The impact of oil price shock of 2014 on the exchange rate in Algeria: Vector Autoregressive Model

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Abstract:

The objective of this paper is to analyze the effects of oil price shock on exchange rate of the Algerian dinar versus US dollar through an empirical analysis using a VAR Model (Vector Autoregressive Model) based on monthly data from June 2012 to December 2016. The findings showed that oil prices exert a significant effect on exchange rate. A 1% decrease in oil price would lead to depreciate the Algerian Dinar of about 0.10% against US Dollar. The Granger Causality Test results indicate that there is a unidirectional causality running from oil price to exchange rate. This is consistent with the literatures that a decrease in oil price will depreciate the exchange rate. In fact, low oil prices generally provokes a large depreciation of exchange rates in oil-exporting countries. This evidence is clearly established in the Algerian case.

Keywords: Algeria, Exchange rate, Impact, Oilprice,shock, Vector Autoregressive Model.

Résumé :

L'objectif de cet article est d'analyser les effets du choc pétrolier sur le taux de change du dinar algérien par rapport au dollar américain à travers une étude empirique utilisant un modèle VAR (VectorAutoregressive Model) basé sur les données mensuelles allant de juin 2012 à décembre 2016. Les résultats ont montré que les prix de pétrole exercent un effet significatif sur le taux de change. Une baisse de 1% du prix du pétrole entraine une dépréciation du dinar algérien de 0,10% par rapport au dollar américain. En outres, les résultats du test de causalité de Granger indiquent

qu'il existe une causalité unidirectionnelle allant des prix du pétrole au taux de change. Ceci est conforme à la théorie selon laquelle la baisse des prix du pétrole entrainera la dépréciation tu taux de change. En fait, les bas prix du pétrole provoquent généralement une forte dépréciation des taux de change dans les pays exportateurs de pétrole. Cette preuve est clairement établie dans le cas algérien.

Mots-clés: Algérie, taux de change, impact, prix du pétrole, choc, modèle VAR.

JEL Classification:C30-F14

I- Introduction:

Oil as the mainstay of the Algerian economy, accounts for over 95 percent of its foreign earnings and about 83 percent of its budgetary allocation, to this end, changes in oil prices has implications for the Algerian economy and, in particular, exchange rate movements.

From 1974 to 1994, the exchange rate of the dinar was determined on the basis of a fixed relationship with a basket of currencies, adjusted from time to time. In1994, the Bank of Algeria introduced a managed float for the dinar through daily fixing sessions that included six commercial banks. This system has been replaced by an interbank foreign exchange market as of January 2, 1996. No margin limits are imposed on the buying and selling exchange rates in the interbank foreign exchange market.[1]

Between June and December 2014, the Brent price of crude oil fell by 44%, resulting in one of the most dramatic declines in the price of oil in recent history.

According to Bodenstein et al. (2012), an oil price shock may be transmitted to the exchange rate through two main channels:

-The terms of trade: A negative terms of trade shock (say, a fall in oil prices for an oil exporter) drives down the price of non-traded goods in the domestic economy and thereby the real exchange rate. As prices of non-traded goods may be sticky, the

[1] IMF, (2017), "Algeria 2017 article iv consultation—press release; staff report; and statement by the executive director for Algeria", IMF Country Report No. 17/141, June 2017.

adjustment of the real exchange rate could require nominal exchange rate depreciation too;

- Wealth effects: A negative oil price shock transfers wealth from oil exporters to oil importers, leading to large shifts in current account balances and portfolio reallocation. In order to restore the external net financial sustainability of oil importers (exporters), the real exchange rate has to depreciate (appreciate) following a negative shock to the oil price, in order to improve the non-oil trade balance.

This paper presents the implications of the oil price fall in the exchange rate in Algeria. Precisely, it is a matter of checking the relationship between oil prices and the exchange rate dinars against the dollar using the VAR model.

The rest of the paper is organized as follows. In section 2 we present the evolutionof Algeria's Macroeconomic Indicators after the oil price shock. Section 3 presents a literature review on the relationship between oil price and exchange rate. Section 4 presents the model and the methodology, followed by the results and discussion in Section 5, and finally, section 6 presents the main conclusion.

II. Impact of the oil price shock on Algeria's Macroeconomic Indicators

The impact of the oil price shock on growth has been limited, but fiscal and external balances have deteriorated significantly.

2.1 External balance and international reserves

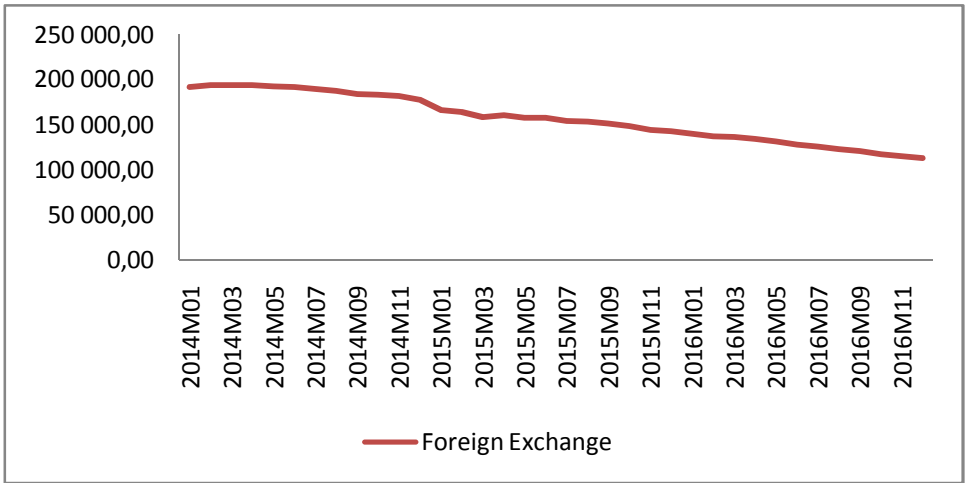
In its note of conjuncture, the Bank of Algeria (2016)[2] indicates that oil price shock combined with a very slight decline in the quantities of hydrocarbons exported (-0.28%), resulting in revenues of hydrocarbon exports of $33.08 billion versus $58.46 billion in 2014. According to International Monetary Fund (2017)hydrocarbon exports declined in value terms from US$33.1 billion in 2015 to US$27.7 billion in 2016 owing to a 22.1 percent fall in prices.As a result of oil price shock, trade balance evolved from near equilibrium in 2014 ($+0.46 billion) to a deficit of $18.08 billion.

[2] Bank of Algeria, (2016), "Monetary and Financial trends in the fourth quarter of 2015, as a consequence of the external shock " , available at: http://www.bank-of-algeria.dz/pdf/ncanglais25082016.pdf (accessed 6 Juin 2017).

Indeed, the oil shock was of such magnitude that the trade balance recorded its first deficit, following eighteen years of consecutive surpluses (Bank of Algeria, 2016, p 2).After recording a deficit of $9.28 billion in 204, after more than fifteen years of surpluses, the current account of balance of payments recorded a widening of its deficit to $27.48 billion in 2015, in context of sharp deterioration in the trade balance. In total, the overall balance of external payments of Algeria, posts a deficit of $27.54 billion ($14.38 billion in the first quarter and $13.16 billion in the second quarter), versus a deficit of only $5.88 billion in 2014 ($1.32 billion in the first half and $4.56 billion in the second).

The record deficit of 2015 combined with the negative valuation effect resulting in international reserves (excluding gold) contracting sharply, standing at $144.13 billion versus $178.94 billion dollars at end 2014 (Bank of Algeria , 2016, p 3).International reserves stood at about US$113 billion at end-2016 (excluding SDRs), equal to 23 months of imports . But reserves have declined almost 41 percent from their peak in 2013 and are projected to decline further over the medium term. (IMF, 2017, p43).

