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FOREIGN EXCHANGE INTERVENTION AND EXCHANGE RATE MOVEMENT IN NIGERIA

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ABSTRACT : This study was set to evaluate the impact of the foreign exchange intervention of the Central Bank of Nigeria (CBN) on exchange rate movement in Nigeria, in view of the prevailing instability in the foreign exchange market in Nigeria, even in the face of enhanced intervention of the Bank in the market. The study adopts the framework of a co-integrating autoregressive distributed lag (ARDL) model, using monthly data, spanning the period 2017M4 to 2022M6, and sourced from the statistical bulletin of the CBN. Findings from the study suggest that the CBN interventions in the foreign exchange market do not significantly impact the movement in exchange rate in Nigeria in both the short- and long-run. This finding raises questions about the need to sustain the interventions, given the impact it has on the external reserves of the country. However, the long-run impact of external reserves on exchange rate suggests that reserves accumulation is consistent with currency appreciation. This, however, is not the case in the short-run, as the short-run impact of external reserves on exchange rate is insignificant, both contemporaneously and for most of its lags. Terms of trade, on the other hand, appears to drive appreciation of exchange rate in the short-run, though its impact of exchange rate in the long-run is statistically insignificant. The study recommends that the CBN discontinues the interventions in the market, and rather explore better options of sustaining the net inflow of foreign capital to Nigeria. This may include providing foreign currency dominated securities, with very competitive naira-based interest rates, for retail investor. This would attract inflow of foreign exchange, for Nigerians both resident in the country and abroad, resulting in a moderation in the foreign exchange market pressure.

KEYWORDS: *Foreign Exchange Intervention, Foreign Exchange Market, Exchange rate, External Reserves, ARDL model.*

I. INTRODUCTION

The outbreak of COVID-19 pandemic resulted in a significant reduction in Nigeria's foreign exchange earnings, as global production and international trade were brought to a halt, following the implementation of several containment measures, such as curfews, lockdowns, and travel restrictions. Specifically, the disruption in production lines in Europe, North America and Asia, reduced global demand for crude oil, leading to a sharp decline in crude oil price. The dampened global demand precipitated a massive decline in crude oil prices in 2020, driving it into negative margins, for the first-time in modern history. This situation has further exposed the susceptibility of the Nigerian economy to external shocks due to the country's overreliance on crude oil receipts, giving credence to calls for diversification of the economy away from the crude oil sector.

During the same period, capital inflows to Nigeria reduced significantly. The sharp decline in foreign portfolio investment was worsened by the pandemic, as exiting portfolio investors began divesting and rebalancing their portfolio, and new investments were lost to emerging preferred investment destinations like Egypt and Angola, where, though the yields are relatively lower than that of Nigeria, their relative stable foreign exchange market lessened investors' concerns about potential delays in funds repatriation. Similarly, the flow of remittances was affected, as Nigerians in diaspora battled with both the fall in their incomes and the increase in the cost of cross-border payments.

On the flip side, the domestic demand for foreign exchange to meet trade obligations, external debt servicing, and international payments, amongst others, continued to surge, resulting in a net outflow of foreign financial resources. The resulting foreign exchange pressure, exacerbated by the widening supply gap casted doubts on any hopes of return to relative stability in the Nigeria's foreign exchange market. This explains why the Central Bank of Nigeria (CBN) continued to intervene in the market to ensure exchange rate stability, in line with her mandate to "maintain external reserves to safeguard the international value of the legal tender currency". However, as the rising demand for foreign exchange, coupled with the decline in foreign capital inflows, constrained external reserve accretion, the resulting negative impact on Nigeria's external reserves, has further limited the Bank's firepower to sufficiently intervene in the foreign exchange market, leading to frequent depreciation of the local currency.

The objective of the CBN interventions in the foreign exchange market is to moderate the prevailing foreign exchange pressure, and consequently, reduce the almost uncontrollable depreciation in the Naira. However, available statistics have raised doubts about the effectiveness of the exercise, as the exchange rate has depreciated to a record high (rising above ₦400 per dollar at the I&E window, and ₦700 per dollar at the black market), as of September 2022. This raises questions about the continued intervention of the CBN in the foreign exchange market and its impact on the exchange rate of the Naira.

