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FOREIGN EXCHANGE INTERVENTION AND MONETARY AGGREGATES: NIGERIAN EVIDENCE

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Abstract

The pre-occupation of this study is to examine the impacts of foreign exchange (forex) intervention on monetary aggregates in Nigeria. The study utilizes quantitative time series data that span the period 1970 to 2006. Since intervention data are often not disclosed, net foreign assets and net foreign private capital are used to capture intervention since both constitute part of forex inflows. However, the net foreign assets and net foreign private capital are adjusted for cumulative values. The cumulative series for these variables are used in preference to their ordinary net level form because such cumulative series allows us to compare accumulated effects of these variables. In order to reflect structural breaks in the economy overtime, a dummy variable was introduced in the model. This 'dummy' takes the value of 'one' for period of 1993 to 1995 when there was direct intervention in the Nigerian forex market and the value of 'zero' for the rest of the estimation periods. The autoregressive distribution lag (ARDL) technique is utilized in this study, to estimate the error correction model (ECM) and the long run coefficients of our model. The result of the long run relationship shows that all explanatory variables except cumulative net foreign assets passed the significant test at 5%. The intuition here is that, since all the variables are not significant, it then implying an incomplete sterilization of intervention in the Nigeria forex market. Given the adverse effects of non-sterilized intervention on the economy - price instability, inflation, deteriorating exchange rate, amongst others - it is therefore recommended that Nigerian government allow intervention to be economically motivated rather than being politically executed.

Keywords: Foreign asset, Monetary aggregates, Structural breaks, Nigeria

INTRODUCTION

In real world, governments of advanced economies with acute financial markets and credible monetary policies generally allow free market forces to determine economic activities. These same governments together with their counterparts in the developing economies have often refused complete free reigns in determining the exchange values of their currencies in the forex markets. Thus, many governments have officially intervened in the foreign exchange (henceforth, used as 'forex') market to try to dampen volatility and protect their economies. They justify their actions that information imperfections sometimes make the forex markets unpredictable and drive exchange rates away from values consistent with their underlying macroeconomic fundamentals needed for growth (Humpage, 2003). Essentially, forex intervention serves has a way to manage the forex markets. The management of forex market through official interventions is of great importance for economic progress for most emerging economies.

For several years, Nigeria has been pursuing a strategy aimed at re-establishing international credit worthiness and other macroeconomic objectives. To achieve these goals, her monetary authority - Central Bank of Nigeria (CBN) – has sporadically intervened in the forex market. Specifically, since 1986 when exchange rate - which was before fixed since 1960 - was floated in the country, the CBN has often arbitrated in the forex market. As part of the International Monetary Fund (IMF) conditions under the Structural Adjustment Programme (SAP), the CBN has been intervening in form of forex purchase in order to accumulate foreign reserves for the government and improve the value of her currency 'naira' relative to other foreign currencies.

However, the issue of whether such intervention drives exchange rates movement and how this happens has vital implication for policy (see Simatele, 2003). Although, the transmission process of how such interventions affects monetary aggregates has been theorized but the efficiency of the forex market and the monetary transmission system in the economy in conjunction with the credibility of the intervention matters for its effectiveness. Since intervention transmission process exists - in order to ascertain its reliability - pragmatic verification becomes necessary. The effect of such interventions on the exchange rate through money supply is therefore an empirical issue that our research attempts to investigate.

For a systematic approach, the rest of the paper is organised as follows: section two reviews relevant literature on exchange rates stability, monetary policy and forex interventions. Section three establishes the theoretical framework and specifies the empirical model while section four articulates the empirical results. Lastly, section five concludes with policy implication.

LITERATURE REVIEW

Exchange rate stability and forex intervention: conceptual view and the Nigeria perspective

One problem often experience economists and policy makers is that of maintaining the exchange rate stability. Both advanced and emerging economies face some challenges in curtailing exchange rate fluctuation: whereas the advanced countries face fewer difficulties in maintaining exchange rate stability, the problem of maintaining stability in the exchange rate is serious in developing countries. In most cases, these problems translate into unsustainable external imbalances. Noted by Nyong (2005) in most developing countries, part of the problem lies in the dependency nature of the economy on foreign goods importation. Not only are capital goods and raw materials imported but also the importation of consumer goods is ever increasing. In spite of years of import substitution industrialization, export promotion policies and the structural adjustment programme adopted there has not been significant structural change in most developing economies. Thus, imports have consistently exceeded exports leading to excess demand, therefore exerting pressure on the stability exchange rate. Certainly, exchange rate stability is difficult to sustain in the face of increasing import, low forex reserves and declining price of export commodities. Nevertheless, this can be managed by means of forex control.

The forex control means the control of all foreign receipts and payments in forms of foreign currencies by the government. Jhingan (2005) stated that forex control aims at equilibrating foreign receipts and payments (not through such market forces but) by direct or indirect control of forex. An objective of the exchange control is to stabilize the exchange rates. Since fluctuating exchange rates can harm the real sector, governments therefore adopt exchange control measures to stabilize the exchange rate value of their currency. Forex control helps protect domestic industries, check non-essential imports; facilitate planning process and reduce the chance of facing unfavourable balance of payment conditions. The governments via her monetary authority control the forex through different autonomous means. Most commonly used tools for stabilizing exchange rate fluctuation include monetary policy, price policy; fiscal policy, interest rate policy and external debt management. Central Banks sometimes use monetary policy by altering the overnight market interest rates through open market operations or adjusted interest rates on their official lending facilities in pursuit of specific exchange rate objective. Although, these monetary policy actions aimed same objective as the forex intervention - being to influence exchange rate - but both are quite different in operations and somewhat transmission channels. In general, adjusting monetary policy instruments to achieve an exchange rate objective does not constitute intervention since it does not provide the

monetary authorities an additional independent means for influencing exchange rate (Humpage, 2003). In fact, all policies directed towards influencing exchange rate, which do not involve official trading of foreign currencies, are not intervention: for intervention – there must be purchase and sale of forex – currencies and/or assets. One of the common means of forex control is '*official intervention'* in the forex market.

