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Hard currency inflows and sterilization policy in Algeria: An ARDL approach

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Abstract. *This paper aims to explore to what degree the Algerian Bank sterilized hard currency inflows using monthly data covering the period January 2002-December 2016, by estimating a sterilization coefficient in both long and short run terms using and ARDL approach, and also by applying a TYDL Granger causality to investigate the relationship among concerned variables. Our results showed that there are four co-integration vectors among the variables, and the evidence suggested that the sterilization coefficient is equal to -0.99, i.e. near to the minus one (-1) which indicates the full sterilization (Algerian Bank roughly sterilizes 99% of the frequent hard currency inflows in both short-run and long-run terms). Indeed, the results also indicated that there are three unidirectional causalities running from Algerian bank's net domestic and foreign assets to the money multiplier and from the latter to the interest rate.*

Keywords: hard currency inflows, sterilization policy, sterilization coefficient, ARDL.

JEL Classification: C22, E52, E5.

1. Introduction

Unquestionably, capital inflows have both benefits and costs. As benefits, they trigger investment and economic growth in the host countries, allow inter-temporal smoothing in consumption, and thus improve welfare across countries. At the same time, as costs, they may lead to a rapid monetary expansion, an excessive rise in domestic demand, inflationary pressures, and a real exchange rate appreciation.

Among the main economic events which have been experienced in the emerging economies during and after 1990s is the notable increase in capital inflows compared to the previous years, this phenomenon eventually led to substantial increase in the central bank's foreign assets. However, the same result has seen in the oil exporting countries since the beginning of 21st century. It should be noted that the former increase resulted from the globalization of capital flows, but the latter came as an aftermath of the oil prices scaling up. Actually, both cases have made it difficult to keep monetary indicators in check.

The aforementioned negative effects have induced policy makers to adopt a variety of measures to reduce the economy's vulnerability, namely exchange rate intervention, fiscal policy, capital controls, and monetary sterilization policy. The latter has been and continues to be the most popular as Lee (1996); Calvo et al. (1993) have confirmed given the experiences of some developing countries in the 1990s, which proved the viability of sterilization as a key element of the central bank's monetary policy in circumstances of intensified inflow of foreign capital. The same result was found in Cardarelli et al.(2010)study since they have characterized policies over an entire episode, they were unable to capture the initial bout of aggressive sterilization, but they confirmed that it was usually the first line of defense against surges of capital inflows.

There is some consensus in the literature regarding the sterilization definition, which is broadly described as the monetary operation through which a rise in net foreign assets is offset by a decrease in net domestic assets, thereby keeping the monetary base constant (Cardarelli et al., 2010; Takagi, 2001). As for the explicit trend toward policy adopting is due to its ability to achieve both exchange rate stability and domestic monetary objectives, therefore solving the conflict between internal and external equilibrium (Obstfeld, 1983), even though Stanley Fischer has classified it as a "half-instrument" if it coincides with the intervention in the foreign exchange market, because the authorities can purchase reserves without limit and sterilize the resulting liquidity, whereas they cannot automatically sell reserves without limit (Obstfeld 2014). In other words, it works for capital inflows, but under tight restrictions for outflows. Actually, this does not contradict with what is stated in Aizenman (2009) study when he has concluded that "the hoarding international reserves and sterilizing the potential inflationary impact have complemented each other during recent years".

Unlike most previous studies that examined the sterilization function in response to capital flow (FDI or speculative flows), this paper looks for estimate and evaluate the

same function, but in response to different type of inflow, what is so-called "hard currency inflows" taking Algerian case as one of the oil exporting countries and using ARDL approach, in addition to investigating the TYDL causational relationship over the period January 2002-December 2016.

