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Article

The Linkage between Oil and Non-Oil GDP in Saudi Arabia

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Abstract: Saudi Arabia is one of the world's major producers of oil. The Saudi Government has launched its vision for the coming decade: Saudi Vision 2030 (also known as 2030 Vision). Saudi Vision 2030 aims to diversify economic income and be independent of oil revenue. The focus of Saudi Vision 2030 is increasing the role of the non-oil GDP in the economy. In this study, I tried to examine the link between oil and non-oil GDP in Saudi Arabia. I used autoregressive distributed lag (ARDL) cointegration, the most common tool used to examine linkages among variables. My ARDL results confirm the long-term cointegration between non-oil GDP and oil rent, thus implying that oil rent-seeking strategies still exist in Saudi Arabia. The short-term dynamics confirmed the impact of oil rent over the non-oil GDP. The ARDL results led to analyses of asymmetric effects. The NARDL model estimated and confirmed the symmetric effect of the oil rent on non-oil GDP. These results demonstrate the challenges in diversifying Saudi Arabia's income.

Keywords: ARDL cointegration; NARDL; non-oil GDP; Saudi Arabia



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1. Introduction

Saudi Arabia is one of the world's top oil producers, providing 12% of the world share, based on U.S. Energy Information Administration (EIA) statistics in 2018. The Saudi economy is highly dependent on oil, as oil's share of the Saudi GDP in 2018 was 29% according to the Saudi Arabia Monetary Authority (SAMA). This dependence exposes the Saudi economy to oil price fluctuations, thus generating economic instability over time. Furthermore, the Saudi economy is driven by the government sector, which acquires 68% of its revenue from oil sales (SAMA statistics). On 25 April 2016, Saudi Arabia launched its 2030 Vision. The focus of 2030 Vision is on diversifying the economy and reducing the country's dependence on oil. Additionally, the government has launched several programs that have enabled the private sector to become the leading sector of the economy. Nevertheless, 2030 Vision intends non-oil GDP to be developed with high growth in the coming years.

Thirteen programs were launched in 2030 Vision, with the focus being placed on developing human capital and promoting the economy for foreign investment attraction with easy business orientation. However, economic reform poses considerable challenges for Saudi leaders, specifically regarding the behavior of the private sector, which has been spoiled with generous government spending even when the economy was facing a downturn. Conversely, non-oil GDP is a major keystone in 2030 Vision as a tool to move toward oil independence. Non-oil GDP is the sum of the government and private sectors. According to recent data from the General Authority of Statistic (GAS)—Saudi Arabia, the non-oil GDP grew at an average rate of 1.7% between 2015 and 2018. This growth rate was lower than the average growth rate of the oil sector in the same period, which was 2.15%. This raises the question as to whether non-oil GDP is linked to oil. Non-oil GDP being linked to oil would pose a serious challenge to achieving the goals of 2030 Vision, which intends to minimize oil dependence in the Saudi Arabian economy. However, in this study, I addressed this linkage by analyzing long-term cointegration and short-term dynamics between non-oil GDP and oil. This study intends to prove the existence or non-existence of

a relationship between oil and non-oil GDP, and the resulting outcomes will have economic policy implications.

2. Literature Review

Countries rich in natural resources witness economic growth only when revenue is recycled into productive and efficient economic policies (Auty 2007). Furthermore, in poor countries, the governance of natural resources focuses on wealth-accumulation activities that do not rely on rent for revenue. Conversely, in rich countries, the governance of natural resources focuses on rent as revenue. However, the role of institutions is authoritative according to institutional economists. The government of countries by weak institutions results in a lack of economic growth. SEEA policy has been implemented in both Indonesia and Malaysia to minimize the effect of natural resource abundance on their economic sustainability. The aim of this policy implementation was to limit the impact of the Dutch disease effect on their economies. Chad and Mauritania have similar economy structures. Mauritania could learn from Chad's economic development plan and, starting with SEEA policy, identify their capacity to channel oil revenue to the economic sectors for economic improvement.

Oil shocks have been consistently measured over time (Hamilton 1983). These measurements have been used to prove that oil shocks are sources of economic changes. The data rebut the idea that oil shocks could create an economic recession in the USA. However, the aggregation of strike activity and coal-price information could enable the accurate prediction of future oil prices, thus creating economic recessions. Asymmetric measurements were developed for oil shocks, to distinguish positive and negative shocks (Mork 1989). Using econometrics models to assess the impact of oil price changes on GNP growth verified an association between oil prices and economic output; furthermore, the model separated positive and negative attitudes toward oil price changes to test for the significance of new variables. The results showed that oil price increases have impacted economic output more than oil price decreases. This result has important policy implications for countries that deal with oil to conduct analyses of the effect of oil price behaviors on their economies, thus enabling the creation of effective strategies to minimize the impacts of oil prices. Furthermore, supply and demand shocks were differentiated as measures for oil shocks (Kilian 2009) using the idea that varying main variables and making the rest constant (*ceteris paribus*) will result in endogeneity amongst variables. This thought led to the idea of using oil prices as the endogenous variable in the model. The result implied that the Federal Reserve should concentrate on the underlying elements driving oil prices instead of focusing on oil prices as its main aspect. However, the variety of oil shock measurements that have been developed over time have enriched the literature regarding the study of oil fluctuations' impact on macro- and microlevel economies. Additionally, it was noted that these fluctuations spill over to the financial markets in both developed and developing economies.

Using structural VAR, researchers (Mehrara and Oskoui 2007) analyzed the influence of the behavior of four types of shock on the output in four oil-producing countries: Iran, Saudi Arabia, Kuwait, and Indonesia. Those shocks were: nominal demand shock, real demand shock, supply shock, and oil shock. A structural vector autoregression (SVAR) was designed with three assumptions: first, there are no long-term effects of nominal shocks on the real exchange rate, and demand shocks have no long-term effects on output; second, supply shocks have no long-term effects on oil price; finally, only oil shocks have long-term effects on oil prices. These results showed that oil price shocks are the main sources of output fluctuations in Iran and Saudi Arabia. However, Kuwait and Indonesia have different characteristics due to a successful saving program in Kuwait and income diversity in Indonesia. Other authors (Mehrara 2008) used a penal data framework for 13 oil-producing countries to evaluate the impact of oil revenue on economic growth. The results showed that oil revenue shocks have asymmetric and nonlinear impacts on outputs in the top oil-producing countries. However, researchers (Ghalayini 2011) studied the

differences in oil price impacts on the economic growth of different countries or groups of countries. The study related the differences among the countries to the differences in export or import of oil in those same countries. The results showed that oil import countries, especially G7 countries, have a negative relationship with oil. Conversely, oil-exporting countries have a positive relationship with the unproven Granger causality-test direction. Additionally, authors (Emami and Adibpour 2012) used SVAR to study the relationship between oil revenue shocks and economic growth in Iran. The results confirmed that oil revenue shocks in either direction, positive or negative, will be followed by asymmetric economic growth. However, negative oil revenue shocks have a strong impact on economic growth compared with positive shocks, due to lack of income diversity. Furthermore, Hamdi and Sbia (2013) studied the impact of oil revenue shocks on economic growth in the long and short terms in Bahrain. The main object of the study was to confirm if the government's enormous spending during oil price peaks can enhance economic stability afterward. The study confirmed that oil revenue is the main catalyst in the long and short term for economic growth, since oil revenue is the government's main source of revenue. The panel SVAR framework technique was used to estimate the impact of oil price shocks on economics performance in African oil-producing countries (Rotimi and Ngalawa 2017). The result showed a significant and large impact of oil shocks on economics performance. However, the interrelationship between main macroeconomics variables and oil prices in non-OPEC oil-exporting countries was analyzed within the VAR framework (Alekhina and Yoshino 2008). The result showed that oil price fluctuations have a statistically significant effect on those countries' real GDP, inflation, interest rate, and exchange rate.

The Saudi economy has distinctive characteristics as an oil-based economy. Few studies have focused on Saudi economic performance and its linkage with oil. These studies tried to differentiate between the revenue from Saudi Arabia's oil exports and its industrial consumption to determine the long-term relationship between oil revenue and real GDP growth. Alkhatlan (2013) used ARDL cointegration to find that oil revenue from exporting oil has a strong positive effect on real GDP growth in the short and long terms. Additionally, a significantly negative impact was observed for oil that is consumed domestically via the industrial sector over the real GDP in the short and long terms. Oil-price growth was applied in an ARDL cointegration model to assess the relationship with real GDP growth in Saudi Arabia (Foudeh 2017). The positive effect of oil price growth and real GDP was significant and direct. Furthermore, the study extended its analysis framework to include the trade partners of oil with Saudi Arabia. China, as the main oil trade partner with Saudi Arabia, had with no indirect effect on Saudi's real GDP. However, Japan's oil trade had a weak and positive effect on Saudi's real GDP. On the other hand, oil trading with South Korea and the UK had a significant negative impact on Saudi's real GDP. The remainder of Saudi's oil trading partners, such as the USA, India, Canada, France, and Germany, had insignificant effects on Saudi's real GDP.