Figure 1: decrease in foreign exchange reserves



Source: International Financial Statistics (IFS), IMF (2017)

2.2 Public finances and GDP

Public finances are affected by the fall in oil prices since mid-2014. The impact of external shock on public finances, heavily dependent on oil taxation, is reflected in the widening budget deficit and erosion of resources of the Revenue Regulation Fund. The trend increased throughout the year in relation to persisting low hydrocarbon exports revenues and consistently high budgetary spending. Indeed, according to data issued by Treasury, revenue from oil taxation totaled 2,273.5 billion dinars versus 3,388.4 billion dinars in 2014. The overall budget balance, thus deteriorated further, reaching a deficit of 2,824.5 billion dinars (16.8% of GDP) versus 1,375.4 billion dinars in 2014 (8% of GDP) and the stock of financial savings fell to 2,151.6 billion dinars (4,488.2 billion dinars at end 2014). Resources of Treasury underwent a drastic erosion of 2,336.6 billion dinars, or a reduction of 52.1% over a year, following several years of sustained efforts in budgetary savings(Bank of Algeria, 2016, p 3).

In its report on Algeria, the IMF (2016), estimates that the economic situation has deteriorated since the oil crisis of 2014. The fall in oil prices has led to a deceleration of economic growth and has led to a budgetary and external deficit.[3]IMF (2017) considers that overall economic activity was resilient, but growth in the non hydrocarbon sector slowed to 2.9 percent in 2016, partly under the effects of spending cuts. Inflation increased from 4.8 percent in 2015 to 6.4 percent in 2016 and stood at 7.7 percent year-on-year in February 2017. Unemployment was 10.5 percent in September 2016 and remains particularly high among the youth (26.7 percent) and women (20.0 percent). Despite fiscal consolidation in 2016, the fiscal and current account deficits remained large, and public debt increased, reflecting in part the assumption of a government-guaranteed debt. International reserves, while still ample, declined rapidly. External debt remains very low.

[3]The current account registered a deficit in 2014 for the first time since 1998.

Table1:Selected Macroeconomic Indicators, 2014–2018

Macroeconomic Indicators	**2015**	**2016***	**2017***	**2018***
Real GDP growth (percent)	3,8	3,5	1,3	0,7
Nonhydrocarbon GDP growth (percent)	5,0	2,9	1,3	0,3
Unemployment (percent, end of period)	11.2	11.2	11.2	11.2
Total revenue (percent of GDP)	30,8	29,5	34,3	30,9
Of which, hydrocarbon	14,1	10,2	11,2	11, 2
Total expenditure	46,6	43,5	37,3	33,5
Overall budget balance (deficit-)	-15,8	-14,0	-3,0	-2 ,7
Gross governmentdebt	8,8	21,0	18,3	19,3
Current account balance (percent of GDP)	-16,6	-16,9	-11,9	-9,7
FDI (percent of GDP)	-0,4	0,9	1,1	1,3
Gross reserves (months of imports)1/	28,4	22,5	19,5	16,7
Externaldebt (percent GDP)	1,8	2,5	2,5	2,7
REER average (percent change)	-4,3	-2,0	-2,0	-2,0

*Estimation

1/ In months of next year's imports of goods and services.

Sources: Algerian authorities; and IMF staff estimates.

According to MFI (2016), Algeria did not take advantage of over a decade of high oil prices to overcome the structural shortcomings in its growth model, as the economy remained overly dependent on hydrocarbons and public spending. From 2002 until 2014, hydrocarbons on average accounted for 98 percent of exports, 69 percent of fiscal revenues, and 36 percent of GDP.

In Algeria, few studies have been carried out to analyze the effects of the oil shock of 2014 on the national economy. We quote the study of Oukaci (2015) and Touati (2017). The results of the Oukaci et al. (2015), based on computable general equilibrium modeling, show that the impact of lower oil prices leads to a fall in gross output of -2.94%. This decline was due to the collapse of the construction and public works branch, followed by the industrial and the hydrocarbons sectors. Imports

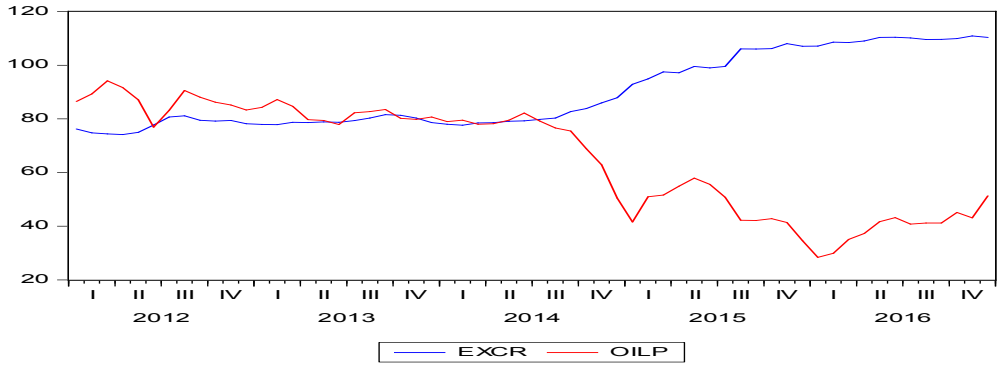
declined by 14.5% and final consumption fell by more than 25%. At a sectoral level, demand for investment registered a sharp decline, particularly in the construction and public works sector and the services sector. For intermediate demand, the industrial sector recorded the largest decrease (-10.90%).

The work of Touati (2017), based on Multipliers Social Accounting matrix analysis, find that the oil shock has a negative effect on allsectors of activity, but the effect remains weak and limited. The negative effect is more pronounced in the Hydrocarbons sector, Services Public Works and Petroleum Sector, Water and Energy Sector and the sector of Transport and Communications. The distributional effect is more pronounced in the Households and Individuals account.

2.3Exchange rate of dinar versus US dollar and interest rate

The impact of the oil price shock on economic fundamentals led to a depreciation of 20% of the exchange rate of dinar versus US dollar and 3.8% versus euro. Therefore, the foreign exchange rate played to a large extent the role of external shocks absorber, thanks to its flexibility, backed by Bank of Algeria's interventions on the foreign exchange inter-bank market. Indeed, and in order to prevent any appreciationof the real effective exchange rate that would be damaging to the medium-term macro-economic stability, the relative flexibility of the exchange rate of dinar allows to partially absorb the impact of decreasing oil prices. The interventions of Bank of Algeria on this market are part of this strategic objective (Bank of Algeria; 2016, p 3).

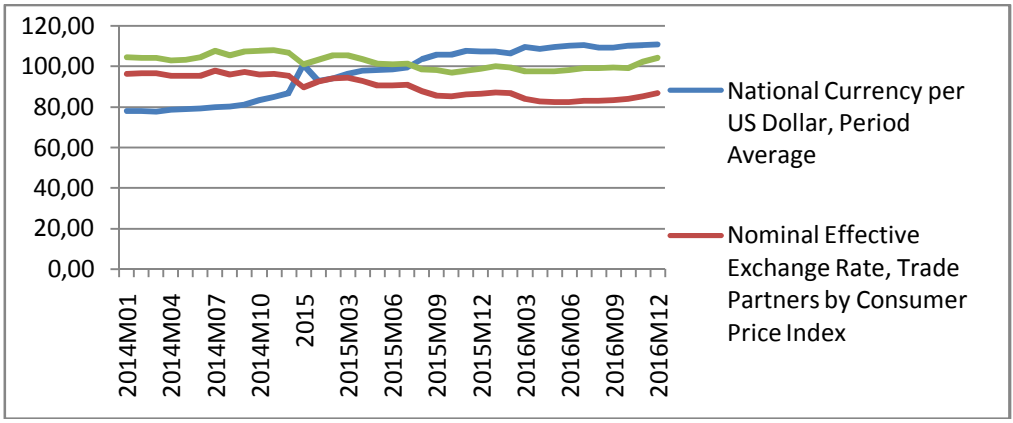
Figure 2: Comparative evolution of the price of oil and the exchange rate



Source: Built by the author from the results obtained by the Eviews7.0 software.