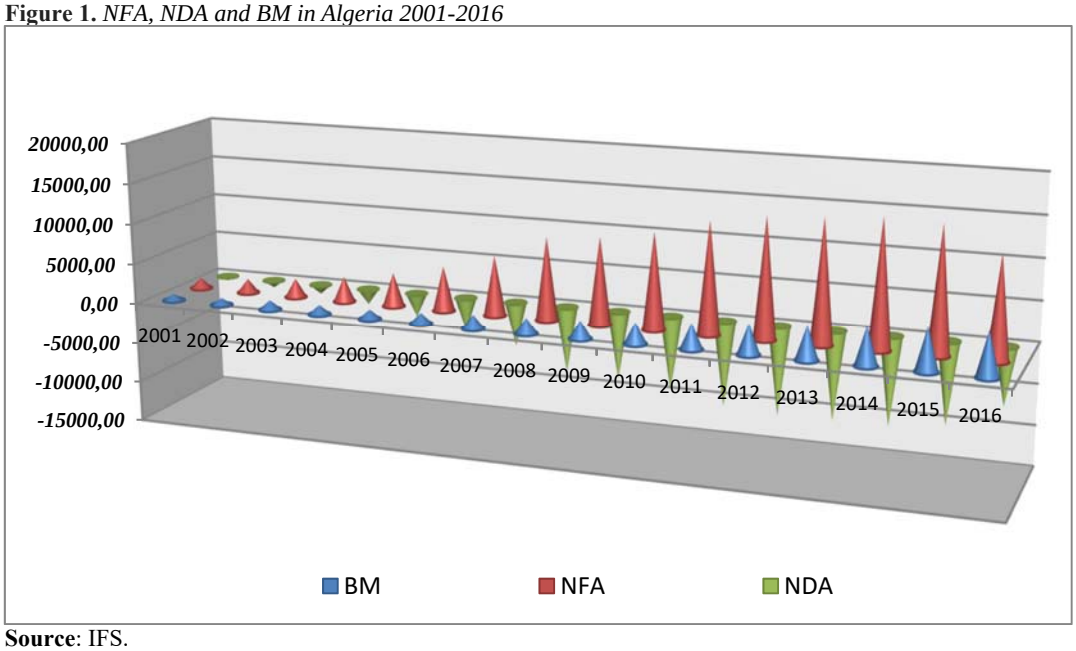
2. Hard currency inflows and sterilization policy of Algerian bank

Since the early 2000s, Algerian economy has received unprecedented oil revenues inflows resulted from oil price boom. Despite their importance as a key trigger for needed development, but they have led to very complicated problems on the money market namely, inflationary pressures was rapidly building up, an undesirable increase of monetary aggregates, and the Algerian bank (AB) has lost its role as a last resort (refinancing operations) since 2001.

However, the above-mentioned problems mainly resulted after a frequent "hard currency monetization", this process occurs when the oil exporter companies (Sonatrach and its foreign partners) waive all returns (dollar denominated) to the AB in exchange for an equivalent amount denominated in local currency. Thus, a structural excess liquidity has emerged as a new phenomenon in need of mopping up.

As a reaction aimed to neutralize the money base and its consequences if the monetary multiplier is taken into account, the AB has been adapting the sterilization policy, through which it has started to decrease its net domestic assets so as to offset the enormous increase in its net foreign assets(1), as shown in the following Figure 1.

Figure 1. *NFA, NDA and BM in Algeria 2001-2016*



Source: IFS.

The behavior of net foreign and net domestic assets tends to be fully inversely symmetrical as shown in the above Figure 1, this aspect expresses the effective practice of sterilization monetary, which eventually aims to achieve its major goal, i.e. neutralizing the money base. Therefore, the net domestic assets have been reduced by more than 08 times during the period 2002-2014 in order to offset the enormous increase in net foreign assets (increased about 11 times). As a result, the monetary base grew only 04 times for the same period, after that, both assets took an opposite trend when oil prices started to fall down.

