Monetary Policy Response To Oil Price Shocks In Algeria: By Using An Bound Testing Approach (ARDL)

استجابة السياسة النقدية لصدمات سعر النفط في الجزائر: باستخدام منهج الحدود (ARDL)

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Abstract:

This paper aims to study the dynamics and impact of oil price changes on indicators of monetary stability and the monetary policy mechanism in response to oil shocks. First, a study of the historical development of oil prices from 1970 to 2018. Second, monetary policy measures in Algeria. Third, the use approach of AutoRegressive Distributed Lags (ARDL) in the study.

The study found that the main cause of the oil shocks is due to the geopolitical crises; the Bank of Algeria has taken three basic measures in response to the drop in oil prices, namely, Raise of the exchange rate, the purchase of sovereign debt, and unconventional financing. As for the econometric study, we reached a cointegrating relationship between the variables of the study. The analysis of the Impulse Function Response test also shows that inflation and the monetary supply are more affected by the oil price shocks.

Keywords: Monetary policy, Oil Price Shocks, ARDL, Impulse Response Functions.

Jel Classification Codes : E52; E58; Q43; C32.

الملخص:

تهدف هذه الورقة إلى دراسة آليات تأثير تغيرات أسعار النفط على مؤشرات الاستقرار النقدي وآلية السياسة النقدية استجابة لصدمات النفط. أولاً، دراسة التطور التاريخي لأسعار النفط من

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سنة 1970 إلى 2018. ثانياً ، تدابير السياسة النقدية في الجزائر. ثالثا استخدام منهج الانحدار الذاتي للتأخر الموزع (ARDL) في الدراسة.

وقد توصلت الدراسة إلى أن السبب الرئيسي للصدمات النفطية يرجع إلى الأزمات الجيوسياسية. كما أن بنك الجزائر اتخذ ثلاثة تدابير أساسية استجابة لانخفاض أسعار النفط، وهي رفع سعر الصرف وشراء الديون السيادية واللجوء للتمويل غير التقليدي. أما بالنسبة للدراسة القياسية فقد توصلنا إلى علاقة تكاملية بين متغيرات الدراسة. ويظهر تحليل اختبار دوال الاستجابة الدفعية أن التضخم والعرض النقدية يتأثران بدرجة أكبر من صدمات أسعار النفط.

الكلمات المفتاحية: السياسة النقدية ، صدمات سعر النفط ، ARDL ، دوال الاستجابة الدفعية.

تصنيف JIL: E52; E58; Q43; C32.

Introduction:

The emergence of oil as an energy source since the last century has been a main axis in the global economic system, and because oil economies rely heavily on oil as a raw material for their export, crude oil price shocks have had implications for monetary stability in these countries.

The question that has been posed since the 1970s is how monetary policy managed to respond to oil shocks in light of the economic recession, understanding what happened at the time will lead us to know possible solutions in the present. (Barsky R. B, and L. Kilian, 2002) since the end of the twentieth century, the world has known, as a result of fluctuations in oil prices, profound shifts in monetary policy systems in response to changes in the global economic system. (Bernanke, B. S. *et al.* 1997) in the past and present, oil has had a major impact on currency movement, inflation, and interest rate to some extent. This explains why the united states adopted in the fall of 1979 a strict monetary policy aimed at fighting inflation on the one hand and stopping capital flight on the other hand and decided to raise interest rates. It reached high levels of 20% with the arrival of the president Reagan in 1980.

Oil shocks have had a major impact on oil-exporting countries since the 1970s. (Farhad Taghizadeh Hesary*et al*, 2013) but what distinguishes the beginning of the 21st century is the continuous rise in oil prices in the oil market, especially in the years 2004, 2005 and 2007 due to the increasing global demand for this strategic material, especially from Southeast Asian countries, the most important of which are China and India, as two prominent economic powers. The occurrence of the financial crisis at the end of the year 2007 is a big shock for the consuming countries, after an increase of more than 140 dollars per barrel in July 2008. (world oil outlook, 2008).

The developments known to the world oil market affected directly or indirectly on monetary stability in the oil economies in general, and in particular the Algerian economy.

Hence, the nature of the problem is clearly shown to us, as follows:

What is the reaction of monetary policy in Algeria to the oil shocks?

Through the problematic study, the study tries to answer the following questions:

- What are the mechanisms of monetary policy in responding to oil price shocks?
- Was the reaction of monetary policy in Algeria appropriate in times of shocks?
- What are the econometric tools in measuring monetary policy response?

Through these previous questions, the following hypotheses were formulated:

- The nature of monetary policy in oil economies is characterized by the absolute dependence on financial policy decisions, away from the independence of the central bank.
- The monetary policy response to the impact of oil shocks is not appropriate for monetary stability.
- The tests (ARDL) and impulse response functions are suitable models for studying monetary policy response.

