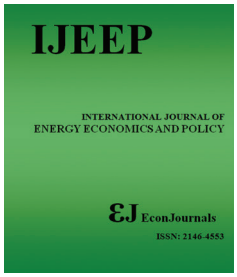

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Impact of Oil Price Fluctuations on Economic Growth in Saudi Arabia: Evidence from a Nonlinear ARDL Approach

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Reviewing prior studies demonstrates that a lack of agreement or unified consensus regarding the impact of oil price on economic growth. This could be due to the differing regions, methods, and time periods investigated. Some studies on Saudi Arabia examined the impact of oil price on economic growth from various perspectives and approaches, but neglected to consider assessing potential control variables and the structural breakpoint in the Saudi economy. This research attempted to bridge the gap between these studies.

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ABSTRACT

This study examined the asymmetric impact of oil price on economic growth in Saudi Arabia in 1970–2020 using annual data from the Saudi Central Bank and the World Bank. Applying a nonlinear autoregressive distributed lag model, this research focuses on the impact of oil price fluctuations, separating oil prices into negative and positive shocks. The results revealed the statistical significance of positive shocks on the partial sum of oil prices in both the short- and long term, whereas negative shocks had long term, but not short term, statistical significance on economic growth. The effect of positive shocks in oil price was greater than the effect of negative shocks in the long- and short term, and negative shocks were not an area of concern for the Saudi economy. Moreover, the coefficient of error correction terms (−1) had a negative and statistically significant value, indicating that any shock in the past years was corrected within 1 year at a rate of 54%. This study provides practical insights supporting policymakers' development of sound policies and useful findings and approaches for economists and energy researchers. The promotion of advanced technology policies to reduce the economic risks of oil price fluctuations is essential.

Keywords: Asymmetric, Oil Price Fluctuations, Economic Growth, NARDL, Saudi Arabia
JEL Classifications: C32, E32, E32, F43, O47, Q43

1. INTRODUCTION

For policymakers, economic growth is a key macroeconomic indicator. As an essential energy, oil became one of the factors affecting such growth following the expansion of the industrial revolution. Global demands for energy increased exponentially, particularly in the second half of the nineteenth century. Energy consumption accelerated the progress of industrialization and economic growth worldwide (Kırca et al., 2020). Previous studies have obtained divergent results related to the effect of oil price on economic growth. Some studies have indicated a statistically significant relationship between oil price and real gross domestic product (GDP) (Darby, 1982; Hamilton, 1983; Rasche and Tatom, 1977; Santini, 1985). In contrast, (Chang and Wong, 2003) concluded that the relationship was marginal.

Scholars have differentiated between the impact of the oil price shocks on importing and exporting countries. Increases in oil price have been shown to positively affect exporting countries and negatively affect importing countries (Kose and Baimaganbetov, 2015). In oil-exporting countries, oil production constitutes a large percentage of the national GDP, and an increase in oil price

supports the value of the country's currency. Berument et al. (2010) asserted that the overall impact of oil price shocks on economic performance often depended on government actions to produce additional revenue. Rising oil price leads to an increase in export revenue and real national income, transferring wealth from oil-importing nations to oil-exporting nations (Berument et al., 2010). For oil-importing countries, an increase in oil price raises transportation and derivative product costs, effecting the terms of trade and disposable income (Quintero Otero, 2020; Mordi and Adebiyi, 2010). Agbanike et al. (2019) examined the impact of uncertainty in oil price on economic growth, finding apparent effects of such uncertainty on oil revenue, investments, and economic growth in Latin America. Maghyereh et al. (2019) indicated that negative oil price shocks lead to an increase in economic growth, whereas positive shocks lead to a decrease in economic growth. Delavari et al. (2008) and Kose and Baimaganbetov (2015) found an asymmetric effect of oil price in oil-exporting countries. Previous studies of oil-exporting countries have suggested the positive effect of oil price on economic growth (Omitogun et al., 2018). In contrast, some studies (Akinsola and Odhiambo, 2020; Alkhateeb and Sultan, 2019) asserted a negative impact. Jiménez-Rodríguez and Sánchez (2005) and Levin and Loungani (1996) examined studies regarding the effect of oil price on growth in exporting countries, identifying differences between countries. The effect was positive in some countries and negative in others.