It is also important to keep in mind that 2009 was the only breakpoint of the persistent decrease (increase) in $^{BM}/_{NFA}$($^{BM}/_{NDA}$), where it recorded in the same year 23.4% (-30.5%) after reaching 48.9% (-96%) in 2001, then it took a completely inverse trend registering 43% (-75.6%) at the end of period. In other words, the AB has kept the money base growing at moderate rate although the tremendous increase in foreign assets depending on substitution feature between monetary counterparts as a core sense of sterilization policy.

3. Literature review

Argy and Kouri (1974), Herring and Marston (1977) and Obstfeld (1983)are the pioneers who put what is called so far “the monetary reaction function”, in which the sterilization coefficient was embedded to explain the response of the central bank’s net domestic assets (NDA) as a monetary policy instrument according to the already change in its net foreign assets (NFA).

The standard form of the monetary reaction function is as follows:

$$\Delta NDA_t = \propto_0 + \beta \Delta NFA_t + \delta Z + u_t$$

where β and δ are respectively the sterilization coefficient and a set of explanatory variables which represent the objectives of the central bank.

Although variations in the choice of explanatory variables over time, recent studies have continued to employ the aforementioned equation depending on various econometric methodologies (e.g. OLS, VAR, 2SLS...).

Using four-variable vector auto-regression model over the period 1981M1–1994M12, Moreno (1996) investigates the response degree of monetary authorities in Korea and Taiwan. The main conclusion of this study is that in both countries, the sterilization is an important element of the response to shocks to foreign assets. The latter were largely offset by shocks to domestic credit, and were generally associated with a little net change in reserve money, particularly in the case of Taiwan. In addition, Korea has had a tendency to sterilize shocks to foreign assets more fully than has Taiwan, achieving a smaller change in an exchange rate with a far smaller change in the money supply.

Focusing on the decade preceding the outbreak of the currency crisis in July 1997 (using quarterly data from 1987 q1 to 1997 q2), Takagi (2001) estimates the degree of sterilization whilst setting aside the question of how sterilization has actually been carried out, since the countries in the sample (Thailand, Indonesia, Korea, Malaysia and the Philippines) have used various sterilization methods. Therefore, he divides its paper into two main steps. The first examines the co-integration and Granger causality tests, whereas the second estimates a structural equation, which indicates the sterilization coefficient depending on ordinary least squares method (OLS). Overall, the causality tests and the regression analysis gave the somewhat perplexing results indicating that, while sterilization was apparently effective in fully limiting the growth of monetary aggregates arising from an increase in foreign assets, it was not causing the level of interest rates to rise.

Christensen (2004) analyzes the relationship between large-scale capital inflows and sterilization efforts in the Czech Republic during 1993–96 using a vector auto-regression (VAR) model, which consists of domestic and foreign interest rates, domestic credit and foreign reserves. The findings support the sterilization success in maintaining monetary independence, but later there was a vicious circle created by high-interest rates, which led to more capital inflows needed for additional sterilization. In the end, the policy proved unsustainable and too costly, and the authorities therefore widened the exchange rate band. Also, Christensen found the problem and he called it a "sterilization game" between the monetary authorities and the commercial banks, when the latter borrowed extensively abroad and invested in domestic bonds, and they were induced by both a credible fixed exchange rate system and high-yielding sterilization bonds.

Aizenman and Glick (2009) estimate the marginal propensity to sterilize foreign asset accumulation associated with net balance of payments inflows. For that matter, the authors select countries in Asia and Latin America and use OLS over sample periods that end 2007 q2, but have varying start points in the 1980s or 1990s. Their findings reveal the extent of sterilization of foreign reserve inflows has risen in recent years to varying degrees in Asia as well as in Latin America. As for some countries, the sterilization of foreign direct investment (FDI) inflows is typically less than for current account surpluses and non-FDI flows, suggesting that misgivings about monetary instability depend on the composition of balance of payments inflows.