The aim of studying the mechanisms of the impact of oil price changes on the indicators of monetary stability through the mechanisms of the Bank of Algeria used and the various monetary policy measures in Algeria to deal with fluctuations in the oil markets.

The curriculum used in the study is a mixture of curricula. We used the historical, descriptive, and standard approach to measure the impact of the monetary policy response to fiscal policy measures in Algeria.

The study is important as it studies the most important strategic sector in Algeria, which is the oil sector and its impact on economic variables, especially this monetary variable, on the one hand, and on the other hand, the Bank of Algeria's ability to take appropriate measures in the face of the consequences of fluctuations in oil prices.

1- history of oil prices shocks:

The history of oil prices at the beginning of the seventies is considered one of the distinct periods in its developments and importance and the impact of these factors on prices on the international oil market. OPEC's strength has emerged at this stage through its control of the sharp drop in prices and has contributed greatly to raising its levels, and it can be said that the seventies is considered the beginning of the real revolution in the world of the oil industry and its pricing in the international oil market.

1.1. 1970-1998: Domination age of OPEC:

The year 1970 was the point between two phases of the historical development of crude oil prices until now, as the first stage was marked by the domination of major international companies or what was called by the sisters for seven in the production and pricing of oil. As for the second stage, it was marked by the control of oil-producing countries over oil prices, through the Organization of Petroleum Exporting Countries (OPEC) and the intense conflict that accompanies it with the producing countries outside OPEC in influencing oil prices. This conflict continued until the end of the 1990s.

On October 17, the Arab members of the organization of the petroleum exporting countries announced a ban on oil exports to selected countries seen as supporting Israel due to the October 06 th, 1973 war, followed by significant cuts. Which caused the first oil shock. (Barsky R. B, and L. Kilian,2002),(See Figure 1 below).

The protests that occurred in Iran at the end of the seventies led to political changes in 1978. The strikes extended to the oil sector, which led to a decrease in Iranian oil production by 4.8 barrels per day (or 7% of global production at the time) and high oil prices, (see figure 1 below). This shortfall has been offset by Saudi Arabia. (FrechH. E., and Lee, W.C., 1987).

Iranian production returned to about half of the pre-revolution levels later in 1979 but declined again when Iraq launched a war against the country in September 1980. (James D. Hamilton, 2011) the combined loss of production from again reached about 6% of global production at that time, causing a second oil shock. (see figure 1 below).

The war between Iran and Iraq continued for years, and the global consumption of oil decreased dramatically in the early 1980s. Saudi Arabia abandoned production cut efforts, beginning to increase production again in

1986, causing the oil price to collapse from $ 27 a barrel in 1985 to $ 12 a barrel at the lowest point in 1986. The third oil shock was with the start of the first gulf war by 1990. Iraq invaded Kuwait in August 1990, which accounts for nearly 9% of global production, this led to high oil prices, but with the intervention of the United States of America and the resolution of the war in favor of Kuwait, prices returned to normal.(See Figure 1 below).

By the end of the nineties, the phenomenal growth in many East Asian countries started before 1997, represented by the miracle of the "Asian tigers". It was widely believed that its growth rate would continue boosting oil prices in the mid-1990s. But in the summer of 1997, Thailand, South Korea, and other countries were fleeing their currency and heavily pressured the financial system. The collapse of the price of oil soon followed, reaching below $ 12 a barrel by the end of 1998. (James D. Hamilton, 2011).

1.2. 1999-2018: The era of OPEC's influence collapsing:

The Asian crisis proved to be short-lived, as the region returned to growth and global consumption of oil returned to strong growth in 1999, and by the end of the year, the price of oil returned to what it was at the beginning of 1997. But that again fell in the face of the wider global economic downturn.

The turmoil and uncertainty caused by the September 11th terrorist attacks in the United States slowed global activity and increased uncertainty, which led to a sharp drop in oil prices during that period. (John Baffes et al., 2015).

The general strike in Venezuela removed 2.1 million barrels per day from oil production in December 2002 and January 2003. This was followed shortly after by the US attack on Iraq, which removed an additional 2.2 million barrels in April to July. These events can be described as external geopolitical events, followed by a continuous increase in oil prices, which reached $ 74.4 a barrel in July 2006.(See Figure 1 below).

The oil price shock ended in September 2008. Oil prices began to decline due to the global financial crisis that started in August 2007. A deep recession has caused oil consumption to decrease. This caused the demand for oil to drop and prices fell to $ 32 a barrel by December, just 5 months after peaking at $ 147. OPEC responded by cutting production to stabilize prices. However, prices continued to fall due to the sharp drop in demand. (Emma Stevenson, 2018).

