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ASYMMETRIC RESPONSES OF OIL PRICE SHOCKS ON ECONOMIC GROWTH IN ALGERIA: AN EMPIRICAL ANALYSIS THROUGH NARDL APPROACH

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ABSTRACT

This empirical study examines the asymmetric effects of oil price shocks on economic growth in Algeria. The dynamic models of Non-linear Autoregressive Distribution Lags (NARDL) are used to analyze this relationship throughout 1970-2018. The results of this study reveal that there is a non-linear connection among the variables in the long run. As the empirical results of the NARDL model estimation shows that the response of real GDP to positive oil shocks is greater than the negative shocks. It is also evident that positive shocks have a low effect on economic growth in Algeria. In the short term, the results show that the effect of oil shocks on economic growth is symmetric and very weak. While the results showed that government revenue has a greater impact on economic growth than capital expenditure. This reflects the urgent need to diversify sources of income to ensure its sustainability as a first stage before focusing on the government spending aspect.

Contribution/ Originality: This study contributes to the existing literature by analyzing the impact of oil price shocks on economic growth in Algeria through the use of the nonlinear approach to the cointegration of the NARDL method developed by Shin (2014). This study also departs from previous studies relating Algerian economy and oil price shocks by considering the effects of both positive and negative oil price shocks on real gross domestic product, inflation rate, government revenue and the real effective exchange rate.

1. INTRODUCTION

The study conducted by Hamilton (1983) dealing with Oil and the macroeconomy since World War II, is considered as the starting point of the introduction of a new approach to tracking the impact of oil shocks on macroeconomic variables. Hamilton (1983) presented a strong evidence indicating that an increase in oil prices had been one of the primary causes of recessions, seven out of eight U.S. recessions were preceded by an increase in oil price shocks (Hamilton, 1983). This study paved the way for the emergence of a large number of contributions in this field to study the effects of oil price shocks on economic activity, such as production (Mork, 1989); Hamilton (1996); Kilian and Vigfusson (2013) inflation Barsky and Kilian (2004); Lacheheb and Sirag (2019) exchange rates; (Amano & Van Norden, 1998); (Chen, 2007) and fiscal policy (El Anshasy & Bradley, 2012). Hamilton (1983) was

then extended to non-linear models by Mork (1989); Hamilton (1996) and Lee, Ni, and Ratti (1995) who propose to consider asymmetric responses by dividing the oil price variable into upward and downward movements (Yanan, Du, & Wei, 2010). Several research papers that were written after Mork (1989) emphasize that economic activity reacts asymmetrically to oil price shocks (Hamilton, 1996); Lee et al. (1995).

In the mid-1970s, with the abrupt quadrupling of oil prices and the subsequent advent of the OPEC in the international economic arena, the debate has focused on the macroeconomic variable's response to oil price shocks on oil-importing economies. However, the macroeconomic challenges facing the oil-exporting economies may be greater than those in the importing countries, as the transfer of massive wealth to these countries has become symbolic of failed economic development strategies in the exporting countries (Abderrezak, 2005). Most of the empirical studies have focused on developed economies and in particular the oil-importing economies, but very few studies have been carried out on the effect of the oil price shock on the key macroeconomic variables for the oil-exporting countries such as Algeria.

60 years ago, Algeria depended heavily on hydrocarbon export revenues, notably oil revenues, to finance the country's economic development programs and it became clear over the past two decades when oil prices peaked in international markets. The oil revenue in this country represents approximately 95% of its export earnings, more than 50% of its budget revenues and about 30% of GDP (Squalli, 2007). Algeria has relied strongly on the oil revenues to achieve some of its development goals, especially when oil prices peaked in oil markets. However, any fluctuation in oil prices will inevitably have an impact on the macroeconomic variables in this country (Dahmani & Manel, 2019). In fact, over the past five decades, there has been no progress in reducing this dependence on hydrocarbons, which means that since the 1970s the Algerian economy had the characteristics of an economy based mainly on the production and exportation of oil. Thus, the Algerian economy has become vulnerable to large fluctuations in oil revenues and the negative effects of the resource curse (Chekouri, 2017).

The aim of this paper is to study the symmetric or asymmetric impact of the oil price shocks on economic activity in Algeria and to trace their effects over different periods, in particular, the behavior of real economic growth. This paper mainly aims to answer the following questions: How does real GDP in Algeria interact to oil price shocks? More specifically, are the effects of the oil price shocks weak or strong on this variable? And whether it is symmetrical or asymmetrical? The NARDL approach, recently introduced by Shin (2014) is applied in the current study to investigate the presence of asymmetric effects in the short and long-run relationship between the oil price shocks and real economic growth in Algeria from 1970 to 2018. The advantage of this model is its ability of modeling the asymmetries and cointegration dynamics simultaneously among the underlying variables and presenting several advantages over standard cointegration techniques (Shahzad, Nor, Ferrer, & Hammoudeh, 2017).

The layout of the paper is structured as follows: Section two provides the literature review; section three presents a brief evolution of oil prices, unemployment rate, and economic growth rate; section four presents data and explains the methodology of the study using the econometric method that was applied for the analysis of the key issue. Section five gives an account of the results and the main findings and section six provides some concluding remarks and policy implications.

2. LITERATURE REVIEW

The important role of crude oil in the global economy has attracted a lot of attention among politicians and economists as well. Most studies in this field have focused on tracking the effects of oil price shocks mainly in developed and net oil-importing economies such as the United States of America, China, and some European countries. However, existing studies that have focused on oil-exporting countries remain scarce and up to date. In general, oil price shocks can have a different impact depending on the sectoral composition of countries, their institutional structures, and their economic development. Many researchers have been interested in understanding the relationship between changes in oil prices and macroeconomic variables such as economic growth, employment,

unemployment, inflation, trade imbalances and fiscal deficit (Farzanegan & Markwardt, 2009). In the next section, we will review several relatively recent studies on industrial and developing economies.

2.1. Industrial Economies

In recent years, there have been a vast number of studies that have addressed the impact of oil price shocks on macroeconomic variables in the oil-importing countries. A recent study by Bergmann (2019) looked at a panel of 12 countries with strong industrial activity (Australia, Belgium, Canada, Finland, France, United Kingdom, Germany, Japan, Netherlands, Norway, Sweden, United States). The objective was to estimate the effect of oil price fluctuations on GDP growth by applying linear and non-linear VAR models. For this objective, the author has opted for a non-linear approach by estimating three different methods of determining oil prices: The asymmetric approach (Mork, 1989) the specification approach at scale by introducing the GARCH model (Lee et al., 1995) and the approach to increase the price of oil (Hamilton, 1996).

The results of this study were in line with the relevant literature, the most important result was the lack of symmetry in the relationship between oil prices and the GDP of the countries studied for 44 years. The researcher studied the presence of moderating effects resulting from a decline in the representative share of oil in energy overall which weakened the causal link between oil prices and economic growth. The results also show that the various increases in oil prices had a smaller effect on GDP growth. More specifically, oil-importing countries clearly and largely benefited from a decrease in their share of oil in the overall share of energy, while oil-exporting countries exhibited more behavior that is variable. In situations where oil prices rise, this advantage can lead to increased demand from countries that suffer more from rising prices. Also, it could be pointed out that the fluctuation in the response to GDP growth is considerably weakened in parallel with the decline in oil shares (Bergmann, 2019).

