THE ASYMMETRIC IMPACT OF OIL PRICE SHOCKS ON THE EVOLUTION OF THE UNEMPLOYMENT RATE IN ALGERIA: NEW EVIDENCE USING NARDL ANALYSIS

Mohamed Dahmani **DRIOUCHE**[*]
Abdelatif **HAMRIT** [**]

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Corresponding authors: dah9moh@yahoo.fr

ABSTRACT

This research aims to study and analyze the asymmetric effects of oil price shocks and the evolution of certain macroeconomic variables on unemployment rates in Algeria during the period 1990-2017 and the use of the nonlinear NARDL model. In the long term, the results showed that there is an asymmetric cointegration which means that there are long-term relationships between the variables of our econometric study and asymmetric effects as well. This is due to the negative shocks of oil prices that have a greater impact on unemployment rates than positive shocks. Also, the effects of oil prices in the short term were asymmetric as diagnostic tests showed the advantage of the first estimated model. The results also showed that economic growth rates have a significant impact on unemployment rates compared to the investment expenditures, as well as the size of loans provided to the private sector. Moreover, the results indicate that the non-hydrocarbon GDP growth is distorted and may not reflect the contribution of this sector in reducing unemployment, as its rise is caused by the previous booms in the oil sector.

KEYWORDS: Positive and negative oil price shocks; unemployment; asymmetric effects, NARDL.

[*] Conférence master (lecturer), University of Djillali Lyabès, Sidi Bel Abbas,
[**] Phd Student, University of Djillali Lyabès, Sidi Bel Abbas, hamritabdelatif@gmail.com , Algeria

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التأثير غير المتماثل لصدمات أسعار النفط على اتجاه معدّلات البطالة في الجزائر: أدلة تجريبية باستخدام نماذج NARDL غير الخطية

ملخص

الهدف من هذه الورقة البحثية هو تحليل الآثار الغير متماثلة لصدمات أسعار النفط وتطور بعض المتغيرات الاقتصادية الكلية على اتجاه معدلات البطالة في الجزائر خلال الفترة 1990-2017 باستخدام نموذج الـ NARDL غير خطي. في المدى الطويل أظهرت النتائج وجود تكامل مشترك غير متناظر، أي وجود علاقات طويلة الأمد بين متغيرات الدراسة وأن هناك تأثيرات غير متماثلة، حيث أن الصدمات السلبية لأسعار النفط لها تأثير أكبر على معدلات البطالة من الصدمات الموجبة. أيضا تأثيرات أسعار النفط في المدى القصير جاءت غير متماثلة حيث أن الاختبارات التشخيصية بينت أفضلية النموذج الأول المقدر. كما بينت النتائج أن معدلات النمو الاقتصادي لها تأثير كبير على معدلات البطالة مقارنة بالنفقات الاستثمارية وكذا حجم القروض المقدمة للقطاع الخاص. بينت النتائج أيضا أن الناتج المحلي خارج قطاع المحروقات مشوه ولا يعكس مساهمة هذا القطاع في التخفيض من حدة البطالة، حيث أن ارتفاعه هو نتيجة للطفرات السابقة في قطاع النفط.

كلمات مفتاحية:

صدمات أسعار النفط الموجبة والسالبة؛ البطالة؛ الآثار غير المتماثلة؛ نماذج الانحدار الذاتي للفجوات الزمنية المتباطئة الموزعة غير الخطية.

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L'IMPACT ASYMÉTRIQUE DES CHOCS DES PRIX DU PÉTROLE SUR L'EVOLUTION DU TAUX DE CHÔMAGE EN ALGÉRIE : UNE PREUVE EMPIRIQUE PAR LE MODÈLE NARDL

RÉSUMÉ

L'objectif de cet article est d'étudier et d'analyser les effets asymétriques des chocs des prix du pétrole et l'évolution de certaines variables macroéconomiques sur les taux de chômage en Algérie au cours de la période 1990-2017 à l'aide du modèle non linéaire NARDL. À long terme, les tests de cointégration asymétrique ont montré qu'il existe des relations à long terme entre les variables et qu'il existe des effets asymétriques, ou les chocs négatifs des prix du pétrole ont un impact sur les taux de chômage plus important que les chocs positifs. De plus, les effets des prix du pétrole à court terme semblaient asymétriques, car les tests de diagnostic ont montré l'avantage du premier modèle estimé. Les résultats ont également montré que les taux de croissance économique ont un impact significatif sur les taux de chômage par rapport aux dépenses d'investissement, ainsi que les crédits fournis au secteur privé. En revanche, les résultats ont montré que le taux de croissance du PIB hors hydrocarbures est déformé et ne reflète pas la contribution de ce secteur à la réduction du chômage, car sa hausse est le résultat des booms précédents du secteur pétrolier.

MOTS CLÉS :

Chocs pétroliers positifs et négatifs ; chômage ; effets asymétriques, NARDL.

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INTRODUCTION

Unemployment is one of the most important macroeconomic issues faced by all governments because of the social and economic impacts it has on their economies. Therefore, governments endeavor to adopt appropriate and effective policies that promote employment rates. As it stands, policymakers examine various factors and phenomena that may have an impact on unemployment rates, such as the potential effect of oil-price shocks on economic activity through various channels to eventually suggest new policies for improving the employment rate.

Since the first oil crisis of the 1970's, the relationship between oil-price shocks and macroeconomic activities has considerably received the attention of economists. The economist Hamilton (1983) revealed that the increase in oil prices affected negatively real gross domestic product (RGDP henceforth) in the United States of America. Economic Theory, through the works of Hamilton (1983; 1988) and Carruth et al (1998) shows that oil-price shocks can affect unemployment in the short term, and most commonly, in the long term. We will focus more on the impact of oil-price shocks on unemployment rather than on GDP as Changes in GDP do not always interact with unemployment (Okun, 1662). We will attempt to answer the central question of the study stated as:

Do oil-price shocks have symmetric or asymmetric effects on unemployment rates in Algeria?

Through the present research, we would study and determine both the asymmetric effects of oil-price shocks and the evolution of some macroeconomic variables on Algeria's unemployment rates. This is feasible by using relatively recent and non-linear standard methods that were developed by Shin et al. (2014) (NARDL Model) and through the use of some annual data covering the period of 1990-2017. In this paper, we would distinguish between positive and negative oil-price shocks and their impacts on unemployment rates in the short- and long-term. It is very important to distinguish between positive and negative movements of oil price changes as this allows us to measure whether unemployment will react differently when oil price falls, compared to how it occurs when the price of oil rises.

This paper's main objective lies in the attempt to enrich the existing body of literature, particularly on the asymmetric impact of oil-price shocks on Algeria's unemployment rates. In specific, we would analyze supply shocks caused by real oil prices.

The structure of the paper is as follows: The first section presents a series of relatively recent models and applied studies that attempted to determine the impact of oil-price changes on the unemployment rate in a number of economies. The second section is devoted to exposing the developments of oil prices vis-à-vis growth and unemployment rates in Algeria. The third section elaborates on the study approach and presents data analysis. Then, it displays the results of the standard study that may support the research hypothesis on the existence of asymmetric effects of oil prices. This section ends with some concluding observations.

