balance	−5.426	0.000***	−6.718	0.000***	
Oil Price Volatility	−0.577	0.130	−1.475	0.070*	I (1)
Δ Oil Price Volatility	−7.778	0.000***	−5.214	0.000***	-
GDP Growth	−2.436	0.000***	−2.437	0.000***	I (0)
Exchange Rate	−1.410	0.080**	−2.111	0.017**	I (1)
Δ Exchange Rate	−9.013	0.000***	−8.871	0.000***	-
Inflation Rate	−2.280	0.011**	−2.339	0.009***	I (0)
Δ Inflation Rate	−8.296	0.000***	−9.993	0.000***	-

***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.
Δ represents the first difference of the variable

Table 2: Panel cointegration tests

Coint. Test	Statistic	P-value	Cointegration
Pedroni residual cointegration test			
Panel v-Statistic	2.862	0.008***	Yes
Panel rho-Statistic	−2.671	0.024**	Yes
Panel PP-Statistic	−3.124	0.000***	Yes
Panel ADF-Statistic	−3.169	0.001***	Yes
Group rho-Statistic	−1.455	0.172	No
Group PP-Statistic	−4887	0.000***	Yes
Group ADF-Statistic	−3.043	0.001***	Yes
Kao Residual Cointegration Test			
ADF	−3.943	0.000***	Yes

***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively

As concluded from the previous panel cointegration tests, there is a long-run equilibrium relationship established among variables in the panel data. The relationship can be summarized therefore as dynamic and asymmetric. The next step in this analysis is to apply the Panel ARDL and NARDL techniques. These two models can provide a thorough understanding of the time dimension (short run and long run) of the relationships between variables, including any asymmetric effects which might be present. Table 3 presents the empirical results of both Panel ARDL and NARDL models, which can be now clearly compared to achieve the main objective of the current paper.

In the ARDL model, the oil price volatility coefficient (0.184) is insignificant in the long-run, which means that oil price volatility is not the main factor for the trade balance of GCC countries. Consequently, NARDL model shows that the partial sum implied in the volatility of oil price (0.375) as positive and significant impacting the trade balance, while on the negative price volatility component (−0.247) is negative and significant, as shown in Table 3.

This empirical finding demonstrates the need for consideration of unidirectional effects in the asymmetric coatings of the NARDL model. The cases of positive oil price volatility, which is frequently correlated with better oil revenues in GCC's countries, may improve trade balance. Conversely, negative oil price volatility can also be the case where the price is weak, and oil revenue drops, may adversely affect the trade balance as well.

Regarding the long-run results obtained from the NARDL estimation, the trade balance is found to be positively and significantly affected by economic growth (0.094) in the long-run, while an appreciation of the exchange rate impacts negatively and significantly the balance at the same period (−0.067). The variables identified as being insignificant were in fact insignificant to the ARDL model, except for the GDP growth and inflation rate, which meant that the NARDL model was the best in capturing long run dynamics.

From the short-run dynamics results, the NARDL model also consistently gives more favorable outcomes in the field of statistical significance compared to the ARDL model. The direct and most significant positive sign (0.147) of oil price volatility partial sum component indicates that positive component of oil price volatility does impact directly and positively the trade balance. Nevertheless, the small negative partial sum component is found insignificant in the short run. Also, GDP growth (0.055), exchange rate (-0.039), and inflation rate (-0.074) have been found to be statistically significant variables for the NARDL model at the short-run time-frame, while they are relatively insignificant for the ARDL model. This further emphasizes the NARDL model's ability to capture the short-run dynamics more effectively.

In addition, the error correction term ECT_{t-1} is shown to be significant at the 1 percent level in both models, but with a very large coefficient (−0.741) at the one hand in comparison to the ARDL model (−0.215) on the other hand. The ECT coefficient implies that the equilibrium is self-corrected if deviations arise.