Several studies have also pointed to the causes and consequences of the significant drop in oil prices from mid-2014 to 2016. (The World Bank, 2015) indicates the following four reasons for the sharp drop in oil prices:

- That supply was greater than expected and demand less than expected.
- Changes in OPEC goals.
- Geopolitical concerns about supply disruptions faded.
- The rise of the US dollar.

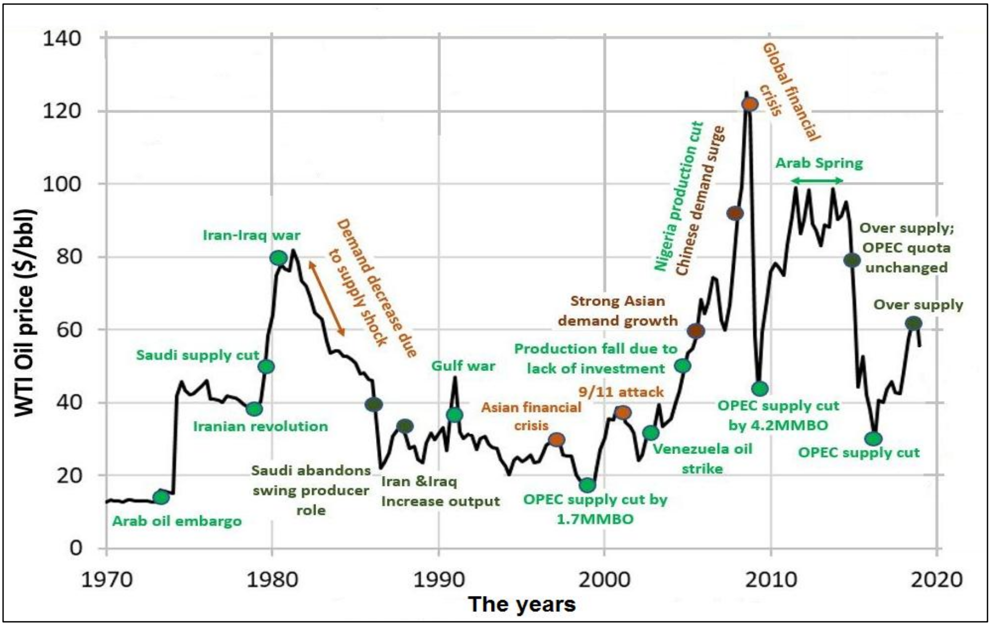
On the one hand, a (Baumeister, C and L Kilian, 2015) study showed evidence that more than half of the price drop from mid-2014 to 2016 was expected from June 2014, because it owes the negative shocks that hit the oil market before June 2014.(See Figure 1 below).

In November 2016, OPEC and some non-OPEC countries agreed to restrict their oil production in an attempt to set a minimum oil price. The announcement of cooperation initially covered the period up to June 2017 before the extension to December 2018. the success of this strategy depends mainly on two factors: compliance with the agreement and the reaction of American oil production. (Irma Álvarez, FraukeSkudelny, 2018).

Model demonstrate (Kilian, L. and Murphy, D.P., 2010),that oil supplies, aggregate demand, and protective demand have contributed to changes in oil prices since June 2017. However, the joint OPEC and non-OPEC agreement to limit production and unexpected outages played a more relevant role in explaining price dynamics in the second half of 2017.

Market participants have focused on lower production in Venezuela and the potential for Iranian exports to drop after the US withdrawal from the 2015 Iranian nuclear deal. in May 2018 sanctions were imposed on Iranian oil exports, starting in November 2018. by October 2018, Iranian oil exports had already decreased by about 0.35 million barrels a day. (Dominic Quint, 2019, 36). (See Figure 1 below).

Figure (1): The historical the evolution to the oil price



Source: EIA, IEA, Oilprice.com, businessinsider.com

2. Literature review of monetary policy and oil shocks:

2.1. Monetary policy reaction to oil shocks:

For decades, volatile oil prices have been the cause of macroeconomic deviation that impedes economic growth (Chen P. Y., *et al.*, 2013), (Ferderer, J. P., 1996). It depicts that oil price shocks have a negative and non-linear relationship with real GDP. Moreover, the positive oil price shock reduces production growth more than negative oil shocks. (Semko, R., 2013), (Hamilton, J.D., 2005).

For simplicity's sake, suppose a one-time oil price shock takes place, while everything else is fixed, there are two main channels for transmission, one is the increased cost of GDP (which is similar to the negative aggregate supply shock); the other is the low purchasing power of local households (which is similar to the opposite aggregate demand shock). (Edelstein,P., Kilian, L., 2009).

This, of course, is not the explanation economists prefer in describing the recession to the reaction of monetary policy to oil price shocks. (BernankeB. S., *etal.*, 1997), for example, take a tacit stance that external oil price shocks are inherently adverse.