Oil exports can be linked with economic growth via government expenditures that are financed by cash inflow from oil exports. Sultan and Haque (2018) examined the linkage between oil exports and government expenditure using the Johansen cointegration framework. They identified the linkage from government expenditure to economic activities via the financing of imports in Saudi Arabia by the cash generated from exporting oil. The result confirmed a positive long-term relationship between economic growth and oil exports as well as government consumption expenditure. However, imports were found to have a negative long-term relationship with economic growth, which is consistent with theory. The relationship between oil revenues and non-oil GDP growth in Saudi Arabia was analyzed (Al Rasasi et al. 2019). The authors used non-oil private activities as non-oil GDP to achieve the study objective. Using the test in Johansen and Juselius (1990), Al Rasasi et al. (2019) found that oil revenue and non-oil GDP growth have a significant long-term relationship. Furthermore, the new estimation of the non-oil GDP was proven to be more accurate than the previous measure.

Government activities in oil countries were assessed by Nili and Moslehi (2008) using the model constructed by Barro (1990) to characterize the relationship with government size as a U-shape. The examination of government activities showed a significant effect of government on economic performance. Government intervention not only has a strong negative impact on economic growth but has also deteriorated the positive effect of public goods that have been provided by the government in those countries. Others (Bjorvatn et al. 2012) studied the role of government to explain the resource curse. They estimated the panel data for 30 oil-rich countries and found that strong governments with a political power balance generate economic growth. In contrast, a weak government with oil revenue damages the impact on economic performance. Additionally, Sadeghi (2017) analyzed the impact of government size on economic performance in 28 oil-exporting countries. The larger the government, measured by government expenditure to non-oil GDP ratio, the more strongly non-oil GDP growth responds to positive oil shocks. Furthermore, non-oil GDP growth is highly volatile when the government is large. A direct association between macroeconomics variable stability and government size was also identified in those countries.

Most of the studies that focused on Saudi economic performance and oil reported results that confirm an association between economic performance and oil. However, Al Rasasi et al. (2019) studied the linkage between non-oil GDP and oil revenues to find a long-term relationship between the two variables, as this study proceeds to show. This study differs from the other studies in two aspects: First, this study uses oil rent to reflect the efficiency of using the oil wells with the lowest cost and not selling oil for foreign currency accumulation. Second, the econometrics framework provides more properties that can be used to achieving the goal of this study.

3. Data and Methodology

3.1. Data

To achieve the object of this study, datasets were acquired from different data banks. The econometrics model consists of a set of variables: real non-oil GDP, oil rent, real effective exchange rate (REER), budget deficit, and total exports and imports. The data were acquired from the Saudi Arabia Monetary Authority for the non-oil GDP and budget deficit. The non-oil GDP only represents the private sector to differentiate the impact of government that is captured by budget deficit, as well as eliminating the effect of oil revenue in the government, following the literature. The REER was acquired from the IFS database of the IMF. The exchange rate has an impact on non-oil GDP (Majidli and Guliyev 2020). Additionally, export and import data were acquired under the direction of the trade database of the IMF. The export and import measures were used to indicate trade openness to ensure competitiveness of the country with the rest of the world in using its comparative advantage; this variable is widely used in the literature for assessing GDP growth. Finally, oil rent statistics were acquired from the World Bank statistics database. This variable is the measure of the profitability of extracting oil. The data were annual and covered the period between 1980 and 2017. The notation of the variables used in the equations is as follows:

- Non-oil GDP (NOGDP): share of the real GDP;
- Oil rent (OR): difference between the world oil price and the average cost of extracting oil;
- Real effective exchange rate (REER): an index of currency change toward main trade partners' currencies reflecting the import weight;
- Total export import (TEI): share of the real GDP;
- Budget deficit (BD): share of the real GDP.

The OLS equation was estimated for NOGDP as a dependent variable. The rest of the variables (OR, REER, M, and X) are independent variables.

$$NOGDP = f(OR, REER, TEI, BD) \quad (1)$$

$$NOGDP_t = \alpha + \beta_1 OR_t + \beta_2 REER_t + \beta_3 TEI_t + \beta_4 BD_t + \varepsilon_t \quad (2)$$

The focus of the study was on non-oil GDP and oil rent, while the rest of the variables were used as control variables. These equations were used to assess the coefficient of the explanatory variables, where α is the intercept of the model; β_1 , β_2 , β_3 , and β_4 are coefficients of the explanatory variables; and ε_t is the error term of the model.

Data Description

Preparation steps were required before proceeding with the estimation of the ARDL cointegration. The first step was statically and graphically visualizing the data. Table 1 provides the descriptive statistics of the variables' data. The variables are normally distributed based on the Jarque–Bera test, except for the real effective exchange rate. However, the kurtosis range does not exceed 1.5 among the variables. The standard deviation of the real effective exchange rate indicates that data are clustered around the center, and non-oil GDP data has a negative skewness, and the rest of the data have positive skewness.

Table 1. Descriptive statistics for the variables.

	LNON_OILGDP	LOIL_RENT	LREER	LOPENNESS	BUDGET_DEFICIT
Mean	−0.912432	−1.037446	4.868264	−0.303034	−0.026215
Median	−0.910867	−1.061068	4.799570	−0.329214	−0.045098
Maximum	−0.654819	−0.327981	5.510207	−0.039753	0.298026
Minimum	−1.252083	−1.638143	4.546845	−0.578242	−0.344899
SD	0.155361	0.295046	0.295814	0.149000	0.136199
Skewness	−0.187299	0.158197	1.243833	0.117010	0.204359
Kurtosis	2.435931	2.580320	3.313378	1.889325	2.912332
Jarque–Bera Probability	0.725953 0.695603	0.437375 0.803573	9.953925 0.006895	2.039911 0.360611	0.276664 0.870809
Observations	38	38	38	38	38

Table 2 lists descriptive statistics for the data in its first difference. The standard deviation among the variables is within a small range, except for oil rent, due to the fluctuations in the oil price that was a part of calculating this variable. Additionally, the skewness difference for the data was negative, though the non-oil GDP data presented positive skewness. The mean of the data in its first difference falls within a small range relative to the mean range of the variables in Table 1. The budget deficit and the real effective exchange rate are not normally distributed based on the Jarque–Bera test.

Table 2. Descriptive statistics for the first difference of the variables.

	DLNON_OILGDP	DLOIL_RENT	DLREER	DLOPENNESS	DBUDGET_DEFICIT
Mean	0.014177	−0.030738	−0.020153	−0.009358	−0.007994
Median	0.008169	−0.040049	−0.018461	−0.001603	0.010242
Maximum	0.262816	0.425475	0.088552	0.164167	0.209838
Minimum	−0.158753	−0.541344	−0.268838	−0.178419	−0.351863
SD	0.100289	0.228204	0.063848	0.080352	0.100430
Skewness	0.823353	−0.333233	−1.726663	−0.263382	−0.747131
Kurtosis	3.466062	2.686825	7.814339	2.491354	5.367542
Jarque–Bera Probability	4.515317 0.104595	0.835979 0.658369	54.11763 0.000000	0.826644 0.661449	12.08370 0.002377
Observations	37	37	37	37	37

The variables in the data do not show any trend except for the real effective exchange rate, which shows a downward trend. This downward trend in the real effective exchange is due to the depreciation of the US dollar over time after 1987, where Saudi Arabia pegged

its Riyal to the US dollar to maintain the value of the Riyal, which is supported by oil revenue in dollar terms. Figure 1 illustrates the levels of the variables in the data.