1- LITERATURE REVIEW

Many researchers have conducted multiple studies using different models on the same topic. However, they have come to different results depending on the nature of the economic structure in each country. Amongst these investigations, the study of Alkhateeb, Tarek Tawfik Yousef, et al (2017) entitled as "Oil price and employment nexus in Saudi Arabia" during the period of 1980-2015". Whereby, the most important indicator of economic growth in Saudi Arabia is attributed to high oil prices, because of the country's heavy dependence on oil revenues. Out of this, employment rates are closely related to oil-price change. Thus, this paper sets forth to examine this problem using Linear and Nonlinear Autoregressive Distributed Lag Models (ARDL and NARDL models) together with the study data and variables. Results from the ARDL model revealed positive effects of economic growth and oil price on employment levels in the short and long term. While in the NARDL model, the results proved that changes in oil price promote employment rates, these effects are asymmetric though as the positive movement of oil prices has a greater impact on the level of employment in the long term. In parallel, the negative movement of oil prices has a negative impact on the level of employment, but these effects are small because of the government support for the economy during the period of the oil-price decline crisis. Whereas, Saudi economic growth has a positive impact on employment in the short and long term in both models. Therefore, higher oil revenues should be afforded in the period of high prices and prosperity, in order to boost employment and reduce unemployment during the period of oil crises.

The second study was conducted by Elsiddig Rahma, Noel Perera and Kian Tan (2016). It attempted to determine the impact of real oil-price shocks on two key macroeconomic indicators in Sudan during 2000-2014, because the Sudanese economy has become heavily dependent on oil exports in the late 1990s. This paper uses Vector Autoregression Models (VAR models), and Granger Causality test to identify the reciprocal effects of fluctuations in oil prices, GDP growth, and unemployment rates in the Sudanese economy. The results indicate symmetric effects between oil prices and GDP growth, as well as the existence of a reverse causality between oil prices and unemployment, as positive oil prices increase output growth and reduce unemployment by creating new job opportunities. In the same vein, negative oil-price shock slows down GDP growth, and it has a crucial negative impact on unemployment, despite the existence of positive factors such as government employment policy and massive migration to the Gulf Arab states and other countries. Yet, similar studies conducted in developed countries continue to dominate the academic field, both in terms of data accuracy and the use of advanced methodologies, as well as the adoption of relatively different and modern models. These works will last as a fundamental reference for many researchers and experts.

Some relatively recent studies include that of Juna Carlos Cuestas and Javier Ordonez (2018). The researchers analyzed oil-price movements vis-à-vis the augmentation of unemployment rates in the United Kingdom, using Bayesian Structural Vector Autoregression (Bayesian

SVAR) methodology and relying on quarterly data covering the period of 2000-2014. This latter was to define the nature of the relationship between oil prices and unemployment rates before and after the UK's economy global crisis of 2008, and to determine the nature of the effects existing between them. The study results indicated that there are asymmetric effects between the study variables, and that the nature of the relationship between unemployment and oil prices varies before and after the crisis period. Despite positive pre-crisis oil-price movements that had a negative impact on employment (inverse relationship) and caused relatively high unemployment rates, lower oil prices after the crisis maintained unemployment rates at relatively low levels. This is because the distinction between positive and negative oil-price shocks paves the way to the development and implementation of economic plans that can stand against the challenges facing the UK economy during crises.

Another worth noting academic study entitled "The Causal Nexus between Oil Prices, Interest Rates, and Unemployment in Norway: Using Wavelet Methods" conducted by Hynjoo Kim Karlsson, Yushu Li and Ghazi Shukur (2018). It endeavors to apply the Wavelet analysis technique and the VAR model in addition to Granger Causality test and Toda-Yamamoto method, using monthly data for 1997-2015, in order to determine the nature of the relationship between the three variables investigated in the Norwegian economy. As Norway is an oil exporter, the rise and/or fall in oil prices reduces and/or rises unemployment rates. This means that there is a one-way inverse causal relationship between them. In simple words, unemployment rates in Norway respond negatively to oil-price shocks two years later, so the effects of oil-price changes on the labor market is not immediately noticed, and therefore this oil price-labor market mechanism should be a concern of decision-making in the short-term.

The study of Johanna Bocklet and Jungho Baek (2017) is also important to mention. It aims to find out whether oil-price changes have symmetric or asymmetric effects on the Alaska unemployment rates; using a quarterly data series during 1987-2014, since labor markets are seem to have different reactions to higher oil prices than to lower oil prices. Therefore, this paper intends to help reveal whether the effect of oil-price change on unemployment is symmetric or asymmetric in Alaska. In this study, the NARDL methodology is implemented and empirical results showed that changes in crude oil-prices have asymmetric effects on the short-term unemployment rate, i.e., an inverse relationship exists, so that the Alaska unemployment rate is more sensitive and responsive to higher oil prices than to lower prices. Yet, the short-term asymmetric effects proved unable to last for long terms.

Irina Kurnysheva and Dmitry Burakov (2017), at the same time, tried to probe how oil-price shocks affect competition in the Russian labor market, the article intended to reveal what the relationship between oil prices, labor, and the overall level of real wages in the Russian economy was between 1990-2016. This was accomplished using Vector Error Correction Model (VECM henceforth) to test the hypothesis that oil-price shocks have an impact on competition in the labor markets of oil-exporting countries. The results demonstrated that there is a long-term relationship between the study variables since the rise of oil prices increases the overall wage level and the employment rates, and the opposite occurs when there is a negative oil shock. In the short term, the oil-price shock has a direct impact on oil revenues and, above all, on expenditure plans. This latter can either decline or rise employment rates. In addition, employment shocks lead to overall real wage growth, because the increasing demand for labor by employers raises competitive pressure in the labor market and leads to augmented employee needs, which can only be covered by more supply of wages.

Nyakundi Michieka and Richard Gearhart (2015) conducted another study entitled "Oil Price Fluctuations and Employment in Kern County: A Vector Error Correction approach". The paper analyzes the short- and long-term effects of oil-price fluctuations on labor and unemployment in this province: California's largest oil producer in 1990-2015. This is acheived by using VECM to know the extent to which oil price correlates with employment, whether in the short or long term. The results revealed a one-way causality between the rise of oil prices and the increase of employment rates (low unemployment) in the long term, since oil prices have symmetric effects on employment (direct relationship). While no causality was found between the variables studied in the short term, Kern Province had accordingly to formulate appropriate economic policies that consider the fact that changes in oil prices have long but not short-term effects on employment and unemployment, such as to consider expanding the industrial base to protect employment from oil-price shocks.

Moreover, it is worth mentioning the study of Bulent Altay, Mert Topcu and Ebrun Erdogan (2013) about assessing the relationship among oil prices, real output growth and employment in Turkey over the period of 2000-2012 by using vector error correction methodology (VECM). Findings indicated a long-run relationship among the variables. In addition, short-term Granger Causality results based on VECM revealed a strong evidence of bi-directional causality link between oil prices and output to employment. Thus, oil-price shocks have noticeable effects on the short-term unemployment rate in the Turkish economy. In the long-term, however, oil and production prices had no obvious impact on employment.

