Developing Country Studies
ISSN 2224-607X (Paper) ISSN 2225-0565 (Online)
Vol.5, No.19, 2015
www.iiste.org

Modeling the Determinants of Foreign Reserves in Nigeria

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Abstract
This study evaluated the determinants of foreign reserves in Nigeria. Literature relevant to the subject matter were rigorously reviewed. The model of the study hypothesized that foreign reserve (RESV) in Nigeria is a function of some macroeconomic variables. The Johansen cointegration tests established evidence of a long run relationship among the variables. The results of the estimated short run coefficients based on parsimonious Error Correction Model (ECM) indicated that RGDP, oil exports (OILEXP) are positive and significant determinants of RESV. This significant deterministic value of OILEXPT remained up to the first period lag. Expectedly, EXCH was found to be significant but negative determinant of RESV. FDI inflows positively and significantly determine RESV only in its first period lag while lending rate (LR) was discovered to be a negative and insignificant determinant. Similarly, the coefficient of inflation rate (INFL) was negative and significant. However, the coefficient of non-oil exports (NOILEXP), though positive, was not significant determinant of RESV. The probability of the diagnostic tests conducted reinforced the robustness of the model. On the basis of the empirical findings we recommend that the government incentivise NOILEXP as a means of positively affecting RESV.
Keywords: Foreign Reserves, Exchange Rate.
JEL Classification: F41, C5, C22.

1. Introduction

The assets denominated in foreign currency, plus gold, held by a central bank, sometimes for the purpose of intervening in the exchange market to influence or peg the exchange rate usually includes foreign currencies themselves (especially US dollars), other assets denominated in foreign currencies, gold, and a small amount of special drawing rights (SDRs). However, in the past, during the Breton Woods system, foreign reserves were used by countries through their central banks to maintain the external value of their currencies at fixed rate. Subsequently, with the collapse of this system, the focus changed. Reserves are now generally maintained by countries for meeting their international payment obligations - both short and long terms, including sovereign and commercial debts, financing of imports, for intervention in the foreign currency markets during periods of volatility. Besides, it helps a country to meet its external obligations and to absorb any unforeseen external shocks, contingencies or unexpected capital movements.

It is pertinent to note that Nigeria's external reserves are mainly from the proceeds of crude oil production and sales. This includes direct sales (NNPC), petroleum profit tax (Oil Companies), royalties, penalty for gas flaring and rentals; and the reserve comprises of the federation, the federal government and the Central Bank of Nigeria portions. Nigeria's external reserve has enjoyed a robust growth in recent times and seems to be on track to recover lost grounds since it peaked at $64 billion in 2008. External reserve has been dwindling, for some time now, at the rate of about N5 billion monthly. According to statistics recently put in the public domain, Nigeria's external reserve suffered massive depreciation of $5.2 billion (N832 billion) in seven months, declining from the peak of $48.85 billion attained on May 2, 2013, to close the year at $43.61 billion by December 31, 2013 (CBN, 2014) approximately $500 million below the $44.1 billion on December 28, 2012, showing a fall by about $700m below the $44.3bn it recorded on January 2, 2013. .

Foreign reserves in Nigeria averaged N774483.82million from 2000 until 2015, reaching an all-time high of N4166778.95million in December of 2014 and a record low of N88635million in March of 2000 (CBN, 2015). In a bid to affect the level and direction of Nigeria's foreign reserve, Sanusi (2013) advocated for the immediate implementation of the treasury single account (TSA); the return of government accounts to the Central Bank to reduce the huge cost of government debt due to poor cash flow management; retention of the monetary policy rate (MPR) at 12 per cent, plus or minus 2 per cent; private sector cash reserve ratio (CRR) at 12 per cent; public sector CRR at 50 per cent; and liquidity ratio at 30 per cent.

Universal official reserves have increased positively and quite rapidly in recent years. This phenomenal growth is a reflection of the enormous importance countries attach to holding an adequate level of international reserves. Thus, to safeguard the value of the domestic currency, foreign reserves are held as formal backing. The monetary authorities attempt to control the money supply as well as achieve a balance between demand for and supply of foreign exchange through intervention (i.e. offering to buy or sell foreign currency to banks) in the foreign exchange markets. When CBN sells foreign exchange to commercial banks, its level of reserves declines by the amount of the sale while the domestic money supply (in naira) also declines by the naira equivalent of the sale. Conversely, when the CBN purchases foreign exchange from the banks its level of reserves increases while it credits the accounts of the banks with the naira equivalent, thus increasing the domestic money supply. More

so, External reserves provide a cushion at a time when access to the international capital market is difficult or not possible. Also, a respectable level of international reserves improves a country's credit worthiness and reputation by enabling a regular servicing of the external debt thereby avoiding the payment of penalty and charges.

