



## **Econometric study on the impact of variations in oil prices on the demand for money in Algeria**

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Received: 10/05/2021	Accepted: 29/05/2021	Published: 30/06/2021
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### **Abstract :**

The purpose of this article is to examine the possible link that may exist between variations in the price of oil and the demand for money in Algeria. For this, we used an econometric study based on two approaches: linear and nonlinear of the distributed autoregressive delay (ARDL), during a period going from 1980 to 2019. The results show that there is, in both approaches, an impact positive variation in the price of oil on the demand for real money in Algeria. However, this impact is asymmetric in the case of nonlinear ARDL. In addition, we have recorded that any positive change in the price of oil will negatively impact the demand for real money, while this impact would be insignificant when the price of oil changes negatively.

### **Keywords:**

Algeria; demand for money; linear ARDL; Oil price.

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## 1. INTRODUCTION

Any economic crisis implies an effective response to the choice of the appropriate economic policy in order to avoid even more serious consequences for the national economy. Money is at the core of economic policy strategies aimed at securing and achieving objectives such as sustained growth, price stability and the fight against inflation, full employment and external balance.

Like any good, money is offered is demanded. Any analysis of the demand for money serves to understand the impact that monetary policy can play on a country's economy, because it provides clear information and visions on the effectiveness of the determinants of the supply of money currency in circulation.

The demand for money function has attracted much interest from researchers and academics, both developed and developing, since Friedman's work in 1956. According to (Friedman and Schwartz, 1982) and (Laidler, 197, p.58), the demand for money is one of the key functions in formulating appropriate monetary policy.

Similarly, Goldfeld (1994) considers the relation between the demand for money and its main determinants as an important building block in macroeconomic theories and is a crucial component in the conduct of monetary policy.

Likewise, the demand for money function is a basic element in conducting monetary policy by making it possible for monetary authorities to effect changes in macroeconomic variables such as income, interest rate and prices by appropriate changes in monetary aggregates (Abdulkheir, 2013,p.35).

Therefore, in order to conduct an effective monetary policy, it is essential to have theoretical and empirical data on the determinants of money demand in the economy, and this by conducting a study on the dynamics of the money demand function in Algeria.

Moreover, stability of the money demand function has been determined as a key to effectiveness of monetary policy (Friedman, 1968, p.11) strongly argued that money supply cannot influence real output in the long run and given this neutrality proposition, stable money demand function provides credibility to the quantity theory with a predictable influence in the general price level.

In the same vein,(Poole, 1970, p.205) pointed out that the efficacy of targeting money supply rests mainly on the stability of the money demand function. In addition, (Bhatta, 2011, p.10) ensures that the choice of an adequate monetary policy, with a strategy of monetary or inflation targeting, requires, on the part of the monetary authorities, a serious study on the stability of the demand for money.

However, there are several reasons in the literature that have prompted economists to study and analyze the stability of the money demand function.

First, the test of stable money demand function which has applied policy utility, to a great extent lies in its predictive power reflected in its out of sample forecasting performance (Vasudevan, 2003, p.71).

Second, the money demand function links the monetary sphere and the real sphere of the economy, for that fact, it plays prominent role in understanding the mechanisms by which shocks are transmitted between these two parts (Alsamara et al., 2016, p.3758).

Then, the volatility of commodity prices, in particular oil prices, as well as recent economic developments have renewed concerns about the stability of the money demand function, as some of the driving forces behind them may have caused instability in the money demand function and made monetary policy ineffective (Svensson, 2005, p.28; Alsamara et al., 2016, p.3758).

In this article, we will summarize the literature review in the first section. Then, in the second section, we will present the work methodology. Finally, in the third section, we will discuss the empirical results and conclude the article.

## **2. Literature review**

For any country, it is essential to study the stability of the money demand function in order to provide it with an appropriate monetary policy strategy.

According to Friedman (1956), a stable real money balances function in the long run makes monetary aggregates a favorable candidate for the intermediate target of the monetary policy.

In their work on the US, Enzler, Johnson, and Paulus (1976) argued that the instability of the MDF is due to a financial innovation that resulted in ratchets on interest rates and income.

Similarly, Boughton (1981), Arango and Nadiri (1981) linked the instability in money demand to a change in the exchange rate regime, caused by the closing down of the foreign exchange market in the wake of the OPEC oil embargo. (Sterken, 2004, p.762) estimated the money demand function (M1) for Ethiopia based on Johansen Maximum Likelihood approach with quarterly data from 1966:Q4 to 1994:Q4.