Cardarelli et al. (2010) develop a sterilization index for 52 countries (8 advanced and 44 developing countries) over the period 1991-2007. Pooled regressions of central banks' ΔNDA on ΔNFA are carried out for each year using monthly observations and without including other explanatory variables. Taking another step further, the authors use $\Delta M2$ instead of ΔNDA to estimate a broader sterilization index that reflects the central bank's effort to prevent the increase in monetary base from causing an expansion of money supply. This has generally occurred through an increase in the reserve requirements for the banking sector, which eventually reduces the money multiplier. Their results indicate that with the onset of the two waves of large capital inflows (during the early 1990s and

early 2000s) there are high values of the sterilization index, i.e. an aggressive sterilization effort when capital begins to pour in. The index subsequently tapers off around 2006, perhaps indicating that as intervention continued, the authorities became increasingly conscious of its cost.

Using monthly data from January 1994 to February 2011 and applying 2SLS regression models, Mansour (2012) explore the effectiveness of hoarding international reserves and sterilization in dollarized and indebted countries such as Turkey and Lebanon. Overall, she finds that both countries theatrically enjoyed from the application of the sterilization policy, but in return, are suffering from economic constraints such deficit in Balance of Payment, high external debt and important dollarization rate, which in theory should decrease the efficiency of the sterilization monetary policy. Also, additional inflows have occurred and need to be sterilized again, which creates a vicious circle of rising capital inflows and the need for additional sterilization has led to less effective policy.

Despite the differences among the estimation methods, there has been a consensus regarding the sterilization coefficient (β as mentioned above). In principle, if the central bank is able to completely offset the increase in NFA by decreasing NDA, then β should take the value of –1, while $\beta = 0$ implies no sterilization. A value of the sterilization coefficient between these levels, $-1 < \beta < 0$, indicates partial sterilization.

4. Data and methodology

4.1. The ARDL model

ARDL approach for co-integration relationship was developed by Pesaran and Shin (1995, 1998) and Pesaran, Shin and Smith (1996,2001) as an unification of Auto-Regressive models and Distributed Lag models, the main advantage of the ARDL model is the possibility to test the long-run relationship irrespective of the order of integration in both large and small samples while Engel-Granger (1987), Johansen (1988), Johansen-Juseluis (1990) and Gregory-Hansen (1996) methods require all variables be of equal degree of integration and also need large samples (>30), this model (ARDL) also removes problems of endogeneity, omitted variables and autocorrelation (Pesaran et al., 2001), the ARDL bounds test to co-integration can be applied whether the variables are I(0) or I(1) or a combination of the I(0) and I(1) series but no I(2) or higher degree of integration.

The ARDL model has several desirable statistical features:

1. The co-integrating relationship can be estimated normally using OLS after selecting the number of lags using Akaike or Schwarz criterion.
2. Testing simultaneously for the long run and short run relationships.
3. The ARDL approach procedure is valid irrespective for both of the variables are I(0) or I(1) but not the I(2) variables.
4. The ARDL model provides unbiased coefficients of explanatory along with t-statistic.
5. The ARDL model corrects the omitted lagged variables bias.
6. The ARDL model is very efficient with small sample sizes.

The purpose of this paper is to examine the degree of sterilization by deriving a domestic credit policy reaction function from two equations which summaries the monetary approach to the balance of payment:

$$M_t^d = AY_t^{\beta 1} Q_1^{\beta 2} \exp(\beta_3 i_t + \beta_4 i_t^* + \mu_t) \quad (1)$$

$$M_t^s = K(D+R)_t \quad (2)$$

When M^d is the money demand as a function of real income (Y), real exchange rate (Q), domestic rate (i) and foreign interest rate (i^*), and A is the scale factor when β_1, β_2, β_3 and β_4 are the parameters of estimation.

