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The Asymmetric Effect of Oil Price Shocks on Economic Growth and Real Exchange Rate in Saudi Arabia*

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Abstract

The aim of this study is to analyze the effects of oil prices on economic growth and exchange rate in Saudi Arabia during the period 1980–2020. For this purpose, the linear and nonlinear ARDL models are estimated. The linear ARDL model shows that the oil price and economic growth are cointegrated. Moreover, the two variables have a significant positive association in the long run. However, the oil price has no significant impact on the exchange rate. When estimating the nonlinear ARDL model, it has been shown that oil price is only cointegrated with economic growth but not with the exchange rate. The estimation of nonlinear effects using the nonlinear ARDL model shows that economic growth is affected by both positive and negative oil shocks in the long run. However, the impact of positive shocks is higher than those of negative shocks. Moreover, results show that the short-run effects of positive and negative oil shocks are not statistically significant. Regarding the exchange rate, our results show that the effects of positive and negative oil shocks are not statistically significant. Consequently, this study concludes that the oil price has an asymmetric effect on economic growth in Saudi Arabia, but not on the exchange rate.

Keywords: Oil Price, Economic Growth, Exchange Rate, Nonlinear ARDL, Saudi Arabia

JEL Classification Code: F31, O47, Q31

1. Introduction

Natural resources are considered as a source of development and improvement in the well-being of nations for natural-resource abundant countries. Crude oil is often regarded as the most important natural resource, given its abundance in many countries. The impact of oil prices on the economy has been examined extensively in the prior literature. Studies have focused on oil-exporting as well as oil-importing countries and aimed at examining the effects of oil price on a wide range of macroeconomic variables. For instance, prior works examined the impact of oil price on economic growth (Olomola, 2006; Herrera et al., 2019), investment (Henriques & Sadorsky, 2011; Phan et al., 2019; Al Samman & Jamil, 2021), stock markets (Lee et al., 2012; Alqahtani et al., 2019), food prices (Baumeister & Kilian, 2014; Olayungbo, 2021) and exchange rates (Aloui et al., 2018; Jung et al., 2020). The previous literature has particularly examined the impact of oil price on economic activity, as it reflects the macroeconomic situation in a country and is in strong relation with already all other macroeconomic variables. In oil-exporting countries, oil revenues allow financing the budget and consequently, a drop in the oil price is often accompanied by a decrease in oil revenues, which may hamper the budget and expenditure of the country. In oil-importing countries, the oil price is seen as a cost and every rise in prices represents a rise in the government expenditure. In such a situation, the inflation

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rate also increases, as crude oil is used for the production of many goods and services.

The goal of this study is to examine empirically the impact of the oil price on economic growth and exchange rate in Saudi Arabia. To this end, the study is based on annual data between 1980 and 2020 obtained from the World Development Indicators. The novelty of the study is that it focuses on the impact of oil price on two important macroeconomic variables (economic growth and exchange rate) in an oil-exporting country with about 11% of global oil production and 16% of total oil reserves. To make the empirical analysis, the paper used the Autoregressive Distribution Lag model (ARDL) developed by and Pesaran et al. (2001). The advantage of the ARDL model is that it allows estimating the short-run and long-run effects in the presence of mixed stationary properties (Abidin et al., 2021). Moreover, the nonlinear Autoregressive Distribution Lag model (NARDL), developed by Shin et al. (2014), is also implemented. The advantage of the nonlinear ARDL model compared to the ARDL is that it allows separating the effects of positive and negative shocks on the oil price. In other words, the nonlinear ARDL model allows examining the effects of positive and negative oil price changes on economic growth and exchange rate dynamics in the short-run and long run (Mehta et al., 2021; Hoang, 2021). As in Ruankham and Pongpruttikul (2021), the empirical methodology consists of implementing the unit root test to check the stationarity of variables. Then, the ARDL model is used to examine the linear effects of oil price on economic growth and exchange rate. Finally, we decompose the oil price and estimate its effects on the two mentioned variables.