The literature indicates that results of studies that have examined the determinants of foreign reserves remains mixed as their method of analysis varied. In the Nigerian context, Abdullateef and Waheed (2010) examine one side of the argument by investigating the impact of change in external reserve positions on some selected domestic macroeconomic variables. In converse, the core objective of this study is to evaluate the determinants of foreign reserves in Nigeria, incorporating variables already considered in some existing studies and many more. Analytically, this study disaggregated exports into oil exports and non-oil exports. This was done to detangle their individual effects so as to make specific policy statements regarding their contributions on Nigeria's foreign reserves. Chowdhury *et al* (2014) incorporated exports into his determinant of foreign reserves model in a highly aggregative form whereas Irefin and Yaaba (2012) made no mention of it.

The remainder of this paper is structured as follows. Section 2 centres on literature review while section 3 briefly describes the theoretical framework and Methodology adopted. Section 4 presents and discusses the empirical results while section 5 concludes the study.

2. Review of related literature

Conventionally, nations of the world affirms the holding of foreign reserves in foreign currencies as an assets held by the central banks and monetary authorities used to back its liabilities, thus maintaining a good exchange rate policy by interfering positively in the international financial markets. IMF (2004) established that foreign reserves are assets readily available to and controlled by monetary authorities for direct financing of payments imbalances, for indirectly regulating the magnitude of such imbalances through intervention in exchange markets to affect the currency exchange rate, and for other purposes. Halliday (1998) identified the main reasons for a country holding external reserves as foreign financial market stability, exchange rate stability, exchange rate targeting, and credit liberty. However, Frankel (1999) stated that "no single foreign exchange regime is right for all countries in all times". According to him, choosing between fixed and floating exchange rates is not a simple matter of selecting one opposite, but rather a multi layered decision surmounting a multiplicity of institutional choices and policies.

Abdullateef and Waheed (2010) extended the study on the determinant of foreign reserves by investigating the impact of change in external reserve positions of Nigeria on domestic investment, inflation rate, and exchange rate from 1986 to 2006. Using the Ordinary Least Square (OLS) and vector error correction (VEC) estimation methods, they found that change in external reserves in the country only influences foreign direct investment (FDI) and exchange rates, and no influence was found on domestic investment and inflation rates. The results further suggested that there is the need for broader reserve management strategies that will aim at maximizing the gains from oil export revenue by utilizing more of these resources to boost domestic investment.

Chin-Hong, *et al* (2011) affirms the relationship between international reserves and its determinant such as, economic size, exchange rate, balance of payments and the opportunity cost of reserves holding in Malaysia for the period 1975 to 2007. The Cointegration test techniques was employed in the study. The test results showed that the international reserves and the specified determinants were cointegrated. The policy implications of the study were that the government needs to know the important factors which can significantly affect the level of international reserves to enable it gain better insight on how to maintain reserve adequacy. More so, Delatte, and Fouquau (2011) adopted a nonlinear approach to examine the dynamics of the international reserves holdings by the emerging economies. They estimated the demand for international reserves with a panel smooth transition model that loosens two restricting hypotheses, homogeneity and time-stability. They found evidence for the presence of a nonlinear behavior in the demand for international reserves, a result that was new to the literature. They claimed that their model specification accounted for the acceleration of foreign exchange reserves accumulation that the linear specifications failed to explain.

Irefin and Yaaba (2012) on the other hand, employed an Autoregressive Distributed Lag (ARDL) approach to run a slightly modified econometrics 'Buffer Stock Model' of Frenkel and Jovanovic (1981) to estimate the determinants of foreign reserves in Nigeria over the period of 1999 to 2011, with focus on income, monetary policy rate, imports and exchange rate. The results debunked the existence of buffer stock model for reserves accumulation and provided strong evidence in support of income as the major determinant of reserves holdings in Nigeria.

Chowdhury *et al* (2014) recently undertook an econometric analysis of the determinants of foreign exchange reserves in Bangladesh, using the Augmented Dicky Fuller (ADF) unit root test to examine stationarity, Engle Granger residual based co-integration approach to show the co-integrating relationship among the variables, and some diagnostic tests for better modeling. The empirical results of their study confirmed the existence of strong relationship among foreign exchange reserves, exchange rate, remittance, home interest rate, broad money, UPI of export and import, and per capita GDP. The study suggested that exchange rate, strong

remittance related policies, quality items of exports and sustainable GDP can keep a substantial and feasible role to make up a healthy amount of foreign exchange reserves for the host country like Bangladesh.