Khaled, Bhutto, and Kalhoro (2019) examine the impact of oil price shocks on the most explanatory macroeconomic variables: real GDP, interest rate, inflation, and exchange rate in the case of five SAARC countries, namely India, Pakistan, Bangladesh, Sri Lanka, and Bhutan. Their research aimed at studying how these emerging South Asian economies respond to oil prices shocks over different time horizons to provide some important policy implications for researchers and policymakers. For this objective, they model this impact using impulse response functions (IRF) and the method of decomposition of the variance of forecast errors (FEVDM) in the self-repression of the Structural Vector Autoregressive (SVAR) using time series data over the extended period from 1982 to 2014. In addition to this, the cointegration of Johansen is applied for testing the long-term relationship. The results of the cointegration test confirm the existence of the long-term equilibrium relationship between all the underlying variables. However, the empirical IRF results explain a significant difference in the behaviour of all the underlying macroeconomic variables in response to exogenous shocks in different time phases. This means that the macroeconomic aggregates used for this study are sensitive even to small oil shocks and give various socio-economic implications in the region. The results of the FEVDM show that each country in the panel studied reacts differently to oil price shocks. This depends on the policies independently applied in each country, its macroeconomic foundations, the composition of its sectors of activity and the heterogeneity between the countries themselves. The results will help governments to reform public policies in the region by controlling macroeconomic fluctuations due to the oil shocks (Ali, Zaman, & Islam, 2018). The results of the cointegration analysis confirm that all variables are cointegrated and influence each other in the long-run path. Furthermore, it is also revealed that shocks of oil price affect the output, interest rate, inflation, and exchange rate in five SAARC nations in the short run and the long run as well with the exception of the inflation and the exchange rate of Bangladesh and Sri Lanka respectively, as it is indicated by the impulse response functions.

The study of Balcilar, Van Eyden, Uwilingiye, and Gupta (2017) focuses on the case of an oil-importing country of South Africa which should be vulnerable to oil price shocks regardless of the phase of the business cycle.

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The authors want to analyse the asymmetrical behaviour of oil price shocks over the different phases of a business cycle and the underlying fluctuations, especially for the case of emerging countries which have not been sufficiently well treated in the economic literature. The purpose of this research is to study the impact of oil price shocks on the different phases of the business cycles in South Africa and to make forecasts of these cycles in both cases of high and low growth regimes. To do this, Balcilar et al. (2017) adopted and estimated a Bayesian MSVAR model with a linear VAR as a benchmark to investigate the role of oil price in different states or regimes namely the high growth–low oil price volatility regime and a low growth–high oil price volatility regime during the period 1960 Q2 to 2013 Q3. Balcilar et al found that the oil price has predictive content for real output growth under the low growth regime. First, the model allowed the researchers to classify regimes as depending on the parameter switches in the full sample and, therefore, it is possible to detect changes in dynamic interactions between the variables. Second, this model allows for many possible changes in the dynamic interactions between the variables at unknown periods. Third, it is possible to make probabilistic inferences about the dates at which a change in regime occurred. The results also show the low growth state to be shorter-lived compared to the higher growth state. They argue that the regime property of the model shows that the duration of the high growth regime on average is longer compared to that of the low growth regime; and that oil price shocks increase the probability of being in a low growth regime. The results of this research call into question the implementation of certain economic policies relating to South Africa's vulnerability to future oil price shocks. The success of these policies depends on the magnitude of its energy intensity as well as its dependence on oil imports. Among the major impacts of this dependence (95% of crude oil needs are imported), these researchers note the increasing inflation caused by oil prices from which appears a great challenge for the monetary authorities of the country to target the inflation in a range included between 3 and 6% (Balcilar et al., 2017).

2.2. Developing Economies

Among the most important recent studies are those presented by Charfeddine and Barkat (2020). The study are very interesting for understanding the problem of oil shocks and their impact. This study is distinguished by the introduction of the gas revenue variable in addition to that of oil revenue which is usually studied. The authors precisely explore the asymmetric impact of short and long-term oil price shocks and changes in energy revenues on the total real GDP, and the level of economic diversification in Qatar's economy. To do investigate this, they used two econometric approaches. The first is the autoregressive structural vector model AB ($AB - SVARX$) with exogenous variables where four asymmetric specifications of oil shocks were calculated (according to (Hamilton, 1996; Mork, 1989)). The second approach is the nonlinear model, which is an autoregressive distributed delay model ($NARDL$). Empirically, the impulse response functions (IRFs) obtained from the structural autoregressive model with exogenous variables ($SVARX$), as developed by Amisano and Giannini (2012) are used to assess the short-run asymmetric responses of Qatar's total real gross domestic product (GDP) and non-oil real GDP of oil prices shocks and oil and gas revenues. In the short term, the results show that the responses of total real GDP and non-oil real GDP to negative shocks in real oil prices and real oil and gas revenues are higher than the impact of positive shocks, which confirms the existence of an asymmetrical impact of short-term shocks. However, the results assume that the impact of shocks does not last more than three quarters. Also, in the long term, NARDL analysis shows that positive shocks of oil prices and on changes in oil and gas revenues have a greater impact on the two indicators of economic activity than negative changes. As a result, the Qatari economy has a major advantage, which provides significant resilience to negative shocks, and the hydrocarbon sector plays a positive role in improving the degree of non-energy diversification. Finally, the researchers note that several policies are being undertaken to improve the level of economic diversification in Qatar and to strengthen the budget revenues and decouple them from oil and gas revenues (Charfeddine & Barkat, 2020).

In the case of the Gulf Countries Cooperation GCC members (Bahrain, Kuwait, KSA, Oman, Qatar, and UAE),

Nasir, Abdulsalam, Shahbaz, and Hammoudeh (2019) studied and examined the impact of oil price shocks on the macroeconomic aggregates in these countries. They applied the SVAR model for the period 1980-2016. Their main result was the significant positive effects of oil price shocks on the GDP, inflation and the trade balance of the GCC countries. However, the results show substantial heterogeneities in the responses and reactivity of GCC members in the face of oil shocks. This suggests the presence of idiosyncrasies in the underlying structure and varying degrees of the dependence of their economies on oil revenues. They argue that there are some considerable differences among the responses of these countries to oil shocks which suggests that the transmission mechanism of oil shocks varies among GCC countries, at least in terms of the intensity. In terms of inflation, there are remarkable differences in the intensity of the impact of oil shocks on the overall price in each GCC country, which commits these countries to adopt risky monetary policies with great challenges to achieve price stability in the face of those shocks and be able to withstand them. The results of this study call for deep involvement in the economic policies of the GCC countries and considerable efforts aimed at the diversification of their economies, to reduce their dependence on oil revenues (Nasir et al., 2019).

Regarding the study of Gbatu, Wang, Wesseh, and Tutdel (2017) which investigate the case of Liberia as a small oil-importing country, authors applied the two asymptotic and bootstrap distribution techniques to model the shocks of the variation in oil prices in the first time, and then assess their impact on key macroeconomic variables in this country. The first observation of this study is the variety of effects produced by the different measures of the oil shocks in Liberia. As for the second, the authors point to asymmetries in oil price shocks due to a failure in the structured financial markets, as well as to the absence of strict monetary policies. Third, the impact of oil shocks on all macroeconomic variables is only felt in the short term. Fourth, unlike most developed economies, lower oil prices have not proven to be beneficial for economic growth in Liberia; and conversely the rise in prices appears more favourable to stimulate the Liberian economy. Consequently, researchers support the idea that an increase in oil prices leads to an overly costly reallocation of resources from the intensive oil sectors, which leads to an intensification of the workforce and a labour intensiveness that contribute better and by far to the GDP than the oil itself. Thus, a general overview of the study shows that if there are possibilities for substitution, the rise in oil prices leads to high employment rate and capital intensity and could have compensatory effects depending on the contribution of these macroeconomic indicators to the constitution of GDP. Accordingly, the fall in oil price regimes in Liberia should witness the application of certain measures and policies aimed at boosting the service sector which is very critical to economic growth in Liberia. For this reason, labour-market friendly policies should be encouraged by Liberian policymakers. (Gbatu et al., 2017).