The asymmetry of fluctuations in oil price on economic growth indicates differing magnitudes of the positive and negative effects of oil price. The asymmetric response of economic growth amid the increase and decrease in oil price could be explained by three effects, which include income, uncertainty, and reallocation effects (Chuku, 2012). The most influential studies have focused on the asymmetric effects of oil price fluctuations on economic growth (Chuku, 2012; Mahmood and Murshed, 2021; Malik et al., 2020; Omitogun et al., 2018; Tajuddin et al., 2021). Recent fluctuations in oil price have resulted in economic downturns in the Saudi Arabian economy due to its heavy dependence on oil revenue (Mahmood and Murshed, 2021). According to Vision of 2030, Saudi Arabia aims to advance economic diversification policies to mitigate its reliance on oil revenue and decrease the effects of oil price fluctuations on the overall national economy. Fluctuations in oil price lead to volatility in revenue, making it difficult to solely depend on such revenue.

Other significant studies have examined the effect of oil price fluctuations on various macroeconomic variables in Saudi Arabia (Abid and Alotaibi, 2020), arguing that the state of crude oil price coincides with global market prices, and private sector demand for oil is dependent on development of the industrial sector. Multiple studies have examined the effects of oil price fluctuations on various economic considerations. Oil price and capital formation were discussed by Alkhateeb and Mahmood (2020). Algaeed (2018) studied the effect of oil price on Saudi import demand. Khamis et al. (2018) discussed the effect of oil price on stock markets. Alkhateeb et al. (2017) examined the effect of oil price on employment. Al-sasi et al. (2017) investigated the volatility of domestic petroleum demand on economic growth. Of more relevance to this study, Mahmood and Murshed (2021) focused on the impact of oil price fluctuations on economic growth. Although interested in the asymmetric effect, oil price was only included as an independent variable, with no additional independent variables incorporated into the study.

While multiple studies on Saudi Arabia's dependence on oil revenue have examined the effect of oil price on economic growth from a differing perspective, neither explanatory variables were not discussed nor was the structural breaking point in the Saudi economy considered. Therefore, this study aimed to investigate the asymmetric impact of oil price on the growth of the Saudi economy, using annual data for 1970-2020. As it is inherently interrelated to other economic concerns, the phenomenon was not studied independently; control variables were included in the current study. A dummy variable was added to account for structural breakpoint using a nonlinear autoregressive distributed lag (NARDL) model to estimate the coefficients.

The results indicate that the effect of positive shocks in oil price was greater than the effect of both long- and short-term negative shocks. In addition, negative shocks to oil price do not appear to be an area of concern for the Saudi economy. One of the findings of this study was the critical necessity of economic diversification to increase non-oil-related revenue sources in the economy to achieve targeted growth, create an investment climate, and increase the revenue sources in alternative economic sectors through policies adopted to encourage private investment in productive sectors and manufacturing industries. Hence, this study supports the development of sound policies by decision makers in developing countries in addition to providing valuable practical insights for economists and energy researchers. The development of policies to advance technology is essential in reducing the economic risks of oil price fluctuations.

The remainder of this study is structured into four sections. Section 2 presents a brief literature review on the relationship between oil price and economic growth. Section 3 describes the data and methodology. Section 4 discusses the results and findings, and section 5 offers conclusions, policy implications, and recommendations.

2. LITERATURE REVIEW

Studies on oil price and macroeconomic variables widely vary, advancing over different time periods and including individual countries as well as combined groups of countries. Many studies were conducted in the early 70s and 80s, as these periods witnessed large oil price fluctuations, which, among other reasons, were behind global macroeconomic volatility and stagflation. Interest in oil price fluctuations also increased following the 2008 financial crisis (Gadea et al., 2016). Moreover, the Covid-19 pandemic led to substantial oil price fluctuation. The following presents relevant studies related to these considerations.