The Bank of Algeria indicates that according to its model, the real value of the Algerian Dinar is overvalued by 4%. According to Bouskin and al (2015), this overvaluation is harmful to the national economy since it subsidizes imports at the expense of domestic production and makes revenue decreases in DA oil taxation. The BA has overstated the DA to fight the high inflation in 2012. Inflation has declined significantly in almost two years and it is incomprehensible that the BA has maintained the value of the Algerian Dinar above the equilibrium price of its model.

Figure 3 :Comparative evolution of the nominal and real effective exchange rate



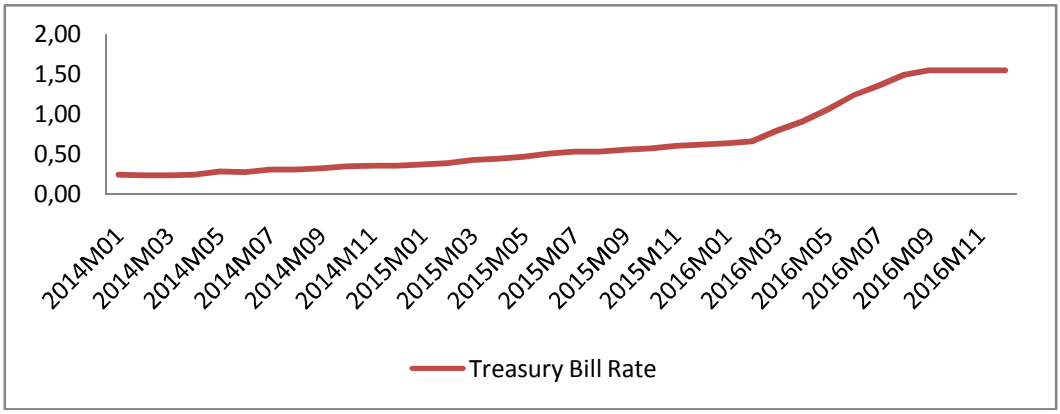
Source: International Financial Statistics (IFS)

According to International Monetary Fund (2016) despite a 25% depreciation of the dinar against the dollar, the nominal effective exchange rate depreciated by only 6.7% in 2015, owing to the depreciation of other trading partners' currencies. The real effective exchange rate (REER) depreciated by 4.3 percent, as the nominal depreciation was partly offset by an increase in Algeria's prices relative to those in its trading partners. The REER remains significantly overvalued, hurting Algeria's competitiveness.[4]

[4]International Monetary Fund, (2016). "ALGERIA 2016 Article IV consultation—press release and staff report", *IMF Country Report No. 16/127*, May 2016, p 5.

Oil prices shock contributed to a sharp reduction in excess liquidity. Indeed, some banks returned to BA for financing, interbank lending picked up, and interest rates increased.

Figure 4:increase of interest rate



Source: International Financial Statistics (IFS), IMF (2017)

III. Review of Related Recent literatures

Many studies have used different empirical methods and examined the impact of the oil price on the exchange rate. Recently, Mensah et *al.* (2017)[5] examines the long-run dynamics between oil price and the bilateral US dollar exchange rates for a group of oil-dependent economies before and after the 2008–2009 Global Financial Crises. Empirical results show evidence of a long run equilibrium relationship between oil price and exchange rate, especially for currencies of the key oil-exporting countries. This relationship is more evident in the post crisis period, which is also the period when both exchange rate volatility and the inverse relationship between oil price and exchange rate experienced a significant increase.

Candemir et *al.*(2017)[6] explore the relationship between the oil prices, asset prices, and foreign exchange rates in the selected GCC economies,. Using a time-varying

[5]Mensah, L., Obi, P. and Bokpin.,G (2017), "Cointegration Test of Oil price and US Dollar Exchange Rates for some Oil Dependent Economies", *Research in International Business and Finance*, Volume 42, December 2017, Pages 304-311.

[6]Candemir, M. and Balcilar, M., (2017), "Dynamics of oil prices, exchange rates and asset prices in the GCC countries", *Topics in Middle Eastern and African Economies Proceedings of Middle East Economic Association* Vol. 19, Issue No. 1, available

parameter VAR other study the coherence, conditional volatility and impulse responses of the exchange rates and stock markets to oil price shocks over specific periods and policy regimes. Results suggest that the impact of oil prices on the exchange rate and asset prices are time dependent. Hence there is a loss in information when using standard linear models that average out effects over time. The response of the exchange rates and asset prices to oil prices weakens and strengthens depending on the regime of the markets. The period following financial crisis uniformly strengthens the relationships between the variables. The responses also vary across the GCC economies, emphasizing the fact that differences exists across these economies although their economic structures increasingly becoming similar.

NikanorI.VolkovaKy-hyangYuhn (2016)[7] studies the effects of oil price shocks on exchange rate movements in five major oil-exporting countries: Russia, Brazil, Mexico, Canada, and Norway. The R2 of the fundamental model doubles in Russia and Brazil, but increases slightly in Canada and Norway when oil prices are added to it. The volatility of exchange rates associated with oil price shocks is significant in Russia, Brazil, and Mexico, but weak in Norway and Canada. It takes much longer for the exchange rate to reach the initial equilibrium level in Russia, Brazil, and Mexico than in Norway and Canada. The asymmetric behavior of exchange rate volatility among countries seems to be related to the efficiency of financial markets rather than to the importance of oil revenues in the economy.

Blokhinaet *al.*(2016)[8]" study the relationship between oil price and the exchange rates in Russian Federation. The regression model has accurately shown a close interrelation between the currency rate of dollar to ruble and oil prices.. The

at:http://meea.sites.luc.edu/volume19/pdfs/1%20Dynamics%20of%20oil%20prices.pdf,(accessed 20 July 2017).

[7]NikanorI.VolkovaKy-hyangYuhn (2016)), "Oil price shocks and exchange rate movements "*Global Finance Journal* Volume 31, November 2016, Pages 18-30

[8]Blokhina, TK., Karpenko, OA. andGuirinskiy AV. (2016), "the relationship between oil prices and exchange rate in Russia", *International Journal of Energy Economics and Policy*, 2016, 6(4), 721-726. , available at http: www.econjournals.com

interrelation with a foreign policy factor - sanctions of the USA and the European Union is also revealed. Oil prices of the Brent oil is the dominating factor in a currency exchange rate formation mechanism of ruble, at least, in the long term. When world oil prices are stabilized and sanctions cancelled, currency fluctuations and uncertainty will be minimized.

Altarturiet *al.*(2016)[9] studied the relationship between oil price and the exchange rates of Organization of Oil Exporting Countries (OPEC) members from February 1999 to March 2016through the wavelet method. The study found that the strength of the relationship between oil price and exchange rate divides into three main categories, namely oil price leads exchange rate, exchange rate leads oil prices, and the relationship keeps changing. Countries which currencies pegged to US Dollar are lagging against oil price changes, countries with floating exchange rates and countries with an undisclosed weighted basket of international currencies leads the changes in oil price, and countries which their currencies pegged to special drawing right experience changing relationships.