3. ALGERIAN ECONOMY BETWEEN OIL DEPENDENCE AND FAILED ATTEMPTS AT ECONOMIC DIVERSIFICATION

After Libya, Algeria is considered one of the North African countries leading producers and exporters of oil and natural gas. Oil and gas revenues play strategic roles in the structure of the Algerian economy. This economy is broadly affected by the international oil market and Algeria's economy relies heavily on crude oil export revenues where this sector products accounted for more than 95% of Algerian exports. Besides, Oil revenues form a substantial portion of the country's annual budget where it represents about 60 % of the state budget. The share of oil value added in the GDP of Algeria averaged about 45.7% in 2016 (Lacheheb & Sirag, 2019). The strategic position of oil revenues on Algeria's economy, also world oil price shocks, and their fluctuations can affect the economic structure of the country and may expose it to cycles crises. Owing to the impact of oil price on real GDP as one of the fundamental macroeconomic indicators, fluctuations in oil prices and their shocks can have a major effect on the Algerian economy. In this situation, any shock to global oil markets can have a symmetric or asymmetric effect on the economic growth and the economic structure of our country. Figure 1 shows the evolution of real and nominal oil prices and the rate of economic growth in Algeria during the period 1970-2018.
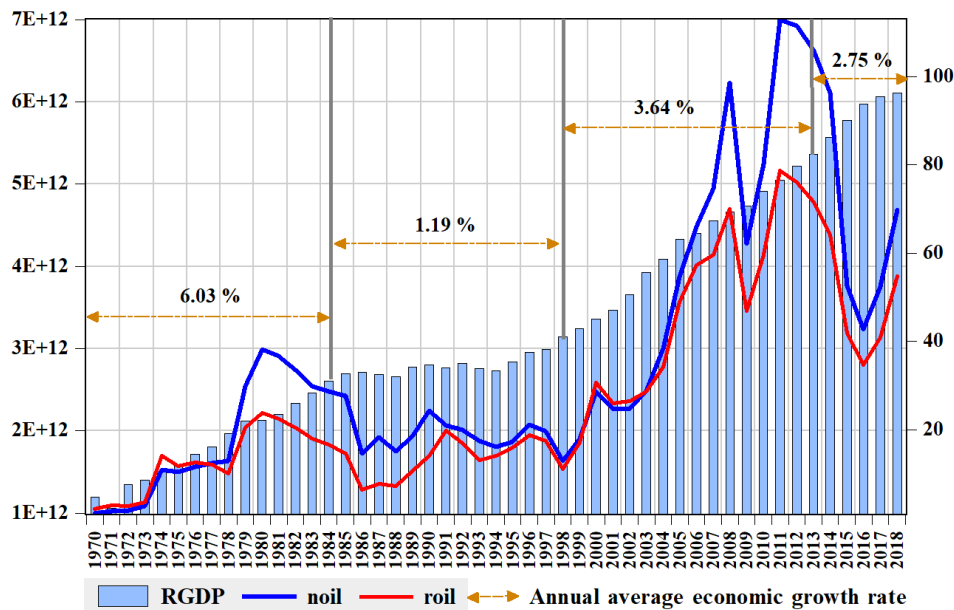
Figure-1. The co-movement between Real GDP, nominal and real oil price.

After the first oil shock, In the mid-1970s, Algeria had the highest growth rate with 8.5% among all oil-exporting late developing countries. It has been touted as one of the most successful experiments in economic development and the most stable country in the region. Even the social and economic policies of this country have demonstrated their commitment to achieving the desired development in the shadow of social justice. Huge efforts have been made for rapid industrialization, building infrastructure, and educating (Lowi, 2004), but quickly the boom session faded and turned into deflation, especially with the decline of oil prices after 1986 (Dahmani, 2015).

In fact, oil prices began to drop from 1982, and more dramatically, the counter shock of 1986, where the price of oil dropped from 27$ to less than 10$. During the 1986-1989 period, Algeria experienced very difficult economic situations caused by this shock, which had a negative impact on principal macroeconomic variables. As a result, Algeria's foreign debt, inflation and unemployment skyrocketed and the decline in economic growth was 1.19% as an annual average during the period of 1986-1998 Figure 1.

In early 1999, oil prices have risen sharply in international markets. in Algeria, this comfortable financial situation led authorities to pursue an expansionist budgetary policy which began in 2001 through the implementation of a series of substantial public investment programs which are The Support Program for Economic Recovery (PSRE) (2001-2004), the launch of the Complementary Plan for Support to Growth (Economic growth support program 2005-2009), the National Program for Agricultural Development (PNDA) and the five-year program (2010-2014) (Dahmani, 2015). Although the financial and economic indicators have improved in Algeria due to the huge oil and gas revenues, and although the growth prospects are encouraging and the economic indicators are satisfactory during this period, the revenues remain subject to the evolution of oil and gas prices. Consequently, the Algerian economy may be faced with a syndrome commonly known as the "resource curse - Richard M. Auty,1994" (Lacheheb & Sirag, 2019).

In 2014, prices collapsed, falling below the 50$. The main cause is an oversupply, fueled by shale oil production in the United States. The price of Brent crude fell below 30$ a barrel in early 2016, which is at its lowest level since 2003. The situation is becoming very difficult for certain producing oil countries, such as Algeria. This sharp drop in oil prices contributed to the erosion of the Algerian finances and the trade balance, were that the current account deficit, which was increased to 9.6% of GDP in 2019 and also international reserves which have been declining to 82.12 billion USD in 2018 and were expected to decrease to 76.2 billion USD by 2020, which covers 17.8 months' worth of imports (Bank of Algeria).

The country's budget deficit also increases from 1.4% of GDP in 2013 to 16.2% of GDP in 2015. Algeria

currently finances its budget deficit with "unconventional" measures. Algeria's growing debt pile and wide deficits will put increasing pressure on the country's state. Also, the decline of oil prices had a direct impact on the large decline in oil revenues by 30%, while the volume of expenses evolved 10.2% in particular, capital expenditures. The deficit was financed mainly by drawings from the Revenue Regulation Fund (RRF), which fell to 12.3% of GDP in 2015 (Chibi, Chekouri, & Benbouziane, 2019). Also, the decline in oil prices was followed by a slowdown in economic growth sharply. The economic growth decreased to 1.6 percent in 2017 from 3.3 percent in 2016 and Unemployment had risen from 10.5 percent in September 2016 to 12.3 percent in April 2017. This rate remains particularly high among young people with 28.3 percent and women with 20.7 percent (IMF, 2018).

4. DATA AND ESTIMATION METHODOLOGY

4.1. Methodology: The NARDL Cointegration Model

In this research we employed the nonlinear ARDL cointegration methodology. This technique was advanced by Shin (2014) and is an asymmetric expansion of the linear ARDL model (Pesaran, Shin, & Smith, 2001). This asymmetric cointegration approach is used to examine the short-run and the long-run asymmetrical effects of oil price shocks on the economic activity in Algeria.