Overall supply shocks are either stagnation and inflation. Their argument is the effect of a recession in the absence of a monetary policy reaction, and the central bank, in combating inflationary pressures caused by oil price shocks, is causing that recession. The reason is that (BernankeB. S., *et al.*, 1997) simply pointed out that the traditional interpretations of the link between oil price shocks and recession based on the direct effects of oil price shocks have failed to explain the recessions that occurred in 1974-1975 and 1982.

Empirical evidence indicates that the transmission channel for is weak and that the request channel for transmission is practically dominant (Kilian, L., 2008). On this basis, the oil price shock, if it occurred in isolation, depression, and deflation, indicating that there is no reason for monetary policy makers to raise interest rates. In reality, therefore, there is a little need for intervention by central bankers.

2.2. Bank of Algeria response to oil shocks:

Algeria still faces important challenges posed by the drop in oil prices four years ago, despite the massive fiscal control policy in 2017, when real GDP growth remains sharply slow. To this end, the monetary authorities have taken several measures to reduce the negative consequences of these shocks.

2.2.1. Raise of the exchange rate and restricting imports:

To adapt to low oil prices since 2014, algeria initially relied only on exchange rate policy before placing most of the burden on fiscal control, while the central bank was working to update its monetary policy framework. However, in the face of sluggish growth, increased unemployment, and financing difficulties, the authorities recently chose to boost activity by increasing spending in 2018, followed by steep fiscal consolidation from 2019 onwards. With the depletion of financial savings and their reluctance to borrow from abroad, they resorted to cash financing. To reduce the trade deficit and promote import substitution, they have tightened import barriers (IMF Country Report, 2018).

Algeria has taken other additional measures to adapt to lower oil prices. Until 2016, authorities mostly responded by raise the exchange rate, relying on their savings to keep spending. In 2016, with buffers dropping rapidly, it embarked on severe fiscal consolidation under the medium-term budget for the first time but stopped the exchange rate raise, which resumed at a much slower pace in mid-2017. It is also working on a long-term plan to reformulate and update its monetary policy framework (IMF Country Report, 2018).

2.2.2. The quantitative easing approach:

To this end, the authorities have adopted a "quantitative easing" policy, in which the central bank, bank of algeria, purchases sovereign bonds directly from the government, public institutions, and the national investment fund for five years. This reduces the funding pressure on the government by reducing the necessity of issuing bonds in the primary market, and government-issued issues of bonds with long maturities and interest rates of 0.5% have been purchased. Between november 2017 and june 2018, the bank of algeria purchased sovereign debt equivalent to 3% of GDP from 2017.(The Report Algeria, 2018).

There are similarities between the quantitative easing policies adopted by the world's leading banks and the monetary policy adopted by the bank of algeria since late 2017. Both involve the expansion of the central bank’s balance sheet to purchase sovereign bonds, a mix of policies known to lead to a rise in inflation, and even hyperinflation.

But there are important differences between the quantitative easing strategy pursued by the world's leading central banks and the algerian quantitative easing policy: (The Report Algeria, 2018).

- First, interest rates were not already at zero in algeria, so it is hard to see this approach as a measure of pure monetary policy.
- Second, sovereign bonds were purchased by global central banks in the secondary market rather than the primary market, which means that these central banks were not directly financing the government or semi-government agencies.
- Third, instead of pursuing fiscal consolidation along with monetary expansion, as was the case with quantitative easing, the algerian authorities pursued a policy of simultaneous monetary and financial expansion, with a commitment to fiscal consolidation only in the long run.

2.2.3. Unconventional financing approach:

Unconventional financing has three main goals: to cover the fiscal deficit, to finance domestic public debt, and to provide funds for the national investment fund. As of June 2018, these total financing sources amounted to 3.6 trillion dinars (26.1 billion euros), of which 2.2 trillion dinars (16 billion euros) during the fourth quarter of 2017 and 1.4 trillion dinars (10.2 billion euros) during the first quarter of 2018.

Regarding the monetary effects of this strategy, to prevent any potential inflationary shocks resulting from increased liquidity, the bank of algeria used sufficient monetary policy tools to neutralize any excess liquidity resulting from unconventional financing operations. In january 2018, the bank resumed open market operations to absorb liquidity at various maturity levels - 24 hours, one week and one month - and raised the reserve requirement rate twice, from 4% to 8% in January 2018 and from 8% to 10% in june 2018.(The Report Algeria, 2018).

Inflation remained stable at 4.3 percent in 2018, and fell to 4.1 percent at the end of march 2019, despite expansionary monetary policy in the framework of "unconventional financing" by the central bank, which amounted to 32 percent of the GDP that was pumped half of it is already in the economy.(Algeria's Economic Update,2019).