Official intervention (or simply intervention) in the forex market implies that the Central Bank or her agents officially trade foreign currencies in an attempt to influence the exchange rates (Humpage, 2000 and Hutchison, 2003). It occurs when monetary authority of a country buys or sells forex in the forex market in order to influence the exchange rates (Adebiyi, 2007). The purchases of forex push down the home currency value of the exchange rates, while the sale of foreign. Monetary authority officially has the mandate to carries out intervention. But apart from monetary authorities, other agents can be officially manipulated by the government of a country in intervening in the forex market. Most governments intervene in the forex markets by acting as the buyers or sellers of the last resort of forex (Suranovic, 2007).

Although, most government allow market forces to determine most economic fundamentals but often refused these forces to solely determine the exchange value of their currencies. These governments profess confidence in the overall competition efficiency of the forex market but do not underestimate the fact that information imperfection sometimes make these markets excessively volatile or drive exchange rates away from values consistent with their underlying macroeconomic fundamentals. While similar information imperfection may affect other financial markets, government interventionists contend that the macroeconomic implications of even temporary forex market failures are great enough to warrant mechanistic corrective actions. As such, discretionary policy becomes necessary to restraint excessive exchange rate volatility in the forex market. But, with fiscal policy too unresponsive and trade control measures too disruptive, such corrective actions automatically falls to monetary authorities in form of forex interventions (Humpage, 2003).

Forex intervention appears to be more common in emerging economies for two reasons. *First,* developing economies exhibits some structural characteristics that often contribute not only to tremendous exchange rate volatility but also to larger effects of such fluctuations on the real economy. As such, intervention becomes discretionary for economic revival. Indeed, when forex market is thin and dominated by a relatively small number of agents, it is likely that the exchange rate will be volatile if the monetary authorities do not provide some guidance and support (Disyatat and Galati, 2005). This problem is compounded if there is no track record of stable macroeconomic policies that consistently anchor market expectations about future monetary base and exchange rate policy. *Second,* developing economies have underdeveloped

and imperfect financial markets. Such underdeveloped and incomplete financial markets imply that hedging against exchange rate risk is costly and sometimes impossible, so that the costs of exchange rate volatility can be substantial for individual agents and the economy as a whole. Therefore, by combining expansionary (or contractionary) open market operations with the sales (or purchases) of forex, the government can expand (or contract) the monetary base without depreciating the exchange rate (see Dreher and Vaubel, 2005). With this, if monetary authority does not want intervention to cause (significant) change in money supply then, the forex trading room would immediately report any currency sale (or purchase) to the open market trading room (or department), which then buys (or sales) some domestic bonds, so that the daily money supply is unaffected.

In Nigeria, these problems - exchange rate volatility and imperfect financial market - were prevalence in 1980s particular as consequent of the early oil crises. To re-position the economy on trajectory growth path, since 1986 when exchange rate was floated, the CBN has sporadically intervened in the forex market. CBN's intervention involves the purchase (or sale) of foreign assets with the domestic assets. Although the degree at which such intervention is not publicly announced but sterilization measure are often implemented. If such intervention is not sterilized (i.e. offset by monetary vagaries), it would result in an increase (or decrease) in the domestic currency base. For example, when the CBN intervenes against the naira, the CBN's portfolio of foreign assets (typically, the United State [US] dollar denominated assets) increases while her naira deposits decreases. At the same time, naira deposits of the commercial banks in the Nigeria banking system increases. As a result, the Nigerian monetary base (i.e. the commercial bank deposits in the economy plus currency in circulation) is increased. The CBN sterilizes this action by selling the appropriate number of naira-dominated assets or bonds in the open market operations to return the exchange rate to the status quo.

Although, officially intervention involves discretionary buying and selling of forex (depending on the direction to pressure exchange rate), but more often than not, most of the official intervention in done by CBN are directed towards mainly purchase of forex rather than to sell. This of course connotes an increasing accumulation of foreign assets. The implication of this is that the value of the naira is push down vis-à-vis the foreign currency making export relatively more cheaper, import relatively more expensive, increase inflow of foreign capital thereby appreciate the exchange rate with view of achieving a favourable balance of payment of position.

Taxonomy of forex intervention and changes in monetary base

In literature, forex intervention has been dichotomized into sterilized or non-sterilized (unsterilized) intervention depending as whether or not such intervention changes the monetary aggregates.

Unsterilized intervention occurs when intervention does not offset changes in the monetary base. Such intervention is an attempt by monetary authorities to influence the exchange rate and its money supply by not buying or selling domestic or foreign currencies (or assets). This is a passive approach to exchange rate fluctuations, and thus allows fluctuations in the monetary base. According to Adebiyi (2007), there is a general agreement that non-sterilized intervention can affect the exchange rate through its effect on money supply. This is because an unsterilized policy allows for the forex market to function independently without manipulation of the supply of the domestic currency (i.e. without the purchases or sales of bonds in the open market operation). Therefore, the monetary base is allowed to change. Unsterilized intervention is very crucial because it can be used to influence the exchange rate and as such the balance of payments stance. This is because non sterilized intervention induces changes in monetary base. These changes will in turn translate in broader money aggregates and affect interest rates. As a result, expectations, capital flows and exchange rate would be affected. The general usage of unsterilized intervention lies in simultaneous pursuit of exchange rate and monetary policies. However, such an intervention may lead to inflationary or deflationary situation if unmanaged appropriately.