AremuIdowuet *al.*(2016)[10] analyzed the dynamic effects of oil price shock and exchange rate on the Nigeria stock market using monthly data from June 1999 to December 2014, applying VAR Model. Granger Causality Test result indicate that there is bidirectional causality between stock price and exchange rate, also there is bidirectional causality between oil price and exchange rate but unidirectional causality from oil proceed to exchange rate.

Salah et *al.*(2015)[11]studied the relationship between oil price and the black market exchange rate US Dollar/Algerian Dinar through an empirical analysis using an (Error

[9]Altarturi, B H., Alshammri A A. ,Hussin TMTT. andSaiti, B. (2016), "Oil Price and Exchange Rates: A Wavelet Analysis for Organisation of Oil Exporting Countries Members"*International Journal of Energy Economics and Policy*, 2016, 6(3), 421-430.

[10]AremuIdowu, R. and AdebiyiAyodeji , M.,(2016), "Analysis of the relationship between Oil price, Exchange rate and Stock market in Nigeria", MPRA Paper No. 73549, posted 11 September 2016 in https://mpra.ub.uni-muenchen.de/73549/1/MPRA_paper_73549.pdf

[11] Salah ,YS ., Si Mohammed, K. and Benmessaoud, N. (2015), "The black market exchange rate and Oil prices in Algeria"*SSRG International Journal of Economics and Management Studies (SSRG-IJEMS) – volume2 issue4 July to Aug 2015*

Correction Model upon quarterly data for the period 1975-2003. Results show that a cointegration relationship is detected between oil and black market exchange rate in Algeria, with unilateral trend causality in short and long run time horizon from oil prices to black market exchange rate.

Ferraro et *al.*(2015)[12]show the existence of a very short-term relationship at the daily frequency between changes in the price of a country's major commodity export and changes in its nominal exchange rate. The relationship appears to be robust and to hold when authors use contemporaneous (realized) commodity price changes in the regression. However, when they use lagged commodity price changes, the predictive ability is ephemeral, mostly appearing after instabilities have been appropriately taken into account.

Osuji(2015)[13] examined the effect of oil price movements on USD-Naira exchange rate pair using 420 observations from monthly time series data for the period January 2008 to December 2014 applying Ordinary Least Squares model and a Vector Auto Regression model. Empirical results show that oil prices on a relative basis significantly affect exchange rate compared to imports. Also, there is evidence of unidirectional Granger causality from oil prices to exchange rate and from oil prices to foreign reserves.

Oluwatomisinet al (2014)[14] examined the effects of oil price, external reserves and interest rate on exchange rate volatility in Nigeria using annual data covering the period 1970 to 2011. The long run relationship among the variables was determined using the Johansen Co-integration technique while the vector correction mechanism was used to examine the speed of adjustment of the variables from the short run

[12]Ferraro,D., Rogo,K. and Rossi,B. (2015), "Can Oil Prices Forecast Exchange Rates? An Empirical Analysis of the Relationship Between Commodity Prices and Exchange Rates" *,Journal of International Money and Finance,Volume 54, June 2015, Pages 116-141.*

[13]Osuji, E. (2015), "International Oil Prices and Exchange Rate in Nigeria: A Causality Analysis", *International Journal of Academic Research in Economics and Management Sciences,* 2015, Vol. 4, No. 3

[14]Ogundipea, OM., Ojeagaa, P. and Ogundipe , AA. (2014), "Oil Price and Exchange Rate Volatility in Nigeria", *IOSR Journal of Economics and Finance (IOSR-JEF)*, Volume 5, Issue 4. (Sep.-Oct. 2014), PP 01-09.

dynamics to the long run equilibrium. It was observed that a proportionate change in oil price leads to a more than proportionate change in exchange rate volatility in Nigeria; which implies that exchange rate is susceptible to changes in oil price.

Benhabibet *al.*(2014)[15]explored the relationship between oil price and the nominal US Dollar/Algerian Dinar exchange rate through an empirical analysis using a VAR Model (Vector Autoregressive Model) upon monthly data for the period 2003-2013. Results show that a 1% increase in oil price would tend to depreciate Algerian Dinar against US Dollar by nearly 0.35%.

Hidhayathulla et al. (2014)[16] examined the effects of oil price on exchange rate of Indian rupee against US dollar using time series data from 1972-73 to 2012-13. Multiple linear regression models are used to analyze the data. The model result suggests that the import of crude oil continues to rise up when the crude oil future price increases.

Tiwari et al. (2013) studied the linear and nonlinear Granger causalities between oil price and the real effective exchange rate of the Indian currency, known as "rupee." By applying wavelet methodology, they discovered that the linear and nonlinear causal relationships between the oil price and the real effective exchange rate of Indian rupee at higher time scales (lower frequency).

Oriavwote et al. (2012) has investigated the relationship between the real oil prices and the Real Exchange Rate. Using time series data covering the period between1980 and 2010, the result of the Johansen cointegration test suggests a long run equilibrium relationship between the real oil prices and the Real Exchange Rate. This relationship was supported by the Granger Causality test which validated the causal relationship from the real oil prices to the Real Exchange Rate. The result from the Generalized

[15]Benhabib, A., Si Mohammed, K. and Maliki, S. (2014), "The relationship between oil price and the Algerian exchange rate", *Topics in Middle E astern and African Economies,* Vol. 16, No. 1, May 2014.

[16]Hidhayathulla, A. and MahammadRafee.B (2014), "Relationship between Crude oil price and Rupee, Dollar Exchange Rate: An Analysis of Preliminary Evidence", *IOSR Journal of Economics and Finance (IOSR-JEF),* Volume 3, Issue 2. Ver. II (Mar-Apr. 2014), PP 01-04.

Autoregressive Conditional Heteroskedasticity test suggests persistence of the volatility between the real oil prices and the Real Effective Exchange Rate.

Nikbakht (2009)[17] has studied the relationship between oil price and exchange rate in OPEC members by using monthly panel of seven countries of OPEC members from 2000:01 to 2007:12. The results shown that, there is a long-run linkage between real oil prices and real exchange rates.Koranchelian (2005)[18] estimates a long-run equilibrium real exchange rate path for Algeria, he find that the Balassa-Samuelson effect together with real oil prices explains the long-run evolution of the equilibrium real exchange rate in Algeria. Empirical result found that in the long-run, Algeria's real exchange rate is time varying, and depends on movements in relative productivity and real oil price.

As we seen from the above literatures, the previous empirical studies have suggested an ambiguous relationship between crude oil prices and exchange rates.

IV- Data and Methodology

4-1 Vector Auto Regression

The Vector Auto Regression (VAR) is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The VAR approach sidesteps the need for structural modeling by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system. The stationary, *k*-dimensional, VAR(*p*) process is written as:

$$y_t = A_1 y_{t-1} + \ldots\ldots A_p y_{t-p} + C_{xt} + E_t$$

Where

y_t is a kx1 vector of endogenous variables

[17] Nikbakht,L. (2010), "Oil prices and exchange rates: the case of OPEC", *Business Intelligence Journal* , January *2010 Vol.3 No.1*

[18] Koranchelian, T. (2005), "The Equilibrium Real Exchange Rate in a Commodity Exporting Country: Algeria's Experience", *IMF Working Paper 05/135, Washington D.C.*

$x_t$is a dx1 vector of exogenous variables

A_1.....A_p are kxk matrices of lag coefficients to be estimated

C is kxd matrix of exogenous variable coefficients to be estimated

E_t is a kx1 white noise innovation process.

4-2 - Data

In our analysis we use the following macroeconomics variables: Oil prices (OILP), Exchange Rates (EXCR)[19], Average Monthly Interest Rates (INT), Consumer Price Index- CPI (Base 2001), Import Unit value index (IUVI) and Money Supply (MS).

The sample comprises 60 monthly observations for the period 2012-2016. These variables are collected from different issues of the Statistical Bulletin of Bank of Algeria, National Statistical Office and Reuters / DGEC.