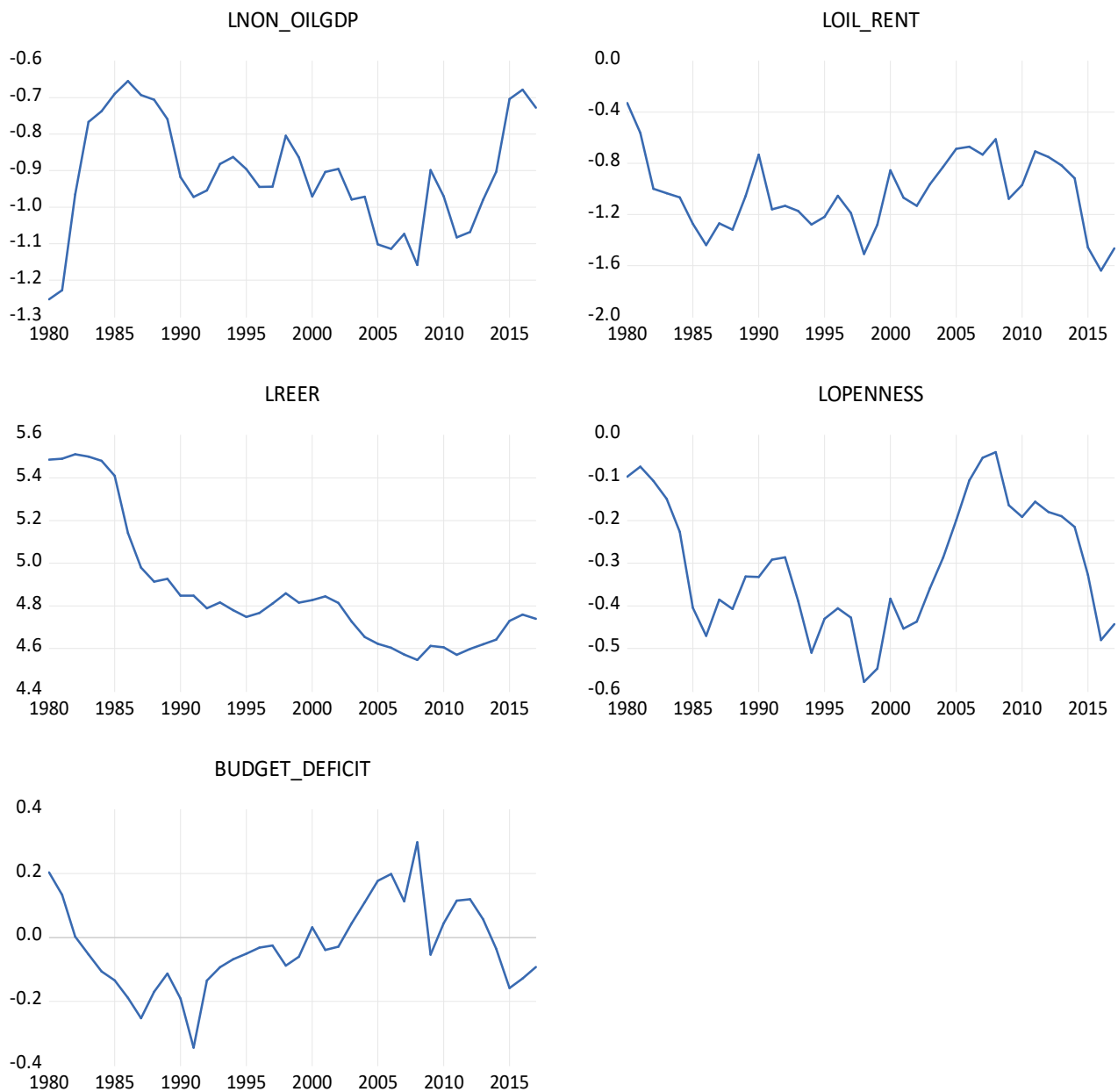


Figure 1. Variables in its level for the data.

Figure 2 illustrates the variables in its first difference. Variables mostly fluctuate on the mean, except for the real effective exchange rate, which had a strong spike in 1987. This spike was due to the shock of Black Monday on the New York Stock Exchange on 19 October 1987. The value of the US dollar against major world currencies decreased after this event, causing this spike to occur. Additionally, the decrease in oil prices in 2008 due to the mortgage crisis caused a spike in the budget deficit in the same year.

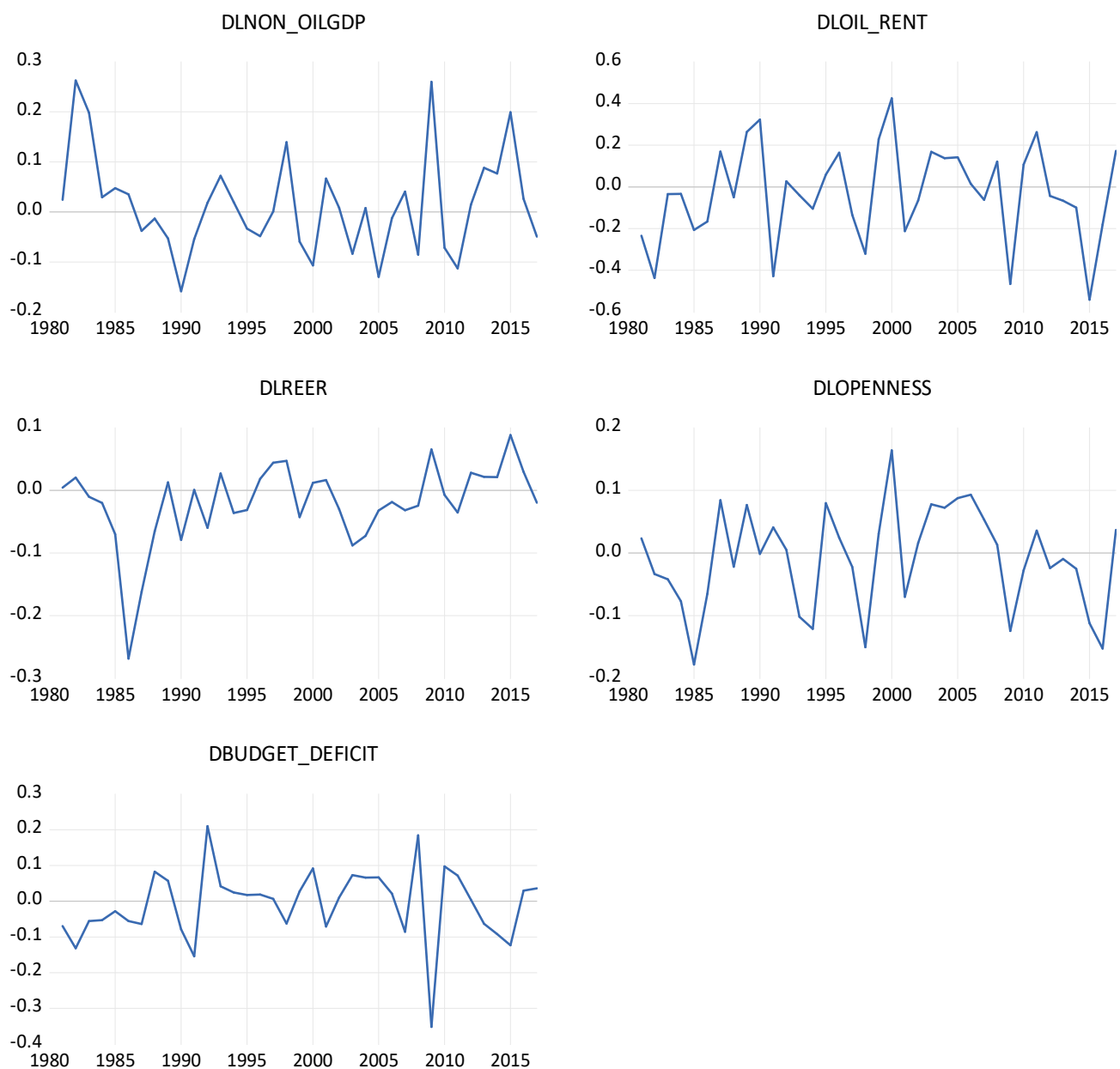


Figure 2. Variables in its first difference.

3.2. Unit Root Test

The autoregressive distributed lag (ARDL) cointegration does not require testing of the unit root as a pre-investigation of the model because the model tests for existing cointegration among the variables of order $I(0)$ or $I(1)$. Furthermore, the cointegration can be a combination of $I(0)$ and $I(1)$. Previously, data of the order $I(2)$ could not be integrated and would invalidate the ARDL bounds-testing methodology (Pesaran and Shin 1999; Pesaran et al. 2001). Therefore, all variables were tested for stationarity prior to the ARDL bounds-testing estimation. The two tests that were used were the augmented Dickey–Fuller (ADF) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests. These two tests were used to assess the unit root for variables in this study.

3.3. ARDL Cointegration Bound Test

ARDL cointegration bound testing is an econometrics method used to examine the possibility of cointegration among a set of variables. Additionally, this technique confirms if the variables will proceed toward an equilibrium in the long term and can differentiate

between long- and short-term relationships. Furthermore, ARDL cointegration is a method for testing the long-term associations among variables. The ARDL method has several advantages over the traditional cointegration method: ARDL can be estimated with I(0) and I(1) at the same time or separately and a single equation setup for ARDL makes the estimation more convenient in setting the framework as well as interpreting the outcomes. The ARDL can be estimated with an unequal lag length for the variables and for a small number of observations and is unbiased in its estimation of the long-term relationship as well the long-term parameters. Lastly, the ARDL clarifies the autocorrelation and endogeneity, since the variables are set up with lags as well as clarification of variables as dependent or independent (Harris and Sollis 2003; Jalil and Ma 2008).

$$\Delta NOGDP_t = \alpha + \sum_{i=1}^p \beta_i \Delta NOGDP_{t-i} + \sum_{i=0}^q \delta_i \Delta OR_{t-i} + \sum_{i=0}^r \gamma_i \Delta REER_{t-i} + \sum_{i=0}^d \rho_i \Delta TEI_{t-i} + \sum_{i=0}^k \sigma_i \Delta BD_{t-i} + \theta_0 NOGDP_{t-1} + \theta_1 OR_{t-1} + \theta_2 REER_{t-1} + \theta_3 TEI_{t-1} + \theta_4 BD_{t-1} + \varepsilon_t \quad (3)$$

Based on (Pesaran et al. 2001), β , δ , γ , ρ , and σ are short-term coefficients, while θ is a long-term coefficient in Equation (3). Therefore, the short-term coefficients examine the dynamic effect of the independent variables on the dependent variable. Furthermore, the long-term variable examines the speed and behavior of the adjustment toward equilibrium. However, this equation contains an error-correction model with unrestricted coefficients. For lag selection, the lag lengths for p, q, r, d, and k are determined by applying information criteria lag selection (AIC, SC, BIC, etc.).

To proceed with the estimation, the ARDL bound test must examine the existence of cointegration by setting the null and alternative hypotheses. Furthermore, the applicable tests for all lagged regressors are the t-statistic (Banerjee et al. 1998) and F-statistic (Pesaran et al. 2001). The null and alternative hypotheses are as follows:

H1: No cointegration exists.

H2: Cointegration exists.