2- OIL PRICES VOLATILITY AND THE TRENDS IN UNEMPLOYMENT RATES IN ALGERIA

Most recent applied studies revolving around labor market have shown that Algeria's unemployment rates are closely related to the economy structure. These rates need long-term policies, which depend on restructuring the economy in general. Among the most important of these studies, we mention that of Davide Furceri [1] (2012) on "Unemployment and Labor Market Issues in Algeria" and that of Kangni Kpodar (2007) on "Why Has Unemployment in Algeria Been Higher than in MENA and Transition Countries? [2] Given the significant role played by oil prices in determining the state's public

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[1] Davide Furceri (2012), Unemployment and Labor Market Issues in Algeria, IMF Working Paper, Middle East and Central Asia Department, WP/12/99.

[2] Kangni Kpodar (2007), Why Has Unemployment in Algeria Been Higher than in MENA and Transition Countries? IMF Working Paper, African Department, WP/07/210.

revenues, we framed them as an explanatory variable to unemployment rates.

Oil prices were marked by sharp and large fluctuations between the early 1970s to the present time. This had a major impact on Algeria's dynamic of economic activity. From **Figure 1**, it is clear that as a result of the 1973 war, crude oil prices rose four times, from $3 per barrel in 1972 to $12 per barrel by the end of 1974. This increase was the result of the Arab oil embargo, which later helped to rise the financial returns of the fuel sector, as increasing revenues were the best solution for financing heavy-industry-based economic development projects. All of this has foregrounded the sector to originate a development strategy to create job opportunities in Algeria. A decrease in unemployment rates accompanied the rise in oil prices from 24.83% in 1972 to 16.33% in 1979. The 1979 Iranian revolution and the 1980 Iran-Iraq war also helped maintain high oil prices during 1979-1985. Although they declined from $35.41 to $26.48 per barrel in 1981, unemployment rates continued to fall to 13.29% in 1984 and stabilized at 13.59% until 1985. At the end of 1986, oil prices collapsed from $27 to under $10. Algeria witnessed difficult economic events during 1989-1986, including mainly the oil shock that had a negative impact on macroeconomic variables, especially on unemployment rates that rose from 16.14% in 1986 to 20.04% in 1990. Despite the slight improvement of oil prices after the Second Gulf War in 1990, unemployment stabilized at 22.25% as an average during 1990-1995. However, by the end of this year, the rates rose to a maximum level of 29.50% in 2000. This rise coincided with an oil-price collapse; it reached its lowest level estimated as 12.16 dollars in 1998.

Oil prices then began to recover at the end of 1999, as OPEC reduced the production three times during 1998 and 1999. While the world economy was growing, Oil prices continued to rise in 2000 and surpassed the highest levels rates 1981. They rose to $28.1 in 2003, jumped in 2007 and kept ascending to the level of $147.27 in 2008[3]. Nevertheless, they quickly declined since the global demand was uncertain because of the global economic recession caused by the mortgage crisis in October 2008. Prices then reached $60 per barrel as the lowest level by the end of 2008, and oil lost about 32% of its value. Meanwhile, during 2001-2011 (oil boom era), Algeria had a significant decline of unemployment rates estimated at a 9.8% low in 2011.

After that, oil prices improved again in 2010. They progressed from an average of $ 80$ to reach 105$ at the end of 2013. This rise was accompanied by a stabilization of unemployment rates, which remained in the range of 10%. It was also a period of stable and modest economic-growth rates (3% as an average). World markets' oil prices were steadily falling in June 2014. The Algerian oil was in the range of 110$ per barrel, on average, and it declined to 53$ in the early days of January 2015 because of several factors. Such as, the US shale-oil boom, the change in OPEC strategic behavior, the decline in world oil demand, especially from some major economies like China, and other factors like the increase in Iranian oil exports and the restoration of their market-share after the West embargo was lifted. Crude oil prices continued to fall in 2016 and reached an annual average of 39$; however, this latter rose in 2017 to 55$ per barrel.

3. THE EMPIRICAL STUDY

3.1. Data and Research Methodology

The objective of this research is to study and identify oil price shocks asymmetric effects and to develop some key economic variables about the direction of Algeria's unemployment rates, using relatively recent standard approaches (non-linear models), and drawing on annual data from 1990-2017. The major macroeconomic variables were selected from a number of studies in this area. These variables are:

- **Unemployment (unem):** in terms of the Annual Unemployment Rate.

[3] Noura bint Abdul-Rahman Al-Yousef, the rise and fall in oil prices from 1970 to 2008, Work Papers, College of Business Administration, King Saud University, Saudi Arabia, June 2008.

- **Oil Prices (roil):** in terms of Real Oil Prices Annual Average (crude oil blends)
- **The growth rate of Real Gross Domestic Product (rgdp):** the RGDP was measured in constant prices for 2000 (using the GDP deflator) which is the most important measure to determine a country's development level of economic activity.
- **Inflation Rate (inf):** measured by consumer prices (%); an indicator that can demonstrate a country's economic stability because most recent applied studies suggest that high and volatile inflationary directions always tend to increase uncertainty levels, large fluctuations in inflation rates affect unemployment rates accordingly.
- **Domestic credit to the private sector (priva):** The ratio of domestic credit granted for the private sector to GDP (% GDP). This variable was used in many recent applied studies to detect the private sector's facilities. It may reflect an important proportion of the investment in this sector. Kar and Pentecost (2000) have shown that private sector loans generated large investments, in many countries, and doubled this latter's productivity, which in turn influenced employment rates.
- **Non-Oil Real GDP Growth (hgdp):** An indicator that measures annual real GDP growth at Constant prices for all sectors except for that of oil. Non-hydrocarbon GDP growth is one of the essential macroeconomic indicators reflecting the national economy's general state over successive years.
- **Government Capital Expenditures (equi):** measured in the ratio of equipment expenditures to GDP. These expenditures of an investment nature (also known as investment expenditures) are generated when GNP increases.

The data were obtained from national statistical agencies and international organizations (ONS, CNES, OPEC, WB, and the Sherbrook University database). To analyze and measure the relationship between these variables, we converted all data series into the logarithmic formula to standardize the measure units (because the units of the variables are in percentages and prices in dollars) as follows:

$$\text{Lunem}_t = \text{f}\,(\text{lroil}_t, \text{lv}_t,\ \text{lz}_t) \qquad (1)$$

That is: (v_t, z_t) are the independent macroeconomic variables to be included in addition to oil prices.