The remainder of this paper is organized as follows. Section 2 presents the related literature on the impact of oil price on economic growth and exchange rate. In Section 3, we describe the data and methods used in the study. Section 4 discusses the empirical findings. Finally, Section 5 concludes the paper.

2. Literature Review

2.1. Oil Price and Economic Growth

A large body of the literature argues that the increase in oil price is transmitted to economic growth via the total factor productivity channel. This has been supported by the fact that a decline in productivity characterized the oil shock of 1973. Moreover, international trade can be affected because the rise in oil price induces a sharp change in terms of trade between oil-exporting countries and oil-importing countries. Furthermore, a rise in the oil price induces an inflationary shock and a rise in prices of almost all goods and services produced in the economy. An increase in the oil price particularly affects the prices of petroleum products. In terms of consumption, the energy bill increases, while enterprises experience a rise in production costs.

On the empirical side, different methods have been used to examine the effects of oil price fluctuations on economic activity. Abdelsalam (2020) examined the effects of oil price and oil price volatility on economic growth in a sample of MENA countries. Different methodologies, such as the fixed effect, random effect, and GMM, have been used in the empirical study. It has been shown that oil price has a positive effect on economic growth in oil-exporting countries and negative effects in oil-importing countries. Moreover, the author concluded that the impact of oil prices on economic growth is asymmetric. Emami and Adibpour (2012) studied the relationship between oil price and GDP in Iran using a structural VAR model during the period 1959–2008. It has been concluded that the relationship between the two variables is asymmetric. The positive and negative shocks on oil prices significantly affect economic growth. However, positive and negative shocks have different effects on economic growth. Akinsola and Odhiambo (2020) checked the relationship between oil price and economic growth in a sample of Sub-Saharan African net oil-importing countries. The panel ARDL and nonlinear ARDL are used in the empirical analysis. The panel ARDL shows no significant short-run effects of oil price on economic growth, while the effects become negative and significant in the long run. The nonlinear ARDL indicates that oil price decreases boost economic growth, whereas oil price increases exert the opposite effects.

2.2. Oil Price and Exchange Rate

The impact of oil price on the exchange rate has been less studied than the oil price-economic growth nexus in the previous literature. Benassy-Quere et al. (2007) stated that the oil price may affect the exchange rate via two channels. First, rising oil price transfers wealth from oil-importing countries to oil-exporting countries, which affects the real exchange rate. Second, the oil price has a significant impact on terms of trade in both oil-exporting and oil-importing countries, which may also affect the exchange rate. The authors also examined empirically the effects of oil price of US dollar exchange rate during the period 1974–2004. The cointegration and causality analyses suggest the presence of positive relationships between the two variables, where a rise in oil price induces a rise in the exchange rate. Huang and Feng (2007) focused on the impact of oil price on the exchange rate in China between January 1990 and October 2005. The findings show that a rise in oil price induces a rise of the exchange rate by 3%. Recently, Kisswani et al. (2019) employed the nonlinear ARDL to check the relationship between oil price and economic growth in five Asian countries.

It has been shown that there are long-run asymmetric effects of oil price on exchange rate only for Indonesia and Malaysia. Finally, Mohammed Suliman and Abid (2020) examined the effects of oil price on the exchange rate in Saudi Arabia between January 1986 and March 2019 using the linear ARDL model and the combined cointegration developed by Bayer and Hanck (2013). The authors concluded that oil price and exchange rate have a strong long-run relationship. Moreover, there is evidence of bidirectional causality between the two variables in the long run, while the unidirectional causal relationship from oil price to exchange rate is confirmed in the short run.

3. Data and Methodology

3.1. Data

The current paper aims to estimate the short-run and long-run effects of oil prices on economic growth and exchange rate in Saudi Arabia between 1980 and 2020. The study is based on the Brent crude oil spot price as a proxy of oil price. Economic growth is measured by the gross domestic product expressed in constant 2010 US$. Finally, we used the real effective exchange rate as a measure of the exchange rate. The real effective exchange rate is defined as the nominal effective exchange rate divided by the price deflator. Gross domestic product and real effective exchange rate index are from the World Development Indicators. The real oil price is from the World Bank. The variables are taken in natural logarithm in the empirical analysis. Table 1 presents some descriptive statistics on the three variables considered in the analysis.

