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The impact of variations in oil prices on the demand for money in Algeria: an empirical study over the 1980-2019 period

Anissa Atmani[1], Nacer-Eddine Mouffok[2]

[1] *University of Bejaia (Algeria), atmani655@gmail.com*
[2] *University of Bejaia (Algeria), nacermouffok2003@yahoo.fr*

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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.

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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. The analysis of money demand is a cornerstone for understanding the effects of monetary policy on the economy, since it highlights the determinants of the amount of money in circulation in the economy.

Since Friedman's pioneering work in 1956, the money demand function has attracted attention of many scholars in both developed and developing countries. According to Friedman and Schwartz (1982) and (Laidler, 1974, p.58) [1], 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) [2].

Thus, a good knowledge of the determinants of money demand in the economy through the study of the dynamics of the money demand function is a key condition to conduct an effective monetary policy. Moreover, stability of the money demand function has been determined as a key to effectiveness of monetary policy. Friedman (1968) strongly argued that money supply cannot influence real output in the long run and given this neutrality proposition, stable money

*Corresponding Author : *Nacer-Eddine Mouffok*

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) [3] pointed out that the efficacy of targeting money supply rests mainly on the stability of the money demand function. Furthermore, (Bhatta, 2011, p.10) [4] states that a stable money demand is one of the most important policy issues that helps central banks choose the appropriate targeting strategy (monetary targeting or inflation targeting) in monetary policy.

Other reasons for studying the stability of the money demand function are identified in the literature. 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) [5]. 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) [6]. 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) [7] and (Alsamara et al., 2016, p.3758).

The rest of the paper is structured as follows. Section one introduces article, section two summarizes the literature review, section three presents the methodology and discusses the data sources, section four represents the empirical results and last section conclude the article.

2. Literature Review

The stability of the money demand function is a crucial element in the conduct of a country's monetary policy. 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.

Over the past three decades, a considerable body of empirical research has been devoted, following Friedman's pioneering work, to studying the stability of the money-demand function in various countries. 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) [8] 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) [9], 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) [10]. Given that this countries are very responsive to the export sector’s contribution to economic activity, so any boom in oil exports must have resulted in instable money for demand (Boye, 2001, p.58) [11]

From a theorical point of view, oil prices affect real money balances as they increase money demand (Pierce et al., 1974, p.50; Mork, 1994, p.20) [12]. 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) [13]. (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. The results of the study show evidence on the long-run equilibrium of MDF which is mainly explained by the oil price, whereas the short-run dynamics of money demand are described by the positive impact of oil price in Saudi Arabia.

Studies dealing with the stability of money demand function in Algeria include(Abderrezak, 2000, p.78; Bakhouche, 2006, p.236; Menaguer, 2009, p.41; Ayad, 2013, p.18; Ahmed, 2015, p.318; Alhakimi, 2018,p.49) [14]. 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.

The contributions of this study are: 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) [15]. 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, given the characteristics of an oil-based economy, this paper argues the role of

oil price as a scale variable and aims to drive a relevant monetary policy reaction in the line with the current economic conditions in Algeria.

3. Methods and Materials

The main objective of this paper is to test the influence of oil price changes on real money demand in Algeria over the period 1980-2018. 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) [16]. 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) [17]. Third, the ARDL method can be applied even if the explanatory variables are endogenous (Pesaran et al., 2001). Fourth, compared to other co-integration techniques, this technique provides better results when working with small samples (Onafowora and Owoye, 2014, p.58) [18].

It is well established in the literature that any money demand function must include a scale variable (income) and the opportunity cost of holding money (interest rate, exchange 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) [19]. This can be explained by the absence of well-developed financial markets; thus real assets are considered more attractive than financial assets. This empirical work implements the money demand function outlined below:

$$RM2_t = \alpha_0 + \alpha_1 OP_t + \alpha_2 INF_t + \varepsilon_t \text{..... (1)}$$

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:

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

Where $\beta_1, \beta_2, \beta_3$ are the long run coefficients while $\varphi_{1i}, \varphi_{2i}, \varphi_{3i}$ and μ_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 β_2/β_1 and β_3/β_1. To get short run coefficient estimates, the estimation of dynamic error correction is carried out using formulation of equation (3).