M^s is the money supply composed of money multiplier (K) of domestic (D) and foreign components (R) of monetary base, and we can obtain the following equation:

$$Ln\ D_t = lnM_t^d - ln\ K - lnR_t \quad (3)$$

And by using logarithms in equation (1) and substituting in equation (3) we get:

$$LnD_t = lnA + \beta_1 lnY_t + \beta_2 lnQ_1 + \beta_3 i_t + \beta_4 i^* + lnK + lnR_t + \mu_t \quad (4)$$

$$d_t = \beta_0 + \beta_1 y_1 + \beta_2 q_t + \beta_3 i_t + \beta_4 i_t^* + \beta_5 m_t + \beta_6 r_t + \mu_t \quad (5)$$

The coefficient β_6 in equation (5) is the sterilization coefficient, and it measures the thrust of monetary policy to sterilize the impact of international reserve flows on monetary base, this coefficient limited between zero (no sterilization) and -1 (full sterilization), and when is $-1 < \beta_6 < 0$ the sterilization is conducted incompletely by the Algerian bank.

Our ARDL framework is as follows:

$$\Delta (NDA)_t = \alpha 0 + \sum_{i=1}^{n} \alpha 1i\, \Delta (NDA)_{t-j} + \sum_{i=1}^{n} \alpha 2i\, \Delta (INT)_{t-j} + \sum_{i=1}^{n} \alpha 3i\, \Delta (MM)_{t-j} +$$
$$+ \sum_{i=1}^{n} \alpha 4i\, \Delta (NFA)_{t-j} + \sum_{i=1}^{n} \alpha 5i\, \Delta (REER)_{t-j} + \beta_1 NDA_{t-1} + \beta_2 INT_{t-1} + \beta_3 MM_{t-1} +$$
$$+ \beta_4 NFA_{t-1} + \beta_5 REER_{t-1} + e_t \quad (6)$$

When:
NDA: is central bank's net domestic asset.
NFA: is central bank's net foreign asset.
MM: is the money multiplier.
INT: is the interest rate.
REER: is the real effective exchange rate.

Depending on monthly data from January 2002 to December 2016 collected from IMF-IFS database, and taking Algeria as a case study, we try to investigate the AB's sterilization reaction function.

4.2. The TYDL Granger causality

The most common way to test the direction of causality is Granger (1969), Sims (1972) and Gwekes (1983), Granger causality is conventionally conducted by estimating VAR models, but this model suffers of the non stationary problem, and the problem here is how to confirm the co-integrating relationship and how to estimate the VAR model when the

system is integrated, the drawback of Granger causality (1969) test is the specification bias and spurious regression, in 1987 Engel and Granger declared that if X and Y two non-stationary and co-integrated variables the standard Granger causality is invalid procedure.

Toda and Yamamoto (1995) and Dolado and Lutkepohl (1996) developed a new procedure of Granger causality based on an augmented VAR modeling by introducing a modified Wald tests (MWald) statistic, and it can be applied with all the integration series types I(0), I(1) and I(2) for both non co-integrated or co-integrated variables, the TYDL (Toda, Yamamoto, Dolado and Lutkepohl) procedure composes from four steps, the first step is to find the maximum order of integration between the variables d_{max} where is the higher order of integration, the second step is to determine the optimal lag order (K) of VAR model in levels as usually choosed by Akaike information criterion (AIC), Schawrz information criterion (SIC), Hannan-Quin information criterion (HQ), the final prediction error (FPE) and the sequential modified LR test statistic (LR), Finally, the TYDL procedure uses the MWald test statistic to test the causal relationships between the variables.

5. Empirical results

5.1. Unit root test

Before we proceed for ARDL testing, we must test for unit root of the variables to determine their order of integration (I(0), I(1) or I(2)), we must run the unit root tests to ensure that none of the series is integrated in I(2), in our study we have used Augmented Dickey-Fuller test (ADF), Philips-Perron test (PP) and the test developed by Ng-Perron (2001), the result are presented in Table 1, and this results indicate that 3 variables (NDA, NFA and INT) are stationary in the level when the two other variables (REER and MM) are integrated order one and none of the variables are I(2) series.