Table 1: Descriptive Statistics

	GDP	BRENT	REER
Mean	26.727	3.723	4.858
Median	26.645	3.824	4.779
Maximum	27.279	4.621	5.509
Minimum	26.058	2.739	4.546
Standard deviation	0.359	0.561	0.286
Observations	41	41	41

Note: Variables in natural logarithm.

The mean value of the Brent oil price is 3.723. The standard deviation, measuring the dispersion from the mean, suggests that oil price is the most volatile variable, as the standard deviation is about 0.561 for Brent oil price, 0.359 for GDP and finally 0.286 for the real effective exchange rate. These results suggest that the exchange rate is not characterized by high volatility in Saudi Arabia, contrary to the oil price, which is determined in international markets. Figures 1–3 plot the variables used in the empirical analysis.

3.2. Methodology

The empirical investigation conducted in this paper is based on the estimation of linear and nonlinear ARDL frameworks. We start by implementing the unit root test proposed by Ng and Perron (2001). The aim is to check the stationarity order of the three variables included in the analysis. Then, the following linear ARDL models proposed by Pesaran et al. (2001) are estimated:

$$\Delta y_t = \alpha + \beta_0 y_{t-1} + \beta_1 x_{t-1} + \sum_{i=1}^{m} \gamma_{1i} \Delta y_{t-i} + \sum_{i=0}^{q} \theta_i \Delta x_{t-i} + \varepsilon_t \quad (1)$$

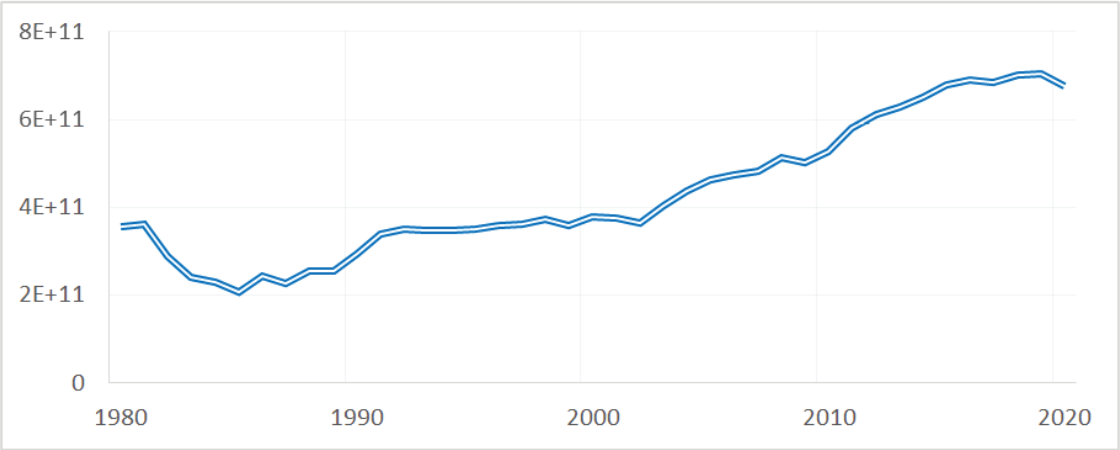

Figure 1: Gross Domestic Product (Constant 2010 US$)