Results reveals evidence of instability related to political regimes and natural disasters. (Omer, 2009, p.39) investigated the stability of money demand function in Pakistan using annual data starting from 1975 to 2006, they claimed that volatility in the interest rate makes velocity volatile and hence the money demand function.

Small number of studies investigated the MDF stability in oil exporting countries. In such economies, oil price volatility is not only an important cause of macroeconomic fluctuations, but also affects the fiscal and monetary policy (Alekhina & Yoshino, 2018, p.13).

Therefore, since the economy of these countries is very dependent on the contribution of exports to their activity, any positive shock in oil exports will imply instability in monetary demand (Boye, 2001, p58).

Theoretically, changes in oil prices can affect real money balances by causing the demand for money to increase (Pierce et al., 1974, p.50; Mork, 1994, p.20). Effects of oil price volatility depends on a particular economy depends on whether that economy is a net importer or exporter, and notably on the degree of the country's dependence on oil and its economic diversification (Alsamara et al., 2016, p. 3762).

(Eltony, « undated ») studied the effect of oil price volatility on seven macroeconomic variables for state of Kuwait. Using quarterly data for the period 1984:01 to 1998:04 and VECM approach, he found that oil shocks have a small and modest impact on the demand for money. He explained that by the lack of well-developed financial markets in Kuwait.

(Alsamara et al., 2016, p.3758) examined the asymmetric impacts of oil price shocks on the stability of money demand in Saudi Arabia based on quarterly data over the period of 1990–2014. They used non-linear autoregressive distributed lag approach. Thus, the results of this study highlight the existence of a long-term equilibrium of MDF. This is particularly explained by the variations in oil prices, while in the short term, the demand for money is seen by the positive impact of the oil price in Saudi Arabia.

In Algeria, studies which analyze the stability of the currency demand function in Algeria are carried out by (Abderrezak, 2000, p.78; Bakhouché, 2006, p.236; Menaguer, 2009, p.41; Ayad, 2013, p.18; Ahmed, 2015, p. 318; Alhakimi, 2018, p.49).

In 2017 Algeria is the 3rd oil producing country in Africa. Oil represents 94% of the country's exports and 60% of the national budget.

This study has for contribution: first, this paper explores the asymmetry of real money reaction to the oil price fluctuations in the case of Algeria.

Second, the study contributes to the existing evidence of the asymmetric effects of oil prices using Non-linear ARDL (NARDL) approach proposed by (Shin et al., 2014, p. 286). This technique allows testing short- and long-run asymmetric response of money demand to the positive and negative partial sums decompositions of the oil price.

Third, knowing the characteristics of an oil-based economy, the article presents the role of the oil price as a scale variable and envisages presenting an adequate monetary policy reaction under the economic conditions that Algeria is experiencing today.

### 3. Methods and Materials

This article aims to examine the impact of variations in oil prices on the demand for real money in Algeria during the period from 1980 to 2019. For this purpose, an ARDL model approach to co-integration developed by Pesaran et al. (2001) is used.

Reasons for employing the ARDL approach are first, it can be used in regardless of whether variables are  $I(0)$  or  $I(1)$  (Pesaran & Pesaran, 1997, p.49).

Second, using linear transformation, an error correction model including the short and the long run dynamics can be derived without lose in information (Banerjee et al., 1993,p.56).

Third, the ARDL method can be applied even if the explanatory variables are endogenous (Pesaran et al., 2001, p.280).

Finally, in comparison with other co-integration techniques, this technique provides better results in the case where the sample is left (Onafowora and Owoye, 2014, p.58).

The literature tells us that any money demand function must include a scale variable (income) as well as the opportunity cost of holding money (exchange rate, interest rate).

However, in the case where the country is heavily dependent on oil, the oil price can act as a good proxy for the scale variable as it captures the income effect generated by international oil price volatility (Alsamara et al., 2016, p.3758).

Besides, in developing economies like Algeria, inflation rate is expected to be more appropriate to measure the opportunity cost (Alhakimi, 2018, p.49). This can be explained by the absence of well-developed financial markets; thus real assets are considered more attractive than financial assets.

This empirical part applies the money demand function as follows:

$$RM2_t = \alpha_0 + \alpha_1 OP_t + \alpha_2 INF_t + \varepsilon_t \dots \dots \dots (1)$$

Here RMD is real money demand expressed in millions, OP is real oil price in US Dollar per barrel, INF is the inflation rate.