Table 2: Descriptive Statistics

	EXCR	OILP	CPI	MS	IUVI	INTR
Mean	89.72452	65.99167	167.2417	12587.46	262.2283	0.644667
Median	81.24000	77.40000	164.8000	13025.95	262.0000	0.340000
Maximum	110.9350	94.20000	188.3300	14138.60	288.6000	2.500000
Minimum	74.14000	28.40000	148.7100	10123.70	239.4000	0.230000
Std. Dev.	13.53912	20.06136	10.51013	1330.340	12.65624	0.555647
Skewness	0.507845	-0.365478	0.484124	-.353797	0.264372	1.914695
Kurtosis	1.506935	1.534788	2.179910	1.546520	2.028874	6.127110
Jarque-Bera	8.152169	6.702853	4.025133	6.533234	3.056644	61.10762
Probability	0.016974	0.035034	0.133645	0.038135	0.216899	0.000000
Sum	5383.471	3959.500	10034.50	755247.5	15733.70	38.68000
Sum Sq. Dev.	10815.16	23745.03	6517.304	1.04E+08	9450.642	18.21589
Observations	60	60	60	60	60	60

Source: Built by the author from the results obtained by the Eviews7.0 software.

From the table above, all the series display a high level of consistency as their mean and median values are within the maximum and minimum values of the series. It can

[19]Algerian Dinar/US dollar (Average values over the period) ,quoted at the uncertain.

be deduced from the table that, excepted CPI and IVUI,variables are note normally distributed. This is evident from our probability for Jarque-Bera which rejected our null hypothesis and supported by Skewness and Kurtosis for the series (See Appendix 2 for the graphic presentation of these variables.)

4-3 Unit Root

Augmented Dicky fuller test (ADF) under Schwartz information criteria is conducted to test the stationary of the series.

4-3-1 ADF strategy on EXCR

We begin by estimating the general model (model 3) including a constant, a linear trend. Results for (model 3) show the trend is not significant because its t-statistics, in absolute value, equals 1.87, below the critical value tabulated by Dickey & Fuller (2.79) at 5% level, so we accept the hypothesis H_0 :β=0, model (3) isn't the good one (See Appendice1) . We pass further to estimate the (model 2), Results show insignificant constant because its t-statistics is lower than its critical value tabulated by Dickey & Fuller (0.032), and we find the Dickey-Fuller statistics (3.06) greater than the tabulated value at 5% level (-1.95) (see table) . So we accept H_0: c = 0. That is we test model (1), and we find the Dickey-Fuller statistics (3.06) greater than the tabulated value at 5% level (-1.95). In that case, we accept the null hypothesis (H_0: ϕ= 1), that is the existence of unit roots and hence, the non-stationary of the series.We find at the end, a non-stationary series IPC, having a stochastic trend and it seems to have, at least, one unit root that should be removed by differentiating to correct the nonstationary. Thus, EXCR is integrated of order 1.

4-3-2 Unit Root Test Results

On the same scenario, we studied the series OILP, INTR, CPI, MS and IUVI. Our results of stationary tests are represented in table (3).

Table3:Unit Root Test Results

Variables	Level						ADF Difference Test	
	t-statistics and tabulated value	model 3 Constant and Trend		Modèle 2 Constant		Modèle1 None	Modèle 1 None	Order of integration
		T de ADF	Ttrend	T de ADF	Tconst	T de ADF	T de ADF	
EXCR	t-statistics	-1.54	1.87	0.41	0.032	3.06	-5.26	I(1)
	tabulated value	-3.45	2.79	-2.91	2.54	-1.95	-1.95	
OILP	t-statistics	-2.09	-1.68	-1.30	0.86	-1.42	-5.31	I(1)
	tabulated value	-3.45	2.79	-2.91	2.54	-1.95	-1.95	
INTR	t-statistics	-3.41	1.46	-3.23	2.78			I(0)
	tabulated value	-3.45	2.79	-2.91	2.54			
CPI	t-statistics	-1.96	2.00	-0.08	0.29	3.53	-7.33	I(1)
	tabulated value	-3.45	2.79	-2.91	2.54	-1.95	-1.95	
MS		-0.48	-0.027	-2.051	2.44	3.52	-4.17	I(1)
	tabulated value	-3.45	2.79	-2.91	2.54	-1.95	-1.95	
IVU	t-statistics	-6.32	2.89					I(0)
	tabulated value	-3.45	2.79					

Source: Built by the author from the results obtained by the Eviews7.0 software.

The results gave evidences of stationary after the first differentiation for OILP, CPI and MS;while INTR and IVUare found to be stationary at level (which level?).

V- Modeling and Estimating VAR model

The first step consists of determining the P-th order of the VAR process.For this end, we have estimated VAR process for values of p ranging from 1 to 4, and we should retain the model having the least values for information criteria (Akaike and Schwarz).

Table 4: Choose a lag length « P »

Lag length	**1**	2	3	4
AIC	33.84985	33.81940	33.70310	**33.21646**
SCH	**35.34190**	36.61515	37.82613	38.69100

Source: Computed by the Author

We have estimated various VAR for P = 1 to 4 after several trials.According to the principle of parsimony the delay which minimizes the two criteria AIC and SIC is P=1.

5-1 Empirical Results

TheEmpirical Results are showmen in table 5

Table 5 :VAR(1) estimation

VectorAutoregressionEstimates

Date: 23/07/17 Time: 22:31

Sample (adjusted): 2012M03 2016M12

Included observations: 58 afteradjustments

Standard errors in ( ) & t-statistics in [ ]

	D(EXCR)	D(OILP)	D(CPI)	D(MS)	INTR	IUVI
D(EXCR(-1))	0.108610	0.635035	0.285311	-40.08617	-0.002365	0.586965
	(0.12911)	(0.40892)	(0.13365)	(11.4710)	(0.03655)	(1.10539)
	[0.84124]	[1.55297]	[2.13484]	[-3.49457]	[-0.06472]	[0.53100]
D(OILP(-1))	**-0.104507**	0.289561	0.094268	-3.693750	0.009813	0.398356
	(0.04442)	(0.14068)	(0.04598)	(3.94633)	(0.01257)	(0.38028)
	[-2.35288]	[2.05831]	[2.05032]	[-0.93600]	[0.78041]	[1.04752]
D(CPI(-1))	-0.140118	0.640066	-0.142615	10.42103	0.034874	2.967928
	(0.12973)	(0.41088)	(0.13429)	(11.5260)	(0.03672)	(1.11069)
	[-1.08010]	[1.55780]	[-1.06203]	[0.90413]	[0.94964]	[2.67215]