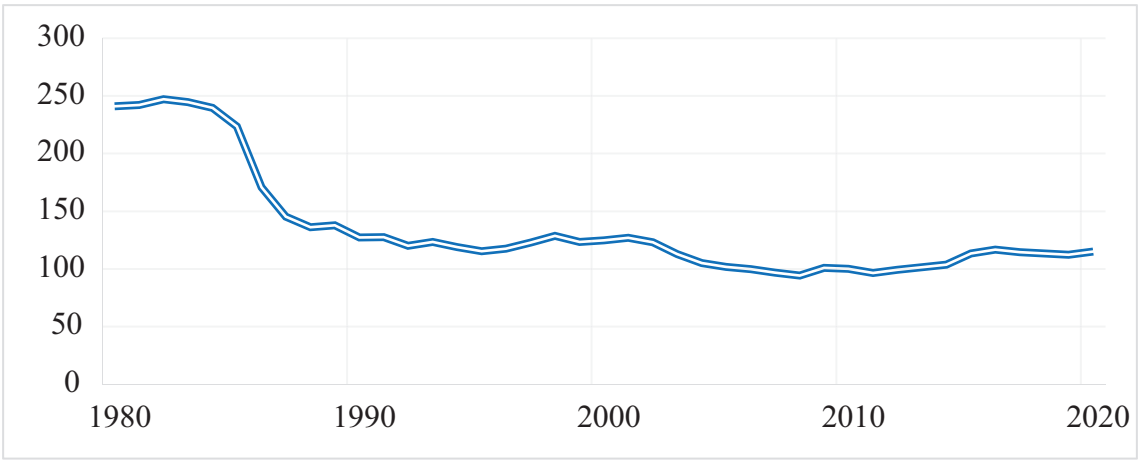

Figure 2: Real Effective Exchange Rate Index (2010 = 100)

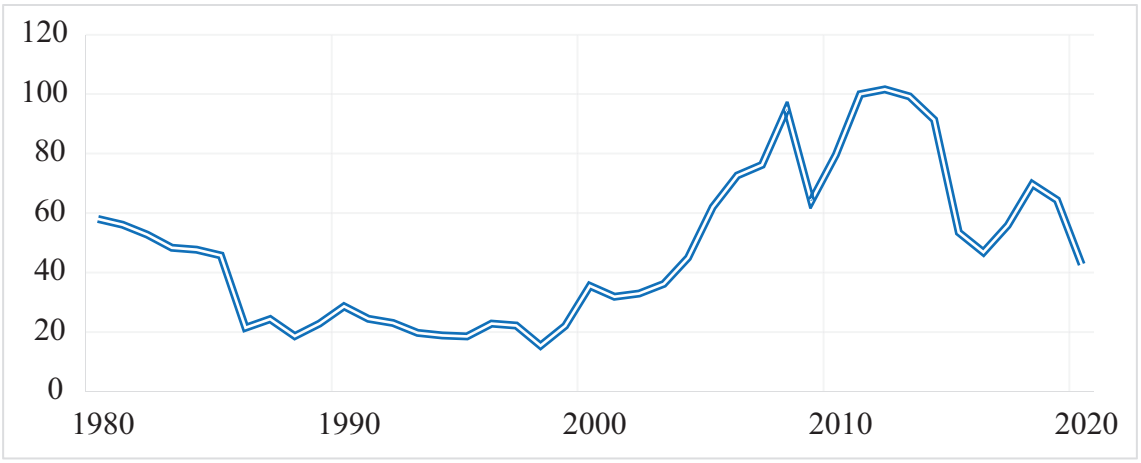

Figure 3: Brent Crude Oil Price (Constant 2010 US$)

$$\Delta er_t = \alpha + \beta_0 er_{t-1} + \beta_1 x_{t-1} + \sum_{i=1}^{m} \gamma_{1i} \Delta er_{t-i} + \sum_{i=0}^{q} \theta_i \Delta x_{t-i} + \varepsilon_t \quad (2)$$

Where y is the gross domestic product, er is the real effective exchange rate, x is the Brent crude oil price, Δ is the difference operator, m and q are the lag length, ε is the residual term.