Real oil price is included as a scale variable to capture the income effect generated by international oil price changes, whereas the inflation rate captures the opportunity cost of holding money. ARDL can be framed for equation (1) as follows:

$$\Delta RM2_t = c + \beta_1 RMD_{t-1} + \beta_2 OP_{t-1} + \beta_3 INF_{t-1} + \sum_{i=1}^a \varphi_{1i} \Delta RM2_{t-i} + \sum_{i=0}^b \varphi_{2i} \Delta OP_{t-i} + \sum_{i=1}^c \varphi_{3i} \Delta INF_{t-i} + \mu_t \dots \dots \dots (2)$$

Where  $\beta_1, \beta_2, \beta_3$  are the long run coefficients while  $\varphi_{1i}, \varphi_{2i}, \varphi_{3i}$  and  $\mu_t$  represents the short run dynamics and random disturbance term respectively. The null hypothesis that the long run relationship doesn't exist that is  $\beta_1 = \beta_2 = \beta_3 = 0$  tested against the alternative hypothesis  $\beta_1 \neq \beta_2 \neq \beta_3 \neq 0$  by means of F-test. If the calculated F-statistic lies above the upper level of the band, the null is rejected indicating co-integration and the long run coefficients can be estimated through  $\beta_2/\beta_1$  and  $\beta_3/\beta_1$ .

To get short run coefficient estimates, the estimation of dynamic error correction is carried out using formulation of equation (3).

$$\Delta RM2_t = c + \sum_{i=1}^r \delta_{1i} \Delta RM2_{t-i} + \sum_{i=0}^m \delta_{2i} \Delta OP_{t-i} + \sum_{i=1}^n \delta_{3i} \Delta INF_{t-i} + \omega ECT_{t-1} + \gamma_t \dots \dots (3)$$

Where  $\delta_{1i}, \delta_{2i}$  and  $\delta_{3i}$  capture short run dynamics and  $\omega$  indicate the divergence/convergence towards the long run equilibrium. The ARDL model in equation (3) assumes a linear combination between the variables and indicates a symmetric adjustment in long and short run. Therefore, a linear ARDL estimation will be misspecified if real oil price has asymmetric impact on real money demand. To account for potential asymmetries, we test the effect of oil price in nonlinear ARDL setting as recommended by (Shin et al., 2014, p.286). To do so, we extend the linear ARDL to NARDL and equation (2) can be expressed as:

$$\Delta RM2_t = c + \theta_1 RMD_{t-1} + \theta_2 OP_{t-1}^+ + \theta_3 OP_{t-1}^- + \theta_4 INF_{t-1} + \sum_{i=1}^{q_1} \rho_{1i} \Delta RM2_{t-i} + \sum_{i=0}^{q_2} \rho_{2i} \Delta OP_{t-i}^+ + \sum_{i=0}^{q_3} \rho_{3i} \Delta OP_{t-i}^- + \sum_{i=1}^{q_4} \rho_{4i} \Delta INF_{t-i} + \xi_t \dots \dots \dots (4)$$

Where  $OP_t^+$  and  $OP_t^-$  are showing partial totally of increasing and decreasing variations of real oil price respectively. They are defined as:

$$OP_t^+ = \sum_{i=1}^t \Delta OP_t^+ = \sum_{i=1}^t \max(\Delta OP_i, 0) \dots \dots \dots (5)$$

$$OP_t^- = \sum_{i=1}^t \Delta OP_t^- = \sum_{i=1}^t \min(\Delta OP_i, 0) \dots \dots \dots (6)$$

Following (Shin et al., 2014, p.286), the nonlinear asymmetric conditional ARDL including  $OP_t^+$  and  $OP_t^-$  is written as:

$$\Delta RM2_t = c + v_1 RMD_{t-1} + v_2 OP_{t-1}^+ + v_3 OP_{t-1}^- + v_4 INF_{t-1} + \sum_{i=1}^{p_1} \rho_{1i} \Delta RM2_{t-i} + \sum_{i=0}^{p_2} (\psi_{2i} \Delta OP_{t-1}^+ + \psi_{3i} \Delta OP_{t-1}^-) + \sum_{i=1}^{p_3} \psi_{4i} \Delta INF_{t-i} + \zeta_t \dots (4)$$

To test for co-integration, the computed F-statistic obtained from equation (4) is compared to two asymptotic critical values: a lower bound critical value and an upper bound critical value proposed by (Pesaran et al., 2001, p.280 ).

If the F-statistic is higher than the upper bound, the null hypothesis of no co-integration is rejected. Long run impact of positive and negative real oil price changes are  $v_2/v_1$  and  $v_3/v_1$  respectively.

Likewise, Wald test is implemented to test the potential asymmetry in effect of real oil prices on real money demand. The null hypothesis of this test supports the presence of asymmetric impact i.e.  $H_0: -v_2/v_1 = -v_3/v_1$ .