Table 1. *Unit test roots results*

Variables	ADF	PP	Ng-P	
			(MZa) (k)	(MZt) (k)
NDA	-10.33***	-10.34***	-80.95***	-6.35***
NFA	-10.17***	-10.15***	-80.86***	-6.35***
MM	-2.58	-3.90**	-7.78	-1.87
D(MM)	-22.26***	-27.52***	-68.40***	-5.84***
REER	-4.84***	-4.60***	-4.18	-1.42
D(REER)	/	/	-79.18***	-6.28***
INT	-5.45***	-5.78***	-27.25***	-3.86***

Note: *** denotes significant at 10%,5% and 1% level. (k) denotes lag length (2) Selection of lag length in NP test is based on Spectral GLS-detrended AR based on SIC.

5.2. Co-integration results

The first step in the ARDL model is bounds test for co-integration by looking a long-run relationship between the variables by carrying out partial F-test, this test is sensitive to the number of lags used for each first differenced variable (Bahmani-Oskooee and

Brooks, 199), the results of the bounds test procedure for co-integration analysis between the NDA and its determinants are presented in the table below:

Table 2. *Bounds test results*

K	90% level		95% level		99% level	
4	I(0) 2.45	I(1) 3.52	I(0) 2.86	I(1) 4.01	I(0) 3.74	I(1) 5.06
Calculated F-statistic					19.05***	

Note: ***denotes statistical significance at the 1%, 5% and 10%.K is the number of regressors.

From Table 2 above, the F-statistic of null hypothesis of lagged variables of the coefficients are zero is rejected at the three significance levels (1%, 5% and 10%), further, since the F-calculated (F = 19.05) exceeds the upper bound (I(1)) of the critical values band, the null hypothesis of no co-integration between NDA and its determinants is rejected in 5% significance level, this result indicates that there is a co-integration relationship among the variables in Algeria monetary policy, this implies that there exist a long-run relationship among net domestic assets, real effective exchange rate, interest rate, money multiplier and net foreign assets.

5.3. Long-run ARDL model of NDA in Algeria

Since the NDA and its determinants are co-integrated, we estimate the long-run parameters of the ARDL model based on the Akaike Information Criterion (AIC), the results presented in the table below:

Table 3. *Long-run ARDL estimation results*

Selected Model: ARDL(1, 1, 0, 4, 0)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
NDA(-1)	0.003963	0.006274	0.631704	0.5286
MM	2.352890	0.057356	41.02245	0.0000
MM(-1)	-2.380774	0.059131	-40.26253	0.0000
NFA	-0.994357	0.006272	-158.5283	0.0000
REER	0.007657	0.153639	0.049839	0.9603
REER(-1)	0.049162	0.223261	0.220200	0.8260
REER(-2)	0.012763	0.227738	0.056042	0.9554
REER(-3)	-0.074716	0.231779	-0.322361	0.7476
REER(-4)	-0.036221	0.148096	-0.244575	0.8071
INT	0.005667	0.006124	0.925462	0.3562
C	0.078051	0.164372	0.474841	0.6356
R-squared	0.995195	Mean dependent var		-0.06198
Adjusted R-squared	0.994871	S.D. dependent var		0.207641
S.E. of regression	0.014871	Akaike info criterion		-5.51209
Sum squared resid	0.032731	Schwarz criterion		-5.29977
Log likelihood	449.2113	Hannan-Quinn criterion		-5.42587
F-statistic	3065.446	Durbin-Watson stat		2.079876
Prob(F-statistic)	0.000000			

The above table presents the results obtained by regressing independent variables on NDA to get long-run sterilization coefficient for the period of the study, the results indicates that the degree to which the AB sterilizes the foreign exchange reserves is equal to -0.99 (significant at 1%), this implies that the AB sterilizes 99% of hard currency inflows during the period of study (near to the minus one i.e. full sterilization). The results also indicate that the MM coefficient is significance at 1% level.