D(MS(-1))	-0.000475	0.003541	-0.000180	-0.217751	0.000180	0.003653
	(0.00151)	(0.00478)	(0.00156)	(0.13400)	(0.00043)	(0.01291)
	[-0.31524]	[0.74140]	[-0.11540]	[-1.62504]	[0.42203]	[0.28289]
INTR(-1)	0.582126	-0.960740	-0.066811	-25.82136	0.814450	1.810351
	(0.34490)	(1.09238)	(0.35702)	(30.6435)	(0.09764)	(2.95293)
	[1.68783]	[-0.87949]	[-0.18713]	[-0.84264]	[8.34178]	[0.61307]
IUVI(-1)	-0.017812	0.025628	-0.000325	-2.455610	0.004695	0.398501
	(0.01639)	(0.05191)	(0.01696)	(1.45609)	(0.00464)	(0.14031)
	[-1.08686]	[0.49373]	[-0.01913]	[-1.68645]	[1.01203]	[2.84006]
C	4.908519	-7.619228	0.762336	750.7747	-1.124090	154.9624
	(4.39881)	(13.9322)	(4.55341)	(390.827)	(1.24524)	(37.6616)
	[1.11587]	[-0.54688]	[0.16742]	[1.92099]	[-0.90271]	[4.11460]
R-squared	0.231838	0.157418	0.140838	0.251400	0.583695	0.230339
Adj. R-squared	0.141466	0.058291	0.039761	0.163329	0.534718	0.139791
Sum sq. resids	92.77590	930.6852	99.41200	732376.5	7.434786	6800.845
S.E. equation	1.348753	4.271853	1.396157	119.8346	0.381812	11.54772
F-statistic	2.565375	1.588040	1.393366	2.854527	11.91773	2.543823
Log likelihood	-95.92101	-162.7873	-97.92450	-356.1630	-22.72451	-220.4648
Akaike AIC	3.549000	5.854734	3.618086	12.52286	1.024983	7.843615
Schwarz SC	3.797674	6.103409	3.866760	12.77154	1.273657	8.092290
Meandependent	0.613914	-0.655172	0.627931	62.75517	0.630345	262.7724
S.D. dependent	1.455639	4.402080	1.424769	131.0101	0.559746	12.45071

Determinant resid covariance (dof adj.)	10283155
Determinantresid covariance	4753128.
Log likelihood	-939.6457
Akaike information criterion	33.84985
Schwarz criterion	35.34190

Source: Authors' calculations

From the table below, we can write the equation of $\Delta EXCR_t$ as:

$\Delta EXCR_t = 4.90 + 0.10 * \Delta EXCR_{t-1} - \mathbf{0.10} * \Delta OILP_{t-1} - 0.14 * \Delta CPI_{t-1} - 0.00047 * \Delta MS_{t-1} + 0.58 * INTR_{t-1} - 0.017 * IUVI_{t-1}$

The estimation of a VAR model indicates that a 1% decrease in oil price would lead the Algerian Dinar to depreciate to 0.10% against US Dollar. This is consistent with the reality. Indeed, low oil prices generally provoke a large depreciation of exchange rates in oil-exporting countries.

5-2 Causality test

The short-run causality is based on a standard F-test statistics to test jointly the significance of the coefficients of the explanatory variable in their first differences. The long-run causality is based on a standard t-test. Negative and statistically significant values of the coefficients of the error correction terms indicate the existence of long-run causality. We have tested the null hypothesis of non-causality between the four variables; we recall that we cannot reject the null hypothesis of non-causality for probabilities greater than 5% significance level. (Table 6) shows that the variableD(OILP) cause, in the sense of Granger, the variable D(EXR) because its probability-value is less than the 5%. Therefore it appears that Granger causality runs one-way from D(OILP) toD(EXR) and not the other way. Granger causality test suggest relationship uni-directional from exchange rate to money supply, from interest rate to domestic priceand from Price to import price

Table6 .Main results of Granger-Causality Tests

NullHypothesis:	Obs	F-Statistic	Prob.
D(OILP) does not Granger Cause D(EXCR)	57	4.91626	0.0111
D(EXCR) does not Granger Cause D(OILP)		0.69668	0.5028
D(CPI) does not Granger Cause D(EXCR)	57	1.03299	0.3631
D(EXCR) does not Granger Cause D(CPI)		1.65566	0.2009

D(MS) does not Granger Cause D(EXCR)	57	0.40946	0.6661
D(EXCR) does not Granger Cause D(MS)		4.80549	0.0122
INTR does not Granger Cause D(EXCR)	57	1.47450	0.2383
D(EXCR) does not Granger Cause INTR		1.36718	0.2638
IUVI does not Granger Cause D(EXCR)	57	0.56849	0.5699
D(EXCR) does not Granger Cause IUVI		0.16771	0.8461

Source: Authors' calculations

5-3 The variance decomposition

The variance decomposition is another tool that may use in VAR system analysis. We found that the share of economic variables such as oil price, consumer price index, money supply, interest rate and import price, in fluctuation of exchange rate D(EXCR) are about 0 % in the first period . In fact, the forecast error variance of the D(EXCR) is exclusively accounted for by its own innovations (100 %). Moreover, in the second period, forecast error is 86.72 % due to variations in D(EXCR), 7.55 % due to variations in Oil price D(OILP), 1.71 % due to variations in consumer price D(CPI), 0.02% due to variations in money supplyD(MS), 2.54% due to variations in interest rate (INTR) and 1.43% due to variations in import price (IUVI). In the end period (10), a head forecast error is 78.59 % due to variations inD (EXCR), 8.96 % due to variations in D (OILP), 7.89 % due to variations in interest rate, 2.81 due to variations in consumer price. The most important conclusion is that oil price and interest rate are determinants of in exchange rateAlgeria.

Table 7: Variance Decomposition of D(EXCR)

Period	S.E.	D(EXCR)	D(OILP)	D(CPI)	D(MS)	INTR	IUVI
1	1.348753	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	1.468235	86.72914	7.553533	1.714885	0.029953	2.541205	1.431286
3	1.512037	82.15466	8.552011	2.816327	0.029214	4.841764	1.606029
4	1.527935	80.95051	8.375467	2.890845	0.029241	6.179314	1.574618
5	1.537112	80.12058	8.499004	2.857282	0.031422	6.883573	1.608139
6	1.543250	79.49932	8.701009	2.839171	0.032772	7.279917	1.647809
7	1.547117	79.10304	8.833304	2.828957	0.033429	7.530753	1.670514
8	1.549523	78.85762	8.905059	2.821671	0.033736	7.700024	1.681892
9	1.551067	78.70080	8.944979	2.816546	0.033905	7.815733	1.688033
10	1.552089	78.59744	8.969461	2.813042	0.034013	7.894242	1.691807

Source: Authors' calculations

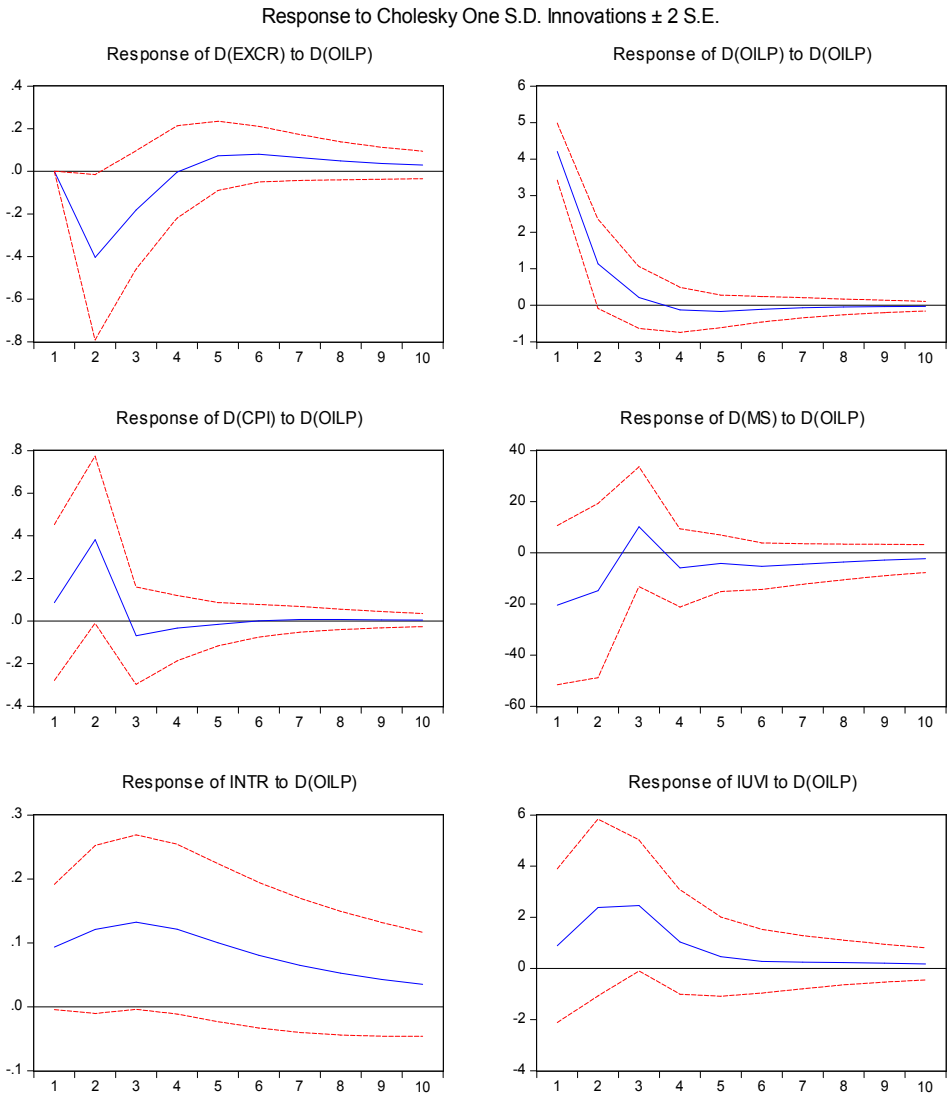
5-4 The impulse responsespresent the dynamic responses of the exogenous variables in relation to the time of variation of the endogenous variable (See Doan (1992), Sims and Zha (1999)). The impulse response is reported in Table 4. Generally, we notice that shocks are temporary, meaning the variables will retrieve their equilibrium in the long run. All the impulse functions converge to 0, which is a confirmation of the stationary (stability) of the VAR model.We retain the following results from the above functions:

- The first diagramshows the response of the Algerian exchange rate to a percent change in oil price. The impulse response shows a negative sign for the US-DZ exchange rate(Quoted at the uncertain) to a response of oil prices in the fourth first periods and finally it goes down to reach its equilibrium, which implies that a rise in oil prices leads to an appreciation in the US-DZ exchange rate. This is consistent with the theory that increase in oil price will reduce the exchange rate. In fact, high oil prices generally provoke a large appreciation of exchange rates in oil-exporting countries.

- The second diagram shows the effect of one standard deviation shock from the oil price on itself. The effect of this variable on itself was positive up to fourth periods with the first two months has the highest effect but became negative after the fourth periods with little impact.
- The third diagram shows thatConsumer Price Index reacts positively in the first period then reacts negatively in the third period and finally it goes down to reach its equilibrium. This is consistent with the theory that increase in OILP will increase the price level

- The response money supply to oil price shows that the effect of one standard deviation shock to oil price on the money supply occur after first period and reached its peak between 3—4 periods after and stabilizes thereafter
- The impact on interest rate (INTR) has a rather immediate and positive effect on first 5 periodsfrom which diminish to its equilibrium.
- Thelast diagram shows that a positive shock to oil price will have a positive effect on importprice in the initial 6 periods and regains its equilibrium after the 7th period.

Figure 5: Response of EXCR, OILP, CIP, SM, INT and IVIU to shocks on OILP

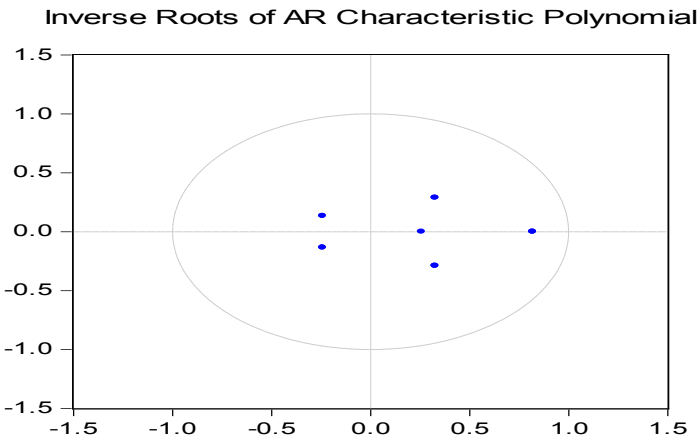


Source: Computed by the Author

5-5: Validation tests

The result of our VAR were tested for serial correlation by using VAR residual serial Correlation LM test which signify that there is no serial correlation. Also, Roots of Characteristic Polynomial were used to test for stability condition which was satisfied.

Figure 5: Validation tests



Source: Computed by the Author

The result of the AR roots for VAR stability suggests that the VAR estimated is stable because the roots are less than one and lie inside the unit circle.

VI- Conclusion

This paper estimates the effect of oil price change on the exchange rate of Algeria Dinar. Before estimating the model, the time series properties of the data are diagnosed using the standard unit root. Interest rate (INT) and imports price(IUVI)are found to be stationary at level, but exchange rate (EXCR), oil prices (OILP), Monetary Supply (MS) and Consumption Price Index(CPI) are stationary after the first differentiation.

Empirical results show that oil prices exert a significant effect on exchange rate. A 1% decrease in oil price would lead the Algerian Dinar to depreciate to 0.10% against US Dollar. In addition, there is a unidirectional causality running from oil prices to exchange rate

The study therefore recommend that the Algeria government should diversify from the oil sector to other sectors of the economy hereby dwindling the impact of crude oil as the mainstay of the economy and overcome the effect of incessant changes in crude oil prices which often culminate into macroeconomic instability.

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Appendix 1: ADF strategy on EXCR

Model 3

Null Hypothesis: EXCR has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.547875	0.8013
Test critical values:	1% level	-4.121303	
	5% level	-3.487845	
	10% level	-3.172314	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(EXCR)

Method: Least Squares

Date: 23/07/17 Time: 19:32

Sample (adjusted): 2012M02 2016M12

Included observations: 59 afteradjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXCR(-1)	-0.054843	0.035431	-1.547875	0.1273
C	3.928951	2.438121	1.611467	0.1127
@TREND(2012M01)	0.051723	0.027598	1.874184	0.0661

R-squared	0.061833	Meandependent var	0.579102
Adjusted R-squared	0.028327	S.D. dependent var	1.467601
S.E. of regression	1.446666	Akaike info criterion	3.625909
Sumsquaredresid	117.1991	Schwarz criterion	3.731546
Log likelihood	-103.9643	Hannan-Quinn criter.	3.667145
F-statistic	1.845443	Durbin-Watson stat	1.497129
Prob(F-statistic)	0.167433		

Model 2

Null Hypothesis: EXCR has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.413270	0.9820
Test critical values:	1% level	-3.546099	
	5% level	-2.911730	
	10% level	-2.593551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(EXCR)

Method: Least Squares

Date: 23/07/17 Time: 19:32

Sample (adjusted): 2012M02 2016M12

Included observations: 59 afteradjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXCR(-1)	0.005996	0.014509	0.413270	0.6810
C	0.043219	1.310893	0.032969	0.9738

R-squared	0.002987	Meandependent var	0.579102
Adjusted R-squared	-0.014504	S.D. dependent var	1.467601
S.E. of regression	1.478206	Akaike info criterion	3.652846
Sumsquaredresid	124.5503	Schwarz criterion	3.723271
Log likelihood	-105.7590	Hannan-Quinn criter.	3.680337
F-statistic	0.170792	Durbin-Watson stat	1.497851
Prob(F-statistic)	0.680960		

Model 1

Null Hypothesis: EXCR has a unit root

Exogenous: None

Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		3.063728	0.9993
Test critical values:	1% level	-2.604746	
	5% level	-1.946447	
	10% level	-1.613238	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(EXCR)