3.2. Nonlinear Autoregressive Distributed Lag Model

To examine the asymmetric effects of oil prices on Algeria's unemployment rates, the NARDL model, Shin et al. (2014), is used. It helps separate long and short-term asymmetric effects. It is also an asymmetric extension of the linear ARDL model; it is formulated as follows:

$$\text{Lunem}_t = \text{f}\,(\ \text{lroil}^{+}{}_t, \text{lroil}^{-}{}_t, \text{lv}_t,\ \text{lz}_t) \qquad (2)$$

The NARDL model adopts a comprehensive analysis to avoid errors as well as to obtain the correct dynamic multiples by eliminating the non-significant variables. Based on our discussion of Algeria's non-linear response to external shocks, we presume that oil price has an asymmetric effect on unemployment rates. The starting point is, therefore, to illustrate the asymmetric long-run regression model as follows:

$$\text{Lunem}_t = \alpha_0 + \alpha_1 \text{lroil}_t{}^{+} + \alpha_2 \text{lroil}_t{}^{-} + \alpha_3\, \text{lv}_t + \alpha_4\, \text{lz}_t + \ \varepsilon_t \qquad (3)$$

$$\text{Y}_\text{t} = \beta^{+}\text{x}_\text{t}^{+} + \beta^{-}\text{x}_\text{t}^{-} + \text{u}_\text{t} \qquad (4)$$

That is: β^{+} and β^{-} are the long-term associated parameters, and $x_t^{+}(\text{lroil}_t{}^{+})$ as well as $x_t^{-}(\text{lroil}_t{}^{-})$ are partial sum processes of positive and negative changes of the variable x_t. And x_t represents detailed vector regression demonstrated as:

$$\text{lroil}_\text{t} = \text{lroil}_0 + \text{lroil}_\text{t}^{+} + \text{lroil}_\text{t}^{-} \qquad (5)$$

$$lroil_t^{+} = \sum_{j=1}^{t} \Delta\, lroil_j^{+} = \sum_{j=1}^{t} \max\left(\Delta lroil_j, 0\right) \qquad (6)$$

$$lroil_j^{-} = \sum_{j=1}^{t} \Delta\, lroil_j^{-} = \sum_{j=1}^{t} \min\left(\Delta lroil_j, 0\right) \qquad (7)$$

Shin etal. (2014), linked correlated equation (3) with the linear ARDL model of Pesaran et al. (2001) to attain the non-linear ARDL (NARDL) relationship as follows:

$$\Delta lunem_t = \alpha_0 + \varrho \mathrm{lunem}_{t-1} + \theta^+ \mathrm{lroil}^+_{t-1} + \theta^- \mathrm{lroil}^-_{t-1} + \lambda\, \mathrm{lv}_{t-1} + \delta\, \mathrm{lz}_{t-1} + \sum_{j=1}^{p} \gamma_j\, \Delta \mathrm{lunem}_{t-j} + \sum_{j=1}^{q} \gamma_j\, \Delta \mathrm{lv}_{t-j} + \sum_{j=1}^{q} \delta_j\, \Delta \mathrm{lz}_{t-j} + \sum_{j=0}^{q} \left(\pi_j^+\, \Delta \mathrm{roil}^+_{t-j} + \pi_{j-}^-\, \Delta \mathrm{roil}^-_{t-j}\right) + e_t, \quad (8)$$

$$j = 1, \ldots, q-1 \ , \ \beta^+ = -\theta^+/\rho \ \text{and} \ \beta^- = -\theta^-/\rho$$

The first step of the econometric analysis is to estimate the NARDL (p,q) model (equation 8) using ordinary least squares (OLS) method. The second step is to conduct the asymmetric tests (nonlinear relationship) to measure the cointegration among the variables $lunem_t, lroil_t^+, lroil_t^-$.

In particular, the null hypothesis that there is no cointegrating relationship i.e. $\rho = \theta^+ = \theta^- = 0$.

It is tested by using the ARDL bounds testing approach to cointegration as proposed by Pesaran et al. (2011) and Shin et al. (2014), which is based on corrected F test (F_{PSS}). This test uses two critical values; lower and upper-bound critical values. 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 of non-cointegration cannot be rejected; and if it lies between the critical bounds, the test is inconclusive.

Finally, in the third step, we test long and short symmetry by using the Wald test, we examine the null hypothesis to test is $H_0: \beta^+ = \beta^-$ i.e. $-\theta^+/\rho = -\theta^-/\rho$. In the short-run symmetry can take one of the following forms: $H_0: \sum_{j=0}^{q-1} \varphi_j^+ = \sum_{j=0}^{q-1} \varphi_j^-$;

In specific, this method is more advantageous compared to other methods in the literature. First, it divides the most important variable (oil price) into two components partial (a positive and a negative one). Second, it allows the use of these variables in different integration order, unlike other methods, which require the integration and analysis of all the variables in the same ranks.

Finally, the NARDL method is the most appropriate to serves this research purposes as it permits not only to measure the short- and long-term asymmetries, but also to measures long-run cointegration relationship. This method also allows investigating the adjustment in the long term of the positive and negative shocks across the cumulative dynamic multipliers (Zouhair Mrabet et al, 2019).

3.3. Econometric Results

3.3.1 Unit Roots Tests

The first step is to examine the stationarity of all variables to test the cointegration between these variables.

we conducted the augmented Dickey–Fuller test ADF (1979) test and Phillips–Perron test PP (1988) to examine the unit root and verify the null hypothesis stipulating that there is a unit root, i.e. the series is non-stationary. The test results are displayed in **Table 1** below:

Table 1. PP and ADF Unit Root Tests Results

Variables	ADF			PP			Integration level
	I	II	III	I	II	III	
$lunem_t$	-0.80	-1.46	-2.89	-0.77	-0.71	-1.90	**I(1)**
$dlunem_t$	** -2.93	** -2.98	-2.90	* -2.87	*** -2.92	-2.85	
$lroil^+_t$	4.15	0.07	-2.13	3.67	-0.002	-2.13	**I(1)**
$dlroil^+_t$	** -2.50	* -4.05	**-3.95	**-2.54	** -3.66	***-3.58	
$lroil^-_t$	2.95	0.21	-1.64	4.28	0.52	-1.64	**I(1)**
$dlroil^-_t$	* -3.81	* -4.72	* 4.77	* -3.81	* -4.73	* -4.91	
$lrgdp_t$	7.31	1.18	*** -3.42	5.24	0.83	*** -3.23	**I(0) or I(1)**
$dlrgdp_t$	-0.85	* -3.71	*** -3.52	-1.36	** -3.69	*** -3.48	
$linf_t$	-1.37	-2.31	2.36	-1.27	-2.31	-2.18	**I(1)**
$dlinf_t$	* -7.92	* -7.83	* -7.84	* -7.92	* -7.83	* -8.18	

lpriva_t	-0.98	-2.51	** -4.18	-0.96	-2.59	* -6.12	**I(0) or I(1)**
dlpriva_t	* -4.26	* -4.18	* -4.78	* -4.26	* -4.18	* -4.78	
lhgdp_t	* -1.75	**-3.18	* -3.30	-1.51	** -3.14	* -3.30	**I(0)**
ldhgdp_t	* -7.40	* -7.27	** -3.72	* -7.86	* -7.70	* -7.52	
lequi_t	0.34	-1.24	-2.67	0.61	-1.12	-2.78	**I(1)**
ldequi_t	* -5.44	* -5.50	* -5.37	* -5.46	* -5.63	* -5.48	

Note: *, ** et *** indicate significance at 1%, 5% et 10% levels, respectively.