The test was applied using the F-test with joint significance for lagged coefficients as follows:

H3: $\theta_0 = \theta_1 = \theta_2 = \theta_3 = \theta_4$

H4: $\theta_0 \neq 0, \theta_1 \neq 0, \theta_2 \neq 0, \theta_3 \neq 0, \theta_4 \neq 0$

However, the test is not a standard test for the F-test statistic because the exact critical values for the arbitrary mix of I(0) and I(1) were not available. Thus, using a previous method (Pesaran et al. 2001), the bound test table was applied for that test. The table showed an asymptotic distribution of the F-statistic for various cases. Furthermore, the study sample is relatively small, and Narayan (2005) provided the F-statistic for a small sample size. Therefore, the table in Narayan (2005) was applied for hypothesis testing as well for robustness checking.

To proceed with the test, rejecting or accepting the null hypothesis relies on comparing the test statistic with the critical value in the table. If the test statistic is greater than I(1), there is a long-term cointegration among the variables, since the F-test considers all variables in the model. If the test statistic is less than I(0), there is no possible long-term cointegration among the variables. However, if the test statistic falls in between the two boundaries, then it is ambiguous and a decision is unclear in this case; thus, another cointegration technique should be applied.

For a cross check, a bound t-test was conducted for hypotheses testing (Giles 2011). The hypotheses were as follows:

H5: $\theta_0 = 0$

H6: $\theta_0 < 0$

The rule for the test is similar to the bounded F-test to accept or reject the null hypothesis. Therefore, if the t-statistic for $NOGDP_{t-1}$ is greater than the I(1) boundary that is stated in (Pesaran et al. 2001), a long-term relationship exists between the variables and the robustness is verified for the bound F-test. However, if the t-statistic is less than I(0), the data for all variables are stationary.

The short-term estimation was applied using the error correction mechanism (ECM) to conduct the acceleration, speed, and magnitude of the adjustment when the model entered disequilibrium.

$$\Delta NOGDP_t = \alpha + \sum_{i=1}^p \beta_i \Delta NOGDP_{t-i} + \sum_{i=0}^q \delta_i \Delta OR_{t-i} + \sum_{i=0}^r \gamma_i \Delta REER_{t-i} + \sum_{i=0}^d \rho_i \Delta TEI_{t-i} + \sum_{i=0}^k \sigma_i \Delta BD_{t-i} + \varphi ECM_{t-i} + \varepsilon_t \quad (4)$$

From Equation (4), the ECM adjusted the model in the long term to converge to its equilibrium after short-term shocks were accrued. Without missing long-term information, the ECM integrated the short- and long-term coefficients in the model. φ is the long-term causality and should have a negative sign to represent the convergence of the model to the equilibrium as well as a significant coefficient.

3.4. Diagnostic Test for the Model

The ARDL bound test assumes that the error term in Equation (2) is serially independent and normally distributed. Thus, the LM test was used to test the serial independence, and the Jarque–Bera test was applied for testing the normality of the error term in the model. The Breusch–Pagan–Godfrey test was used to test the existence of heteroscedasticity in the model.

3.5. Stability Test of the Model

The dynamic stability of the model provides an assurance that the model has an autoregressive structure, which was a requirement in this case. CUSUM and CUSUM squares are the two tests that were applied (Brown et al. 1975; Pesaran and Pesaran 1997).

3.6. Granger Causality Test

Cointegration among variables indicates a causality among them. The causality could be one- or two-way. Granger (1969) stated that correlation measurements among variables are not sufficient to understand their relationships due to the absence of the indirect relationship of a third variable in the framework. Furthermore, the existence of cointegration should be double-checked by assessing the causality among the variables. As such, the VAR model was applied to examine the absence of Granger causality as follows:

$$Y_t = \alpha_0 + \sum_{j=1}^m a_j Y_{t-j} + \sum_{j=1}^m b_j X_{t-j} + u_t \quad (5)$$

$$X_t = \sigma_0 + \sum_{j=1}^m c_j X_{t-j} + \sum_{j=1}^m d_j Y_{t-j} + \mu_t \quad (6)$$

where u_t and μ_t are not correlated and are white-noise series, $E[u_t u_s] = 0$, and $E[\mu_t \mu_s] = 0$, on the condition that $t \neq s$. However, m is infinite and does not exceed the length of the data under study.

The test followed the hypothesis for accepting or rejecting the null hypothesis. The hypotheses set for Equation (4) are $H_0 = b_1 = b_2 = \dots = b_m = 0$ and $H_1 : Y$ Granger causes X . Additionally, the hypotheses set for Equation (5) are $H_0 = d_1 = d_2 = \dots = d_m = 0$ and $H_1 : X$ Granger causes Y . Therefore, if the null hypothesis is rejected in either of those tests, it suggests that there is a Granger cause existence. However, if the null hypothesis is rejected in both cases, it implies there is feedback from the two variables. If the null hypothesis is accepted in both cases, it means no long-term cointegration exists between the two variables. This coincidence can occur when the data are insufficient to satisfy the asymptotics of the ARDL cointegration and causality test, which will also contradict the ARDL cointegration result (Giles 2011). Furthermore, a_j 's and c_j 's are the short-term dynamics between Y_t and X_t . Those coefficients lead to movements in the short term once the other variable changes. However, the appropriate lag length must be specified to proceed with the estimation using the AIC.

3.7. Nonlinear Autoregressive Distributed Lag (NARDL) Model

Equation (2) assumes that oil rent has a symmetrical effect on non-oil GDP. This raises the question of whether the assumption that oil rent affects non-oil GDP symmetrically over time is valid. This question addresses the fluctuations in oil rent over time, which may have an asymmetric effect on non-oil GDP. The possibility of the asymmetry of the independent variable affecting the dependent variable was addressed using a nonlinear autoregressive distributed lag (NARDL) model (Shin et al. 2014). Mensi et al. (2018) analyzed the impact of oil production on non-oil GDP and found that oil production positively affects non-oil GDP. However, the impact of oil production on non-oil GDP is asymmetric; the positive and negative shocks of oil production have different effects on non-oil GDP. Furthermore, other researchers (Moshiri and Banihashem 2012; Charfeddine and Barkat 2020) have addressed the impact of oil shocks and oil revenue as well as gas revenue on economic growth. Moshiri and Banihashem (2012) investigated the impact of oil shocks on both oil-exporting and -importing countries. They found that higher oil prices have a stronger impact on economic growth than lower oil prices. Additionally, Charfeddine and Barkat (2020) analyzed the impacts of oil prices, oil revenue, and natural gas revenue on the real GDP and the non-oil GDP. They found a stronger impact of negative than positive shocks of the oil price, oil revenue, and natural gas revenue on the real GDP and non-oil GDP. Zhu et al. (2016) assessed the oil shocks in the importing oil economy, examining the impact of oil shocks on the Chinese stock returns. Their results showed variation in the outcomes in different markets stages and found that oil shocks have an asymmetric effect on market returns. The outcomes of various studies (Shin et al. 2014; Mensi et al. 2018; Moshiri and Banihashem 2012; Charfeddine and Barkat 2020; Zhu et al. 2016) motivated my consideration of nonlinear cointegration since oil rent was the focus of this study.

Considering the symmetric and asymmetric effects of oil rent requires rewriting oil rent to represent the upward and downward changes in the series. A positive change (OR_t^+) represents an increase in oil rent, and a negative change (OR_t^-) represents a decrease in oil rent. These new variables were generated using the partial sum concept, as stated in Equations (7) and (8). Thus, $ORPos$ and $ORNeg$ in Equation (3) are replaced to provide Equation (9).

$$ORPos_t = \sum_{k=1}^n \Delta OR_t^+ = \sum_{k=1}^n \max(OR_t, 0) \quad (7)$$

$$ORNeg_t = \sum_{k=1}^n \Delta OR_t^- = \sum_{k=1}^n \min(OR_t, 0) \quad (8)$$

$$\begin{aligned} \Delta NOGDP_t = & \alpha + \sum_{i=1}^p \beta_i \Delta NOGDP_{t-i} + \sum_{i=0}^q \delta_i \Delta ORPos_{t-i} + \sum_{i=0}^m \psi_i \Delta ORNeg_{t-i} + \\ & \sum_{i=0}^r \gamma_i \Delta REER_{t-i} + \sum_{i=0}^d \rho_i \Delta TEI_{t-i} + \sum_{i=0}^k \sigma_i \Delta BD_{t-i} + \theta_0 NOGDP_{t-1} + \theta_1 ORPos_{t-1} + \theta_2 ORNeg_{t-1} \\ & + \theta_3 REER_{t-1} + \theta_4 TEI_{t-1} + \theta_5 BD_{t-1} + \varepsilon_t \end{aligned} \quad (9)$$

Equation (9) is characterized as a nonlinear autoregressive distributed lag (NARDL), since it contains the partial sum process within the equation considering the positive and negative change in oil rent. However, the NARDL model is estimated using the same procedure as for the ARDL model. $\Delta ORPos$ and $\Delta ORNeg$ represent the symmetric and asymmetric effect of the oil rent over the non-oil GDP, respectively. Critical values are applied for NARDL cointegration to test the calculated F against F_{PSS} and t_{BDM} (Pesaran et al. 2001; Banerjee et al. 1998). Thus, if the calculated F is greater than F_{PSS} and t_{BDM} , long-term cointegration is implied. The standard Wald test of the distributed χ^2 with one degree of freedom was used to analyze the long-term symmetric effect by testing $H_0 : \delta_i = \psi_i$ against $H_1 : \delta_i \neq \psi_i$. Furthermore, the test was applied for the short-term effect as $H_0 : \theta_1 = \theta_2$ against $H_1 : \theta_1 \neq \theta_2$. However, if the test fails to reject the null hypotheses for the long- or short-term effect, it means there is a symmetric effect of oil rent on the non-oil GDP. Conversely, if the test indicates there is not enough evidence to accept the null hypotheses, it means the effect of oil rent on non-oil GDP is asymmetric.