5.4. Short-run ARDL model of NDA in Algeria

According to Granger (1987), if a co-integration relationship exists between the variables, then a dynamic error correction model also exists, and the general form of it can be written as:

$$\Delta \text{NDA}_t = \alpha 0 + \sum_{i=1}^{n} \alpha 1i \, \Delta \text{NDA}_{t-1} + \sum_{i=1}^{n} \alpha 2i \, \Delta \text{INT}_{t-1} + \sum_{i=1}^{n} \alpha 3i \, \Delta \text{MM}_{t-1} +$$

$$+ \sum_{i=1}^{n} \alpha 4i \, \Delta \text{NFA}_{t-1} + \sum_{i=1}^{n} \alpha 5i \, \Delta \text{REER}_{t-1} + \lambda \text{ECT}_{t-1} + \mu_t \quad (7)$$

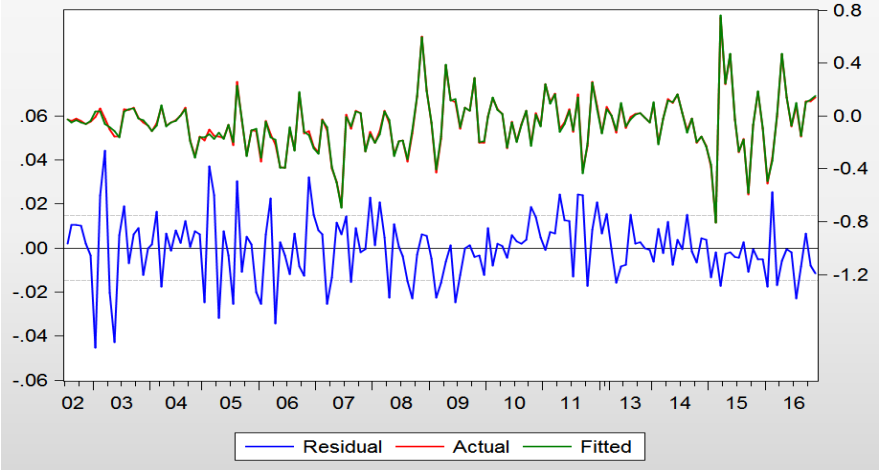
The table below shows the static behavior of the variable over the data period to introduce the short run estimation to the model and to estimate the short run adjustment coefficient (error correction term), the results from the estimated error coefficient model are presented in Table 4, except the MM coefficient is significantly different from zero at the 5% level of significance, the error correction term possessed expected sign and statistically significant, the error correction term is equal -0.996 which implies that about 99% adjustment towards long-run equilibrium take place in one month, the coefficient of NFA (sterilization coefficient) is statistically significant and equals to -0.994, which suggest that the AB sterilizes 99% of hard currency inflows in the short-run .

Table 4. *Short-run ARDL estimation results*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INT)	0.00566	0.006124	0.925462	0.3562
D(MM)	2.35289	0.057356	41.02245	0.0000
D(NFA)	-0.99435	0.006272	-158.5283	0.0000
D(REER)	0.00765	0.153639	0.049839	0.9603
D(REER(-1))	-0.01276	0.227738	-0.056042	0.9554
D(REER(-2))	0.07471	0.231779	0.322361	0.7476
D(REER(-3))	0.03622	0.148096	0.244575	0.8071
CointEq(-1)	-0.99603	0.006274	-158.7668	0.0000
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
INT	0.00569	0.006145	0.925997	0.3560
MM	-0.02799	0.033804	-0.828175	0.4089
NFA	-0.99831	0.007835	-127.4156	0.0000
REER	-0.04151	0.079589	-0.521673	0.6027
C	0.07836	0.165045	0.474787	0.6356

Moreover, when the estimated values are fitted against the actual values, it perform very well in terms of tracking the cyclical nature of the movements in Algeria, the results represented in the Figure 2.