In this study, the nonlinear autoregressive distributed lag NARDL model is used to estimate short and long-run nonlinearities via positive and negative partial sum decompositions of explanatory variables. Before developing the full representation of the NARDL model, we introduce the following long-term asymmetric regression in Equation 1 (Shin, 2014):

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + \mu_t \qquad (1)$$

With y_t refers to gross domestic product, x_t refers to explanatory variables and μ_t is a stationary zero-mean error process that represents deviations from the long-run equilibrium. β^+ and β^- are the asymmetric long-run parameters related to the positive and negative change in x_t, respectively.

where x_t is a $k \times 1$ vector of regressors which is decomposed in Equation 2 as:

$$x_t = x_0 + x_t^+ + x_t^- \qquad (2)$$

where x_0 is an arbitrary initial value and x_t^+ and x_t^+ denote partial sum processes which accumulate positive and negative changes in x_0, respectively, and are defined in Equation 3 as follows:

$$x_t^+ = \sum_{j=1}^{t} \Delta x_j^+ = \sum_{j=1}^{t} \max(\Delta x_j, 0); \quad x_t^- = \sum_{j=1}^{t} \Delta x_j^- = \sum_{j=1}^{t} \min(\Delta x_j, 0) \quad (3)$$

We consider the following nonlinear ARDL model presented by Equation 4:

$$y_t = \sum_{j=1}^{p} \emptyset_j y_{t-j} + \sum_{j=0}^{q} (\theta_j^+ x_{t-j}^+ + \theta_j^- x_{t-j}^-) + \varepsilon_t \qquad (4)$$

Shin (2014) showed that by associating (1) with the linear ARDL(p,q) model (Pesaran et al., 2001) we can obtain the NARDL(p,q) asymmetric conditional model. The asymmetric error correction model AECM can be represented by the Equation 5 and Equation 6 (Kocaarslan, 2020) is:

$$\Delta y_t = \rho y_{t-1} + \theta^+ x_{t-1}^+ + \theta^- x_{t-1}^- + \sum_{j=1}^{p-1} \gamma_j \, \Delta y_{t-j} + \sum_{j=0}^{q-1} (\varphi_j^+ \Delta x_{t-j}^+ + \varphi_j^- \Delta x_{t-j}^-)$$
$$+ \; \varepsilon_t \qquad\qquad\qquad\qquad (5)$$

$$\Delta y_t = \rho \left(y_{t-1} + \frac{\theta^+}{\rho} x_{t-1}^+ + \frac{\theta^-}{\rho} x_{t-1}^- \right) + \sum_{j=1}^{p-1} \gamma_j \, \Delta y_{t-j} + \sum_{j=0}^{q-1} (\varphi_j^+ \Delta x_{t-j}^+ + \varphi_j^- \Delta x_{t-j}^-)$$
$$+ \; \varepsilon_t \qquad\qquad\qquad\qquad (6)$$

we put:

$$\beta^+ = -\frac{\theta^+}{\rho} \, , \qquad \beta^- = -\frac{\theta^-}{\rho}$$

Where $\beta^+ = -\theta^+/\rho$ and $\beta^- = -\theta^-/\rho$, Δ is the first difference operator and ε_t is a white noise. This new technique presents the long and short-run asymmetric effect in four steps (Ahad & Anwer, 2019):

1- We would estimate Equation 5 using the OLS method;

2- The second step involves testing for the presence of a cointegration relationship between the levels of the series y_t, x^+ and x^- using the F_{PSS} (based on a modified F-test) statistic proposed by Shin (2014). This statistic refers to the joint null hypothesis of no co-integration $H_0: \rho = \theta^+ = \theta^- = 0$ against the alternative of cointegration $H_0: \rho \neq \theta^+ \neq \theta^- \neq 0$. The relevant testing procedure uses two critical bounds; the upper and the lower bound.

If the empirical value of the F_{PSS} statistic exceeds the upper bound, then there is evidence of a long-run equilibrium relationship. If it lies below the lower critical bound, the null hypothesis cannot be rejected; and if it lies between the critical bounds, the test is inconclusive;

3- In step three, by using the Wald test, we examine the null hypothesis to test is $H_0: \beta^+ = \beta^-$ (Nusair., 2020) for the long run symmetry. The short-run symmetry can take one of the following forms:

$$H_0: \; \sum_{j=0}^{q-1} \varphi_j^+ = \sum_{j=0}^{q-1} \varphi_j^- ;$$

4- Once the existence of a cointegration relation is confirmed, the estimation of the asymmetric dynamic multiplier effects of a unit change in x^+ and x^- on y_t, we can use the following equation:

$$m_h^+ = \sum_{i=0}^{h} \frac{\partial y_{t+i}}{\partial x_t^+}$$

$$m_h^- = \sum_{i=0}^{h} \frac{\partial y_{t+i}}{\partial x_t^-}$$

with h = 0,1,2 ... ... for x_t^+ and x_t^-, respectively. Note that if $h \rightarrow \infty$ so $m_h^+ \rightarrow \beta^+$ et $m_h^- \rightarrow \beta^-$ où β^+ et β^- are the positive and negative asymmetric coefficients at long-term; respectively. The last step consists to drive the asymmetric cumulative dynamic multiplier impacts of 1% increase and 1% decrease in each independent variable on the dependent variable.

4.2. Data Description and Model Specification

This paper investigates the asymmetric effect of oil price shocks on the evolution of economic activity in Algeria. The data frequency is annual, and the observation spans are from 1970 to 2018 of the following six variables: Real gross domestic product "RGDP" is used as a proxy for economic activity, the consumer price index-based inflation rate "INF", the share of government revenue in GDP "Gov_re", government capital expenditures as a share of GDP "Ca_exp", the real effective exchange rate "REER" and the oil price "OP" expressed in $US (the Saharan Blend oil price for Algeria).

All variables are in real local currency and it has been expressed in logarithms to reduce sharpness and for ease of comparison and explanation (Ahad & Anwer, 2019). Data are collected from various sources such as the National Office of Statistics, Algerian Ministry of Finance and the World Bank and the IMF (IFS). We selected the empirical models proposed through many different studies concerned with oil-exporting. The functional form of the model is presented by Equation 7:

$$LRGDP = f(LOP_t, LCa\_exp_t, LGov\_re_t, LREER_t, LINF_t) \qquad (7)$$

This nonlinear cointegration approach (NARDL) is applied if the series are expected to be integrated asymmetrically. We expect an asymmetric impact of oil prices on the real GDP. The Equation 8 is written as follows:

$$LRGDP = LOP_t^+ + LOP_t^- + LCa\_exp_t + LGov\_re_t + LREER_t + LINF_t \qquad (8)$$

5. EMPIRICAL RESULTS AND DISCUSSION

5.1. Unit Root Test

As the first step of this empirical analysis, we carried out unit root tests for all of the variables using Augmented Dickey-Fuller (ADF) and Philips and Perron (PP) tests, the results are presented in the Table 1 and Table 2 as below:

Table-1. ADF test results.