The error correction form was estimated using Equation (10) to ensure the convergence of the model on its equilibrium in the short term, in case disequilibrium occurs. Equation (10) was estimated with optimum lags that were driven from the ARDL ($n_1, n_2, n_3, n_4, n_5, n_6$).

$$\Delta NOGDP_t = \alpha + \sum_{i=1}^p \beta_i \Delta NOGDP_{t-i} + \sum_{i=0}^q \delta_i \Delta ORPos_{t-i} + \sum_{i=0}^m \psi_i \Delta ORNeg_{t-i} + \sum_{i=0}^r \gamma_i \Delta REER_{t-i} + \sum_{i=0}^d \rho_i \Delta TEI_{t-i} + \sum_{i=0}^k \sigma_i \Delta BD_{t-i} + \varphi ECM_{t-i} + \varepsilon_t \quad (10)$$

φECM_{t-i} has to be negative and significant to have long-term equilibrium in the model. However, the size of φ indicates the amount that will be corrected in the short term to converge again on the equilibrium.

The asymmetric cumulative dynamic multiplier was used to determine the robustness of the result of the asymmetric effect of oil rent on non-oil GDP. The cumulative dynamic multiplier (CDM) incorporates a unit change in the effect of x_t^+ and x_t^- on y_t , as shown in Equation (11).

$$m_h^+ = \sum_{j=0}^h \frac{\partial NOGP_{t+j}}{\partial OR_t^+} m_h^- = \sum_{j=0}^h \frac{\partial NOGP_{t+j}}{\partial OR_t^-} \quad h = 0, 1, 2, \dots \quad (11)$$

Note that when $h \rightarrow \infty$, $m_h^+ \rightarrow \beta^+$ and $m_h^- \rightarrow \beta^-$, as β^+ and β^- are calculated as follows: $\beta^+ = \frac{\theta_1}{\theta_0}$ and $\beta^- = \frac{\theta_2}{\theta_0}$.

4. Estimation and Finding

4.1. Unit Root Test

Autoregressive distributed lag (ARDL) cointegration requires the variables being studied not to exceed I(1) to be implemented in the model. The second step before proceeding to ARDL cointegration is testing for the unit root of the variables. The unit root test for stationarity ensures the integer rank of the series which stated in Table 3 by using the augmented Dickey–Fuller (ADF) test and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test for the variables in its level in the model. The reason for performing the ADF and KPSS tests was to ensure the stationarity of the series by using two different methods with opposite null hypotheses. The ADF test result shows that no variables except the oil rent series were stationary (statistically significant at the 5% level). From this result, the null hypothesis was rejected, indicating that the alternative hypotheses of stationarity of the series are supported. However, the KPSS test results showed that the variables were stationary, except for the real effective exchange rate series, which was statistically significant at the 1% level. This result led to a rejection of the null hypothesis, supporting the alternative hypotheses of the nonstationarity of the series. The unit root test in both data level and its first difference confirmed that one of the series was ranked I(0) order, which is the oil rent. Having variables with different ranks permitted the use of the ARDL cointegration method given that none of the variables is ranked I(2).

Table 3. Unit root test result of the data in its level.

Variable	ADF		KPSS	
	H0: Variable Has a Unit Root		H0: Variable Is Stationary	
	Intercept	Intercept and Trend	Intercept	Intercept and Trend
Non-oil GDP	−2.578961 (0.1063)	−2.678587 (0.2507)	0.12809	0.0970256
Oil rent	−3.082564 ** (0.0367)	−3.061880 (0.1302)	0.101389	0.108633
REER	−2.419564 (0.1435)	−0.764536 (0.9600)	0.777435 ***	0.189787 **
Openness	−1.836196 (0.3578)	−2.648418 (0.2627)	0.150616	0.143146 *
Budget deficit	−2.696718 * (0.0842)	−3.082067 (0.1254)	0.284958	0.123577 *

*, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. *p*-values are indicated in parentheses.

Table 4 lists the results of the ADF and KPSS tests for the stationarity of the variables in their first difference. The ADF results show that all variables are stationary in the first difference (statistically significant at the 5% level). The KPSS test results show that the variables were stationary in their first difference, resulting in failing to reject the null hypotheses with no trend. The budget deficit series must reject the null hypotheses with 5% statistical significance in their first difference, indicating a trend in the test. However, visualizing the series at the first difference in Figure 2 confirms the lack of a trend in the series. Per the unit root test result, non-oil GDP, REER, openness, and budget deficit are of I(1) order, whereas oil rent is of the order I(0). The unit root test results for both methods confirm that one of the series is of the order I(0), which is the oil rent. The testing of variables with different ranks permitted the use of the ARDL cointegration method. Additionally, the unit root test confirmed that no series is of the order I(2), which would not be applicable in the ARDL cointegration procedure.

Table 4. Unit root test result for the data in its first difference.

Variable	ADF		KPSS	
	H0: Variable Has a Unit Root First Difference		H0: Variable is Stationary First Difference	
	Intercept	Intercept and Trend	Intercept	Intercept and Trend
Non-oil GDP	−4.914160 *** (0.0003)	−4.864846 *** (0.0020)	0.135416	0.127208 *
Oil rent	−5.893782 *** (0.0000)	−5.804781 *** (0.0002)	0.141058	0.129084 *
REER	−3.452574 *** (0.0154)	−3.892281 ** (0.0227)	0.31768	0.0539674
Openness	−4.601235 *** (0.0007)	−4.545597 *** (0.0046)	0.125626	0.143146
Budget deficit	−7.360451 *** (0.0000)	−7.278868 *** (0.0000)	0.175729	0.152582 **

*, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. *p*-values are provided in parentheses.

4.2. Autoregressive Distributed Lag (ARDL) Cointegration Model Estimation

For ARDL cointegration, the Akaike information criterion (AIC) was used to determine the optimum lag-length distribution for the model as the non-oil GDP was the dependent variable in the model. The AIC suggested the model lag distribution for the ARDL was (1, 1, 0, 2, 1), as shown in Table 5. Thus, the optimum lag length for the variables non-oil GDP, oil rent, REER, openness, and budget deficit were $p = 1$, $q = 1$, $r = 0$, $d = 2$, and $d = 1$, respectively.

Table 5. Estimated primary ARDL model.

Variable	Coefficient	t-Statistic	Probability
LNON_OILGDP(-1)	0.495306 ***	4.567575	0.0001
LOIL_RENT	−0.279863 ***	−4.200282	0.0003
LOIL_RENT(-1)	−0.123284	−1.524708	0.1394
LREER	0.109591 ***	3.667362	0.0011
LOPENNESS	−0.001030	−0.006999	0.9945
LOPENNESS(-1)	0.454976 **	2.525987	0.0180
LOPENNESS(-2)	−0.190677	−1.614140	0.1186
BUDGET_DEFICIT	−0.252568 **	−2.272039	0.0316
BUDGET_DEFICIT(-1)	0.357607 ***	3.499279	0.0017
C	−1.318678 ***	−6.207564	0.0000

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

4.3. Diagnostic Test for the Model

For the ARDL bound test, the ARDL cointegrating model should be tested to ensure that the model does not contain serial correlation or heteroscedasticity to ensure that the model is normally distributed. The R^2 value for the model is 0.9391, and the adjusted R^2 is 0.9180, which implies that almost 94% of the variation in the dependent variable can be explained by the model, and the remaining can be explained by the error term. The Durbin–Watson statistic is 1.6456. By comparing the critical value in the DW table, which is 1.587 for $n = 36$ and $k = 5$, I found the statistic exceeds the critical value; thus, the model is not spurious. The F-statistic is 44.579 with a *p*-value of 0.0000, indicating that the null hypotheses was rejected for the zero coefficients. Table 6 provides the test results for serial correlation (Breusch–Godfrey serial correlation LM), heteroscedasticity (Breusch–Pagan–Godfrey), and normality (Jarque–Bera). The model passed the tests, as shown in Table 6.

Table 6. Model diagnostic tests results.

Test	χ^2	Probability
Breusch–Godfrey Serial Correlation LM Test	1.456088	0.4829
Breusch–Pagan–Godfrey Heteroscedasticity Test	4.643201	0.8642
Jarque–Bera Test	0.764979	0.6821

4.4. Stability of the Model

The ARDL cointegration model should be tested for the structural stability of the parameters in the long term to ensure the robustness of the result. [Brown et al. \(1975\)](#) suggested applying the cumulative sum of the recursive residual (CUSUM) and cumulative sum of the recursive residual of squares (CUSUMSQ) to ensure the long-term stability of the parameters in the model. The CUSUM and CUSUMSQ results are presented in Figures 3 and 4, respectively, with 5% significant levels. The test requires that the plots of CUSUM and CUSUMSQ remain between the 5% critical bounds to ensure the significance of the parameters in terms of the constancy and stability of the model. In this study, the plots for CUSUM and CUSUMSQ are between the 5% boundaries, implying that the model is stable and there was no systematic change in the coefficients over the study period.