#### 4. Results and discussion

Our empirical analysis took into account annual data for Algeria over the entire period from 1980 to 2019. The data are collected from the World Development Indicators and the reports of the Algerian bank. More precisely, we use the following variables: real money demand (RM2) measured as money supply (M2) deflated by GDP deflator, the oil price expressed in \$US and inflation rate. Thus, for the purposes of this article and for our analysis, we will use asymmetric changes, both positive and negative, in oil prices.

First of all, it is necessary to verify that all variables are not integrated of order two (I(2)), otherwise the ARDL approach will not be applicable. Consequently, we use Augmented Ducky Fuller test to examine the stationarity of the selected variables. Table 1 shows the unit root test results which reveal that all the variables are stationary in first differences and therefore we can continue with testing for co-integration in the ARDL framework.

**Table N°01:** Stationary tests results

	ADF		PP	
	Level	1 <sup>st</sup> Dif.	Level	1 <sup>st</sup> Dif.
RM2	1,45	-3,40***	2,29	-3,88***
OOP	-0,49	-4,16***	-0,51	-5,50***
INF	-1,59	-4,70***	-1,39	-5,68***

**Source:** The authors

The optimal lag structure of the ADF and PP test is chosen based on the Akaike and Schwarz Information Criterion. \*, \*\*, \*\*\* Indicate the significance at 10%, 5% and 1%, respectively

The optimal delay structure of the ADF and PP test is chosen according to the Akaike and Schwarz information criterion.

The result of ADF test show that all the variables (real money demand RM2, real oil price OP and inflation rate INF) are stationary after they converted to first difference. The findings of PP test appear to support the stationary of the three variables at first difference, and thus all variables are  $I(1)$ .

**Table N°02:** Bounds test for co-integration in the linear and the nonlinear specifications

Model specification	F-statistic	99% lower bound	99% upper bound	Conclusion
Linear ARDL	10,2297	5,15	6,36	Co-integration
Nonlinear ARDL	15,6027	5,15	6,36	Co-integration

**Source:** The authors



Taking this into consideration, we will examine the long-term relationship between the variables using the linear ARDL co-integration test. Table 2 for bounds test shows evidence for a strong co-integration in our proposed models since the F-statistic 10.22 and 15.60 are higher than the upper critical bound in the both linear and nonlinear ARDL model respectively. Thus, the various diagnostic tests show that our linear and non-linear ARDL models have no econometric problem.

**Table N°03:** Linear ARDL estimation

Variable	Coefficient	t-statistic	P-value
<b>Long run results</b>			
$OP_t$	45,5135	2,6577	0,0120
$INF_t$	-187,3737	-2,2702	0,0299
<b>Short run results</b>			
<i>Intercept</i>	234,281	6,4233	0,0000
$\Delta OP_t$	-7,6225	-3,6423	0,0009
$\Delta INF_t$	-18,5260	-3,5837	0,0011
$CointEq_{t-1}$	-0.0724	-5,2338	0,0000
$R^2$	0,9830		
Heteroskedasticity	0,7076		0,5925
Serial correlation	1,7547		0,1897
Jarque-Bera	2,1103		0,3481
Ramsey reset	2,7010		0,1101

**Source:** The authors

Also, according to the estimated results of the long-term relationship, it appears that there is a positive and significant effect of the price of oil on the demand for real money in the linear ARDL model. It means that increasing oil price is increasing the demand for money in Algeria. But this result is not reliable due to an argument that both increasing and decreasing oil price would not have same effects.

Therefore, we have done this analysis in the nonlinear setting. Results are presented in Table 5.

Whereas Table 4 presents the long run coefficients computed from the dynamic model shown in Table 5. Results reveal that in the long run, oil price affects RM2 only when it records an increase.

The estimated long run effect associated with positive oil price changes is 25, 2649 and is statistically significant at the 5% level (see Table 4).

However, the negative changes in the price of oil are insignificant. This means that when the real price of oil increases, the demand for real money increases. But, in the event that this price drops, that will not imply the drop in this demand for real money.

Otherwise, an evidence of asymmetry can be observed from the magnitudes of oil price increasing and decreasing variables, the coefficient of oil price increases is showing higher magnitude than the coefficient of oil price decreases.

According to table 3, the Wald test rejects the null hypothesis in the long run for real oil price at 1% significance level, which supports the presence of an asymmetric impact of oil prices on real money balances in the long run.

In regards to the impact of variations in oil prices in the short term, it can be seen from the results of Table 3 that the coefficient of  $CointEq_{t-1}$  in the linear ARDL model is negative and significant.