On the other hand, sterilized intervention occurs when the monetary authority neutralized her forex interventions - usually with an equal change in the net domestic credit either simultaneously or within a very short lag (see Gosh, 2002). It represents a method used by the Central Bank to equalize the effect of forex transactions on the domestic monetary base by offsetting the purchase or sale of domestic assets within the domestic market. Such sterilization process used to manipulate the value of one domestic currency relation to another usually limits the amount of domestic currency available for forex. For example, if the Central Bank purchases domestic currencies by selling foreign assets, the money supply will shrink because it has removed domestic currencies from the forex market in the domestic economy. Generally, any intervention that is sterilized would not have any significant growth on the money supply.

As noted by Humpage (2003), the main reason most central banks neutralize the monetary effects of their forex operations is that sterilization prevents forex transactions from interfering with the domestic objectives of monetary policy. Different Central Banks have diverse ways of sterilizing their intervention. But the most commonly used sterilization process is

by simple combination of expansionary (or contractionary) monetary policy, say open market operation with sales (or purchases) of forex. For instance, on account of any forex intervention in the forex trading room (or department under the Central bank), the monetary authorities will report such action to the open market trading room and the commensurate counter actions (sale or purchase of domestic bonds) would be implemented. Sterilization is most important in countries (like Japan, United States (US), Nigeria etc) whose Central Banks are independent from fiscal coordinators, but whose fiscal authorities maintain the primary responsibility for intervention but under the control of monetary authorities.

One of the important usefulness of sterilized intervention is that it provides monetary authorities an additional instrument with which to pursue an exchange rate objective independent of their monetary policy. Aside countering undesirable exchange rate movements, sterilized intervention serves amongst two important purposes for countries particularly, developing ones. First, its serves as a way for a the country to alter its debt composition without affecting its monetary base. For instance, a decrease in the value of a country's domestic currency will cause a debt instrument issued in a foreign country and dominated in that foreign country's currency to be made more expensive. Second, it either prevents or curbs inflationary tendencies.

Literature provides that sterilized intervention offsets the value of currencies in the forex market either through a portfolio-balance channel or via a signalling channel. In brief, the signalling channel assumes that the central bank intervention might present an informative content. Typically, monetary authorities have a better understanding of the economic environment and possess superior information on monetary policy. Thus, the central bank may anticipate shifts in monetary aggregates and other variables which affect currency values and therefore intervenes in the forex market. Indeed, results by Watanable (1992), Levis (1995) and Kaminsky and Lewis (1996) generally suggest that central bank's intervention is informative of future changes in the monetary policy, even if a clear link has not been established (see Vitale, 2006). With respect to the portfolio balance channel of transmission, when intervention activity did not carry any information content, intervention by a central bank influences exchange rate. In fact, as the forex dealers are risk adverse, they will be willing to accommodate a portfolio shifts associated with an intervention operation only if they are compensated with an adjustment in the value of the foreign currency.

Whichever channel is followed the forex market provides the domestic economy all necessary information, transactions and fundamentals for sterilization. The forex market customers provide all the supply of currency. These customers are primarily formed by the financial arms of industrial corporations and by other unsophisticated commercial financial

traders whose forex transactions are due to liquidity and are not motivated by movements in exchange rates (Vitale, 2006). Beside this population of unsophisticated customers, a central bank places orders with the forex brokers or forex dealers as part of its intervention operations.

There are two alternative scenarios by which the Central Bank can intervene in the forex markets: direct intervention scenario and the indirect intervention scenario. In the direct intervention scenario, the basic need for sterilization to hold is that the Central Bank only operates via the direct market, trading small quantities of foreign currency with the subset of the forex market dealer. However, in the indirect intervention scenario, the central bank employs a broker to enter large transactions into the inter-dealer market. The direct intervention is more effective and cost efficient to the Central Bank than the indirect scenario. In addition, it could easily lead to sterilization since all information and transactions on intervention are available to the monetary authority.

Empirical Literature

While vast empirical literatures on intervention exist in advanced economies only a few have been documented for emerging economies. Although, empirical evidences presented here is comprehensive but not exhaustive. Some empirical works provided evidence on effect of intervention on exchange rate. Murray et al. (1997) studied Canada and observed implied exchange rate volatility to be strategic dependent on intervention. Dominguez (1998) examined intervention with respect to its effect or exchange rate volatility. He found implied volatility to be sample dependent in most advanced countries. Some provided evidence on proper timing for interventions. Humpage (1999) showed that the US interventions undertaken in conjunction with changes in the federal funds rate have no apparent effect on exchange rate. Cheung and Chin (2001) utilised the China's intervention data and discovered that intervention takes place at times when volatility is high in the forex market.

Dreher and Vaubel (2005) observed that by combining expansionary open market operation with sales of forex, Central Banks can expand the monetary base. They carried out a panel data analysis for 158 countries between 1975-2001 and all observations support their hypothesis. They concluded that democratic elections tend to have a significantly positive effect on the level of forex intervention. Also, Galati, Melick and Micu (2005) examined the effect of intervention on higher movement of Yen/Dollar exchange rate. Their result suggests that Central Bank intervention has no statistically significant systematic impact on the mean or higher movement of the exchange rate.

On studies related to the emerging market countries where data limitations are very pronounced mixed results were also observed. Disyatat and Galati (2005) noted that the effect of intervention on exchange rate volatility in emerging countries appear to be dependent on the monetary policy framework pursued and/or whether the interventions are publicly announced or not. Domac and Mendoza (2002) studied the Central Bank's intervention in Mexico and Turkeys and discovered asymmetric effects of intervention on exchange rate. Tapia and Tokman (2004) studied the effectiveness of intervention in Chile using both daily and intra-daily data. They observed that intervention varied through the sample studied in line with the changing policy framework of the Central Bank.