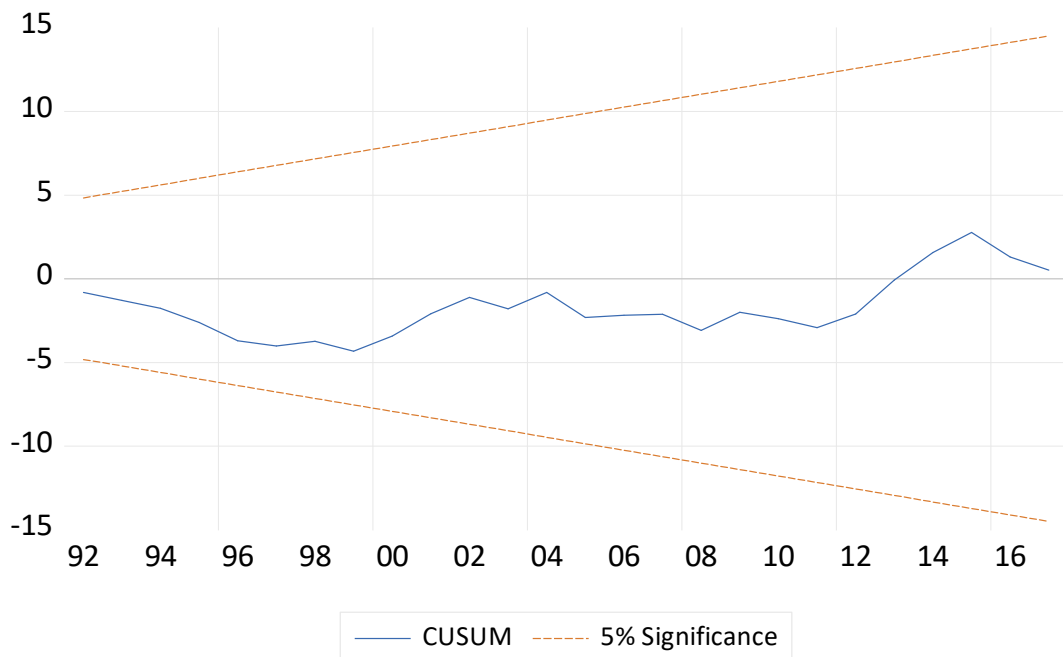


Figure 3. Plot of CUSUM test results.

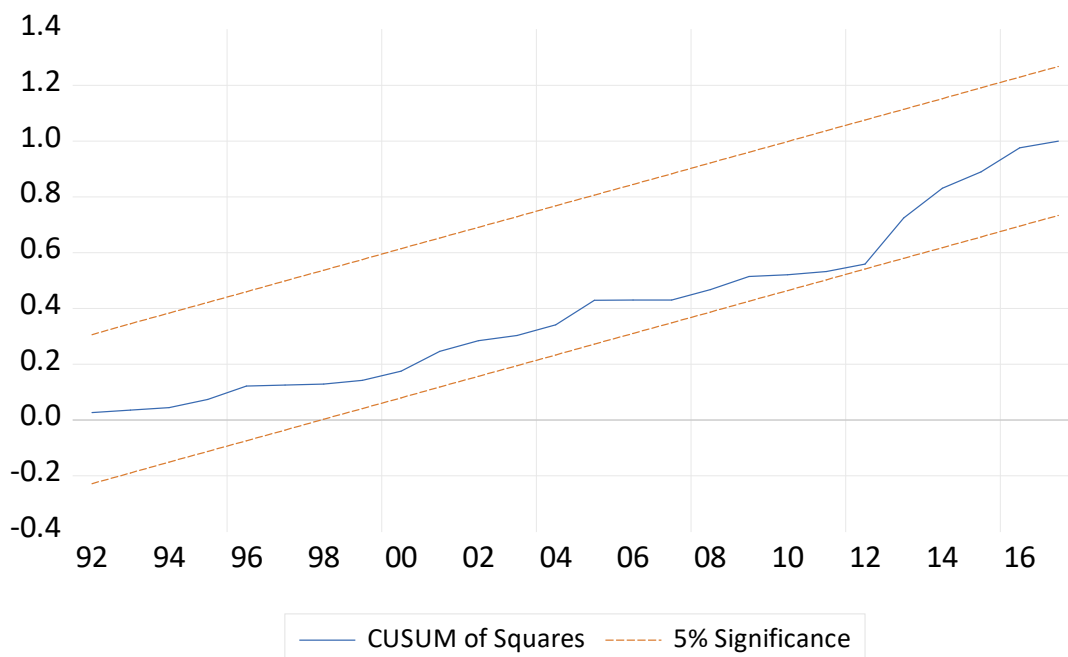


Figure 4. Plot of CUSUMSQ test results.

4.5. ARDL Cointegration Bound Test

The model passed the diagnostic test, so I could proceed with the bound test for cointegration. By estimating the ARDL cointegration model with a lag length of (1, 1, 0, 2, 1), the F-statistic associated with this estimation was found to be 10.47393. Therefore, testing the existence of cointegration among the variables required the F-statistic to be compared with the critical values in Table CI(iii), case III in (Pesaran et al. 2001, p. 300) and case III in (Narayan 2005, p. 1988). Table 7 lists the critical values for $k = 4$ (Pesaran et al. 2001), which is the number of independent variables, and $k = 4$, $n \approx 40$ for (Narayan 2005). The F-statistic exceeds the upper bound of both the Pesaran and Narayan critical values at the 1% level, indicating evidence of a long-term relationship between the variables in the model.

Table 7. Bound test for Pesaran and Narayan critical values.

Critical Values	Pesaran		Narayan	
	Lower Bound I(0)	Upper Bound I(1)	Lower Bound I(0)	Upper Bound I(1)
1%	3.74	5.06	4.428	6.250
5%	2.86	4.01	3.202	4.544
10%	2.45	3.52	2.660	3.838

4.6. Cross Check for Cointegration

The t-statistic for $Non_oil\ GDP_{t-1}$ should be compared with the critical value in Table CII (iii), case III in [0] (p. 303). The critical 1%, 5%, and 10% values at $k = 4$ are stated with the lower bounds of I(0) and upper bounds of I(1) $[-3.43, -4.60]$, $[-2.86, -3.99]$, and $[-2.57, -3.66]$. The t-statistic for $Non_oil\ GDP_{t-1}$ is -4.6541 , which exceeds the I(1) bound at the 1% level, indicating the robustness of the conclusion regarding the long-term relationship among the variables.

4.7. Long- and Short-Term Relationships

4.7.1. Long-Term Relationship

The long-term relationship among the variables was tested, and the model was tested for serial correlation, heteroscedasticity, and normality to ensure the statistical properties of the estimation. Table 8 provides the long-term estimation results of the variables. Non-oil GDP is significant at the 1% level, with a negative sign, ensuring cointegration in the model. Oil rent is significant at the 1% level and has a long-term negative effect on non-oil GDP. This result is consistent with those previously reported (Alkhathlan 2013), where industrial oil consumption was reported to have had a negative impact on the real GDP of Saudi Arabia. However, this result can be explained through the increases in the cost of the production inputs for non-oil industry when oil prices increase, assuming the cost of producing oil is fixed in Saudi Arabia. This case applies to the inputs into production that are produced outside of Saudi Arabia, as the cost of raw materials increases when oil prices increase. This result supports the existence of oil-rent seeking in oil-abundant countries' behavior toward income diversification. Additionally, higher rent provides an attractive incentive for employees to move from the low-productivity industrial sector to the high-productivity oil sector. Thus, the existence of higher-paid jobs in the oil sector pressures the low-productivity sector to increase employees' wages and salary to be competitive in the labor market, thereby increasing the cost of production for those industries.

Table 8. Long- and short-term coefficients for the ARDL approach.

Variable	Coefficient	t-Statistic	Probability
C	−1.318678 ***	−6.207564	0.0000
LNON_OILGDP(-1)	−0.504694 ***	−4.654141	0.0001
LOIL_RENT(-1)	−0.403147 ***	−4.899329	0.0000
LREER(-1)	0.109591 ***	3.667362	0.0011
LOPENNESS(-1)	0.263269 ***	2.798012	0.0096
BUDGET_DEFICIT(-1)	0.105039	1.008263	0.3226
D(LOIL_RENT)	−0.279863 ***	−6.017447	0.0000
D(LOPENNESS)	−0.001030	−0.009105	0.9928
D(LOPENNESS(-1))	0.190677 **	2.315156	0.0288
D(BUDGET_DEFICIT)	−0.252568 ***	−3.092255	0.0047
Coint. Eq(-1)	−0.504694 ***	−7.773449	0.0000

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

The real effective exchange rate (REER) is significant at the 1% level and has a positive effect on non-oil GDP in the long term. The increase in REER implies a depreciation of the local currency, which weakens the competitiveness of local products in international markets due to the relative price decrease. This result is consistent with a traditional framework of exchange rate. Furthermore, this result supports the finding in (Sultan and Haque 2018), where export had a positive effect on economic growth, which was tracked through an increase in aggregate demand. The depreciation in the SAR is a consequence of the USD weakening against world currencies, since the SAR has been pegged to the USD since 1986¹. Therefore, Saudi's locally produced products will be evaluated by local currency, which reflects the value in USD, since the SAR has been fixed with the USD over time.