Δ the difference I: the first model without constant and trend, II: the second model with constant, III: the third with constant and trend

The results indicated that time series of the variables $lunem_t$, $lroil^+{}_t$, $lroil^-{}_t$, $linf_t$, lequi_t contain a unit root, and then these variables are stationary in first difference i.e., integrated of the first order I (1). However, as to the series of the variables $lrgdp_t$ and $lpriva_t$, the results showed that the series are stationaries at the level I(0), but the result is inconclusive. Other traditional unit roots such as PP and ADF often lead to spurious results as by ignoring the structural break in the series, (Rahman, Z. U., & Ahmad 2019), (Muhammad Shahbaz & all 2015).

Therefore, we conducted other relatively recent tests such as the unit-root test with a structural break (Zivot-Andrews). In the Zivot-Andrews tests, the null hypothesis is that the series has a unit root with the structural break, and if the t statistic exceeds in absolute value the critical values tabulated in Zivot and Andrews the null hypothesis of unit root can be rejected (1%, 5%, and 10%). **Table 2** illustrates the test results below:

Table 2. Zivot and Andrews test for unit roots with one structural break

Variables	Level		First Difference		Integration level
	I	II	I	II	
$lunem_t$ TB	-3.05 (3) 2013	-5.04 ** (3) 2004	-5.42 ** (1) 2004	-2.92 (1) 2001	**I(0)**
$lroil^{+}{}_t$ TB	-3.52 (1) 2012	-3.48 (1) 2004	-5.67 * (1) 2005	-5.70 * (1) 2012	**I(1)**
$lroil_t{}^{-}$ TB	-3.46 (0) 2012	-2.46 (0) 2003	-5.03 *** (0) 2002	-5.16 ** (0) 2009	**I(1)**
$lrgdp_t$ TB	-3.51 (0) 2010	-5.53 * (0) 2002	-6.28 * (0) 2006	-5.64 * (0) 1995	**I(0)**
$linf_t$ TB	-4.12 (1) 2000	-3.89 (1) 1997	-12.06 * (0) 2001	-9.90 * (0) 2001	**I(1)**
$lpriva_t$ TB	-2.83 (2) 2001	-3.96 (2) 2001	-2.65 * (2) 2001	-2.75 * (2) 2001	**I(1)**
$lhgdp_t$ TB	-10.03 * (0) 1998	-4.81 *** (0) 1998	-9.23 * (0) 1998	-9.46(0)* 1998	**I(0)**
$lequi_t$ TB	-3.92 (0) 2007	-3.60 (0) 2005	-5.95 * (0) 2010	-6.07(0)* 2010	**I(1)**

TB: is the time of the break.

I: Model without constant and trend the critical values are -5.75 (1%), -5.08 (5%)، -4.82 .(10%) , II: the model with constant the critical values are -5.34 (1%), -4.93 (5%)، -4.58 .(10%). (K): The number of lag order is shown in parentheses and determined by AIC to remove the serial correlation in the series of residuals. * ** and *** mean the unit root is rejected by the null hypothesis at the levels 1, 5 and 10% respectively. ZIVOT and Andrews (1992) results confirmed that most findings of the ADF and PP tests, except for the Lunem series, which is stationary at level, and contain structural break (2004) as well as for the Lrgdp and Lhgdp series, approved the first test results.

3.3.2. Multicollinearity Diagnostics

Before estimating the necessary econometrics models it is required to consider calculating the correlation coefficient between independent variables or calculating the Variance Inflation Factor (VIF) to avoid multicollinearity problem between independent variables, and to make sure the model is not spurious, and it does not reflects the true relationship between the variables. To confirm this, the VIF was calculated. If the VIF value is $VIF > 5$, this means that there is a problem of multicollinearity between the independent variables. **Table 3** below illustrates VIF values from the Eviews.10 output for the models before and after removing the variables:

Table 3. Variance Inflation Factor (VIF)

Indep variable	**VIF before removal**	**VIF after** $lrgdp$ **removal**	**VIF after** $lequi$ **removal**
$lrgdp$	5.47	---	3.95
$lpriva$	1.42	1.41	1.41
$lhgdp$	1.28	1.27	1.27
$lequi$	4.77	3.44	---
$lroil$	4.59	3.52	4.08

Source: EViews 10 software package outputs

Table 3 indicates a multicollinearity problem between independent variables particularly between $lrgdp$ and $lequi$. In the first model, VIF value for $lrgdp$ is greater than 5 and it is almost 5 for $lequi$. To eliminate this problem, the variables were removed separately while estimating the different models. After that, the VIF was calculated for several times, and all values proved below the 5 accordingly, as shown in the previous table. These results entail the ability to generate and estimate different models using the NARDL method.

3.3.3. Estimation of the NARDL Models

After testing for stationarity of all-time series variables, and after determining the dynamic correlation between the independent variables using the VIF, it is possible to identify and estimate the number of different models to explore the asymmetric effects of oil-price shocks and some major macroeconomic variables on Algeria's unemployment rates, depending on many recent macro-econometric studies, (see Cuestas, J. C., & Gil-Alana, L. A 2018, Nusair, S. A 2016, Nusair, S. A 2016). These models are as follows:

I $\quad \text{Lunem}_t = \text{f}\,(\,\text{lroil}^{+}{}_t, \text{lroil}^{-}{}_t, \text{lrgdp}_t, \text{linf}\,{}_t) \quad (9)$

II $\quad \text{Lunem}_t = \text{f}\,(\,\text{lroil}^{+}{}_t, \text{lroil}^{-}{}_t, \text{lpriva}_t, \text{linf}\,{}_t) \quad (10)$

III $\quad \text{Lunem}_t = \text{f}\,(\,\text{lroil}^{+}{}_t, \text{lroil}^{-}{}_t, \text{lhgdp}_t, \text{linf}\,{}_t) \quad (11)$

IV $\quad \text{Lunem}_t = \text{f}\,(\,\text{lroil}^{+}{}_t, \text{lroil}^{-}{}_t, \text{lequi}_t, \text{rgdp}\,{}_t) \quad (12)$

After this, the NARDL models can be estimated according to some relatively recent studies (see Ibrahim M, 2015; Shin et al, 2014; Bahmani-Oskooee & Mohammadian, 2016; Saeed A. Meo 2018). **Table 4** below demonstrates nonlinear cointegration test results for the four models as follows:

Table 4. Asymmetric Cointegration based on Nonlinear Bounds Testing Approach

NARDL	F	Lower bounds	Upper bounds	Decision
I	*** 3.32	2.20	3.09	yes
II	3.54 **	2.56	3.49	yes
III	2.35	2.56	3.49	no
IV	* 5.57	3.29	4.37	yes

Notes: The statistics F (F_{PSS}) Nonlinear denote the F-statistic proposed by Pesaran, Shin, and Smith (2001).

*, ** et *** indicate significance at 1%, 5% et 10% levels, respectively.

the null hypothesis for Asymmetric Cointegration is: $\rho = \theta^{+} = \theta^{-} = 0$

This table indicates that Wald test (F_{-PSS}) value exceeded the upper bounds at 1% for model IV and at 5% and 10% for model II and model I respectively. This proves thus the asymmetric cointegration relationship, i.e. the existence of a long-term relationship between the variables in the non-linear models IV, II and I respectively. Whereas, the null hypothesis was accepted in model III i.e. the absence of a cointegration relationship because Wald test (F_{-PSS}) value is below the lower bounds at 1%.