Variables	Series at level		Series in first difference		Stationarity
	I	II	I	II	
$LRGDP_t$	-3.86 *	-4.77 *	-9.44 *	-10.49 *	I(0)
LCa_exp_t	-1.20	-1.77	-6.17*	-6.12*	I(1)
$LGov\_re_t$	-2.04	-3.04	-5.13*	--5.07*	I(1)
$LREER_t$	-2.42	-3.89 **	-5.21*	-6.00*	I(1)
$LINF_t$	-3.01**	-3.15	-9.80*	-9.71*	I(0)
LOP_t	-2.37	-2.92	-6.49*	-6.48*	I(1)

Note: *, ** et *** indicate significance at 1%, 5% et 10% levels, respectively.
I, II, present the equation: with constant & with constant and trend, respectively.

Table-2. Phillips-perron (pp) test results.

Variables	Series at level		Series in first difference		Stationarity
	I	II	I	II	
$LRGDP_t$	-1.75	-2.15	-8.71*	-9.19*	**I(1)**
LCa_exp_t	-1.23	-1.86	-6.16*	-6.10*	**I(1)**
$LGov\_re_t$	-2.03	-2.95	-6.60*	-6.62*	**I(1)**
$LREER_t$	-2.36	-1.71	-5.23*	-5.59*	**I(1)**
$LINF_t$	-3.04**	-3.16	-9.86*	-9.77*	**I(0)**
LOP_t	-2.37	-2.98	-6.51*	-6.50*	**I(1)**

Note: *, ** et *** indicate significance at 1%, 5% et 10% levels, respectively.
I, II, present the equation: including constant & with constant and trend, respectively

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If we use the traditional unit root tests ADF and PP, the results show that all variables are nonstationary in level and stationary in first difference I(1), However, the variable LRGDP and LINF are stationaries at the level I(0). But, these results appear inconclusive. The popular unit root tests such as ADF and PP often lead to spurious results like ignoring the structural break in the series (Boufateh, 2019). We start by the test of the procedure of (Zivot & Andrews, 1992) unit root in the presence of one structural break where it is applied to a series in the level as well as to a series in the first difference. Table 3 summarizes this unit root test results.

Table-3. Zivot and Andrews test for unit roots with one structural break.

Variables	At level		At first difference (Δ)		Stationarity
	I	II	I	II	
$LRGDP_t$	-7.05* (1)	-5.57** (1)	-13.81* (0)	-18.50 * (0)	I(0)
TB	1988	2003	1980	1995	
LCa_exp_t	-3.73 (0)	-3.35 (0)	-7.07* (0)	-7.05 * (0)	I(1)
TB	1989	1989	2000	1992	
$LGov\_re_t$	-5.00 **(1)	-4.79 (1)	-6.01* (2)	-6.51* (2)	I(1)
TB	1986	2010	1982	1989	
$LREER_t$	-4.30* (3)	-3.60 (3)	-4.95** (2)	-4.53** (2)	I(1)
TB	1995	1982	1980	1986	
$LINF_t$	-6.13* (0)	-5.95* (0)	-11.03* (0)	-10.90* (0)	I(0)
TB	1997	1997	2001	2001	
LOP_t	-3.65 (0)	-3.42 (0)	-6.88* (0)	-7.28* (0)	I(1)
TB	1985	2005	1999	1987	

Notes: The 1%, 5%, and 10% critical values are $-5.34, -4.93$, and -4.58 (model I); $-5.57, -5.08$, and -4.82 (model II); respectively. (...) The number of lag order is shown in parentheses and determined by AIC. (TB) is the time of the break.
*Statistical significance at the 1% level.
**Statistical significance at the 5% level.

Overall, these results confirm the conclusions drawn from the ADF and PP tests and indicate that most variables are stationary in the first difference but not stationary in the level. But the unit-roots test of Z-A shows that a series of LRGDP and LINF are stationaries at the level I(0).

5.2. NARDL Models for Short and Long-Run Analysis

5.2.1. Results of Asymmetric Cointegration

To test the cointegration relationship under a NARDL model, Shin (2014) recommended using the joint null

hypothesis of the level variables (undifferentiated) and comparing the critical values of Pesaran et al. (2001) tests. If F calculated is greater than the upper critical value, then there is proof of cointegration. Otherwise, no evidence of cointegration is found.

Table-4. Bounds test form nonlinear cointegration.

Test	Model 01 $LRGDP = f(LOP_t, LCa\_exp_t, LREER_t)$	Model 02 $LRGDP = f(LOP_t, LGov\_re_t, LINF_t)$
F_{PSS}	8.300	8.487
99% Upper bounds	4.37	5.06
99% Lower bounds	3.29	3.74
Decision	Cointegration	Cointegration

Notes: The statistics FPSS Nonlinear denote the F-statistic proposed by Pesaran et al. (2001).

The calculated F_{PSS} is equal to 8.300 & 8.487 in model 01 and 02, respectively, these values are greater than the tabulated statistic (of the upper bound = 4.37 and 5.06) at a significance of 1% level. As a result, there is a strong evidence of a cointegration relationship between the studied variables in both models.

5.2.2. Results of Tests for Long and Short-Run Asymmetry

After confirming the existence of a cointegration relationship, we can proceed with the estimation of the NARDL model, the following table represents the results obtained:

Table-5. The results of NARDL estimation.

	ECM form with $\Delta\, \mathbf{LGDP_t}$ as an endogenous variable			
Variables	**Model 01**		**Model 02**	
	Coefficient	**t-statistic**	**Coefficient**	**t-statistic**
Panel A : Short run				
$\Delta\, LGDP_{t-1}$	0.102	1.560	0.012	0.182
$\Delta LREER_t$	-0.057**	-2.262	---	---
$\Delta LRev_t$	---	---	0.005	0.238
$\Delta LRev_{t-1}$	---	---	0.017	0.846
$\Delta LCPI_t$	---	---	-0.002	-0.544
$\Delta LROP_t^+$	0.038***	3.935	0.030***	2.761
$\Delta LROP_{t-1}^+$	-0.031***	-2.905	-0.051***	-4.468
Constant	---	---	3.364***	6.938
ECT_{t-1}	-0.216***	-7.531	-0.165***	-6.886
R^2	0.574		0.633	
R^2 Adjusted	0.533		0.565	
Panel B: Long run model				
$LExp_t$	0.137***	3.061	---	---
$LREER_t$	-0.030	-0.350	---	---
$LRev_t$	---	---	0.295**	2.284
$LCPI_t$	---	---	-0.079**	-2.285
$LROP_t^+$	0.174***	3.435	0.210***	4.810
$LROP_t^-$	0.009	0.147	0.113	1.644
Constant	24.628***	21.208	---	---
Panel C: Symmetry tests				
W_{LR}	61.711***(0.000)		6.360**(0.016)	
W_{SR}	0.124 (0.723)		1.529 (0.224)	

Notes: $LROP_t^+$ and $LROP_t^-$ are the estimated long-run coefficient associated with positive and negative changes of real oil price, respectively. ECT_{t-1} is the error correction term, which measures the speed of adjustment to long-run equilibrium.
*, ** and *** indicate the significant at 10%, 5% and 1% level of significance, respectively.

W_{LR} denotes the Wald test for null of long-term symmetry defined by: $H_0: -\theta^+/\rho = -\theta^-/\rho$

And W_{SR} refers to Wald test for null hypothesis of short-term symmetry defined by $\sum_{j=0}^{p^*} \varphi_j^+ = \sum_{j=0}^{p^*} \varphi_j^-$.