Trade openness is significant at the 1% level and has a positive effect on non-oil GDP in the long term. This result is consistent with the findings reported in (Sultan and Haque 2018). The size of trade can be measured by the sum of the exports and imports in the GDP. An increase in this size strengthens the local industry to enable interactions with the rest of the world. The variable that was used in this study was the sum of all exports, including oil exports, which was found to have a positive effect on non-oil GDP. However, Aljebrin (2018) investigated the effect of non-oil trade openness on GDP growth and concluded that non-oil trade openness has a positive effect on GDP growth. Therefore, the trade openness in Saudi has a positive effect on total GDP or non-oil GDP.

Government budget deficit has an insignificant effect on non-oil GDP. However, the sign of the coefficient is positive, which is consistent with previously reported findings (Al Rasasi et al. 2019) in terms of the direction of the coefficient. However, this result contradicts their finding of a long-term effect of the government's role in non-oil GDP. The government is developing the economy through oil wealth and directing spending toward the development of infrastructure, but this strategy might be not consistent in the long term. This might change with the Saudi 2030 Vision.

4.7.2. Short-Term Dynamics

The OLS equation was tested for short-term dynamics causality in the form of (1, 1, 0, 2, 1) using the ARDL framework. Table 8 lists the results for the causality of the short-term causality. Short-term dynamics were confirmed, since the coefficient of the error correction term (ECT) is negative and significant at the 1% level. This implies the existence of a long-term relationship between the dependent variable and the regressors. Furthermore, the coefficient of the ECT confirms that the model converges to its equilibrium when there is a deviation from the equilibrium with a speed of 50% correction in one year. The ECT ensures the model closes gaps that occur in short-term periods of about two years. The oil rent has a negative effect in the short term on non-oil GDP, confirming the rent-seeking strategy as the main strategy for the Saudi economy at the 1% level of significance. REER has no effect in the short term due to the monetary authority policy of a fixed exchange rate, where the rate is affected by inflation in the long term, not in the short term. Trade openness behavior was confirmed as occurring in the long term, but only the lag period, not the moment period, is significant at the 5% level. This result reflects how non-oil GDP can be used to assess the previous performance of trade on current decisions, as confirmed by the current moment sign, although it is insignificant. This study found that government budget deficit is significant at the 1% level. This result contradicts previously reported findings (Al Rasasi et al. 2019) regarding the government's role in non-oil GDP in the short term. The behavior of the government has a negative sign in the short term due to the higher budget deficits associated with higher taxation of the private sector. However,

the government's policies toward the private sector have little momentum, which is justified by the insignificant effect of the government's role in the long term.

4.8. Normalizing Coefficients

The results in Table 8 for the long-term effects show the direction and cannot be used to infer the size of the effect on the level of non-oil GDP without normalizing the coefficients with non-oil GDP (−1). Table 9 provides the normalized coefficients with significant probability as an elasticity effect. A 1% increase in oil rent results in a decrease in the non-oil GDP of approximately 0.8% at the 1% significance level. A 1% increase in the REER results in an increase in non-oil GDP of approximately 0.22% at the 1% significance level. Additionally, a 1% increase in trade openness results in an increase in non-oil GDP of approximately 0.52% at the 5% significance level. The budget deficit is insignificant; however, if it were significant, it would imply that a 1% increase in the budget deficit would result in an increase in non-oil GDP of 0.20%. The inelastic response of non-oil GDP could be a result of a lack of diversification of the sector as a response to the change in oil rent. Furthermore, the response to REER given inelastic behavior is due to the size of the sector that receives the shock and does not adjust. Additionally, the size of the sector in relation to the total trade in the economy has less of a response, in that the sector cannot grow rapidly enough in relation to the economy.

Table 9. Normalized coefficients.

Variable	Coefficient	t-Statistic	Probability
LOIL_RENT	−0.798796 ***	−4.175715	0.0003
LREER	0.217144 ***	3.025654	0.0055
LOPENNESS	0.521642 **	2.429173	0.0223
BUDGET_DEFICIT	0.208125	0.894637	0.3792

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

4.9. Granger Causality Test

The Granger causality test is a method used to determine the causality among variables. This method will be used to visualize the direction of the relationship among the variables after examining the long-term relationship. However, uni- or bi-directional causality among variables is expected in this test. The causal relationship among non-oil GDP, oil rent, real effective exchange rate, trade openness, and budget deficit are tested within augmented VAR following the (Toda and Yamamoto 1995) method. Table 10 shows the test statistic and direction of the relationship. This method tests the short-term Granger causality among the variables. There is an existence of uni-directional causality running from oil rent and budget deficit to non-oil GDP. Furthermore, there is bi-directional causality between trade openness and real effective exchange rate. However, this bi-directionality is significant at 10%. The bi-directionality can be explained by assessing the increase or decrease in aggregate demand through international trade on Saudi products, causing an increase in the price index that results in a change in the REER. The change in the REER will offset or motivate overall trade in the economy. This is a circle in the economy and has an adjustable point as steady state in the long-term. Overall, this result is consistent with the ARDL cointegration dynamics' short-term outcome.

Table 10. Granger causality and block exogeneity Wald tests.

Variable	Direction of Causality					
	Non-Oil GDP	Oil Rent	REER	Openness	Budget Deficit	
Non-Oil GDP	–	0.945596	0.368009	1.181361	0.168679	
Oil Rent	8.326921 ***	–	0.670127	0.029586	0.145094	Oil Rent → NON-OIL GDP
REER	0.551549	1.289366	–	3.421956 *	0.108738	REER → OPENNESS
Openness	1.000331	0.331079	3.784324 *	–	1.980349	OPENNESS → REER
Budget Deficit	3.895102 **	0.075699	0.231392	0.440694	–	BUDGET DEFICIT → NON-OIL GDP

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

4.10. Nonlinear Autoregressive Distributed Lag (NARDL) Approach

The ARDL approach assumes the relationships among the variables are linear. However, the NARDL approach tests the asymmetric effect of the independent variables on the dependent variable. The focus of this study was the relationship between oil rent and non-oil GDP. Thus, the oil rent variable was replaced by its upturns and downturns over the data span. Equation (10) was estimated by replacing the oil rent variable with its positive and negative attributes. The estimation of the equation is reported in Table 11. The AIC suggested that the model lag distribution for the NARDL is (2, 1, 1, 1, 1, 1). The diagnostic test for the model implies that the model is quite stable with a square CUSUM within the bounds (significant at the 5% level). Furthermore, there is no serial correlation among the variables, as proven by the F-statistic for the LM test and the heteroscedastic ARCH test. The Jacque–Bera normality test produced a significant F-statistic at the 5% level. Therefore, the model passed the diagnostic tests for normality, heteroscedasticity, and functional form. The R^2 explains the goodness of fit for the multivariate equation of the model. However, the bound test requires comparing the F-statistic of the model with the critical value in Table CI(iii), case III in (Pesaran et al. 2001, p. 300). The F-statistic for the bound test is 5.63 which is greater than I(1) at the 1% significance level, which is 4.68 in Table CI(iii), case III (Pesaran et al. 2001, p. 300). Thus, a significant long-term cointegration exists in the model at the 1% level. The error correction term (ECT) is negative and significant at the 1% level. Furthermore, the short-term cointegration was confirmed since the t-statistic for ECT is -6.41 , which is greater than the critical value in Table I of (Banerjee et al. 1998, p. 276) of -5.04 . The ECT implies that the model corrects itself for any deviation from the equilibrium by 52% a year, which means two years are required to correct the deviation from the equilibrium. The goal of this estimation was to test if oil rent has a symmetric or asymmetric effect. Therefore, the hypotheses were tested to accept or reject the null hypotheses, implying that the coefficients of the positive and negative oil rent are equal or differ from each other. The Wald test result is 0.3979 at a 0.6943 significance level, so it failed to reject $H_0: \delta_i = \psi_i$, which indicates that positive and negative oil rent attributed are symmetrically affecting the non-oil GDP in the long term. Furthermore, the Wald test results produced the same result for the short term, at -0.1709 at the 0.8658 significance level; therefore, this study concludes that it fails to reject $H_0: \theta_1 = \theta_2$, and positive and negative oil rents are symmetric in the short term.

Table 11. Nonlinear autoregressive distributed lag (NARDL) results.

Variable	Coefficient	t-Statistic	Probability
C	−1.306677 ***	−3.405717	0.0024
LNON_OILGDP(-1)	−0.520255 ***	−3.923828	0.0007
LOIL_RENT_Pos(-1)	−0.324478 ***	−3.476050	0.0020
LOIL_RENT_Neg(-1)	−0.333297 ***	−3.742354	0.0011
LREER(-1)	0.137625 **	2.211858	0.0372
LOPENNESS(-1)	0.206169 *	1.790679	0.0865
BUDGET_DEFICIT(−1)	0.039827	0.295026	0.7706
D(LNON_OILGDP(-1))	−0.043364	−0.392845	0.6981
D(LOIL_RENT_Pos)	−0.299240 ***	−2.894131	0.0082
D(LOIL_RENT_Neg)	−0.183162 *	−1.868169	0.0745
D(LREER)	0.176272	1.107032	0.2797
D(LOPENNESS)	−0.025166	−0.152985	0.8797
D(BUDGET_DEFICIT)	−0.298567 *	−2.175495	0.0401
Coint. Eq(-1)	−0.520255 ***	−6.414993	0.0000

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

However, the NARDL F-statistic for bound test cointegration is lower than the ARDL bound test in both the long and short terms. This result is interesting when compared to that reported by Mensi et al. (2018). The results contradict the conclusion of the existence of asymmetric effects of oil on non-oil GDP (Mensi et al. 2018). The cumulative dynamic multiplier was assessed to check the robustness of the validity of the result.