Method: Least Squares

Date: 23/07/17 Time: 19:33

Sample (adjusted): 2012M02 2016M12

Included observations: 59 afteradjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXCR(-1)	0.006469	0.002112	3.063728	0.0033

R-squared	0.002968	Meandependent var	0.579102
Adjusted R-squared	0.002968	S.D. dependent var	1.467601
S.E. of regression	1.465422	Akaike info criterion	3.618967
Sumsquaredresid	124.5527	Schwarz criterion	3.654180
Log likelihood	-105.7595	Hannan-Quinn criter.	3.632713
Durbin-Watson stat	1.498541		

First difference

Null Hypothesis: D(EXCR) has a unit root

Exogenous: None

Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.265000	0.0000
Test critical values:	1% level	-2.605442	
	5% level	-1.946549	
	10% level	-1.613181	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(EXCR,2)

Method: Least Squares

Date: 23/07/17 Time: 19:33

Sample (adjusted): 2012M03 2016M12

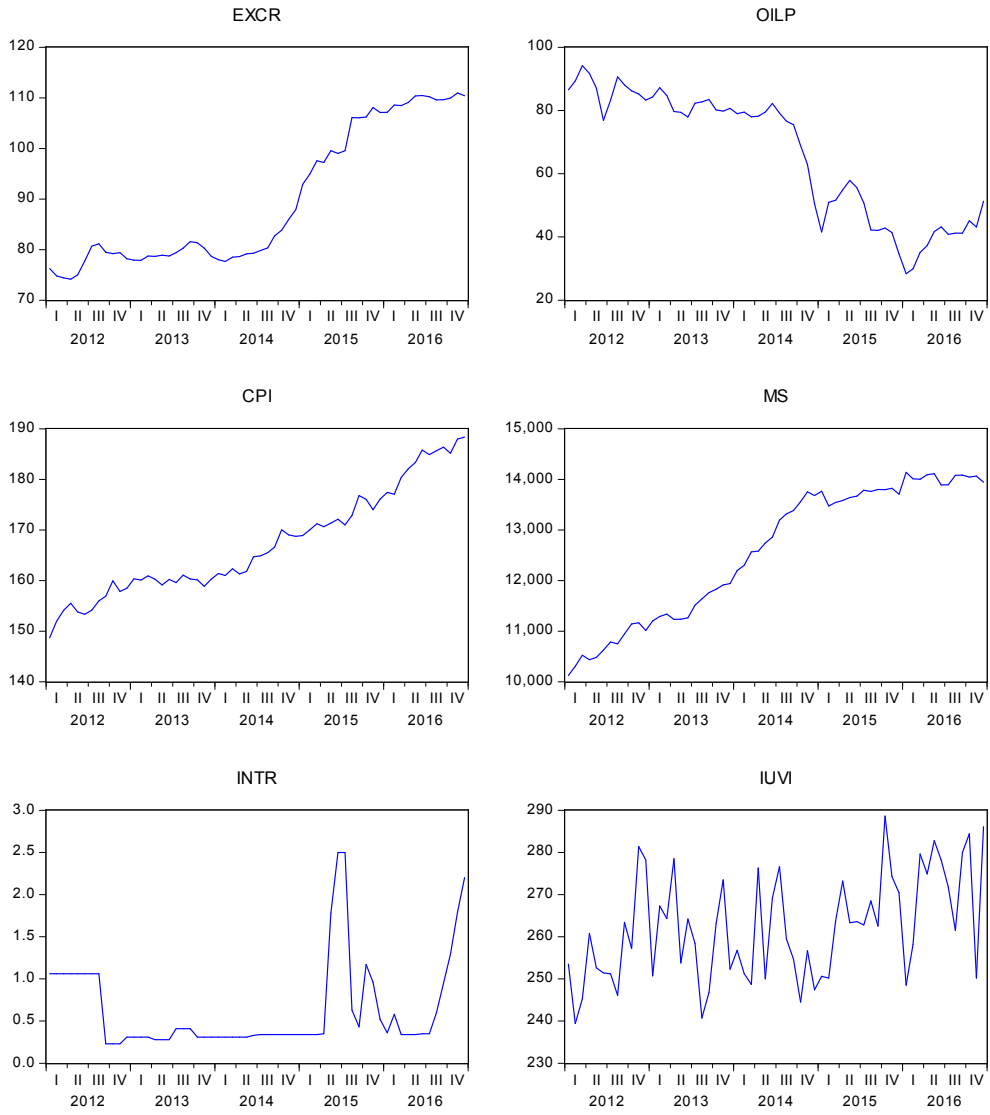
Included observations: 58 afteradjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXCR(-1))	-0.648158	0.123107	-5.265000	0.0000

R-squared	0.327146	Meandependent var	0.015552
Adjusted R-squared	0.327146	S.D. dependent var	1.803584
S.E. of regression	1.479438	Akaike info criterion	3.638292
Sumsquaredresid	124.7579	Schwarz criterion	3.673817
Log likelihood	-104.5105	Hannan-Quinn criter.	3.652130
Durbin-Watson stat	2.107553		

Source: Authors' calculations

Appendix2: EXCR, OILP, CPI, MS INTR and IUVI figures



Source: Built by the author from the results obtained by the Eviews7.0 software

Appendix3 : Granger-Causality Tests

Pairwise Granger Causality Tests

Date: 23/07/17 Time: 22:40

Sample: 2012M01 2016M12

Lags: 2

NullHypothesis:	Obs	F-Statistic	Prob.
D(OILP) does not Granger Cause D(EXCR)	57	4.91626	0.0111
D(EXCR) does not Granger Cause D(OILP)		0.69668	0.5028
D(CPI) does not Granger Cause D(EXCR)	57	1.03299	0.3631
D(EXCR) does not Granger Cause D(CPI)		1.65566	0.2009
D(MS) does not Granger Cause D(EXCR)	57	0.40946	0.6661
D(EXCR) does not Granger Cause D(MS)		4.80549	0.0122
INTR does not Granger Cause D(EXCR)	57	1.47450	0.2383
D(EXCR) does not Granger Cause INTR		1.36718	0.2638
IUVI does not Granger Cause D(EXCR)	57	0.56849	0.5699
D(EXCR) does not Granger Cause IUVI		0.16771	0.8461
D(CPI) does not Granger Cause D(OILP)	57	2.48874	0.0929
D(OILP) does not Granger Cause D(CPI)		2.53516	0.0890
D(MS) does not Granger Cause D(OILP)	57	1.32224	0.2753
D(OILP) does not Granger Cause D(MS)		1.61370	0.2090
INTR does not Granger Cause D(OILP)	57	0.44027	0.6462
D(OILP) does not Granger Cause INTR		0.03191	0.9686
IUVI does not Granger Cause D(OILP)	57	0.10864	0.8973

D(OILP) does not Granger Cause IUVI		1.81222	0.1735
D(MS) does not Granger Cause D(CPI)	57	0.08023	0.9230
D(CPI) does not Granger Cause D(MS)		2.09556	0.1333
INTR does not Granger Cause D(CPI)	57	4.88264	0.0114
D(CPI) does not Granger Cause INTR		0.84554	0.4351
IUVI does not Granger Cause D(CPI)	57	0.40943	0.6661
D(CPI) does not Granger Cause IUVI		5.36675	0.0076
INTR does not Granger Cause D(MS)	57	0.69847	0.5020
D(MS) does not Granger Cause INTR		0.63699	0.5330
IUVI does not Granger Cause D(MS)	57	0.47525	0.6244
D(MS) does not Granger Cause IUVI		0.01776	0.9824
IUVI does not Granger Cause INTR	58	0.64634	0.5280
INTR does not Granger Cause IUVI		0.23480	0.7915

Source: Authors' calculations