The variable (oil price in our case) is then decomposed into positive and negative changes, as follows:

$$x_t^+ = \sum_{i=1}^{t} \Delta x_i^+ = \sum_{i=1}^{t} \max(\Delta x_i, 0) \quad (3)$$

$$x_t^- = \sum_{i=1}^{t} \Delta x_i^- = \sum_{i=1}^{t} \min(\Delta x_i, 0) \quad (4)$$

Then, we re-estimate the same relationships by using the Nonlinear ARDL model proposed by Shin et al. (2014), which may be written as follows:

$$y_t = \alpha + \beta_0 y_{t-1} + \beta_1 x_{t-1}^+ + \beta_2 x_{t-1}^- + \sum_{i=1}^{m} \gamma_{1i} \Delta y_{t-i} + \sum_{i=0}^{q} \left(\theta_i^+ x_{t-i}^+ + \theta_i^- x_{t-i}^- \right) + \varepsilon_t \quad (5)$$

$$\mathrm{er}_t = \alpha + \beta_0 \mathrm{er}_{t-1} + \beta_1 x_{t-1}^+ + \beta_2 x_{t-1}^- + \sum_{i=1}^{m} \gamma_{1i} \Delta \mathrm{er}_{t-i} + \sum_{i=0}^{q} \left(\theta_i^+ x_{t-i}^+ + \theta_i^- x_{t-i}^- \right) + \varepsilon_t \quad (6)$$

4. Empirical Results

4.1. Unit Root Test

Before estimating the linear and nonlinear ARDL models, we should test the stationarity of variables used in the analysis. As mentioned before, the NG-Perron unit root test is estimated. Results are in Table 2.

The table shows that the gross domestic product, real effective exchange rate, and Brent crude oil price are not stationary at levels. When we differentiate the variables, the same test shows that they become stationary at a 1% level. Consequently, the NG-Perron unit root test indicates that all variables considered in the analysis are stationary at levels. We move to estimate the linear ARDL model.

4.2. Linear ARDL Results

The linear ARDL cointegration test permits examining if the variables considered in the analysis are cointegrated or not. In other words, we search if the variables have long-run relationships. The results of the cointegration test of linear ARDL are presented in Table 3.

Regarding the oil price-economic growth relationship, the linear ARDL test shows mixed results. The *F*-statistic test shows that the variables are cointegrated at the 10% level, while the *t*-statistic test shows that the variables are not cointegrated. Consequently, the cointegration tests moderately support the presence of cointegration between oil price and economic growth in Saudi Arabia between 1980 and 2020. In other words, there is little evidence of long-run relationships between oil price and economic growth. Regarding the relationship between oil price and exchange rate, the linear ARDL test indicates that the *F*-statistic and *t*-statistic do not show that variables are cointegrated, which means that there is no long-run relationship between oil price and exchange rate in Saudi Arabia. The estimation of short-run and long-run effects of oil price on economic growth and exchange rate is done using the ARDL approach. The results are presented in Table 4. The table contains results regarding the effects of oil price on economic growth and exchange rate in the short-run and long run.

Table 2: Unit Root Tests Results

Variables	Levels				First Difference			
	MZa	MZt	MSB	MPT	MZa	MZt	MSB	MPT
GDP	−4.253	−1.455	0.342	21.397	−18.603***	−3.028***	0.162***	1.394***
REER	−1.236	−0.574	0.464	45.987	−14.517***	−2.682***	0.184**	1.731***
BRENT	−4.269	−1.439	0.337	21.136	−19.428***	−3.030***	0.155***	1.564***
Critical Values								
1%	−23.800	−3.420	0.143	4.030	−13.800	−2.580	0.174	1.780
5%	−17.300	−2.9100	0.168	5.480	−8.100	−1.980	0.233	3.170
10%	−14.200	−2.6200	0.185	6.670	−5.700	−1.620	0.275	4.450

Notes: ***, **, and *Denote the rejection of the null hypothesis of a unit root.

Table 3: Bounds Test Results of the ARDL Model

Statistic	Oil Price-Economic Growth		Oil Price-Exchange Rate	
F-statistic	3.586*		2.699	
t-statistic	−2.084		−2.430	
Critical Values				
	F-statistic		*t*-statistic	
	I(0)	*I*(1)	*I*(0)	*I*(1)
1%	4.94	5.57	−3.43	−3.82
5%	3.62	4.16	−2.86	−3.22
10%	3.02	3.51	−2.57	−2.91

Notes: ***, **, and *Denote the rejection of the null hypothesis of no cointegration.