Mahmood and Murshed (2021) employed NARDL to examine the effect of oil price on economic growth, finding symmetrical effects of oil price on long-term economic growth and asymmetrical short-

term effects. A rise in oil price had positive effects on incomes, and oil price cuts had harmful effects on income. Moreover, short-term positive effects were stronger than negative effects. Tajuddin et al. (2021) used a panel autoregressive distributed lag (ARDL) model and annual time series data to examine the 1995-2018 period in five ASEAN countries of Indonesia, Malaysia, the Philippines, Singapore, and Thailand, demonstrating that only the internet exerted long-term positive effects on economic growth. As for short-term effects, variables of internet, crude oil price, and inflation effected the economic growth in all five ASEAN countries. Akinsola and Odhiambo (2020) investigated the impact of oil price on economic growth in seven oil-importing countries of Ethiopia, Gambia, Mali, Mozambique, Senegal, Tanzania, and Uganda, applying ARDL and NARDL. They found that a rise in oil price had an insignificant impact on short-term economic growth for all countries but exerted a significant long-term negative impact. Furthermore, a decline in oil price had a positive and significant effect on economic growth, whereas a rise in oil price presented a negative effect. Alkhateeb and Sultan (2019) used the Pearson's bound test method and vector error correction to study the effect of oil price on economic growth in India in 1989-2017, concluding that the negative effect of oil price affected economic growth. Omitogun et al. (2018) used ARDL to investigate the Nigerian economy in 1981-2016, finding that oil price and revenue positively and significantly affected both short- and long-term economic growth. Alkhateeb et al. (2017) employed the NARDL model to examine the effect of oil price on employment in Saudi Arabia in 1980–2015, identifying a positive effect of oil price on employment. They found that the positive effect of oil price was greater than the negative effect, demonstrating an indirect effect of oil price on national income. Al-sasi et al., (2017) study demonstrated that the annual rate of increase in domestic demand for oil doubled in comparison to the average rate of income growth. Fluctuations in oil price were shown to affect the rate of inflation, the level of unemployment, and the rate of economic growth. Gadea et al. (2016) identified that the effect of oil price shocks on GDP growth had declined over time. The negative effect of the shock was also found to be greater during times of large oil price increases, implying the nonlinearity of the relationship. In Kazakhstan, Kose and Baimaganbetov (2015) used a structural vector autoregression (SVAR) model to examine monthly data from 2000 to 2013, concluding that oil price shocks exerted a greater negative effect on economic performance. Farhani (2012) used simple linear regression, dynamic regression, and vector auto regression (VAR) to estimate the impact of oil price increases on US economic growth in 1960-2009, revealing a weak relationship due to the presence of breakpoints and the asymmetric effects of the oil price fluctuations. Chuku (2012) used SVAR and Granger causality analysis to investigate the Nigerian economy for 1970Q1-2008Q1, finding an indirect asymmetric effect of oil price shocks. The results highlight that although Nigeria is a major exporter of crude oil, it does not significantly affect the dynamics of global oil markets. Berument et al. (2010) employed VAR in the Middle East and North Africa countries, revealing a positive and statistically significant impact of the increase in oil price on output in Algeria, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Syria, and the United Arab Emirates, whereas oil shocks obtained no statistically significant impact on output in Bahrain, Djibouti, Egypt, Israel, Jordan, Morocco, and Tunisia. Delavari et al. (2008) examined the effect of oil price in Iran from 1989 to 2007, finding an asymmetric effect of oil price shocks on economic growth. Jiménez-Rodríguez and Sánchez (2005) investigated responses to oil price shocks in major industrial countries, finding that economic activity was negatively affected by the increase in the oil price in all oil-importing countries, except Japan. Meanwhile, the impact of oil price shocks on GDP growth differed in oil-exporting countries; for instance, the United Kingdom was negatively affected by the oil price increase, whereas Norway was positively affected. This difference was interpreted in terms of differing economic sectors in each country. Hamilton (1983) examined the impact of oil price shocks on the US economy in 1949:Q2-1972:Q4, employing a Granger causality test and revealing a one-way causality of oil price based on production.