Table 5 demonstrates the nonlinear impacts of real oil prices on real output using two models; the first one includes government capital expenditure and real effective exchange rate as an explanatory variable, the second model contains government revenue and consumer price index as an exogenous variable. In both models, we introduce oil price shocks to check their effects on real GDP.

Results of the asymmetric test for model 01 in Table 5 show that the Wald statistic (W_{LR}) calculated is equal to 61.711 with a probability of 0.000 that is lower than 1%, therefore the null hypothesis of symmetry is rejected, and we accept the alternative hypothesis of asymmetry. To test the short run asymmetry, The Wald statistic Table 5 W_{SR} is equal to 0.124 and which corresponds to the probability of 0.723; hence, this probability is greater than 0.01. Thus, the null hypothesis of symmetry is accepted and the effect of oil shocks on economic growth is symmetric in the short term. The findings of the Wald test in the second model reveal the same conclusions of model 01, where the asymmetric effect exists only in the long run at 5% of significance level. Thus, real GDP responds differently to a decrease as compared to an increase in oil prices.

Empirical results of the NARDL process indicate that in both models we estimate that only positive oil shock which has a significant influence in the total real output, and the negative oil shocks do not have any short-run effect. In this context, we can say that in the first model 1% increase in real oil price leads to an increase of 0.038% of real GDP (at the 1% level), while in the second model we have found that the rise of 1% in oil price may affect real GDP positively by an evolution of 0.03%.

From model 01, it is clear that in the short term the depreciation on real effective exchange rate could stimulate economic activity in Algeria; this result is statistically significant at 5% of level. On the other hand, in model 02, the government revenue and its first lag impact have positive effects on real GDP, but the estimated coefficients are not significant. Besides, inflation adversely affects output, where 1% rise in consumer price index declines the level of total real GDP by 0.002%.

In the two models, the error correction term has a negative sign, which provides the existence of cointegration evidence. ECT_{t-1} is highly significant (at 1%) where 21.6% (16.5%) of the short-run deviation in model 01 (model 02) from equilibrium is regulated yearly to restore the equilibrium in this relationship.

In the long run, the impact of oil prices increase is greater than oil prices decrease, where in the first model (second model), 1% increase in oil prices raises economic growth by 0.174% (0.210%) at 1% of statistical significance. Whereas a drop in oil prices leads to a decrease in total Algerian GDP (a positive sign proves the same trend of change between the independent and dependent variable), but in both models the long-run effects of negative oil price shocks are insignificant, meaning that the economic activity does not respond to a decrease in oil prices at the long term.

In regards to the impact of the explanatory variables in the long run; the results of model 01 denote that the effect of capital expenditure (LCa_exp_t) is positive and significant at the 1% level; a 1% rise in LCa_exp_t is associated with about 0.137% increase in real GDP. Furthermore, the long-run influence of the real effective exchange rate is not significant. According to the findings of model 02, government receipts positively affect output

in the long run, if LRev_t rises with 1% then the real GDP increase with 0.295% at the 5% of significance level, this suggests that public revenue contributes to economic activity in the long run. Finally, inflation affects negatively the total GDP and 1% increase in consumer price index reduces economic growth by 0.079%.

5.3. Dynamic Non-Linear Multiplier Results

The analysis of the asymmetric effect of oil prices on GDP can be completed by examining the asymmetry model obtained from the dynamic multipliers. These multipliers highlight the adjustment process before the shock to the new equilibrium (after the shock) (Charfeddine & Barkat, 2020). The positive and negative dynamic multipliers associated with the changes of LROP_t^+ and LROP_t^- are given respectively by:

$$m_h^+ = \sum_{i=0}^{h} \frac{\partial LGDP_{t+i}}{\partial LROP_t^+}$$

$$m_h^- = \sum_{i=0}^{h} \frac{\partial LGDP_{t+i}}{\partial LROP_t^-}$$

Where $h = 0, 1, 2, \ldots$ and if $h \to \infty$ then $m_h^+ \to \beta^+$ & $m_h^- \to \beta^-$.

Figures 2 and 3 show the dynamic multipliers for 15 years, in which the red heavy dotted line refers to the difference between the effect of a positive shock of 1% and a negative shock of 1% as well. The thin red dotted lines indicate the confidence interval for this gap. The solid black line indicates the positive oil shock (top) and the dotted black line (broken) means the negative shock (bottom). Regarding the two figures below, positive oil price shock is significant and most domineering which confirms the results of Table 5.

The results of Figure 2 show a strong and rapid reaction to positive changes in oil prices for up to two years; after that, the response of real GDP to oil price increase starts to stabilize until arriving at the third year, from this period (3rd year) the speed of convergence develops gradually towards the long-term coefficient. It should be noted that the multipliers take approximately thirteen years to converge to long-term multipliers.

In Figure 3 we notice a relative reaction to positive shock for only two years, before arriving at the third year this reaction to LROP_t^+ is degrading. Besides, starting from the third period, the disequilibrium takes longer to be corrected (approximately between 15 years and over).
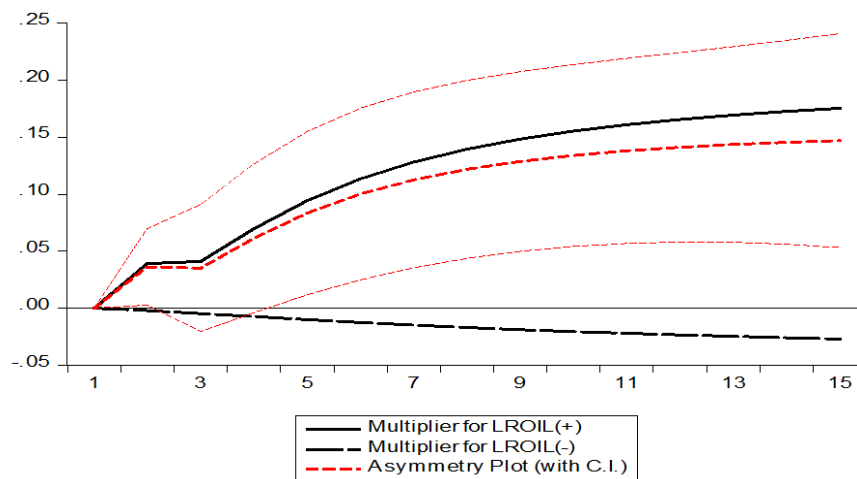

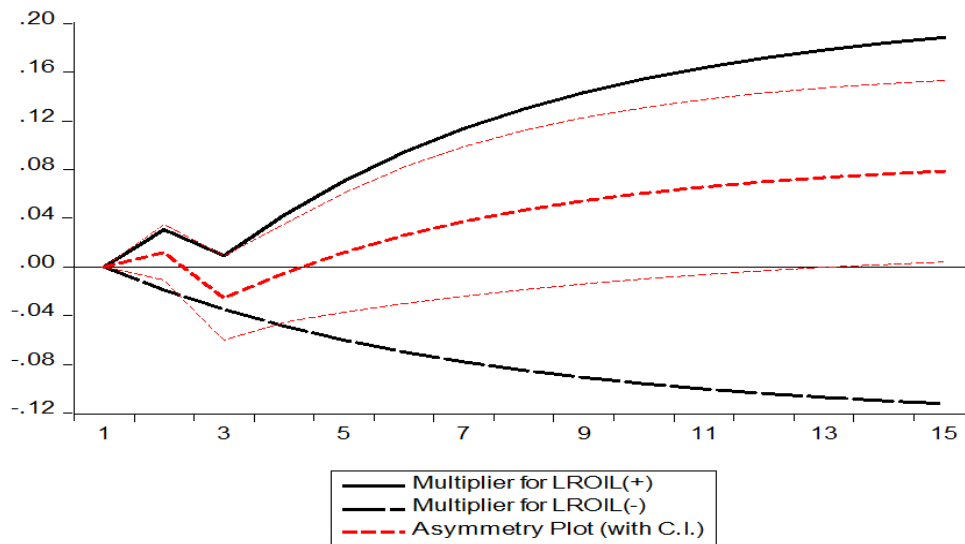**Figure-2.** The cumulative effects of positive and negative oil shocks on GDP (model 01).