3. Theoretical framework and methodology

3.1. Theoretical framework

The reviewed literature indicated that there exist a plethora of studies that have examined the relationship between foreign reserve and macroeconomic variables (see for example, Abdullateef and Waheed, 2010; Chin-Hong, et al, 2011; Irefin and Yaaba, 2012; Chowdhury et al, 2014, among others).With no attempt of reinventing the wheel, this study adopts a similar model used by Chowdhury et al (2014) to evaluate the determinants of foreign exchange reserves in Bangladesh. Our model detract from Chowdhury et al (2014), at least in twofold, i) it was able to accommodate the splitting of export into oil and non-oil, ii) it revealed period of convergence to long run equilibrium after a short run shock from any of the determinants.

3.2. Methodology

3.2.1. Model Specification

Leaning on the theoretical models earlier reviewed, the model of this study includes foreign reserve as the dependent variable and exchange rate, oil exports, Foreign Direct Investment (FDI), real GDP, lending rate, non-oil exports and inflation rate as the explanatory variables. We hypothesize that foreign reserve in Nigeria is a function of the explanatory variables. This is algebraically expressed in equation one;

$$\mathrm{RESV} = (EXCH, OILEXP, FDI, RGDP, LR, NOILEXP, INFL) \quad (1)$$

Equation two presents the estimable version of equation (1).

$$\mathrm{RESV}_t = \psi_0 + \psi_1 EXCH_t + \psi_2 OILEXP_t + \psi_3 FDI_t + \psi_4 RGDP_t + \psi_5 LR_t + \psi_6 NOILEXP_t + \psi_7 INFL_t + \zeta_t \quad (2)$$

Where;

RESV	=	Foreign Reserve
EXCH	=	Exchange Rate
OILEXP	=	Oil Exports
FDI	=	Foreign Direct Investment
RGDP	=	Real Gross Domestic Product
LR	=	Lending Rate
NOILEXP	=	Non-Oil Exports
INFL	=	Inflation Rate
ξ	=	Error Term

3.2.2. Estimation Technique/Procedure:

The data used in this study are annualized secondary time series obtained from the WDI (2013) over the period 1970 to 2013. We choose to examine the the stationarity properties of the time series to avoid spurious regression analysis. The Augmented Dickey-Fuller (ADF) and the Philip-Perron (PP) unit root tests were employed. While the ADF approach accounts for the autocorrelation of the first differences of a series in a parametric fashion by estimating additional nuisance parameters, the PP unit root test makes use of non-parametric statistical methods to take care of the serial correlation in the error terms without adding lagged difference terms (Gujarati, 2009). The ADF test consists of estimating the following equation:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + \varepsilon_t \quad ----------(3)$$

Where ε_t is a pure white noise error term; t is time trend; Y_t is the variable of interest; β_1, β_2, δ and α_i are parameters to be estimated; and Δ is the difference operator. In ADF approach, we test whether $\delta = 0$. On the other hand, the PP test is based on the following statistic:

$$\tilde{t}_\alpha = t_\alpha \left(\frac{\gamma_0}{f_0}\right)^{1/2} - \frac{T(f_0 - \gamma_0)(se(\hat{\alpha}))}{2 f_0^{1/2} s} \quad ----------(4)$$

Where $\hat{\alpha}$ is the estimate; $\tilde{t}_\alpha$ is the t-ratio of α; se($\hat{\alpha}$) is the coefficient standard error and s is the standard error of the regression. Also, γ_0 is a consistent estimate of the error variance in the standard Dickey-Fuller test equation (calculated as $(T-k)s^2/T$, where k is the number of regressors). The term f_0 is the estimator of the residual spectrum at zero frequency.

Following the stationarity tests, cointegration test was carried out using the Johansen Cointegration approach which is typically used in a setting where all variables in the system are I(1). The cointegration model helps us to trace the nature of drift of the variables of interest. The Error Correction Model (ECMs) which is a

category of multiple time series models enabled us to directly estimate the speed at which a dependent variable - RESV - returns to equilibrium after a change in an independent variable. The sign of the ECM term must be negative and significant to ensure convergence of the dynamics to the long-run equilibrium

4. Empirical analysis/findings

Unit Root Test Results

The tests were performed assuming intercept and no trend in both ADF and PP unit root specifications. The results of both methods are similar in terms of identifying the order of integration of the variables. All the variables are integrated of order one, I(1). This scenario permitted us to proceed to the Johansen cointegration tests.