Reviewing prior studies demonstrates that a lack of agreement or unified consensus regarding the impact of oil price on economic growth. This could be due to the differing regions, methods, and time periods investigated. Some studies on Saudi Arabia examined the impact of oil price on economic growth from various perspectives and approaches, but neglected to consider assessing potential control variables and the structural breakpoint in the Saudi economy. This research attempted to bridge the gap between these studies.

3. MATERIALS AND METHODS

3.1. Data

The study employed annual time series data of real GDP growth rate (*Gro*); inflation (*inf*), measured via the consumer price index (CPI); exchange rate, measured via the official exchange rate (Local currency to US dollar, period average); oil price fluctuations, measured using percentage change in real oil price; and money supply (*m*), measured by broad money growth. The data was collected from the Saudi Central Bank and the World Bank for 1970-2020. The rationale behind choosing this period was the inclusion of base years for all oil price fluctuations from the early 1970s to mid-2019.

3.2. Methodology

To examine the asymmetric impact of oil price fluctuations on economic growth in Saudi Arabia, this study benefited from the approaches of previous studies (Chuku, 2012; Mahmood and Murshed, 2021; Omitogun et al., 2018; Malik et al., 2020; Tajuddin et al., 2021a; Tehranchian and Seyyedkolaee, 2017) in determining the model variables, which are as follows:

$$Gro=f(op,ex,inf,m) \quad (1)$$

where *Gro* indicates the real GDP growth rate, *ex* represents the exchange rate, *inf* is inflation rate (referring to CPI), *m* represents money supply, and *op* indicates oil price fluctuations.

4. RESULTS

Before estimating the model, it is necessary to assess the behavior of the time series. This was accomplished by using a unit root test and the Zivot and Andrews (1992) unit root test.

4.1. Unit Root Test

A unit root test is used to examine a stationary time series; that is, to determine whether there is a problem related to unit root or if it is not among the time series used in the study. The Augmented Dickey–Fuller stationary test results in Table 1 clarify that all series were stationary at the first difference, rejecting the non-stationarity for all the series (Gro, ex, op, inf, m) at 1% and 5% significance levels. The results of Kapetanios, Shin and Snell Nonlinear Unit Root Test in Table 1 also showed that all variables are nonlinear-stationary because the t-statistics in KSS calculate greater than the KSS critical values. As the time series presents stationarity in the first difference, NARDL could be applied.

4.2. Zivot and Andrews (1992) Unit Root Test

Ignoring structural breaks in the time series could lead to spurious results. Thus, Zivot and Andrews (1992) unit root test was also used to test time series stationarity. The result in Table 2 shows the stationarity of series with different break points. The dependent variable presented a structural breakpoint in 1986. A dummy variable was added to the model to demonstrate the effect of a structural change.

4.3. NARDL

To examine the asymmetric effect of oil price fluctuations (positive and negative shocks) on economic growth in Saudi Arabia, the NARDL method developed by Shin et al. (2014) was applied in this study. The NARDL model is specified as follows:

$$\Delta(Gro) = \alpha_0 + \sum_{i=1}^{n} \propto_1 \Delta Gro_{t-i} + \sum_{i=1}^{m} \propto_2^{+} \Delta op^{+}_{t-i} + \sum_{i=1}^{m} \propto_3^{-} \Delta op^{-}_{t-i} + \sum_{t=1}^{s} \propto_4 \Delta ex_{t-i} + \sum_{t=i}^{k} \propto_5 \Delta inf_{t-i} + \sum_{t=i}^{k} \propto_6 \Delta m_{t-i} + \propto_7 Gro_{t-i} + \propto^{+}_8 op^{+}_{t-i} + \propto^{-}_9 op^{-}_{t-i} + \propto_{10} ex_{t-i} + \propto_{11} inf_{t-i} + \propto_{12} m_{t-i} + e_t \quad (2)$$