Figure-3. The cumulative effects of positive and negative oil shocks on GDP (model 02).

5.4. Diagnostics Tests

Table 6 below shows the results of the following tests: LM test which is used to detect the serial correlation, the autoregressive conditional heteroskedasticity test (ARCH) which aims at revealing whether the errors are heteroskedastic, the normality test "Jarque Bera" which confirms whether all the residuals of the model follow a Normal distribution and finally the Reset test which is Ramsey's test of functional misspecification.

Table-6. Results of diagnostics tests of the estimated model.

Model	Model 01	Model 02
Test	Statistic (p-value	Statistic (p-value)
LM test	$x^2_{SC} = 1.466 \ (0.246)$	$x^2_{SC} = 0.384 \ (0.539)$
ARCH	$x^2_{FF} = 0.946 \ (0.336)$	$x^2_{FF} = 0.010 \ (0.918)$
Normality test	$JB = 2.134 \ (0.343)$	$JB = 0.573 \ (0.750)$
Ramsey RESET	$F = 1.194 \ (0.281)$	$F = 0.918 \ (0.343)$

According to Table 6 above, the LM test is based on the null hypothesis "the absence of serial correlation". The result was estimated using the x^2_{SC} statistic which is lower than the tabulated value corresponding to the estimated model. Therefore, the null hypothesis is accepted and there is no serial correlation.

Similarly, the autoregressive conditional heteroskedasticity ARCH (1) shows that the variance of the errors is constant over time. also, the Jarque-Bera test indicates that the null hypothesis which says that the residuals are normally distributed, has not been rejected. The results of the Ramsey RESET test indicate the rejection of the null hypothesis "existence of model misspecification", hence, the model takes the appropriate functional and it is correctly specified.

Figure 4 and Figure 5 reveal the stability of the model 01 and model 02 respectively. By using CUSUM and CUSUM of the squares' tests it is consequently clear that the coefficients of our two equations are stable, because the estimated models are within the significance line of 5% for both types of tests, thus, both models are dynamically stable.
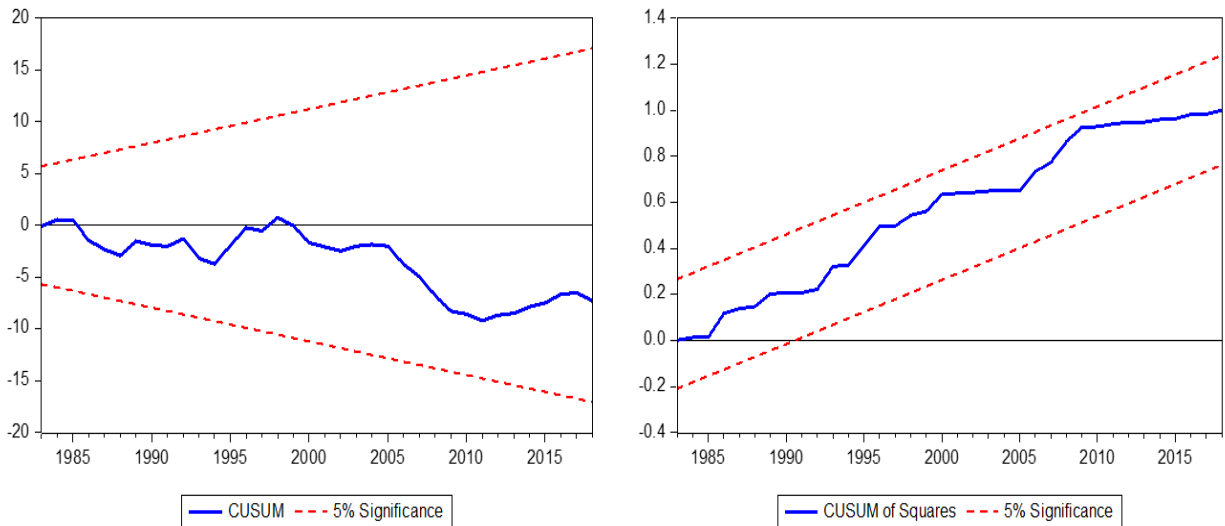
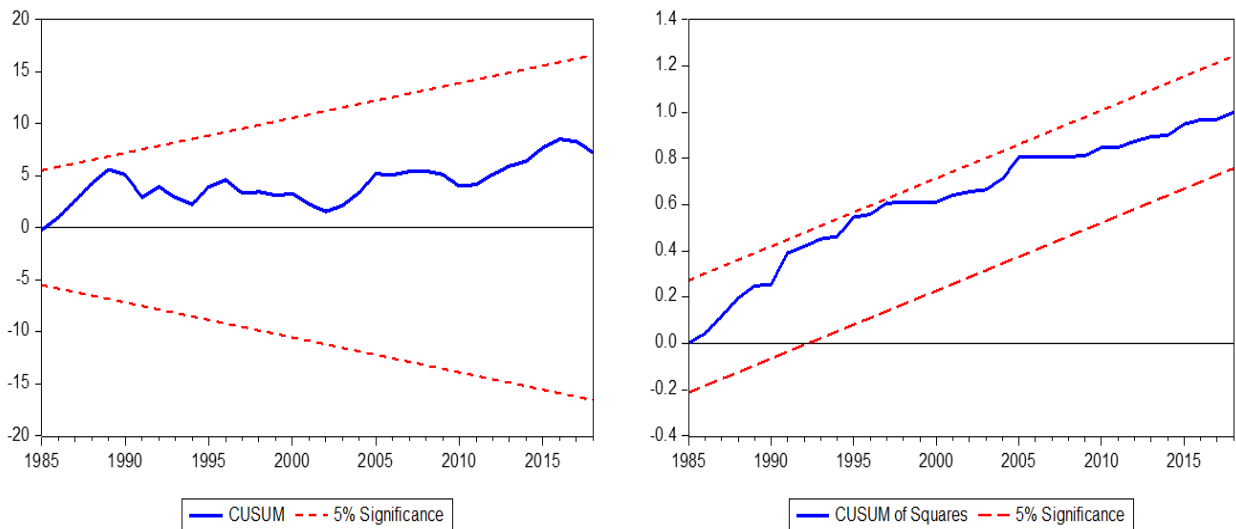**Figure-4.** The graph of the CUSUM and CUSUM squares test (model 01).

Figure-5. The graph of the CUSUM and CUSUM squares test (model 02).

5.5. Further Discussions

The results suggest that positive oil price changes have a considerably larger impact on real GDP in both short and long-run terms. Also, the negative oil price changes are not statistically significant, meaning that the dropping in oil prices has no significant effect on real output. Thus, reflects the puzzling role of oil shocks in Algeria.

In most oil-exporting countries, such as Algeria, the hydrocarbons funds are being used for adjusting the operational budget, these revenues are usually drawn to provide subsidies for basic commodities and gasoline (Moshiri & Banihashem, 2012).