3. Econometric methodology:

The statistic time series practices assert that classical econometric techniques might result in spurious regression results if the variables are integrated. Previously this problem was tackled by taking the first difference but this method removes the long-run information in the data. Over the time, statistical research methods have made it possible working with the integrated data. A contemporary econometric technique provides robust results by establishing a cointegrating vector among variables, known as the bounds method test of ARDL.(Strohsal, T and Weber, E., 2013).

3.1.Bounds approach test (ARDL):

Over the past decade, considerable attention has been paid in empirical economics to testing for the existence of relationships in levels between variables. In the main, this analysis has been based on the use of cointegration techniques. Two principal approaches have been adopted: the two-step residual-based procedure for testing the null of no-cointegration(Engle RF, Granger CWJ, 1987); and the system based reduced rank regression approach due to (Johansen S., 1995). In addition, other procedures such as the variable addition approach of (Park JY., 1990), the residual-based procedure for testing the null of cointegration by (Shin Y., 1994), and the stochastic common trends (system) approach of (Stock and Watson, 1988) have been considered. All of these methods concentrate on cases in which the underlying variables are integrated of order one. This inevitably involves a certain degree of pre-testing, thus introducing a further degree of uncertainty into the analysis of levels relationships. See, for example, (Cavanagh, *et al.*,1995).

This paper proposes a new approach to testing for the existence of a relationship between variables in levels which is applicable irrespective of whether the underlying regressors are purely I(0), purely I(1) or mutually cointegrated. The statistic underlying our procedure is the familiar Wald or F-statistic in a generalized dicky–fuller type regression used to test the significance of lagged levels of the variables under consideration in a conditional unrestricted equilibrium correction model (ECM). It is shown that the asymptotic distributions of both statistics are non-standard under the null hypothesis that there exists no relationship in levels between the included variables, irrespective of whether the regressors are purely I(0), purely I(1) or mutually cointegrated. We establish that the proposed test is consistent and derive its asymptotic distribution under the null and suitably defined local alternatives, again for a set of regressors which are a mixture of I(0) and I(1) variables(Pesaran M. H., *et al.*, 2001).

Two sets of asymptotic critical values are provided for the two polar cases which assume that all the regressors are, on the one hand, purely I(1) and, on the other, purely I(0). Since these two sets of critical values provide critical value bounds for all classifications of the regressors into purely I(1), purely I(0) or mutually cointegrated.

Among the five cases proposed by (PesaranM. H., *et al.*, 2001), we will apply in this research paper Case III (unrestricted intercepts; no trends) $C_0 \neq 0$ and $C_1=0$. Again, $\gamma=0$. Now, the intercept restriction $C_0 = -(\pi_{yy},\pi_{yx.x})\mu$ is ignored and the ECM is:

$$\Delta y_t = c_0 + \pi_{yy} y_{t-1} + \pi_{yxx} x_{t-1} + \sum_{i=1}^{p-1} \psi_i' \Delta z_{t-i} + \omega' \Delta x_t + u_t \text{ ....(01)}$$

3.2. The study data and model:

The present study employs five variables including real gross domestic product (LRGDP), real oil price Global (LROPG), Inflation rate (LInf), the real exchange rate (LRER), and Money and quasi money (LM2), Knowing that the All variables are expressed in natural logarithm. Use of annual time series data during (1970-2018). This is assuming that the variables take a different order in the degree of integration not different from I(0) and I(1), and this calls for the use of the methodology of limits (ARDL), as shown in the following models:

- $\Delta lRGDP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta lRGDP_{t-i} + \sum_{i=1}^{n} \alpha_{2i} \Delta lInf_{t=i} + \sum_{i=1}^{n} \alpha_{3i} \Delta lROPG_{t=i} + \sum_{i=1}^{n} \alpha_{4i} \Delta lM2_{t=i} + \sum_{i=1}^{n} \alpha_{5i} \Delta lRER_{t=i} + \alpha_6 lRGDP_{t-1} + \alpha_7 lInf_{t-1} + \alpha_8 lROPG_{t-1} + \alpha_9 lM2_{t-1} + \alpha_{10} lRER_{t-1} + \mu_t$ ……….. (2)
- $\Delta lInf_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta lRGDP_{t-i} + \sum_{i=1}^{n} \alpha_{2i} \Delta lInf_{t=i} + \sum_{i=1}^{n} \alpha_{3i} \Delta lROPG_{t=i} + \sum_{i=1}^{n} \alpha_{4i} \Delta lM2_{t=i} + \sum_{i=1}^{n} \alpha_{5i} \Delta lRER_{t=i} + \alpha_6 lRGDP_{t-1} + \alpha_7 lInf_{t-1} + \alpha_8 lROPG_{t-1} + \alpha_9 lM2_{t-1} + \alpha_{10} lRER_{t-1} + \mu_t$ ……….(3)
- $\Delta lM2_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta lRGDP_{t-i} + \sum_{i=1}^{n} \alpha_{2i} \Delta lInf_{t=i} + \sum_{i=1}^{n} \alpha_{3i} \Delta lROPG_{t=i} + \sum_{i=1}^{n} \alpha_{4i} \Delta lM2_{t=i} + \sum_{i=1}^{n} \alpha_{5i} \Delta lRER_{t=i} + \alpha_6 lRGDP_{t-1} + \alpha_7 lInf_{t-1} + \alpha_8 lROPG_{t-1} + \alpha_9 lM2_{t-1} + \alpha_{10} lRER_{t-1} + \mu_t$............(4)
- $\Delta lRER_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta lRGDP_{t-i} + \sum_{i=1}^{n} \alpha_{2i} \Delta lInf_{t=i} + \sum_{i=1}^{n} \alpha_{3i} \Delta lROPG_{t=i} + \sum_{i=1}^{n} \alpha_{4i} \Delta lM2_{t=i} + \sum_{i=1}^{n} \alpha_{5i} \Delta lRER_{t=i} + \alpha_6 lRGDP_{t-1} + \alpha_7 lInf_{t-1} + \alpha_8 lROPG_{t-1} + \alpha_9 lM2_{t-1} + \alpha_{10} lRER_{t-1} + \mu_t$............(5)

We have canceled the fifth model of the price of oil as a dependent variable because it is an unrealistic model as it is determined by external and geopolitical elements, which the internal variables, whatever their size, cannot affect the price of oil.

The results of the hypothesis test using the F-statistic are according to the following conditions:

- If the calculated wald test value is greater than the upper limits of the critical values, a conclusive conclusion can be drawn to the presence of cointegration;
- If the calculated wald test value is between the upper and lower limits of the critical values, a conclusive conclusion cannot be drawn from the presence of cointegration;
- If the calculated wald test value is smaller than the minimum critical values, a firm conclusion can be drawn that no cointegration exists.

The bounds test procedure is also provided for the related cointegration test proposed by (Banerjee A.*et al.*,2001) which is based on earlier contributions by (Banerjee *et al.,* 1986) and (Kremers J. M.,*et al.*,1992). Their test is based on the t-statistic associated with the coefficient of the lagged dependent variable in an unrestricted conditional ECM. The asymptotic distribution of this statistic is obtained for cases in which all regressors are purely I(1), which is the primary context considered by these authors, as well as when the regressors are purely I(0) or mutually cointegrated.

4. Empirical results:

4.1. Unit root and tests:

We adopted the unit root tests to know the degree of stability of the variables used in the study on two tests, namely Augment Dicky Fuller test and the Philips Perron test as shown in Table 1 below:

Table (1): Unit Root Test

Variable	Rank integration	ADF test statistic (with trend and intercept)		P-P test statistic (with trend and intercept)	
		Level	*First Diff.*	*Level*	*First Diff.*
LRER	I(1)	-3.159861	-3.769316**	-3.121004	-5.320668*
LRGDP	I(0)	-4.828837*	-	-2.184529	-9.063024*
LM2	I(0)	-5.136574*	-	-5.141788*	-
LROPG	I(1)	-2.113462	-6.053478*	-2.113462	-6.006302*
LInf	I(1)	-2.582467	-9.694969*	-3.224629	-9.763108*

Source: outputs of EViews11

Note:* significantat at 1%.
** significantat at 5%.

Through Table 1 above, the results of the study variability stability test show that the two variables lrgdp and lm2 have a degree of integration of I(0), and we have three variables lrer, linf and lropg of their degree of integration I(1), and this proves the validity we previously assumed that the variables have integration degrees that are not different from I (0) and I (1), and this means that we can use the methodology bounds (ARDL).

4.2. Cointegration test and ECM estimation:

This section examines the cointegration of variables in the ARDL bounds test framework. This test is carried out in two stages:

The first stage is to find the optimal combination based on choosing the smallest value for the following criteria: AIC, SC, HQ, LR, and FPE. For each model separately, use an unrestricted VAR model for this purpose. As shown in Table 2 below.

The second stage is to estimate the previous models according to the combination chosen for each model, then wald test for each model. the following table 2 shows the cointegration test. For the four models:

Table (2): Cointegration Test Results

Dependent Variable	**F-Statistics**		**Combination**		**Cointegration**	
D(LRGDP)	4.493949**		ARDL(2, 4, 1, 1, 2)		Yes	
D(LInf)	2.350316		ARDL(1, 0, 1, 0, 1)		No	
D(LM2)	6.422976*		ARDL(3, 2, 2, 4, 4)		Yes	
D(LRER)	3.004094		ARDL(1, 0, 0, 0, 3)		No	
Asymptotic Critical Valuesᶲ						
k	%1		%2.5		%5	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
4	3.74	5.06	3.25	4.49	2.86	4.01

Source: outputs of EViews11
ᶲ:(Pesaran et al., 2001), Table CI(iii) Case III: Unrestricted intercept and no trend.
Note: * significant at 1%.
** significant at 2.5%.
*** significant at 5%.