Table 3: ARDL and NARDL estimates

Dependent Variable	Trade Balance			
	Panel ARDL		Panel NARDL	
	Coefficient	t-Statistic	Coefficient	t-Statistic
Independent variable				
Long-Run coefficients				
Oil price volatility	0.184	1.612	-	-
Positive oil price volatility	-	-	0.375***	3.847
Negative oil price volatility	-	-	−0.247**	−2.315
GDP growth	0.062*	1.885	0.094*	1.794
Exchange rate	−0.028	−0.583	−0.067*	−1.712
Inflation rate	−0.147*	−1.749	−0.055*	−1.834
Short-run coefficients				
Δ Oil price volatility	0.085	1.412	-	-
Δ Positive oil price volatility	-	-	0.147***	3.024
Δ Negative oil price volatility	-	-	−0.093	−1.528
Δ GDP growth	0.029*	1.762	0.055*	1.684
Δ Exchange rate	−0.014	−0.517	−0.039*	−1.782
Δ Inflation rate	−0.032	−0.758	−0.074**	−2.043
ECT_{t-1}	−0.215***	−3.217	−0.741***	−5.483
Diagnostic Tests				
F-Statistic	15.874***		24.962***	
Breusch-Pagan LM	1.457 (0.692)		1.124 (0.771)	
Breusch-Godfrey LM	1.124 (0.570)		0.847 (0.655)	
RESET	0.924 (0.341)		0.637 (0.428)	
No. of Obs.	192		192	

***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses are P values

The NARDL model has the larger coefficient indicates a faster speed of adjustment to the equilibrium in the long term than the ARDL model.

The ECT coefficient in the NARDL model specifying the situation with the trade balance is −0.741, which means that 74.1% of disequilibrium in the trade balance would be corrected at the first period (year), while in the ARDL estimates, the ECT coefficient is found to be -0.215, which means that the correction process toward long-equilibrium would take more than 4 years. The more rapid response speed accentuates the advantage of NARDL model in explaining the process of dynamic adjustment by capturing the dynamic pattern of adjustment process more realistically.

The diagnostic tests presented at the lower panel of Table 3; (namely Breusch-Pagan LM, Breusch-Godfrey LM, and RESET) for heteroskedasticity, serial correlation and functional form misspecification indicate that both models are free of the three problems as the P-values are all insignificant. However, the NARDL model exhibits a higher F-statistic (24.962) compared to the ARDL model (15.874), indicating a better overall fit of the NARDL model to the data and economic nexus.

6. CONCLUSION

The current research presents a comparative empirical analysis by employing the ARDL (Autoregressive Distributed Lag) and NARDL (Nonlinear Autoregressive Distributed Lag) to investigate the relation between oil price volatility and trade balance of GCC countries. Based on the empirical investigation, the NARDL model outperforms the ARDL model in several aspects; Firstly, it captures the asymmetric effects of positive and negative oil price volatility on the trade balance more effectively. Secondly, it reveals statistically significant long-run and short-run impacts of GDP growth, the exchange rate, and inflation rate, which were relatively insignificant in the ARDL model. Thirdly, it exhibits a faster speed of adjustment towards the long-run equilibrium, as indicated by the larger ECT_{t-1} coefficient. Overall, it has a better overall fit to the data, as evidenced by the higher F-statistic and other diagnostic tests. These results suggest that the NARDL model provides a more comprehensive and reliable analysis of the impact of oil price volatility on the trade balance of GCC countries, accounting for asymmetries and capturing the dynamics more accurately.

Although the positive oil price impacts showed greater effects on trade balance as opposed to the negative ones in the short run, the effect was reversed in the medium to long run. It's the reliance of GCC economy on oil exports as the primary source of income is one of the factors which caused the imbalance of trade between them and others. Thus, rising oil prices are likely to result in positive trade balance which are reflected in the exports earnings.

In brief, the outcome of the study showed that the more significant effect of an increase in oil price on the balance of trade was clearer than the decrease. Surprisingly, this phenomenon is rooted deep in the potential Dutch Disease problem. Consequently, if economies encounter an oil boom, an appreciation of the real exchange rate is expected, non-oil exports become less competitive and consumption exceeds production, ultimately worsening the trade balance.

The empirical findings from the current study which utilized both panel ARDL and NARDL models, reinforce the notion that oil price fluctuations are a serious obstacle on the final picture for the international trade balances of GCC economies. Oil price shocks, as illustrated by the NARDL model, show that drastic oil price fluctuations, particularly negative ones have adverse effects on these countries. Therefore, proactive policy measures are needed to mitigate the adverse effects. Policymakers need to emphasize on declining the level of dependence on oil as well as promote non-oil sectors development and diversify production. This could be achieved by both creating advantages in terms of foreign direct investment, helping the development of the entrepreneurship and in the field of human capital development.

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