Table 1: ADF and PP Unit Root Results

Variable	ADF Statistic	Order of Integration	PP Statistic	Order of Integration
LRESV	-3.600987**	I(1)	-6.291427**	I(1)
LEXCH	-5.747095**	I(1)	-5.747095**	I(1)
LOILEXP	-6.321432**	I(1)	-6.321432**	I(1)
LFDI	-12.11608**	I(1)	-12.11608**	I(1)
LRGDP	-6.040398**	I(1)	-6.040398**	I(1)
LR	-10.30800*	I(1)	-10.59059*	I(1)
LNOILEXP	-6.112590**	I(1)	-6.311580**	I(1)
INFL	-3.263222**	I(1)	-3.482507**	I(1)

NB: **(*) implies significant at 1%(5%) level of significance.

Table 2 presents the Johansen cointegration tests. Lag length of three (3) was observed as suggested by both AIC and SIC. As usual, the null hypothesis underlying the test is that r = 0, against the alternatives that r > 10. The null hypothesis of no cointegration among the variables of interest is rejected at 5% level of significance since the values of trace statistic and max-eigen statistic do not lead to the rejection of the null hypothesis. Thus, there is evidence of a long run relationship among the chosen variables.

Table 2: Johansen cointegration test results

H_0	H_1	Trace Statistic	5% Critical Value	Max-eigen Statistic	5% Critical Value
r = 0	r > 0	535.5927 *	239.2354	143.2710*	64.50472
r ≤ 1	r > 1	392.3217 *	197.3709	106.8378*	58.43354
r ≤ 2	r > 2	285.4839 *	159.5297	83.04658*	52.36261
r ≤ 3	r > 3	202.4373 *	125.6154	52.39057*	46.23142
r ≤ 4	r > 4	150.0467 *	95.75366	46.80879*	40.07757
r ≤ 5	r > 5	103.2379*	69.81889	33.26709*	33.87687
r > 6	r > 6	69.97084*	47.85613	28.51179*	27.58434
r > 7	r > 7	41.45905	29.79707	19.03567	21.13162
r > 8	r > 8	22.42339	15.49471	14.07129	14.26460
r > 9	r > 9	8.352102*	3.841466	3.841466*	0.2189
r > 10	r > 10	5.342202	1.211213	1.342465	0.0039

NB: * implies rejection of the null hypothesis (H_0) at 5% level of significance. The Trace test indicates 10 cointegrating eqn(s) at the 0.05 level whereas max-eigen value test indicate 5 cointegrating equations at 5% level.

The results for the estimated short run coefficients based on parsimonious Error Correction Model (ECM) are presented in Table 4. The parsimonious model was obtained from the overparameterized model by applying the general to specific method. The results indicate that RGDP is a positive and significant determinant of RESV. OILEXPT emerged as an indispensable positive determinant of RESV. This significant deterministic value of OILEXPT remained up to the first period lag. Expectedly, EXCH was found to be significant but negative determinant of RESV. Thus, a rise in EXCH (interpreted here to mean devaluation of Nigeria's Naira) will cause RESV to drop. FDI inflows positively and significantly determine RESV only in its first period lag while LR was discovered to be a negative and insignificant determinant. Similarly, the coefficient of INFL is negative and significant. However, the coefficient of NOILEXP, though positive, was not significant determinant of RESV (Table 3).

Table 3: Parsimonious ECM

Dependent Variable: Δ LRESV			
Variable	**Coefficient**	**Std. Error**	**Prob.**
C	0.008203	0.077993	0.9169
D(LRGDP(-1))	0.102944	0.191689	0.0489
D(LOILEXPT)	0.976895	0.184823	0.0000
D(LOEXPT(-1))	0.376756	0.187146	0.0523
D(LEXCH)	-0.202986	0.225248	0.0374
D(LFDI(-1))	0.078650	0.123464	0.0585
D(LR)	-0.011863	0.017166	0.4944
D(INFL)	-0.012671	0.004489	0.0080
D(LNOILEXP)	0.023742	0.146694	0.8732
ECM(-1)	-0.603074	0.167496	0.0010
R-Squared = 0.699016; Adjusted R-Squared = 0.626050; F-statistic = 3.580041; prob.(F-statistic) = 0.000000; DW = 2.208526			

The error correction term, ECM(-1) is significant with the expected sign, indicating a strong convergence to long run equilibrium after the short run shocks The ECM(-1) coefficient values of -0.603074, implies that about 60.3 per cent of the departures of the actual from the equilibrium rate of RESV is corrected in each period (annually). This further indicates that, it takes an average of three (3) years to restore full equilibrium.