4.4. Diagnostic and Stability Analysis

Table 3 demonstrates the diagnostics tests of the Breusch–Godfrey Serial Correlation revealing no issues (the P = 0.129 was above 0.05.). The autoregressive heteroskedasticity test indicated no heterogeneous problem (the P = 0.721 was above 0.05.). A Ramsay's regression equation specification error test clarified that the model was correctly identified (the P = 0.869 was above 0.05). Figures 1 and 2 explain the representation of the cumulative sum of the square residuals. It demonstrated that the parameters were stable as the curves lying within the critical bounds of the 5% region.

4.5. Estimation of Long-term Coefficients

The asymmetric effects of oil price fluctuations on economic growth in Saudi Arabia were estimated, and long-term results are shown in Table 4, demonstrating that the coefficient of positive shock on the partial sum of *op* (*op*_POS) is statistically significant. An increase in oil price increases economic growth. The *op*_NEG coefficient of *op*_POS is also statistically significant. A decrease in oil price (negative shock on the partial sum of *op*) results in a decline in economic growth. The results confirm the asymmetric effect of positive and negative shocks on the partial sum of oil price. This finding is congruent with previous findings (Alao and Payaslioglu, 2021; Berument et al., 2010; Chuku, 2012; Mahmood and Murshed, 2021), while contradicting the findings of Tajuddin et al. (2021). The coefficient of *ex* is statistically significant. In the long term, a 1% increase in the *ex* leads to a 0.89% increase in economic growth. The coefficient of *m* is statistically significant. In the long term, a 1% increase in *m* leads to a 0.41% increase in

Table 1: Unit root and stationary tests

The augmented dickey–fuller (ADF) stationary test		
	At level	At first difference
Gro	−1.1901	−5.4245***
ex	−12.0482***	−6.7626***
inf	−1.6101	−3.6611**
m	−2.8642	−6.5429***
op	−2.1884	−6.3205***
Kapetanios, Shin and snell nonlinear unit root test		
	Estimate	t-statistics(P-value)
Gro	1.226162	8.553146 (0.0000)
ex	1.563014	9.834359 (0.0000)
inf	1.201585	7.040876(0.0000)
m	0.934404	6.423053(0.0000)
op	0.972906	6.468460 (0.0000)
KSS critical value		
10%	−2.66	
5%	−2.95	
1%	−3.55	

(**,***) represent significance at 5% and 1% levels, respectively. Source: Author's analysis using EViews 12/2021

Table 2: Zivot and Andrews (1992) unit root test

Variables	Break in	T-statistic (Prob.)	Breakpoint
Gro	Trend	−3.5673 (0.0267)	1986
op	Intercept	−3.9503 (0.0015)	1986
ex	both	−4.6532 (0.0380)	1983
inf	both	−5.0897 (0.0490)	1987
m	both	−4.4239 (0.0404)	2013

Source: Author's analysis using EViews 12/2021.

Table 3: Diagnostic tests

Statistics	Estimated value	Prob
Breusch–Godfrey serial correlation lagrange multiplier test	2.450276	0.1296
Heteroskedasticity test (ARCH)	0.128381	0.7218
Ramsey's RESET test	0.027619	0.8693

ARCH, Autoregressive Conditional Heteroscedasticity. Source: Author's analysis using EViews 12/2021.

Table 4: Estimation of long-term coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
op_POS	0.294571	0.058921	4.999405	0.0000
op_NEG	−0.212528	0.074395	−2.856750	0.0081
ex	−0.890820	0.189410	−4.703126	0.0001
m	0.409819	0.107779	3.802392	0.0007
inf	−0.027843	0.081994	−0.339574	0.7368
D86	1.173507	0.368293	3.186343	0.0036
C	−3.029247	0.285380	−10.61479	0.0000

Source: Author's analysis using EViews 12/2021.