As shown, the oil price positively impacts economic growth in the long run. The coefficient is equal to 0.428 and is statistically significant at 5%. This means that an increase in oil price induces a rise in the gross domestic product in the long run. These results are expected as Saudi Arabia is an oil-exporting country. In the short run, results show that the effects of oil prices on economic growth are positive and statistically significant. However, the short-run effects of oil price on economic growth (0.0062) are lower than those of the long-run. The error-correction term is negative and statistically significant at 5%. Regarding the effects of oil price on the exchange rate, in the long run, the table indicates that the coefficient is positive but statistically insignificant. In the short run, the effects of oil price on the real effective exchange rate are also not significant. This finding suggests that the exchange rate is not affected by changes in oil prices. This confirms the results of Table 3 which shows that there is no long-run relationship between oil price and exchange rate in Saudi Arabia.

4.3. Nonlinear ARDL Results

After estimating the linear effects of oil price on economic growth and exchange rate, we now examine the nonlinear effects of oil price. This is done using the nonlinear ARDL approach proposed by Shin et al. (2014). Results of the nonlinear ARDL model for the existence of cointegration between variables are reported in Table 5.

According to the table, the two statistics are statistically significant at the 5% level. Using the *F*-statistic and *t*-statistic, it is shown that there is a cointegrating relationship between the oil price and economic growth. This may confirm that oil price and economic growth have long-run relationships. Regarding the oil price-exchange rate relationship, only the *F*-statistic is significant at the 10% level. The *t*-statistic is

Table 4: Long-Un and Short-Run Results of the ARDL Model

Variables	Oil Price-Economic Growth			Oil Price-Exchange Rate		
	Coefficient	*t*-statistic	*p*-value	Coefficient	*t*-statistic	*p*-value
Long-Run Effects						
BRENT	0.428**	2.08	0.046	0.047	0.23	0.821
constant	25.407***	32.13	0.000	4.532***	5.62	0.000
Short-Run Effects						
GDP	0.064	0.44	0.665	–	–	–
REER	–	–	–	0.414***	2.95	0.006
BRENT	0.062*	1.73	0.094*	0.003	0.23	0.816
ECT	−0.075**	−2.08	0.046	−0.079**	−2.43	0.020

Notes: ***, ** and *Denote the significance at 1%, 5% and 10% level, respectively.

Table 5: Bound Test Results of the Nonlinear ARDL Model

Statistics	Oil Price-Economic Growth		Oil Price-Exchange Rate	
F-statistic	5.518**		4.069*	
t-statistic	−3.623**		−2.147	
Critical Values				
	F-statistic		*t*-statistic	
	I(0)	*I*(1)	*I*(0)	*I*(1)
1%	4.94	5.57	−3.43	−3.82
5%	3.62	4.16	−2.86	−3.22
10%	3.02	3.51	−2.57	−2.91

Notes: ***, ** and *Denote the significance at 1%, 5% and 10% level, respectively.

Table 6: Long-Run and Short-Run Results of the Nonlinear ARDL Model

Variables	Oil Price-Economic Growth			Oil Price-Exchange Rate		
	Coefficient	*t*-statistic	*p*-value	Coefficient	*t*-statistic	*p*-value
Long-Run Effects						
BRENT_POS	0.118***	3.63	0.001	−0.003	−0.20	0.846
BRENT_NEG	−0.073*	−1.75	0.094	0.00002	0.00	0.999
constant	16.060***	3.63	0.001	0.850*	1.99	0.060
Short-Run Effects						
GDP	0.398***	2.94	0.008	–	–	–
REER	–	–	–	0.321*	1.74	0.097
BRENT_POS	0.032	0.41	0.685	−0.125	−1.38	0.182
BRENT_NEG	−0.037	−0.69	0.496	0.038	0.63	0.533
ECT	−0.610***	−3.62	0.002	−0.172**	−2.15	0.043
Asymmetry Tests	W_{LR} = 179*** (0.000)			W_{LR} = 0.027 (0.870)		
	W_{SR} = 3.645* (0.069)			W_{SR} = 0.984 (0.332)		
Long-Run Asymmetric Coefficients	BRENT_POS = 0.194*** (0.000)			BRENT_POS = 0.037 (0.849)		
	BRENT_NEG = 0.121** (0.022)			BRENT_NEG = −0.000 (0.999)		