In evidence related to Africa, Simatele (2003) studied for Zambia economy. He regressed the spot exchange rate on intervention variables. He utilised different approaches to test the impact of intervention on the volatility of exchange rates - particularly, he used the contemporaneous values and one lag of intervention variables - and found out that intervention affect spot exchange rate. With regard to Nigeria, Adebiyi (2007) observed that foreign intervention is sterilized because the cumulative aid, which constitute part of forex inflows and net foreign assets variables that are proxies for intervention are statistically insignificant.

THEORETICAL FRAMEWORK AND MODEL SPECIFICATION

Building the framework on sterilized policy

The link between forex intervention, money supply, order flow and exchange rates is due to both signalling and a portfolio balance channels of transmission. Whether adopting signalling or portfolio channel, there are two possible alternative scenarios to the central bank intervention. These are the direct and indirect intervention scenarios. Thus, most empirical studies on intervention have largely focused on the effect of direct (sterilized) intervention (see Murray et al., 1997; Dominguez, 1998; Humpage, 1999; Liviatan, 2001; Gosh, 2002; Simatele, 2003; Tapia and Tokman, 2004; Dreher and Vaubel, 2005; and Adebiyi, 2007). Upon certain assumptions, this study is also built on effect of direct (sterilized) intervention on monetary aggregates in Nigeria upon.

The assumptions

- We thus assume that a single foreign currency (dollar) is traded for the currency of the domestic economy (naira).
- We assume that the forex trading takes place both in the direct section of the forex trading market where customers' trades are executed by a population (or its sample

representative) of forex dealers and also trades take place in the different forms of centralized electronic trading.

- We also suppose that the production function in the economy largely depends on demand for money and that the exchange rate under consideration is the spot rate.
- Furthermore, we assume that expectation and information are sine qua non to intervention in the market.
- Lastly, we assume that the forex dealers form a continuum of agents of mass 1, uniformly distributed in interval (0, 1).
- Essentially, given these assumptions, the theoretical framework for this study follows the analysis of a direct forex scenario developed by Vitale (2006). In this analysis, we construct both the forex market position without the central bank intervention and the market position when the Central Bank intervenes.

Modelling the forex market scenario without intervention

Without intervention in the forex market, we assume that at the beginning of a trading day t, an active forex dealer X possess some units of domestic bonds D_t^x and some foreign bonds, F_{t-1}^x. With D_t^x and F_{t-1}^x, this individual trades with her customers. Her customers collectively place a market order for the foreign currency equal to $-C_t^x$, so that if C_t^x, is positive, the individual dealer X will purchase foreign currency from her customer or client but if C_t^x is negative, she will sell foreign currency to her client. Nevertheless, before trading starts on the centralized inter-dealer platform, she owns F_t^x. units of foreign bonds. Where:

$$F_t^x = F_{t-1}^x + C_t^x \qquad 3.1$$

If forex trade takes place, the total foreign currency traded by the individual X will be the sum of those traded with the clients C_t^x and those traded at the inter-dealer trading, I_t^x. The foreign bond, F_t^x will now be.

$$F_t^x = C_t^x + I_t^x \qquad 3.2$$

With equation 3.1, the dealer X can then liquidate her endowment and invest into a portfolio of domestic bonds, D_t^x; foreign bonds, F_t^x and real balance $M_t^x \cong (M_t^x / P_t)$. Where P_t is the prevailing price level at day t. The domestic bonds pay day-by-day interest rates, the foreign bonds pay day-by-day interest rates (quite different from that of the domestic bonds) and the real balances

return total output q(M_t^x) at the end of the day as they are employed into the production technology. Thus, the individual budget constraint becomes

$$D_t^x + R_t F_t^x = D_t^{*x} + R_t F_t^{*x} + M_t^x \qquad 3.3$$

Where R_t is the spot (exchange) rate i.e. the number of units of domestic currency requires to purchase one unit of the foreign currency. But, the optimal quantity of foreign currency that this dealer X will trade in the forex market in order to maximize wealth (I_t^*) corresponds to the linear demand function i.e. a limit order, in the logarithm of the spot rate analogous to this function below.

$$I_t^x = f\left(V_t^x, R_t, f_t^x, \left\{E_t^x / N^x{}_t\right\}, \sigma^2{}_{t,x}\right) \qquad 3.4$$

Where I_t^x is positive (negative) when dealer X buys (sells) the foreign currency in the market; $\{E_t^x | N_t^x\}$ represents the conditional expectation (E_t^x) of next spot exchange rate given the information (N_t^x) dealer X posses in day t; $\sigma_{t,x}^2$ represents corresponding conditional variance based on the uncertainty in the forex market; and R_t represents aggregate trading intensity of the population of forex dealers.

Given the demand of the individual forex dealer in day t, through aggregation we can obtain the total demand for the foreign currency on the part of the population (or its sample representative) of the forex dealer. In particular, following our assumption that the forex dealer form a continuum of agents of mass 1, uniformly distributed in the interval (0, l) then for a day t the aggregate trading intensity of the population (V_t) becomes;

$$V_t = \int_0^1 V_t^x .xx' \qquad \textit{(Where } x' = \Delta x\textit{)}$$

Also, if we assume that the total population of forex dealers still falls in that continuum and that the total number of day t in a year is **n** then, the annual aggregate trading intensity of the population ($V_{t,a}$) becomes

$$V_{t,a} = \int_1^n \left(\int_0^1 v^{x'}{}_t .xx'\right)x'$$

The aggregate inter dealer in day t becomes

$$I_t = \int_0^1 I_t^{x'}.xx'$$

In addition, the annual aggregate inter-dealer or the total foreign currency in part of the population of forex dealers becomes;

$$I_{t,a} = \int_1^n \left(\int_0^1 I_t^{x'}.xx'\right)x'$$

Also, the corresponding aggregate initial endowment becomes

$$F_t = \int_0^1 f_t^{x'} xx'$$

At equilibrium, the total foreign currency on the part of the population of the forex dealer at day t, I_t equals the total amounts of foreign currency supplied in the inter-dealer market via the group of forex brokers, B_t. That is, I_t = B_t (at equilibrium in day t)