Therefore, short run relationships exist. Both oil price and inflation rate are showing negative effects on RM2.

On the other hand, over the long term, variations in the price of oil in the short term tend to decrease the demand for real money, since any increase of 1% in the price of oil implies a decrease in RM2 of 7.62%.

**Table N°04:** Long run coefficients for nonlinear ARDL model

Variable	Coefficient	T-statistic	Prob.
$INF_t$	-72.0105	-4.1886	0.0003
$OP\_P_t$	25.2649	5.7082	0.0000
$OP\_N_t$	7.4654	1.2633	0.2181

**Source:** The authors

Regarding the nonlinear model, positive changes in oil prices have a negative impact on the demand for real money with a lag period.

A boom in oil prices increases the income level of both the individuals and the economy, which encourages households to increase their consumption and/or ownership of foreign assets.

As the opportunity cost of holding the national currency increases, this leads to a decrease in the ownership of real money balances. Similar results are reported by (Siregar & Ward, 2002, p.52).

In addition, the fall in oil prices has an insignificant effect on RM2, while its second lag shows a negative effect. In other words, two years lags oil prices decrease are also determining real money demand in short run.

When oil price decreases, production and investment fell. This decline in production results in an increase in demand for goods and an increase in the interest rate. This in turn decreases the demand for real cash balances.

This findings supports earlier studies that oil price shocks are an important determinant in the long run of money supply in oil exporting economy (Boye, 2001; Siregar & Ward, 2002, p.52; Olomola & Adejumo, 2006, 29; Farzanegan & Markwardt, 2009, p.142).

Finally, the impact of the inflation variable on the demand for real money seems negative for both models in both cases, in the short and in the long run.

**Table N°05:** Nonlinear estimation results

Variable	Coefficient		t-statistic	P-value
<i>Intercept</i>	831,9124	126,6929	6,566370	0,0000
<i>RMD<sub>t-1</sub></i>	-0,294964	0,068790	-4,287915	0,0002
<i>OP<sub>P</sub><sub>t-1</sub></i>	7,452249	1,501049	4,964695	0,0000
<i>OP<sub>N</sub><sub>t-1</sub></i>	2,202036	1,573337	1,399596	0,1739
<i>INF<sub>t-1</sub></i>	-21,24050	3,574307	-5,942551	0,0000
$\Delta RMD_{t-2}$	-0,188369	0,124361	-1,514693	0,1424
$\Delta OP_{P_t}$	-15,29885	4,398717	-3,478025	0,0019
$\Delta OP_{P_{t-1}}$	-11,14070	4,769549	-2,335797	0,0278
$\Delta OP_{N_t}$	-5,071535	3,080051	-1,646575	0,1122
$\Delta OP_{N_{t-2}}$	-7,588594	2,942658	-2,578823	0,0162
$\Delta INF_t$	-12,10530	4,830985	-2,505762	0,0191
<b>R<sup>2</sup></b>	0,795402			
<b>Heteroskedasticity</b>	0,5420			0,8437
<b>Serial correlation</b>	0,5464			0,5863
<b>Jarque-Bera</b>	0,5280			0,7679
<b>Ramsey reset</b>	0,0719			0,7908

**Source:** The authors

## 5. Conclusion

The main objective of this article is to examine the impact of the variation in oil prices on the stability of the money demand function in Algeria during a period from 1980 to 2019. This research examined this issue in both linear and non-linear ARDL settings developed by (Shin et al., 2014, p.286) in order to capture both short and long run asymmetric relations between money demand and real oil prices.

Also, CUSUM and CUSUMSQ tests were performed to examine the stability of the money demand function over several periods.

Regarding the linear ARDL model, and from our results, we see that there is a positive effect of changes in the price of oil on the demand for real money in the long term. Conversely, real oil price tends to have small negative effect in the short run which is may be due to the public support to the economy in times of crises including oil revenues saved during oil price booms.

As for the nonlinear model, any change in oil prices implies a positive impact on the demand for real money in the long run, while any fall in oil prices has insignificant consequences. Furthermore, real oil price is found to have an asymmetric impact on real money demand meaning that real money demand reacts differently to a decrease compared to an increase in oil prices.

The greater impact of oil price increases on real money demand is related to the high dependence of the Algerian economy on oil. Also, for the two models, the results show that variations in inflation have a negative impact on the demand for real money in Algeria.

Finally, a stability test reveals that there is a stability of the function of real money balances, since the CUSUM and CUSUMSQ tests do not exceed the critical thresholds of 5%.

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