Long-run and Short-run Asymmetry Test

In the second step, the experimental results of the nonlinear models' estimations are displayed in **Table 5**. Besides, the Wald tests of asymmetric in long-run and short-run are shown in **Table 6.**

For the model I, in the long and short-term, the values of Wald test are significant at 5% and 1% respectively, and therefore the null hypothesis is rejected and the alternative is accepted, i.e. oil-price shocks have asymmetric effects on unemployment rates. However, in model II, the effect of positive and negative oil shocks on unemployment rates is symmetric in both the long and short run, but the results are insignificant. Finally, in model IV, Wald statistic is significant only in the long-term at 1%, that is, the alternative hypothesis of asymmetric effect is accepted for this model.

Table 5. Estimation results of the NARDL model (short-run)

Dependent Variable: ΔUnem	The Three Different Models		
Variables	**I**	**II**	**IV**
C	---	---	---
$dlunem_t(-1)$	* 1.17	---	* 0.38
$dlunem_t(-2)$	** 0.57	---	---
$dlroil^+{}_t$	** - 0.40	---	---
$dlroil^+{}_t(-1)$	- 0.15	---	---
$dlroil^+{}_t(-2)$	---	---	---
$dlroil^+{}_t(-3)$	---	---	---
$dlroil^-{}_t$	* - 0.43	- 0.03	- 0.10
$dlroil^-{}_t(-1)$	* 1.61	** 0.21	---

$dlroil^{-}{}_{t}(-2)$	* 1.1	---	---
$dlroil^{-}{}_{t}(-3)$	---	---	---
$dlinf_{t}$	* 0.15	---	---
$dlinf_{t}(-1)$	* 0.08	---	---
$dlinf_{t}(-2)$	** 0.03	---	---
$dlrgdp_{t}$	- 0.43	---	* 1.72
$dlrgdp_{t}(-1)$	* 6.52	---	** 1.39
$dlrgdp_{t}(-2)$	1.35	---	---
$dlpriva_{t}$	---	- 0.01	---
$dlpriva_{t}(-1)$	---	0.01	---
$dlequi_{t}$	---	---	* 0.15
$dlequi_{t}(-1)$	---	---	* 0.19
$ECM(-1)$	* - 3.24	* - 0.63	* - 0.76
R^2	0.93	0.60	0.81
$\bar{R}^2$	0.85	0.52	0.75

Notes: « + » and « - » demonstrate the positive and negative partial processes, respectively

F_{PSS} statistic is used to test the null hypothesis: $\rho = \theta^{+} = \theta^{-} = 0$
*, ** and *** indicate the significant at 10%, 5% and 1% level of significance, respectively.
ECT_{t-1} is the error correction term, which measures the speed of adjustment to long-run equilibrium.

Table 6. Long-run non-linear ARDL model results and asymmetric tests

Variables	**I**	**II**	**IV**
$lroil^{+}{}_{t}$ (θ^{+})	* - 0.29	*- 0.48	0.04
$lroil^{-}{}_{t}$ (θ^{-})	* - 0.66	*- 0.63	* - 0.60
$Lrgdp_{t}$	* - 1.63	---	* - 2.59
$Linf_{t}$	* - 0.11	*- 0.02	---
$Lpriv_{t}$	---	*- 0.37	---
$Lequi_{t}$	---	---	** - 0.34
c	* 50.13	* 3.85	* 77.92
	Long-run Asymmetry		
	I	**II**	**IV**
W_{LR}	** 8.52	1.10	* 13.19
	Short-run Asymmetry		
	I	**II**	**IV**
W_{SR}	* 18.86	1.41	1.02

Notes: *, ** and *** indicate the significant at 10%, 5% and 1% level of significance, respectively.

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

W_{SR} refers to Wald test for null hypothesis of short-term symmetry defined by: $\sum_{j=1}^{p^*} \pi_j^+ = \sum_{j=1}^{p^*} \pi_j^-$.

Result Analysis of the Nonlinear Models in the Long-run

Findings of the three models indicate that long-term oil-price negative shocks ($\text{lroil}^-{}_t$) have a greater impact, than positive shocks ($\text{lroil}^+{}_t$) have, on unemployment rates at the level of significance 1%. The results the model I showed that the positive shock in oil prices by 1% leads to a decrease in the unemployment rate by 0.29%. Whereas, if a negative shock at 1% happens, unemployment rates will increase by 0.66%. Models **II** and **III** revealed nearly the same results. Therefore, it is concluded that long-run negative shocks have a greater impact than positive shocks on Algeria's unemployment rates.

The asymmetric consequences of the positive and negative oil-price shocks on long-run unemployment rates entail the urgent need to diversify the country's economic structures. The transition towards a diversified economy may raise the value-added out of the non-hydrocarbon sectors and therefore create permanent and productive job opportunities. This diversification may strengthen Algeria to face the world oil-market fluctuations and uncertainty. The findings indicated that, as the public sector can offer a limited number of job opportunities, the private sector might create more new opportunities. As the results of model **II** showed that the increase in the rate of loans provided to the private sector by 1% will push unemployment rates down by 0.37%.

The results also indicated that economic growth rate Lrgdp_t increased, in the long term, by 1% in model I and model IV, and this, in turn, will help decline unemployment rates by 1.63% and 2.95% respectively. This result is consistent with Okun's law; where that reducing unemployment rate requires to raising real GDP. However, the domestic product out of the non-hydrocarbon sectors (Lhgdp_t) proved distorted and unreflective of the sector's progress, and its rise is the result of previous hydrocarbon-sector booms, where the results showed the absence of cointegration relationship in the model Ⅲ. While, the inflation rates Linf_t had very little impact on the direction of unemployment rates (a decline of 0.11% and 0.02% in model I and II respectively). The results proved all significant at 1% in the long-run. Model IV results confirmed model I results regarding the economic growth rate. It was also shown in the results that an increase of 1% in the government capital expenditures will reduce unemployment rates by 0.34%.

Result Analysis of the Nonlinear Models in the Short-run

Model I result indicate that the effects of oil-price shocks in Algeria proved asymmetric in the short run, and these results are consistent with many recent studies; negative shocks have a greater impact than positive shocks. According to **Table 5**, a negative oil shock ${\mathrm{dO}^-}_t$[4] causes an increase of 0.43% in unemployment rates; this result is significant at 1%. While negative shocks at late intervals $\mathrm{dO}^-(-1)$, $\mathrm{dO}^-(-2)$, decrease unemployment rates by 1.61% and 1.1% respectively.

While, any positive oil-price shock dO^+ reduces unemployment rates, but at lower rates, ie 0.40%, and at a significant level at 5%. Nonetheless, the effects of these positive and negative oil shocks, in model II and model IV, proved very weak (see **Table 5**).