In fact, according to the results of this study, the strong positive correlation between public capital expenditure and real oil prices and between government revenues and oil prices proves that the increase in oil prices is the only source of budget equilibrium. Thus, oil prices influence fiscal policy and this can be a key propagation mechanism for transmitting oil price shocks to the national economy (Bollino, 2007); (Arezki & Kareem, 2013); (Husain, 2008). Although, if we highlight the trade-offs between increased spending in response to rising oil prices and the institutional capacity to effectively absorb such an increase and in order to realize economic growth, we find that the last oil boom (2004-2008) allowed the oil-producing countries to increase their public receipt and spending which both had relatively weak indices of government effectiveness (Villafuerte, 2008).

Consequently, the ability to transfer the oil windfall to promote economic performance may be associated with the government's fiscal policy. The public sector is the sole recipient of the oil revenues and tends to start-up to large but inefficient investment projects. The investment costs are expensive and the time needed to finish a project is longer due to the variations in oil prices (Moshiri & Banihashem, 2012). Besides, during the oil boom, the Algerian government like most oil-exporting countries follows an expansionary fiscal policy financed by excessive oil funds and starts to proceed social programs and contributes to large direct and indirect subsidies for the whole society (IMF., 2018).

According to the findings of this study, the following problematic can be discussed: "Is the positive effect of rising oil prices in the short and long terms sufficient to keep pace with sustainable economic development?" The empirical results of NARDL estimation reveal that the contribution of oil prices increase to economic growth is positive but it remains low a 1% rise in oil prices leads to 0.03% increase approximately of real GDP in short run and 0.17% (0.216%) in the long term for model 01 (model 02).

The weak contribution of positive oil shocks in stimulating economic growth proves certain dependency on hydrocarbons. Algeria still has a problem of deindustrialization; volatile growth has been evident since 2000, due to a recovery in the hydrocarbon sector and aggregate demand captured by building and public works sector, recording a peak of 13% in 2006.

However, non-hydrocarbons industry represents only a marginal share in GDP (4.5 percent in 2004). Besides, except for the Steel, Mechanics, Metallurgy and Electronics industries (SMMEI) sector benefited from public demand and the rest of the industrial sectors experienced negative growth (Benabdallah, 2009). Concerning agriculture, its contribution had also been marginal, especially in recent years. Production in volume of non-hydrocarbons industry underwent a significant slowdown where it decreased by 27.7% between 1989 and 1998, noting that the production of SMMEI also experienced a decline of 51.1% in the same period. Currently the increase volume of this sector is extremely low (0.7%, -0.3% and 1.7% in 2016, 2017 and 2018 respectively). Besides, leather and footwear industry are measured as follow 0.1%, -1.9% and 5.9% (during the same previously mentioned 2016, 2017 and 2018). The various industries attained very low volume of production ranging from a negative value to a positive one (-11.7% to 1.6% and 2.8%) during the same years (ONS, 2015).

In that sense, some reasons may be behind the Algerian slow growth, it had a modest investment in the manufacturing sector with rapid deindustrialization, which managed to a fast reduction in the share of manufacturing in Gross Value Added, from 17% in 1970 to less than 5% in 2010 (Bouznit & María, 2016). All efforts at industrial reformations have not occurred in any type of development in their performance (Begga & Merghit, 2014).

The hydrocarbons oil boom funds of higher oil prices are unable to create a diversified sector base. By adding the accumulation of oil revenues which can delay economic performance and a massive return of industrialization (deindustrialization). Despite the depreciation of the exchange rate and according to all factors mentioned previously, it can be seen as evidence for Dutch disease theory in Algeria.

Otherwise, the origin of the non-significance of oil prices decrease can be explained by the growth of building and public works sector (absence of contribution of the tourism sector and manufacturing production, etc.) which had kept growth rates in their positive levels (but relatively weak).

For example, the fall in real oil prices in 2009 (around 49 $ per barrel) led to negative rates of hydrocarbons GDP (-8%) against a non-hydrocarbons GDP of 9.6% thanks to the GDP of building and public works sector (8.5% in the same year), while the total GDP reached 1.6%.

As a consequence, oil-exporting and developing countries (such as Algeria) face a severe policy challenge to degrade their dependence on energy resources by diversifying their economic activities to have a more stable financial stream that promotes long-term sustainable economic growth (Nusair, 2016). It should take policy measures to substantially expand and diversify their economic base. Such procedures incorporate applying

structural amelioration that encourage the development of the non-hydrocarbons sector (Cherif & Hasanov, 2014). Also, the main political challenge for Algeria is to give more importance to the private sector through facilities of trade regulations and improvement of the business climate; the opening of new fields of activity; the rationalization of subsidies and the improvement of the functioning of the labor market (IMF., 2018).

It is necessary to reconstruct the growth model of Algeria, which has been dependent on the public sector for decades, thus, requires a well-sequenced and structured process. An important challenge for policy makers is the depletion of oil reserves because of the high consumption of energy especially by households, while that energy consumed by businesses remains very low and in fact it is the latter that stimulates economic growth.

Also, a major challenge for policymakers is the trade-off between to spend oil revenues to respond the needs of the current generation and to invest them to secure the future of next generation by preserving a long-term fiscal sustainability and by emphasizing on the rational use of energy products (Manama, 2016).

6. CONCLUSION AND POLICY IMPLICATIONS

The present paper aims to test the asymmetric effect of oil price shocks on economic growth in Algeria from 1970 to 2018. We apply the Non-linear Autoregressive Distribution Lags (NARDL) model in which short-and long-run asymmetric effects are captured through positive and negative partial sum decompositions of the explanatory variable (oil price).

Asymmetries are introduced via positive and negative partial sum decompositions of oil price. Also, we have selected two variables to reflect the fiscal policy which are government revenue and the capital expenditure, through which oil prices pass into economic growth, in addition to the inflation and exchange rates. The results of the study reveal that there is a non-linear connection among the variables in the long-run relationship as the evidence of asymmetric cointegration tests confirms the existence of a long-run relationship between oil price shocks and the real GDP. In the long term, the main findings of NARDL model estimation show that the positive oil shocks increase the real GDP by 0.17% (0.21%) in the long term for model 01 (model 02), but it remains low, while the negative shock leads to a decrease of 0.01% (0.11%).

Therefore, a GDP response is greater with positive oil shock than that of the negative shocks and this observation confirms the existence of an asymmetric effect in the long run. In the short term, the results show that the effect of oil shocks on economic growth is symmetric and very weak. The results showed also that government revenue has a greater impact on economic growth than capital expenditure, and this reflects the need to diversify income to ensure its sustainability.

Given the persistence of low oil prices and the continued shrinking of government revenues in Algeria and based on these results of our econometric study, we can propose some suggestions for policymakers which are presented as follow:

- Policymakers are seriously asked to diversify the real sector and the budgetary resources to limit the harmful effects of oil price shocks and efficiently allocate oil rents in the periods of oil price boom.
- They need to Apply proactive and Strict fiscal policies, improve the rationalizing of public spending, reduce ballooning budget deficits and phase out energy consumption subsidies, while promoting the usage of renewable energies and rationalizing the current energy used (Matallah, 2020).
- They need to carry out a series of reforms related to the subsidy budget and work to increase the efficiency and reduce unproductive expenditure to increase the fiscal primary balance and ensure debt sustainability.

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