The inter-dealer order flow, B_t corresponds to the customers' order which reach the inter-dealer through the group of the forex broker besides, clients trading directly with individual forex dealers. Recall that C_t^x represents the value of dealer X customers' order, while C_t represents the total customer order flow. With this, C_t (i.e. the total customers' order flow at day t corresponds to

$$C_t = \int_0^1 C^{x'}{}_t.xx'$$

Also, if we denote the total order flow by O_t then in practice, O_t is expected to be the sum of the inter-dealer flow ($\boldsymbol{B}_t$) and the customer order flow, C_t. That is, at any day t, the total order flow is presented as:

$$O_t = \boldsymbol{B}_t + C_t \qquad 3.5$$

Equation *3.5* can be rewritten as:

$$O_t = \int_0^1 I_t^{x'}.xx' + \int_0^1 C^{x'}{}_t.xx'$$

However, through aggregation, we obtain the annual total order flow, $O_{t,a}$ as:

$$O_{t,a} = \int_1^n \left(\int_0^1 I_t^{x'}.xx' + \int_0^1 C^x{}_t.xx' \right) x' \qquad 3.6$$

Equation *3.6* represents the aggregative framework of the forex market order for order of foreign currency in a particular year. This shows the yearly forex traded without the government (via central bank) intervention in the market. That is with expression in equation *3.6 - intervention is completely absent.*

Modelling the forex market with intervention

Besides the population of unsophisticated customers, a central bank - acting on behalf of the fiscal authority or the government - places order (i.e. requests for forex or currency in order to accumulate foreign assets with either the forex brokers or forex dealers as part of its intervention activity. Most of these interventions by the central bank through direct contact and negotiation with the forex dealers are always kept secrets. However, news of intervention would spread quickly in the market through the inter-dealer section of the forex markets. With this, intervention would influence market expectation (E_t) and hence exchange rate (R_t). This study is based on the direct intervention scenario. In the direct scenario, the central bank chooses to negotiate in day t with a subset of the forex dealers. Thus, any dealer *XE(0,λ),* with *0<λ<1,* trades the foreign currency with the central bank and her unsophisticated customers. On the contrary, any dealer λ *E(λ,1)* only receives market order from her unsophisticated customers. More precisely, any dealer X receives an uninformative collective market order C_t^{kx} from her base of unsophisticated customers, where we recall our normal convention that C_t^{kx} *>0* if these clients sell the foreign currency and C_t^{kx}<0 if these clients purchase the foreign currency. By aggregation, we calculate the overall sophisticated customers order flow in day t, C_t^x as;

$$C^k{}_t \equiv \int_0^1 C_t^{n,x'}.xx'$$

And the annual customer order flows $C_{t,a}^x$ becomes

$$C^k{}_{t,a} \equiv \int_1^n \left(\int_0^1 C_t^{n,x'}.xx' \right) x' \qquad 3.7$$

We assume that C_t^k follows a white noise process, so that C_t^k ~NID (0, σ^2_c). A positive value for C_t^k implies that commercial customers and/or non sophisticated financial traders collectivity decide to sell the foreign currency in response to a current account surplus or to capital inflows. Clearly, an appositive interpretation applies to a negative value for C_t^k. Beside market order from her unsophisticated clients, any privilege dealer X, with X E (0, λ), receives a market order $C_t^{cb,x}$ from the central bank due to its intervention operations with

$$C_t^{cb,x} \equiv -B^{cb}{}_t + U_t^{cb,x} \qquad 3.8$$

Where B_t^{cb} captures the intensity of the informative components of the central bank market order (i.e. captures intervention activity) which is directed to influence exchange rate while $U_t^{cb,x}$represents the central bank intervention operations in the forex market not directed to affect exchange rates. Indeed, as discussed in section 2.26, not all central bank interventions are directly to achieve exchange rate objective pursuit. In fact, some are conducted on behalf of other governmental institutions for profit making, some are conducted to diversify portfolio of national assets and some to evaluate market conditions. We assume that $U_t^{cb,x}$ follows a white noise process, so that $U_t^{cb,x}$ ~ NID (0,σ^2_{cb}). That is, the market operations of the central bank are random and not related to fundamental and exchange rates. Then aggregating across all the privileges forex dealers at day t, the central bank intervention operation becomes:

$$C_t^{cb} \equiv \int_0^{\lambda} C_t^{cb,x'} .xx'$$

Also, the annual central bank intervention with all n dealer of *XE(0,λ)* becomes

$$C_t^{cb} \equiv \int_1^{n} (\int_0^{\lambda} C_t^{cb,x'} .xx')x' \qquad 3.9$$

This equation 3.9 is the macro-framework of central bank's intervention in the economy. In practice, with equation 3.9 the foreign assets (bonds) and the foreign aids composition of the economy will definitely differ vis-à-vis their position in the economy with only equation 3.6. This is because these variables (foreign bonds and foreign aids) constitute substantial parts of forex in the economy. As such, if a central bank keeps intervention data confidential from any empirical study, these variables can proxy intervention in such study (See Adebiyi, 2007). Thus,

to study how intervention affects monetary supply, a theoretical model based on impact of foreign assets and foreign aids on money supply is plausible.

DATA ADJUSTMENT, EMPIRICAL MODEL & ESTIMATION PROCEDURES

The study utilizes quantitative time series data that span through 1970 to 2006. Since intervention data are often not disclosed, net foreign assets and net foreign private capital are used to capture intervention since both constitute part of forex inflows (Adebiyi, 2007). However, the net foreign assets and net foreign private capital are adjusted for cumulative values. The cumulative series for these variables are used in preference to their ordinary net level form because such cumulative series allows us to compare accumulated effects of these variables (Simatele, 2003). In order to reflect structural breaks in the economy overtime, a dummy variable was introduced in the model. This 'dummy' takes the value of 'one' for period of 1993 to 1995 when there was direct intervention in the Nigerian forex market and the value of 'zero' for the rest of the estimation periods.