From Table 2 above, the following results can be drawn:

a. In terms of the real GDP model, the results of the wald test show that the calculated F-statistic (4.493) is greater than the upper limit of the tabular value at a significant level of 2.5% and this means rejecting the null hypothesis and acceptance of the alternative, with simultaneous integration in the long run.

b. For the inflation rate model, the results of the wald test show that the calculated F-statistic (2.350) is smaller than the minimum tabular value at a significant level of 5%, which means accepting the null hypothesis and rejecting the alternative, and the lack of simultaneous integration in the long run.

c. In the monetization of the money model and the father of money, the results of the wald test show that the calculated F-statistic (6.422) is greater than the upper limit of the tabular value at the 1% level of significance, which means rejecting the null hypothesis and acceptance of the alternative, with simultaneous integration in the long run.

d. For the real exchange rate model, the results of the wald test show that the calculated F-statistic (3.004) falls between the minimum and highest of the tabular values at the level of significance of 5% and this means accepting the null hypothesis and rejecting the alternative, and the lack of simultaneous integration in the long run.

The estimation of the error correction model is an important and essential stage of the testing of the boundary methodology, and this is after we have found a synchronous integration between the study variables, after correcting the random error limit Coint Eq(-1). Table 3 shows the estimation of the error correction model:

Table (3): Error Correction Model

Dependent Variable: $D(LRGDP)_t$			
Independent variables	**Coefficient**	**t-Statistic**	**Prob.**
D(LRGDP(-1))	0.292145**	2.324397	0.0271
D(LRER)	0.005504	0.236193	0.8149
D(LM2)	-0.005025	-1.208339	0.2364
D(LM2(-1))	0.003360	0.816063	0.4209
D(LM2(-2))	-0.001554	-0.347890	0.7304
D(LM2(-3))	-0.008377**	-2.304205	0.0283
D(LINF)	-0.001023	-0.239360	0.8125
D(LROPG)	0.015157	1.081838	0.2879
D(LROPG(-1))	-0.043067*	-3.265344	0.0027
CointEq(-1)	-0.103951*	-5.608711	0.0000
R-squared	0.618228	**DW**	1.822302
Adjusted R-squared	0.520059	**Akaike info**	-5.072009
Combination	ARDL (2, 1, 4, 1, 2)		

Source: outputs of EViews11

Notes: * significantat at 1%.
** significantat at 5%.

Table (4): Error Correction Model

Dependent Variable: D(LM2)$_t$			
Independent variables	**Coefficient**	**t-Statistic**	**Prob.**
D(LM2(-1))	0.224696	1.668003	0.1078
D(LM2(-2))	-0.267369**	-2.462676	0.0210
D(LRGDP)	4.494529	1.261502	0.2188
D(LRGDP(-1))	-16.76967*	-4.672398	0.0001
D(LRER)	-1.386459	-2.002855	0.0561
D(LRER(-1))	0.047204	0.073451	0.9420
D(LRER(-2))	1.882302*	2.881551	0.0080
D(LRER(-3))	2.556948*	3.955411	0.0006
D(LINF)	-0.065173	-0.521099	0.6069
D(LINF(-1))	-0.353755*	-2.911868	0.0075
D(LROPG)	2.414169	7.786871	0.0000
D(LROPG(-1))	0.350061	0.963990	0.3443
D(LROPG(-2))	1.046542	3.022743	0.0057
D(LROPG(-3))	0.486616	1.545158	0.1349
CointEq(-1)*	-1.166435	-6.800399	0.0000
R-squared	0.855313	**DW**	2.104604
Adjusted R-squared	0.787793	**Akaike info**	1.599990
Combination	ARDL (3, 2, 4, 2, 4)		

Source: outputs of EViews11

Notes: * significantat at 1%.