Figure 1: Plot of cumulative sum of recursive residual

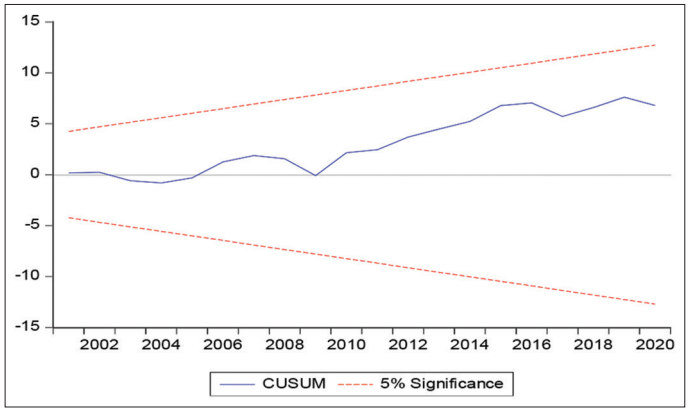

Figure 2: Plot of cumulative sum of squares

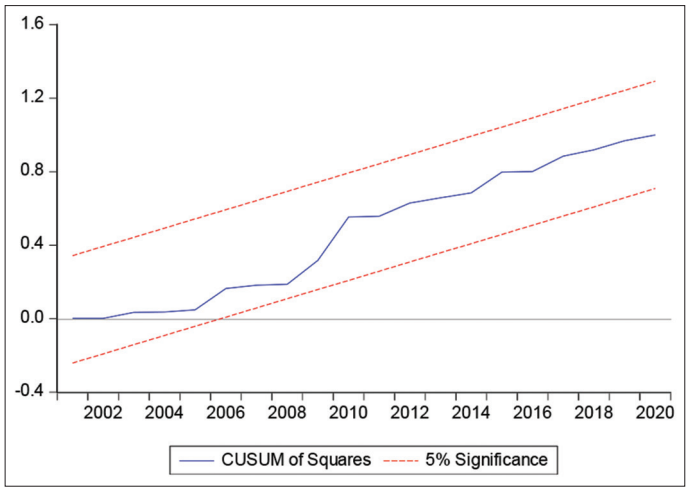

Table 5: Wald test

Equation: LRFORM			
Test statistic	**Value**	***Df***	**Prob**
t-statistic	20.33251	27	0.0000
F-statistic	413.4109	(1, 27)	0.0000
Chi-square	413.4109	1	0.0000

Source: Author's analysis using EViews 12/2021

Table 6: Estimation of short-term coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RGDP(−1))	0.270370	0.098718	2.738800	0.0108
D(*op*_POS)	0.130898	0.047662	2.746380	0.0106
D(*op*_NEG)	−0.039992	0.035443	−1.128347	0.2691
D(*ex*)	0.041000	0.122250	0.335376	0.7399
D(*inf*)	−0.071564	0.017076	−4.190798	0.0003
D(*m*)	0.059607	0.029215	2.040253	0.0512
CointEq(−1)*	−0.542938	0.063724	−8.520093	0.0000

Source: Author's analysis using EViews 12/2021.

economic growth. The coefficient *inf* did not significantly affect economic growth.

4.4.2. Long-term asymmetry test

A Wald Test was used to investigate similarities in the effect of positive and negative shocks on the partial sum of oil prices. In Table 5, the null hypothesis was rejected, and acceptance of the alternative hypothesis revealed the asymmetric effect of both positive and negative shocks on the partial sum of oil prices.