Diagnostic Test

To check how "good" the fitted model is, several diagnostic tests of model adequacy were carried out (Table 4). To this effect, the Jarque-Bera (JB) Test of Normality, the Breusch- Godfrey (B-G) serial correlation LM test, Ramsey Reset Test and the Breusch-Pagan-Godfrey (B-P-G) test for Heteroskedasticity were considered. The JB test of normality is an *asymptotic*, or large-sample, test. The Breusch-Godfrey test was used to complement the Durbin Watson test statistics for autocorrelation. The Ramsey Reset Test (RRT) is a general test of specification error. If the probability value is insignificant, it is an indication that the initial model might have been miss-specified.

Table 4: Summary of diagnostic tests for the mode

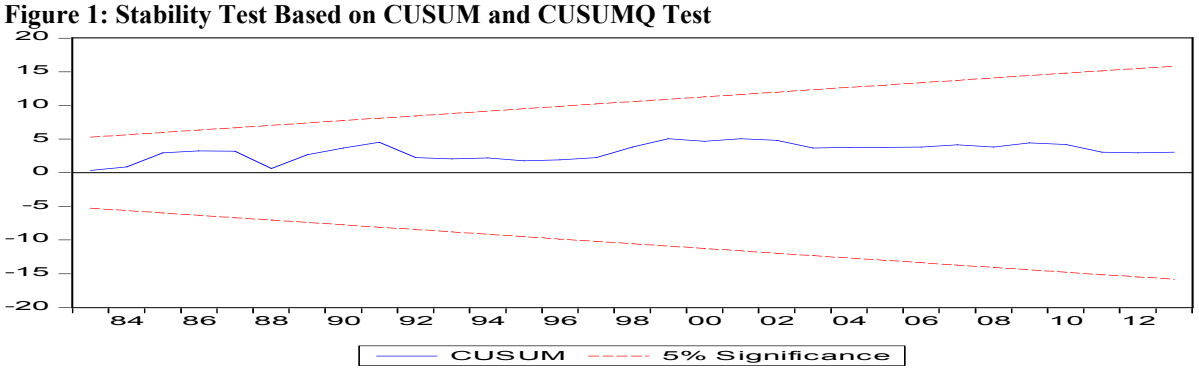
Test	***Probability***
Jarque-Bera Normality	0.95
Breusch-Godfrey (B-G)	0.45
Ramsey Reset	0.34

Source: Computed by the Authors using E-views 8.

The probability of the diagnostic tests is satisfactory. Under the null hypothesis that the residuals are normally distributed, the JB test for residual normality assumption is not violated. The table also shows that the error process could be described as normal for the determinants. The value of the DW together with that of Breush-Godfrey serial correlation LM test show that our model is not plagued by autocorrelation of any order. The results of the RRT suggest that the model is well specified, and hence the results are plausible.

Also, the stability test based on cumulative sum test (Figure 1) shows that our estimated coefficients are dynamically stable since the fitted line fall with the 5% critical region, meaning that we can rely on the estimated results for forecast.

Figure 1: Stability Test Based on CUSUM and CUSUMQ Test



Source: Authors' Initiative

5. Conclusions

This study evaluated the determinants of foreign reserves in Nigeria. Literature relevant to the subject matter were thoroughly reviewed. The model of the study hypothesized that foreign reserve (RESV) in Nigeria is a function of exchange rate (EXCH), oil exports (OILEXP), Foreign Direct Investment (FDI), real GDP (RGDP), lending rate (LR), non-oil exports (NOILEXP) and inflation rate (INFL). The Johansen cointegration tests established evidence of a long run relationship among the variables. The results of the estimated short run coefficients based on parsimonious Error Correction Model (ECM) indicated that RGDP is a positive and significant determinant of RESV. OILEXPT emerged as an indispensable positive determinant of RESV. This significant deterministic value of OILEXPT remained up to the first period lag. Expectedly, EXCH was found to be significant but negative determinant of RESV. Thus, a rise in EXCH (interpreted here to mean devaluation of Nigeria's Naira) will cause RESV to drop. FDI inflows positively and significantly determine RESV only in its first period lag while LR was discovered to be a negative and insignificant determinant. Similarly, the coefficient of INFL was negative and significant. However, the coefficient of non-oil exports (NOILEXP), though positive, was not significant determinant of RESV. The probability of the diagnostic tests conducted reinforced the robustness of the model. On the basis of the empirical findings, at least, regarding NOILEXP, we recommend that that the government incentivise exports in that direction as a means of positively affecting RESV.

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