Figure 2. *Plot of actual and fitted values*



5.5. TYDL Granger causality

The second step in testing for causality (after the determine of higher order of integration d_{max} which equals to 1) is to investigate the optimum lag length (K) chosen by AIC, LR, FPE, SC and HQ, where we must be caution when we select the lag length, because if the chosen lag length is less than true lag, the omission of relevant lags can cause bias, and if it is more than true lag, cause the estimate to be inefficient (Caporal and Pittis, 1999), the Table 5 chows that the optimum lag length is 1 (k = 1) out of maximum of 10 lags length as selected by AIC, FPE, SC and HQ.

Table 5. *Lag length criterion*

Lag	LR	FPE	AIC	SC	HQ
1	NA	6.18e-15*	-18.5277*	-17.9790*	-18.3048*
2	18.84413	7.76e-15	-18.30183	-17.20443	-17.85591
3	44.04099	7.80e-15	-18.29982	-16.65371	-17.63093
4	29.65216	8.81e-15	-18.18527	-15.99047	-17.29343
5	17.30137	1.11e-14	-17.96682	-15.22331	-16.85201
6	38.0736*	1.13e-14	-17.96210	-14.66989	-16.62433
7	23.25561	1.34e-14	-17.82267	-13.98176	-16.26194
8	26.08830	1.52e-14	-17.72768	-13.33806	-15.94398
9	20.50057	1.84e-14	-17.58437	-12.64606	-15.57772
10	29.25516	1.99e-14	-17.56387	-12.07685	-15.33425

* indicates lag order selected by the criterion.
LR: sequential modified LR test statistic (each test at 5% level).
FPE: Final prediction error.
AIC: Akaike information criterion.
SC: Schwarz information criterion.
HQ: Hannan-Quinn information criterion.

It's clear from Table 6 that there are just three causalities. The first from MM to INT. The second and the third are respectively from NDA to MM and NFA to MM, and there is no evidence of any causal relationship between the other variables in Algeria during the period of study (January 2002- December 2016).

Table 6. *TYDL Granger causality results*

Dependent variable: INT			
Excluded	Chi-sq	df	Prob.
MM	14.25064	1	0.0002
NDA	0.486708	1	0.4854
NFA	0.245439	1	0.6203
REER	2.168847	1	0.1408
Dependent variable: MM			
INT	0.002769	1	0.9580
NDA	43.86719	1	0.0000
NFA	47.49640	1	0.0000
REER	0.056682	1	0.8118
Dependent variable: NDA			
INT	0.370071	1	0.5430
MM	1.282599	1	0.2574
NFA	2.365417	1	0.1241
REER	1.109135	1	0.2923
Dependent variable: NFA			
INT	0.337987	1	0.5610
MM	2.568563	1	0.1090
NDA	0.371836	1	0.5420
REER	1.257297	1	0.2622
Dependent variable: REER			
INT	1.216469	1	0.2701
MM	1.784828	1	0.1816
NDA	0.150393	1	0.6982
NFA	0.000351	1	0.9850

6. Conclusion

This paper aimed to develop and estimate the reversed symmetry of AB's assets as a reaction function in order to analyze the monetary implications of the sterilization policy in Algeria using monthly data covering the period January 2002-December 2016, by employing an ARDL multivariate co-integration and TYDL Granger causality to estimate the degree of sterilization that the Algerian central bank has used in controlling hard currency flows.

As we showed in the paper, the degree to which a change in net foreign assets affects net domestic assets is estimate by the coefficient α_4 in ARDL model (both short and long run). The evidence suggests that the Algerian central bank sterilizes roughly 99% (coefficient near to the minus one (-0.99) which indicates full sterilization) of hard currency inflows in both short-run and long-run terms during the period of the study. Therefore, the AB has been able to completely isolate the money base from frequent hard currency inflows.

Note

(1) It important to keep in mind that during the period of study, the most dominant component of AB's net foreign assets is the official reserves ranging from 97 to 98%, the remainder is mainly shared by both SDRs and monetary gold.

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