3.3.4 Cumulative Effects of Negative and Positive Oil Shocks on Unemployment Rates

To illustrate further the result analysis, we can be completed by examining the asymmetry model obtained from the dynamic multipliers. These multipliers emphasize the adjustment process before the shock to the new equilibrium (after the shock) (Charfeddine, L., & Barkat, K, 2020). It also gives us time to adjust to the new balance. The positive and negative dynamic multipliers correlated with the changes of Lroil_t^+ and Lroil_t^- are put as:

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[4] dO is the abbreviation of dlroil

$$m_h^+ = \sum_{i=0}^{h} \frac{\partial Lunem_{t+i}}{\partial \mathrm{lroil}^+{}_t}, \; m_h^- = \sum_{i=0}^{h} \frac{\partial Lunem_{t+i}}{\partial \mathrm{lroil}^-{}_t}$$

Figure 3 illustrates the dynamic multiples for 15 years. The thick dotted red line indicates the difference between a 1% positive shock and a 1% negative shock, and the thin dotted red lines symbolize the confidence interval for the different effects of both shocks (positive and negative). Whereas, the continuous black line indicates a positive oil shock and the dotted black one indicates a negative shock. Models I and IV results showed a strong reaction to oil-price negative changes; convergence towards long-run coefficients takes place gradually, but the response to positive changes is slow. It is worth noting that in both models the multiples take about nine years to converge towards the values of long-term multiples.

3.3.5 Examination of residuals for models estimated

Table 7. Results of Examination of Residuals for these Models

Diagnostic Tests of the Models			
Test Type	**Model I**	**Model II**	**Model III**
LM $_{(F)}$ test (P-value) -2-	1.80 (0.30)	0.15 (0.85)	1.71 (0.22)
ARCH $_{(F)}$ test (P-value) -2-	0.06 (0.93)	0.80 (0.32)	0.25 (0.62)
Normality test $_{(JB)}$ (P-value)	0.77 (0.67)	1.32 (0.51)	0.61 (0.73)
RESET $_{(F)}$ test (P-value)	0.04 (0.84)	2.81 (0.01)	2.5 (0.02)
CUSUM	**stability**	**stability**	**stability**
CUSUMSQ	**stability**	**stability**	**stability**

According to the stability and the diagnostic tests, the three estimated models are highly reasonable and compatible (the results of LM test indicates the absence of serial correlation in the residuals, the ARCH test shows that the variance of the errors is constant over time, the Jarque-Bera test confirm the approximate normality of the residuals). The diagnostic test was conducted using Ramsey Test, and its results for the model I reject the null hypothesis "existence of model misspecification", hence, the model takes the appropriate functional and it is correctly specified. however, model II and model IV results are insignificant.

Both tests of CUSUM and CUSUM of the squares for the three models illustrate that the parameter line is within the boundaries of critical lines at 5 % probability level area indicating complete stability in the three models. That is, CUSUM and CUSUM of the squares tests point out that the estimated coefficients were stable. At last, it is concluded that diagnostic tests demonstrate that Model I is the best and that it overcame all econometric problems.

CONCLUSIONS

This paper's contribution, from a new perspective, lies in the fact that it tracks the asymmetric effects of oil-price shocks as well as the evolution of the direction in economic growth rates and some macroeconomic variables on Algeria's unemployment rates during 1990-2017. It was validated and confirmed, using the NARDL model, that oil-price shocks have asymmetric effects. Moreover, cointegration tests (Shin et al, 2014) revealed a long-term relationship between the study variables in the three different models. However, long and short-term asymmetry tests proved significant only in the first model (I), and the diagnosis tests confirmed that this model is the best and that it jumped over all standard problems. The results also showed the existence of long-term asymmetric effects and short-term symmetric effects in model IV, but asymmetry tests in model II were insignificant. Overall, the results demonstrated that negative oil-price shocks have a greater impact than positive shocks, especially in the long term, on unemployment rates. They also demonstrated that economic growth rates have a greater impact on unemployment rates than investment expenditures and private sector loans. However, the domestic product without the fuel sector, revealed distorted and unreflective of this sector's development, rather its increase is the result of previous fuel-sector mutations.

The asymmetric consequences of the positive and negative oil-price shocks on long-run unemployment rates call for diversifying the country's economic structures. Therefore, understanding the direction of oil-price shocks is critical for policymakers, particularly in oil-exporting countries. Long-term results proved that, in consistency with many recent studies, negative shocks have a greater impact than positive shocks.

Economic diversification strategy has now become an urgent concern for Algeria. Diversification policies comprise structural reforms that promote and develop the non-fuel sector, such as improving the public sector effectiveness, promoting private sector development, improving the financial sector, changing the workers' structure of motives and encouraging private sector employment. Also, volatile and depleted oil revenues should be transformed into more stable financial investments, which can help develop the country's economy by establishing engines for long-term sustainable economic growth. The cyclic government expenditure should also end by using appropriately the revenues adjustment fund by setting clear rules of the deposit and the withdrawal processes. Algeria can also benefit from Norway's experience as a preventive solution to strengthen the country's economy. To expand the study of this topic, more in depth-studies, on the current economic structure and on the channels through which oil price changes, are needed. At last, it would be useful to analyze the effects of oil-price shocks on the budget deficit, the current account, the profit prices and the real exchange rates.

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Appendices

Figure 1: Oil-prices development, growth rates and unemployment direction in Algeria

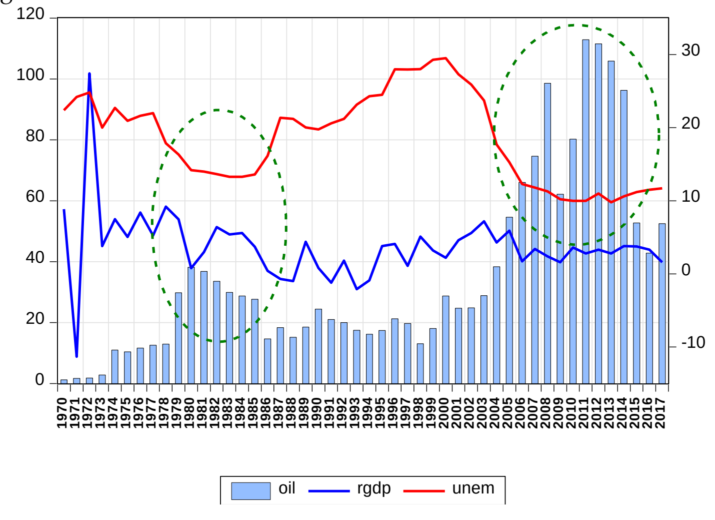
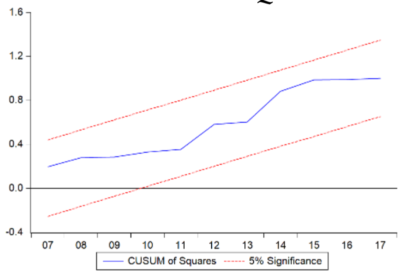