The robustness of the asymmetric effect implies that the cumulative dynamic multiplier effect applies. This multiplier was used to characterize the effect of positive oil rent (OR^+) and negative oil rent (OR^-) on non-oil GDP (NOGDP), as shown in Equation (11). Figure 5 shows the plot of the cumulative dynamic multiplier effect as it is obtained from Equation (11). This multiplier characterizes the pattern of the adjustment of non-oil GDP to the new equilibrium in the long term

following unitary positive or negative shock over 20 years. However, this multiplier is estimated based on the best fit of the NARDL model, which is conditioned to the general specification criteria. The solid line shows the positive change, and the dashed line shows the negative change, which characterize the adjustment of non-oil GDP to the positive and negative shocks of oil rent at the forecast horizon. The asymmetry line is the middle line, close to the zero-horizontal line. However, the upper and lower lines between which the asymmetry line is located show the 95% confidence interval lines. The main aim of the cumulative dynamic multiplier is to confirm the asymmetry of the shocks of a variable over the other variables. Therefore, the rule of thumb is confirming the asymmetry when the zero line is outside of the 95% CI lines. If the zero line is in between the 95% CI lines, the asymmetry is not confirmed at a 5% level of confidence. In my results, the zero line falls between the 95% CI lines, thus confirming that the asymmetric effect of oil rent on non-oil GDP is not significant at the 5% confidence level. The result of the cumulative dynamic multiplier confirms the symmetric effect of oil rent on non-oil GDP.

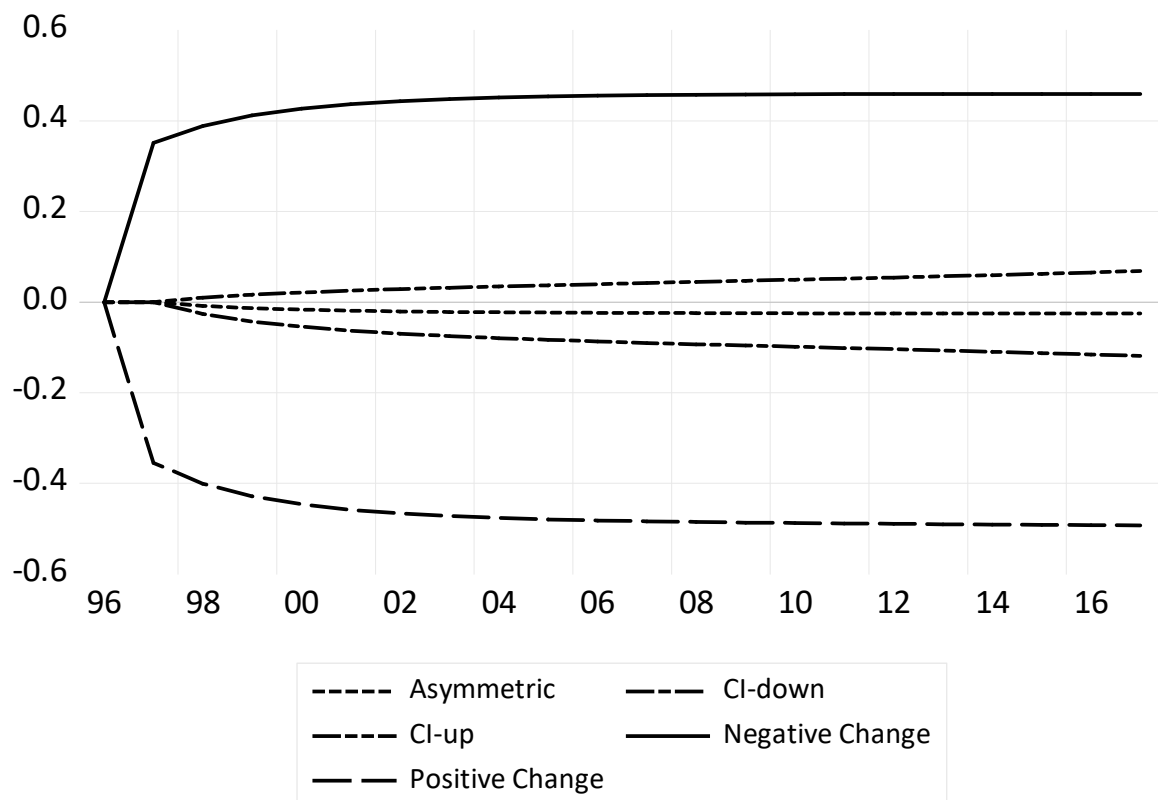


Figure 5. Cumulative dynamic multiplier results.

5. Conclusions

This study examined the dynamic effects of the cointegration between oil and non-oil GDP in the long and short terms by using data covering the period between 1980 and 2017. The model consists of oil rent, real effective exchange rate, trade openness, and budget deficit. The ARDL cointegration approach was applied to assess the existence of long-term cointegration among the variables. Additionally, the model was used to examine dynamic short-term effects between the dependent and independent variables. The Granger causality (Al Rasasi et al. 2019) method was used to analyze causation among the variables, and the NARDL model was applied to investigate the asymmetric effects of oil rent on non-oil GDP.

The ARDL estimation confirmed the existence of long-term cointegration among the variables. The error correction term confirmed the short-term dynamic cointegration among the variables. The ARDL result shows a significant negative relationship between oil rent and non-oil GDP and a significant positive relationship of real effective exchange rate and trade openness with non-oil GDP. In the short-term dynamics, a negative relationship was found between both oil rent and budget deficit and non-oil GDP, but a positive relationship between trade openness and non-oil GDP in the second period of the short-term dynamic frame. The Granger causality test results confirm the result

of the ARDL model in the short term, and the NARDL model result implies a symmetric effect of oil rent on non-oil GDP. The cumulative dynamic multiplier confirms the symmetric effect of oil rent on non-oil GDP.

Unlike previous findings (Alkhathlan 2013; Foudeh 2017; Sultan and Haque 2018), the results in this study show a negative impact of oil rent on non-oil GDP, in contrast with a positive impact of oil on total GDP. However, Alkhathlan (2013) reported a negative impact of oil revenue on the industrial sector, which is consistent with this study's findings. Other studies' (Al Rasasi et al. 2019; Sarwar et al. 2021) findings are also consistent with this study's outcomes in terms of the negative effect of oil on GDP. The explanation for this negative impact is the increase in input prices due to the increase in oil prices. The private sector is indirectly affected by this increase from two channels: first, through the increase in wages in the oil sector motivating increases in wages in the other sectors to increase, and second, through intermediate inputs that are affected by oil prices.

The impacts of government through budget deficits are seen in the short-term rather than the long-term. This finding is consistent with those previously reported (Bird 2001), where tight macroeconomic policy was limited in developing countries, and structure reform involved policy tools that were more effective in the long term. This finding can support the Saudi Arabian Government in its 2030 Vision, which involves attempting to restructure the economy. Additionally, the results contrast those of Haque (2020), who found that government policy has a negative impact on the private sector: as budget deficit increases, the size of the private sector decreases. However, the impact of the real exchange rate is positive, which is consistent with the literature: a fixed exchange rate encourages more investment by promoting certainty regarding the exchange rate. The results of this study are consistent with that of Haque (2020), where trade openness was shown to have a positive impact on the private sector. However, I found that trade openness has a positive impact, in contrast to those in a previous study (Belloumi and Alshehry 2020). This difference might have resulted from using different data sets. Additionally, this study focused on the private sector, whereas Belloumi and Alshehry (2020) focused on total GDP. This difference suggests that sectorial analyses might produce different results, which can provide a wider vision for policy makers. However, this study's findings regarding trade openness are consistent with those of Sarwar et al. (2021), who examined the post-VAT introduction period in Saudi Arabia. However, Haque (2020) mentioned that the oil sector is competing with the private sector for economic resources, and the outcome of this study proves that oil rent has a negative relationship with the private sector.

The nonlinear model assessment results demonstrate the symmetric effect of oil rent on non-oil GDP. This result contrasts with those of Mensi et al. (2018), which might be due to the usage of non-oil GDP with an elimination of the government sector, of which more than 60% is oil revenue.

The results of this study demonstrate the challenges faced by the Saudi Government in reaching the goals of its 2030 Vision. Those challenges comprise the 2030 Vision strategies that focus on ensuring the private sector becomes the leading sector in the Saudi economy. With respect to this study's outcome, the private sector is indirectly impacted by oil through economic resources. These resources are mobile and spill through to the high productivity sector. Furthermore, the private sector, using intermediates as inputs, is affected by oil price. These challenges are the existing characteristics of the Saudi economy, and the government should take them into consideration.

This study's findings have important implications for the government policies focused on the private sector to promote the 2030 Vision. The policies aimed toward the private sector should motivate the private sector to implement renewable energy sources in their production process. This policy may reduce the dependence of the private sector on oil in its inputs. Additionally, the government should review its subsidy strategy and devote funds toward industrial sectors that are more efficient and independent of oil. Such a policy may reduce the role of the government in the industrial sector when the government budget is tight. Furthermore, the Saudi Government should develop other, currently non-existent, sectors (tourism, etc.) that are not associated with oil.

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Notes

¹ Saudi Arabia Monetary Authority (SAMA) 55 annual report.

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