For modeling purpose, in order to determine whether forex intervention in Nigeria is sterilized, this study investigates if intervention has significant effect on the growth of money supply. the variables employed are defined which are Broad Money Supply (M_2), Cumulative Net Foreign Asset (CNFA), Cumulative Net Foreign Private Capital (CNFP), Real Gross Domestic Product (RGDP) and Dummy (DUMY). The equation for estimation is specified as:

$$M2_t = \alpha_0 + \alpha_1 CNFA_t + \alpha_2 CNFP_t + \alpha_3 RGDP_t + \alpha_4 DUMY_t + \mu_t \qquad 3.10$$

Ω_t is the stochastic error term and its normally independently distributed (NID) with mean 0 and variance σ^2**:** Ω_t ~NID (0, σ^2). With $\Psi_i > 0$ (for i = 0 to 4), equation 3.10 seems to find whether or not CNFA and CNFP would have significant positive effect on M_2 given that some level of structural break exists in the economy. In other to show the effect of real variables on monetary aggregates, the RGDP, which represents a proxy for income gap was included. This equation is a standard way of checking for sterilization with a measure for income gap (Sarno and Taylor, 2001, and Adebiyi, 2007).

The autoregressive distribution lag (ARDL) technique is the estimation approach utilized for this study. This will be used to estimate the error correction model (ECM) and the long run coefficients of our model. Before estimating the ECM and the long run coefficient, we first carried out necessary tests: unit root test and test of cointegration. First, we proceed by determining the underlying properties of the process that generates our time series. That is, to test whether each variable in equation 3.10 is stationary. This investigation is necessary to

ensure consistency in subsequent econometric modeling. To test for unit roots, we employed the Dickey Fuller (DF) and Augmented Dickey (ADF) tests which use equation 3.11 and 3.3 respectively, to test for the null hypothesis of non stationarity (i.e. presence of unit roots) for the series X_t.

$$\Delta X_t = \beta_0 + \beta_1 X_{t-1} + \mu_t \qquad 3.11$$

$$\Delta X_t = \beta_0 + \beta_1 X_{t-1} + \sum_{i=1}^{n} \alpha_i \Delta X_{t-1} + \varepsilon_t \qquad 3.12$$

Where U_t and E_t ~NID (0, σ^2) and X_t represents each series of M_2, CNFA, CNFP, RGDP and DUMY, in equation 3.10 The t-statistics obtained are compared with the special critical value constructed by Dickey Fuller (1979) and Engle and Granger (1987, 1990). Furthermore, the cointegration test performed is based on the unit root test for the residuals generated in the long run static (ordinary least square, OLS) regression of M_2. Last, the ECM entails using the residuals generated in the long run static regression of equation 3.10 which was used to test for the unit root to reparametrize the short run specification. The ECM integrates the short run dynamics with the long run equilibrium without losing the information. For equation 3.10, the corresponding ECM is:

$$\begin{aligned}\Delta(M_2)_t = {} & b_0 + \sum_{i=0}^{n} b_{1i} \Delta M_{2t-i} + \sum_{i=0}^{n} b_{2i} \Delta CNFA_{t-i} + \sum_{i=0}^{n} b_{3i} \Delta CNFP_{t-i} + \sum_{i=0}^{n} b_{4i} \Delta RGDP_{2t-i} \\ & + \sum_{i=0}^{n} b_{5i} \Delta DUMY_{t-i} + b_6 CNFA_{t-1} + b_7 M_{2-1} + b_8 CNFP_{t-1} + b_9 RGDP_{t-1} \\ & + b_{10} DUMY_{t-1} + b_{11} ECM_{t-1} + \varepsilon_t \end{aligned} \qquad 3.13$$

This first part of equation 3.13 with b_1, b_2, b_3, b_4 and b_5 represents the short run dynamics of the model whereas the second part with b_6, b_7, b_8, b_9 and b_{10} represents the long run equilibrium relationship. The Null Hypothesis in the equation is $b_6 = b_7 = b_8 = b_9 = b_{10} = 0$ which means the non existence of the equilibrium relationship, the ECM_{t-1} is the lag of the error correction term.

DISCUSSION OF RESULTS

Here, we discussed empirical results of the unit root and cointegration tests and presents both ECM and long run coefficients for our stationary series. The result of the unit root test (see Table on the appendix) shows that the level form of the variables implies strong evidence in favour of the null hypothesis of non-stationary of each series. All the test-statistics (absolute values) were lesser than the critical values at 95% level. This leads us to conclude that all the

variables were integrated of order one, conventionally denoted as I(1). Next, we verify for cointegration that entails dual stages: first, establish if series are cointegrated and second, if cointegrated estimating the long run coefficients. For the first, the OLS residual series was stationary implying that money supply and the regressors are cointegrate. The existence of cointegration amongst our variables implies that there exists a stable long-run equilibrium relationship between the series. The result of the long run relationship (presented in Table 2b, at the Appendix) shows that all explanatory variables except cumulative net foreign assets passed the significant test at 5%. So, not all the variables are significant which implies an incomplete sterilization of intervention in the Nigeria forex market. Since intervention is not fully sterilized, it has effect on monetary aggregates.