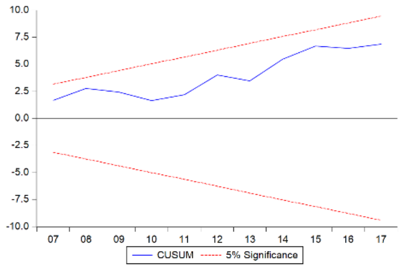
Figure 2 : Cumulative sum of recursive residuals and cumulative sum of squares of recursive

Model I

CUSUMSQ

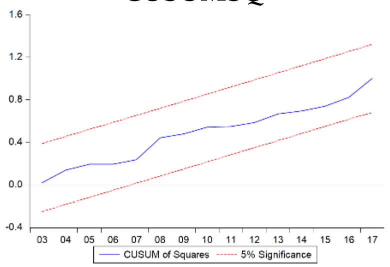


CUSUM

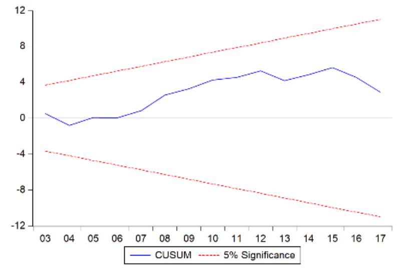


Model II

CUSUMSQ

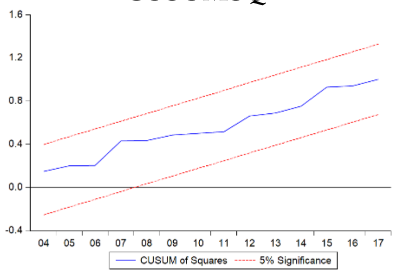


CUSUM



Modem IV

CUSUMSQ



CUSUM

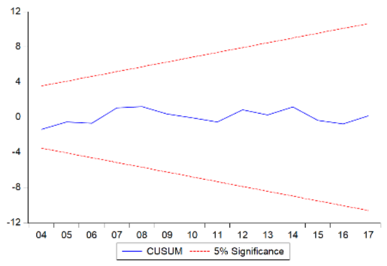


Figure 3: Cumulative Effects of Negative and Positive Oil Shocks on Unemployment Rates

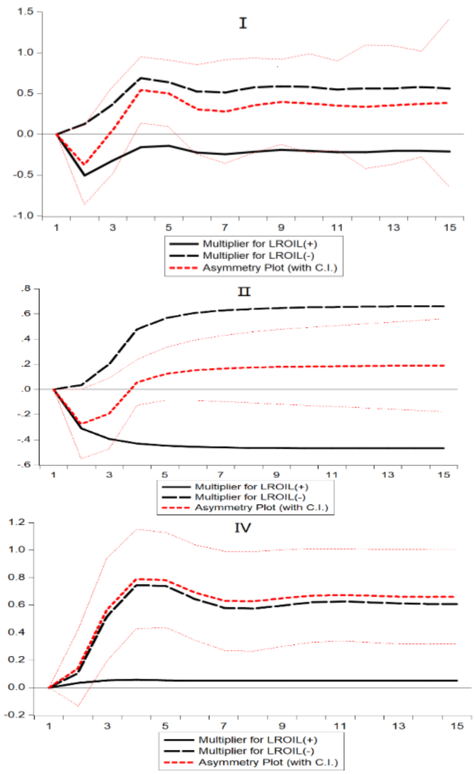
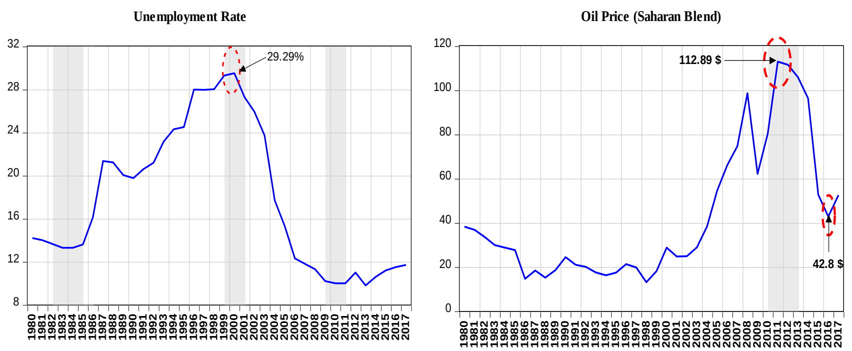
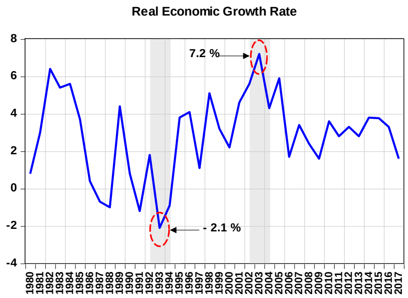
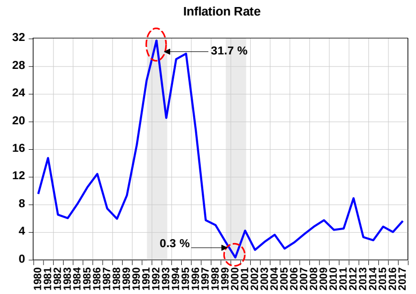
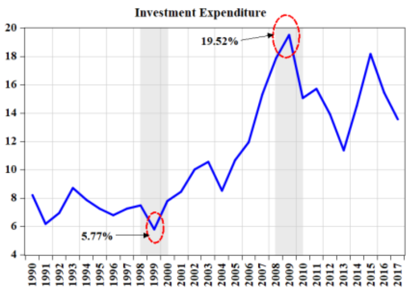


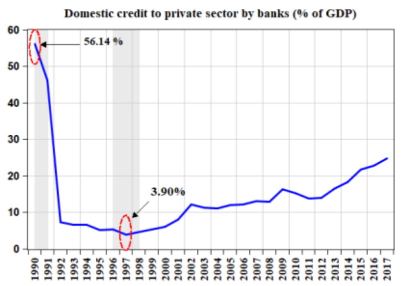
Figure 4: Direction of the study variables during 1980-2017

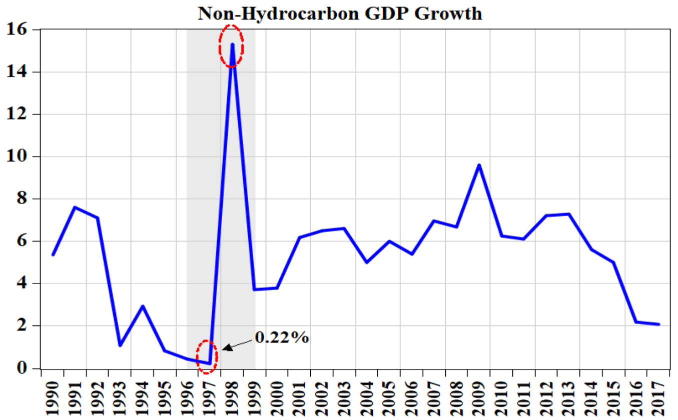



Real Economic Growth Rate
7.2 %
- 2.1 %


Inflation Rate
31.7 %
0.3 %


Investment Expenditure
19.52%
5.77%


Domestic credit to private sector by banks (% of GDP)
56.14 %
3.90%


Non-Hydrocarbon GDP Growth
0.22%