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

Where $\delta_{1i}, \delta_{2i}\ and\ \delta_{3i}$ capture short run dynamics and ω 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 miss-specified 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:

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

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

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

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

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

$$\Delta RM2_t = c + \upsilon_1 RMD_{t-1} + \upsilon_2 OP_{t-1}^+ + \upsilon_3 OP_{t-1}^- + \upsilon_4 INF_{t-1} + \sum_{i=1}^{p_1} \rho_{1i} \Delta RM2_{t-i} + \sum_{i=0}^{p_2} (\psi_{2i} \Delta OP_{t-1}^+ + \psi_{3i} \Delta OP_{t-1}^-) + \sum_{i=1}^{p_3} \psi_{4i} \Delta INF_{t-i} + \zeta_t \ldots\ldots\ldots (4)$$

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 $\upsilon_2/\upsilon_1$and υ_3/υ_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: $-\upsilon_2/\upsilon_1 = -\upsilon_3/\upsilon_1$

4. Results and Discussion

The empirical analysis uses annual data for Algeria over the period of 1980-2018. 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. In our analysis, we make use of asymmetric oil price changes in where we distinguish between positive oil price changes and negative oil price changes.

As a starting point, 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 1shows 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 1: Stationary tests results

	ADF		**PP**	
	Level	1st Dif.	Level	1st 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***

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 lag structure of the ADF and PP test is chosen based on 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 areI(1).

Table 2: 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

In view of that, we examine the long-run relationship among the variables by 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. The diagnostic tests are showing that our linear and non-linear ARDL models are out of any econometric problem.

Table 3: Linear ARDL estimation

Variable	Coefficient	t-statistic	P-value
Long run results			
OP_t	45,5135	2,6577	0,0120
INF_t	-187,3737	-2,2702	0,0299
Short run results			
$Intercept$	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

Moreover, the estimated results of the long run relationship show a positive and significant impact of oil price on the real money demand 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 4presents 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, negative changes in oil price are found to be insignificant. This means that when real money demand increases when real oil price rises, but does not follow the real oil price when it drops.

In addition, 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. Regarding the short run impact of oil price changes, from the results in table 3 it can be seen 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. Contrary to the long run, oil price in short run tends to decreases the demand for real money as 1% increase in oil price decreases RM2 by 7,62%.

Table 4: 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

In the nonlinear model, positive oil price changes negatively affect real money demand contemporaneously as well as one 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) [20].

Moreover, oil price decreases have insignificant impact on RM2 but its second lag appears to have 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, p.58; Siregar & Ward, 2002, p.52; Olomola & Adejumo, 2006, p.29; Farzanegan & Markwardt, 2009, p.142) [21]. Finally, inflation variable shows negative influence on the demand for real money in short and long run in both models.

Table N°05: Nonlinear estimation results

Variable	Coefficient		t-statistic	P-value
$Intercept$	831,9124	126,6929	6,566370	0,0000
RMD_{t-1}	-0,294964	0,068790	-4,287915	0,0002
OP_P_{t-1}	7,452249	1,501049	4,964695	0,0000
OP_N_{t-1}	2,202036	1,573337	1,399596	0,1739
INF_{t-1}	-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
R^2	0,795402			
Heteroskedasticity	0,5420			0,8437
Serial correlation	0,5464			0,5863
Jarque-Bera	0,5280			0,7679
Ramsey reset	0,0719			0,7908

5. Conclusion

This paper sought to explore the effects of oil price volatility on the stability of money demand function in Algeria over the period 1980-2019. 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. Further, the CUSUM and CUSUMSQ tests were performed to verify the stability of money demand function over time.

Unit root test results show that all variables used in the analysis are integrated od order one. In addition, bound tests show evidence of strong co-integration in both the linear and the nonlinear model.

In the linear ARDL model, results reveal positive impact of oil price on real money demand in the long run. 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.

In the non linear model, oil price increases appear to have positive effect on the real money demand in the long run, whereas oil price decreases are found to be insignificant. 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. In addition, inflation has negative influence on the demand for real money in short and long run in both models.

Another empirical aspect of this study which involves test of stability exhibit the stability of the real money balances function as neither the CUSUM nor the CUSUMSQ plots cross the 5 percent critical boundaries.

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