According to Engle and Granger (1987) once there is cointegration, a single equation – error correction model – is used to estimate the short run dynamic model. In essence, the model is used to capture the short run deviations that might occur in estimating the long run cointegrated equation already discussed. Since cointegrated series implies that there is error correction representation, we therefore present the parsimonious regression of ECM for money supply (see Table 3 on Appendix). In the results, the all regressors are statistically significant at 5% level except cumulative net foreign assets. With net foreign private capital significant and net foreign assets insignificant, confirms again that intervention is not completely sterilized in Nigerian economy. This confirmation is statistically robust. Essentially, over 81% of systematic variation in the broad money supply are accounted for by changes in the real gross domestic product cumulative net foreign assets, cumulative net foreign private flow, the dummy variable and the lagged of money supply. Furthermore, the coefficient of the ECM_{t-1} was rightly signed and significant – being negative and large in magnitude. This confirms a long run relationship between the dependent and independent variables and thus any perturbation or disequilibrium on account of previous annual shock will adjust back to the long run equilibrium in the current year. The overall model was highly significant. There is no residual serial correlation in the model, hence, decision makers can absorbed these findings for policy purposes.

CONCLUSION AND POLICY IMPLICATIONS

The study has established amongst others that the government intervention in the forex market is not fully sterilized. Based on this finding, we proffer the following recommendations. First, the CBN should ensure that intervention in the Nigerian forex market is not motivated by political considerations but rather by economic need (for instance, depreciating exchange rate depreciation in order to boost the strength of their foreign wealth in domestic currency). Given the adverse effects of non-sterilized intervention on the economy - price instability, inflation,

deteriorating exchange rate, amongst others - it is therefore necessary that Nigerian government allow intervention to be economical (and not politically).

Second, there should be harmonization of various objectives of macroeconomic policies, especially fiscal and monetary policies. Expansionary monetary and fiscal policies in the past worsen exchange rate depreciation. To rectify this, further monetary policy implemented triggered inflation. Thus, to sterilization of intervention, macroeconomic targets should be properly formulated, implemented, coordinated, harmonized and controlled not to frustrate objective of intervention. Lastly, the CBN should shun detrimental speculation in the forex as well as rent seeking behaviour and only organize direct intervention policies that are geared towards enhancing appropriate monetary stance, inflation control, and exchange rates stability, thus achieve pursued sterilization in the Nigeria economy.

In conclusion, although, our findings showed that intervention in the Nigerian forex market is not (fully) sterilized but recommendations proffered were focused on measures to ensure sterilization of interventions in the market. However, given the fact that unsterilized intervention can be useful in some aspects especially to surrogate and/or complement conventional monetary policy instruments, instigate expectation, capital inflows, and stabilize exchange rates. I therefore suggest that future studies on the interactions between forex intervention and monetary aggregates in African countries will be more valuable (and broaden academic nexus) if they are based on the effects of 'official' non-sterilized intervention in the forex markets.

SCOPE FOR FURTHER RESEARCH

This research work has been conducted based on a country specific analysis by focusing on the relationship between foreign exchange and monetary aggregates in Nigeria. With regards to future research, this phenemenon can be examined in a panel environment where cross country analysis will be carried out. This type of analysis will definitely results in a more robust estimation and inferences drawn from such models will be more useful for policy purposes.

REFERENCES

Adebiyi, M.A. 2007. "An Evaluation of Foreign Exchange Intervention and Monetary Aggregates in Nigeria (1986-2003)." *Munich Personal RePEc Archive Paper.* No 3817.

Bollard, A. 2004. Letter to Dr Cullen on Intervention Policy Under Section 16 of the Reserve Central Bank of Nigeria, CBN. 1996. Statistical Bulletin, Lagos.

Central Bank of Nigeria, CBN. 2006. Statistical Bulletin, Abuja.

Cheug, Y. and M.D. Chinn. 2001 "Currency traders and exchange rate dynamics: A Survey of the US Market." *Journal of International Money and Finance.* 20: 439-471.

Dickey, D.A and W.A Fuller. 1979. "Distribution of Estimators for Autoregresion time series with a unit root." *Journal of American Statistical Association* 74 (4):27-31.

Disyatat, P. and O. Galati. 2005. "The Effectiveness of Foreign Exchange Interventions in Emerging Countries: Evidence from the Czech Koruna." *Bank for International Settlement Working Paper.* No 172.

Domac, I. and A. Mendoza. 2002. "Is there Room for Foreign Exchange Interventions Under an inflation Targeting Framework? Evidence from Mexico and Turkey." *World Bank Policy Research Working Paper.* No 3288.

Dominguez, K. M. 1998. "Central Bank Intervention and Exchange Rate Volatility."*Journal of International Money and Finance.* 18:161-190.

Dominguez, K. M. 2003. "The Market Microstructure of Central Bank." *Journal of International Economics.* 59: 25-45.

Dreher, A. and R. Vaubel. 2005. "Foreign Exchange Intervention and Political Business Cycle: A panel Data Analysis." *Thurgauer Wirstschaft Institute Research Paper Series.* No 9.

Engle, R.F and C.W. Granger. 1987. "Cointegration and Error Correction: Representation, Estimation and Testing." *Econometrica.* 55 (2):251-276.

Engle, R.F and C.W.J. Granger. 1990. "Long Run Economic Relationship: Readings in Cointegration." *Oxford*

Galati, G., W. Melick, and M. Mini. 2005. "Foreign Exchange Market Intervention and Expectations: The Yen/Dollar Exchange." *Journal of International Money and Finance.*

Gosh, A. 2002. "Is it Signalling? Exchange Intervention and the Dollar-Deutschemark Rate". *Journal of International Economics.* 32: 201-220.

Gujarati, G.N. 2007. *Essentials of Econometrics.* 3rd Ed., New Delhi: McGraw-Hill Education Publishing.

Humpage, O.F. 1999. "US Intervention Assessing the Probability of Success*." Journal of Money, Credit and Banking.* 4: 731-477.

Humpage, O.F. 2000. "The United States as an informal foreign exchange speculator." *Journal of International Financial Markets, Institutions and Money.* 10: 287-302.