** significantat at 5%.

4.3. Impulse Response Functions:

The analysis of the impulse response functions is based on knowing the magnitude of the impact of a variable shock in a variable or a group of variables, during certain periods, and in our study, we will analyze the impact of the oil price shock as a variable determined externally and the response of the economic variables under study, Table 5 and Figure 2 illustrate this test:

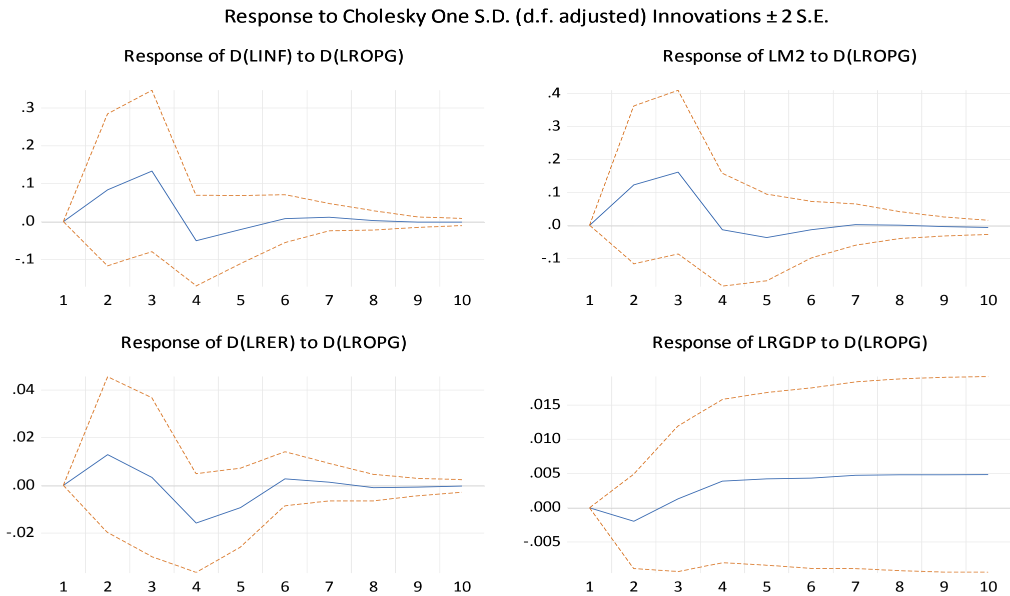
Table (5): Impulse Response Functions

Period	D(LINF)	LM2	D(LRER)	LRGDP
1	0.000000	0.000000	0.000000	0.000000
2	0.083864	0.122771	0.012884	-0.001982
3	0.133509	0.161576	0.003385	0.001309
4	-0.050561	-0.013057	-0.015797	0.003894
5	-0.021346	-0.036846	-0.009311	0.004218
6	0.007574	-0.013420	0.002752	0.004319
7	0.011639	0.002512	0.001346	0.004745
8	0.002698	0.000595	-0.000957	0.004808
9	-0.001728	-0.003504	-0.000712	0.004820

10	-0.001386	-0.006185	-0.000244	0.004845

Source: Outputs of EViews11

Figure (2) :Impulse Response Functions



Source: Outputs of EViews11

Through the figure and the table above it is clear the following:

We find that the response of the rate of inflation to the shock of the oil price was in the form of a varying increase in the first and second periods, after which it decreased in the third period at a rate of (-0.050561) and returns gradually from the fourth period to its normal and stable situation.

We find that the M2 monetary response took a similar path to the inflation response, as it rose in the first and second periods and decreased in the third by a rate of (-0.013057) and returned to normal.

As for the response of both the real exchange rate and the real GDP to the shock of the oil price, it is almost non-existent, as we find that the response to the real exchange rate rose in the first period and then decreased in the second and third and returns to its normal position in the sixth period. As for the real GDP, it seems that it has taken a path toward an increase, but with a rate of (0.004845), almost non-existent.

Conclusion:

Through this research paper, we tried to answer the following question: How does monetary policy response to the oil price shocks in Algeria? In a first step, we provided a historical overview of the developments and the most important events of the oil price during the study period 1970 – 2018, Focusing on the various factors that were the cause of the oil shocks. In a second step, we focused on the various tools and channels that the monetary authority in Algeria uses in response to oil shocks to achieve the goal of monetary stability. In a third step, we attempted to quantify the relationship between study variables, by estimating four models using the ARDL method as a method of co-integration.

The study reached the following results:

- The main cause of oil shocks is due to geopolitical crises, with the exception of some financial crises;
- The Bank of Algeria, at the beginning of its management of monetary policy, has taken three basic measures in response to the drop in oil prices, namely, the raise of the exchange rate while restricting imports, the purchase of sovereign debt directly from the government to cover the budget deficit and unconventional financing of the state budget;
- The current monetary policy of the Algerian Central Bank is not well suited to face oil shocks.
- As for the econometric study, we reached an integrative relationship between the study variables in two models: money supply and real GDP.
- The analysis of the impulse function test shows that two variables are more affected by oil price shocks: inflation and monetary mass.

Recommendations:

- The Bank of Algeria should wipe up enough liquidity already pumped through unconventional financing operations;
- Bank of Algeria would be willing to tighten the monetary policy stance if inflationary pressures emerged;
- Monetary authorities should strengthen the role of interest rates as a channel for the transmission of monetary policy impact.

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