4.6. Estimation of Short-term Coefficients

Table 6 displays the short-term results, the coefficient error correction terms (ECT) (−1) had a negative and statistically significant value, indicating that any past shock was corrected within one year at a rate of 54%. This result demonstrates long-term equilibrium in Saudi Arabia. In the short term, a rise in oil price (positive shock on the partial sum of oil price) increases economic growth. These results support the findings of Tajuddin et al. (2021), but the effect of negative shocks on the partial sum of oil prices on economic growth were not statistically significant. The coefficient of *ex* also did not demonstrate statistical significance on economic growth. The coefficient of *m* shows statistical significance. A 1% increase in *m* leads to a 0.06% increase in economic growth. The coefficient *inf* has a statistical significance. In the short term, a 1% increase in the *ex* leads to a 0.07% decrease in economic growth.

5. CONCLUSIONS AND POLICY IMPLICATIONS

This study aimed to examine the asymmetric impact of oil price fluctuations on economic growth in Saudi Arabia. Accordingly, the study employed annual data from 1970 to 2020. Furthermore, a nonlinear ARDL methodology was used to examine long- and short-term effects. In contrast to previous research on Saudi Arabia, this study presents the first study to introduce control variables, adding the effect of structural breakpoint to the dependent variables. Oil price fluctuation (*op*) was divided into two variables (*op*_POS and *op*_NEG) to identify positive (*op*) effect and negative (*op*) effect, demonstrating the positive and statistical significance of positive shocks on the partial sum of oil price on economic growth in the long term. This result indicates that a rise in oil price leads to an increase in Saudi Arabia's revenue, which leads to an increase in economic sector productivity and economic growth, whereas the *op*_NEG coefficient of *op*_POS has statistical significance on the partial sum of oil prices on economic growth in negative shocks in the long term. The result indicated an asymmetric effect of positive and negative shocks on the partial sum of oil prices. Additionally, the Wald Test confirmed the asymmetric effect of positive and negative shocks on the partial sum of oil prices. In the short term, a positive shock in oil prices was found to be positive and showed statistical significance in terms of economic growth. However, negative shocks' effect on the partial sum of oil prices did not demonstrate statistical significance on economic growth. The results indicate that the effect of positive oil price shocks was greater than the effect of negative shocks in the long and short term. In addition, negative shocks to oil price were not an area of concern for the Saudi economy. The inflation (*inf*) measure referring to CPI revealed that negative oil price shocks did not have statistical significance on economic growth in the long term, but in short term, the coefficient was negative and showed a statistically significant impact on economic growth. The exchange rate (*ex*) measure from the official exchange was

found to be negative and showed a statistically significant impact on economic growth in the long term, while the coefficient did not affect statistical significance on economic growth in the short term. Money supply (*m*), measured by the broad money growth was found to be positive and had a statistically significant impact on economic growth in the long term); however, in the short term, the coefficient was positive and had a statistically significant impact on economic growth. In the short-term results, the coefficient ECT (−1) had a negative and statistically significant value, indicating that any past shock was corrected within one year at a rate of 54%. This result demonstrates long-term equilibrium in Saudi Arabia.

One of the apparent effects of the study results is the implication of the necessity for economic diversification to increase non-oil revenue sources in the economy to achieve targeted growth, including the creation of an investment climate and increasing the revenue of economic sectors, in addition to adopting policies that encourage private investment in productive sectors and manufacturing industries. Hence, this study provides practical insights supporting policymakers' development of sound policies and useful findings and approaches for economists and energy researchers. The promotion of advanced technology policies to reduce the economic risks of oil price fluctuations is essential.

5.1. Research Recommendations

Based on the results, the study advocates reducing dependence on oil revenue, which should be directed to other strategic sectors of the economy, such as manufacturing, transportation, and tourism, to increase economic growth. This study also indicates the necessity of developing appropriate investment policies to attract foreign and local investors to increase investment and enhance economic growth. It may be more useful to assess monthly data when investigating the impact of oil price because available high-frequency data can reveal oil price fluctuations.

5.2. Limitations

This study is limited to the economy of Saudi Arabia and could be expanded in the context of all OPEC countries to obtain more comprehensive results. Further studies can also be carried out to examine the positive relationship between oil price and economic growth. Finally, it would be useful to analyze the impact of oil price fluctuations on economic growth in light of the Covid-19 pandemic.

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