Humpage, O.F. 2003. "Government Intervention in the Foreign Exchange Market." *Federal Reserve Bank of Clevedland Working Paper.* No 15.

Hutchinson, M.M. 2003. "Intervention and Exchange Rate Stabilization Policy in Developing Countries." *Journal of International Finance,* 6:109-127.

Holub, T. 2004. "Foreign Exchange Interventions Under Inflation Targeting: The Czech Experience." *Czech national Bank International Research and Policy Notes.*

Iyoha, M.A. 2003. "An Overview of leading Issues in the structure and Development of the Nigerian Economy Since 1960." In Iyoha, M.A and C.O Itesede (Eds*.) Nigerian Economy: Structure, Growth and Development.* Benin City: Mindex Publishing.

Iyoha, M.A. 2007. *Intermediate Macroeconomics*. Benin City: Mindex Publishing.

Jhingan, M. L. 2005*. International Economics.* 5th Ed., New Delhi: VRINDA Publications (P) Ltd. Kamin Sky, G.L Lewis. 1996. "Does Foreign Exchange International Signal Future Monetary Policy?" *Journal of Monetary Economics,* 37: 285-312.

Kim, S.J., T. Kortain and J. Sheen. 2000. "Central Bank Intervention and Exchange Rate Volatility-Australian Evidence*." Journal of International Financial Market, Institution and Money.* 381-405.

Livantan, L. 2001. "Tight Money and Central Bank Intervention: A Selective Analytical Survey." *Bank of Isreal Discussion Paper.* No. 03.

Murray, J. M. Zelmer and D. McManuss. 1997. "The Effect of Intervention on Canadian Dollar Volatility." *Proceedings of a* Conference hosted by the Bank of Canada. 311-357.

Nyong, M. O. 2005. *International Economics: Theory, Policy and Applications*. Calabar: Wusen Publishers.

Nwaobi, C.G 2004. "Money and Output Intervention in Nigeria: An Econometric Investigation Using Multivariate Cointegration Techniques." *Economic Bulletin. No* 30 (3):1-10.

Obadan, M. I. 2002. "Towards Exchange Rate stability in Nigeria." A Paper Presented at the Year 2000 One Day Seminar of the Nigerian Economic Society (NES) at the Federal Palace Hotel, Lagos.

Obaseki, R.J. 2007. "Nigeria: Why Must Nigeria Keep Foreign Exchange Reserve?" Vanguard Newspaper. Lagos: May

Sarno, L. and M.P. Taylor. 2001. "Official Intervention in the Foreign Exchange Market: is it effective, and if so, how does it work?" *Journal of Economic Literature.* 39.

Simatele, M.C.H. 2003. Financial and Sector Reforms and Monetary Policy in Zambia. PhD. Dissertation, Economic Studies, Department of Economics, School of Economies and Commercial Law, Goteberg University.

Suranovic, S.M. 2007. *International Finance Theory and Policy.* George Washington: University Press on Line Resources.

Tapia, M. and A. Tokman. 2004. "Effects of Foreign Exchange Intervention under Public Information: The Chilean case." *Economic Spring*: 1-42.

Taylor, M. 2003. "Is Official Exchange Rate Intervention Effective?" *Center for Economic Policy Research discussion paper.* No. 37-58

Vitale, P. 1999. "Sterilized Central Bank Intervention in the Foreign Exchange Market." *Journal of International Economics,* 49:689-712.

Vitale, P. 2006. "A Market Micro Structure Analysis of Foreign Exchange Intervention." *European Central Bank of Working Paper Series No* 629.

Watanable, T. 1992. "The Signalling Effect of Foreign Exchange Intervention: The Case of Japan." *Bank of Japan*. Mineo.

APPENDICES

Table 1: Unit root tests: level form

Variables in x	AD/ADF-test statistics	Lag Length	Critical Value for ADF at 95%.	Order of Integration
M_2	0.77160	3	-2.9591	I(1)
CNFA	-1.2609	3	-2.9591	I(1)
CNFP	-1.2609	3	-2.9591	I(1)
GDP	-1.1538	3	-2.9591	I(1)
DUM	-2.0383	3	-2.9591	I(1)

Sources: authors' computation, using E-views 7.1

Table 2a: Test for cointegration

Test statistic	DF critical statistic:	LC	AIC	SBC	HQC
-7.0899	-4.8806	-380.2165	-381.2165	-381.9335	-381.4502

Sources: authors' computation, using E-views 7.1

Table 2b: Estimates of Long Run Coefficients

Regressors	Coefficients	Standard Errors	T-statistics
CNFA	0.31051	0.10372	1.9936
CNFP	2.71310	0.22848	11.8744
GDP	0.10883	0.17339	6.2764
DUM	101580.9	15431.7	6.5826

Sources: authors' computation, using E-views 7.1

Table 3: Regression results for parsimonious representation of the ECM

Regressors	Coefficients	Standard Errors	T-statistic
$dDM_2(-1)$	-0.86518	0.25472	-3.3966
$dDM_2(-2)$	-1.14330	0.20703	-5.5226
$dDM_2(-3)$	-8.43200	0.41254	-4.4679
dDCNFA	-0.04034	0.02101	-1.9198
dDCNFP	-2.02390	0.49091	-4.1222
dDGDP	0.095200	0.11408	8.3452
dDDUM	818601.1	18421.4	4.4438
ECM(-1)	-0.971030	0.26540	3.6588
R-Bar Squared	= 0.81374	F-Statistic	= 19.7242
Prob.(F- statistic)	= 0.00000	DW-Statistic	= 2.03960

Sources: authors' computation, using E-views 7.1

Note: Where **x** represents (ordinary) level form of each variable and Dx is the difference form for the variable

* Indicates that the value apply for the DF which of course has no lag.