Notes: ***, ** and *Denote the significance at 1%, 5% and 10% level, respectively.

not statistically significant. This may confirm the results of the linear ARDL model. Consequently, the nonlinear ARDL shows the presence of a long-run cointegrating relationship only between oil price and economic growth in Saudi Arabia, whereas little evidence on the significant effects of oil price on the exchange rate is found. We consequently move to the estimation of short-run and long-run nonlinear effects of oil price on economic growth and exchange rate. Results are presented in Table 6. The table suggests that the impact of oil price shocks on economic growth is different. When we consider a positive shock on oil price (increase), economic growth increases and has a coefficient of 0.118, which is significant at 1%. However, when we consider a negative shock on oil price (decrease), the table shows that the coefficient is negative and statistically significant only at 10%. These results mean that economic growth is affected by positive and negative oil shocks in the long run. However, the effects of positive shocks are higher than those of negative shocks. In the short run, the positive and negative shocks on oil prices are not statistically significant.

Table 6 also shows that the Wald test suggests that asymmetry is present in the long-run and the short run. Moreover, the long-run asymmetric coefficients confirm the previous results since the positive and negative shocks of oil prices significantly affect economic growth in the long run. However, the impact of positive shocks (0.194) is higher than those of negative shocks (0.121). Consequently, economic growth in Saudi Arabia is more sensible to oil price increases than to oil price decreases in the long run. Regarding the nonlinear effects of oil price on the exchange rate, Table 6 shows that positive and negative oil shocks coefficients are not statistically significant in the long run. Moreover, the short-run coefficients are also insignificant. The Wald test also confirms these results since it shows that there is no asymmetry in the short-run and long-run. These findings are similar to those found in the linear ARDL model and indicate that oil price has no significant effect on exchange rates in Saudi Arabia.

5. Conclusion

Oil is considered a primary source of revenues in oil-exporting countries. Consequently, the oil price is an important instrument that affects almost all economic and social areas. It is therefore important to examine the effects of oil price on the macroeconomy in oil-exporting countries. A big number of studies have focused on estimating the impact of oil price on the macroeconomy in oil-exporting countries and oil-importing countries. This paper is an attempt to check the effects of oil prices on the economy of Saudi Arabia. More specifically, it analyses the impact of Brent crude oil price on economic growth and exchange rate in Saudi Arabia between 1980 and 2020. The linear and nonlinear ARDL cointegration tests are used in the analysis.

The empirical analysis starts by testing the stationarity using the NG-Perron unit root test developed by Ng and Perron (2001). The test shows that the three variables are not stationary at levels and stationary at the first difference. After checking the stationarity, we examine the presence of cointegration between oil price, economic growth, and exchange rate using the linear ARDL model. Results show that there is little evidence on the presence of cointegration between oil price and economic growth, while no cointegration between oil price and the exchange rate is confirmed. These results are confirmed by the estimation of long-run and short-run coefficients. Indeed, the oil price has positive short-run and long-run effects on economic growth but not on exchange rate. When estimating the nonlinear ARDL model, it has been shown that oil price and economic growth are cointegrated at a 5% level, while this is not true for the exchange rate. The estimation of the short-run and long-run effects using the nonlinear ARDL model shows that economic growth is affected by positive and negative oil shocks in the long run. However, the impact of positive shocks on economic growth is higher than those of negative shocks. Regarding the exchange rate, our results show that the short-run and long-run effects of positive and negative oil shocks are not significant.

Consequently, the oil price has no effect on the exchange rate in Saudi Arabia. As policy recommendations, authorities should take into consideration the impact of negative shocks on the oil price. Since negative shocks on oil prices negatively affect economic growth in the long run, authorities should implement some policies to reduce these effects. Moreover, the economy should be diversified so that the negative effects of oil price decreases may be absorbed by other economic activities, such as industry, tourism, services, etc.

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