Attempts to correct this inconsistency would benefit, immensely, from researches that measure the relationship between CBN's foreign exchange interventions and exchange rate movement in Nigeria. There are significant numbers on foreign exchange interventions on advanced economies (Fatum, 2006; Neely, 2011; Bordo, Humpage, & Schwartz, 2012; Dominguez, Fatum, & Vacek, 2013; Adler et al. 2015; Daude et al. 2016; Bernanke, 2010; Chen, 2011; Menkhoff, 2012; Rincon & Toro, 2011; Hoshikawa, 2008; Fatum, 2008). However, available studies regarding Nigeria are limited (Adebiyi, 2007; Dayyabu et. al, 2016; and Kayode et. al., 2021). These studies (Adebiyi, 2007; Dayyabu et. al, 2016) focused on the relationship between foreign exchange intervention and exchange rate movement, using net foreign assets (NFA) as proxy for CBN foreign exchange intervention. However, NFA of a country is the value of the assets that the country owns abroad, minus the value of the domestic assets owned by foreigners. It reflects the indebtedness of that country, not the direct interventions of CBN in the foreign exchange market.

It is against this backdrop that this study seeks to empirically investigate the relationship between CBN interventions in the foreign exchange market and exchange rate movement in Nigeria. Specifically, the main objective of this paper is to measure the impact of the CBN's foreign exchange intervention on exchange rate movement in Nigeria. Foreign exchange intervention, for this research, is the direct sale of foreign exchange by the CBN in the foreign exchange market, which comprises her foreign exchange sales to the Bureau De Change (BDC) operators, and her cash backed foreign exchange sales at the Retail Dutch Auction System (RDAS) the Wholesale Dutch Auction System (WDAS). The study adopts the framework of Autoregressive Distributed Lag (ARDL) model, which enables the use of the Bounds test approach of Pesaran, Shin, and Smith (2001), as its main estimation technique.

II. LITERATURE REVIEW

2.1 Conceptual Framework

2.1.1 Foreign Exchange

No country can survive, and achieve its macroeconomic objectives, in autarky. This implies that nations of the world must interact and carry out trade across international boundaries to earn income and at the same acquire goods and services that they do not have specialty in production. An acceptable medium of exchange is key for international transactions to be successful since a country's local currency is not acceptable in the purchase of goods and services in a foreign country. Thus, the concept of foreign exchange which involves the conversion of local currencies into foreign currencies to aid the success of buying and selling across international boundaries cannot be over-emphasized (Alabi, 2015).

Campbell (2010), and Omojolaibi and Gbadebi (2014) opined that foreign exchange is the exact amount of a currency, say the Nigerian naira that is exchanged for the same amount of say, the American dollar. According to Ahmed (2001), foreign exchange rate is defined as the relative value of the domestic currency in relation to that of another country. Nzotta (2004) opined that foreign exchange rate is the rate of transformation of one currency to another or the rate at which one currency is exchanged for another. Ewubare and Ushie (2022) opined that foreign exchange which is the price of a foreign currency in relation to that of a domestic currency determines the relative prices of domestic and imported commodities. That is, foreign exchange reflects the ratio of a local currency to that of a foreign currency. It is the price of one currency in relation to another currency (Azid *et al*., 2005).

For this study, foreign exchange is defined as the rate of exchange between local currencies of a home country to the currencies of foreign countries. That is, it implies the amount at which a currency, say the Nigerian naira is exchanged for the American dollar.

2.1.2 Foreign Exchange Intervention

Foreign exchange market intervention, also known as currency intervention, occurs when the central bank or monetary authority sells or buys foreign currency to ease volatility and bring calmness to the foreign exchange market. This is to ensure that the exchange rate is stable enough to support the achievement of macroeconomic objectives of government and boost economic activities of the country. Thus, when the price of foreign exchange increases, the central bank intervenes by selling foreign exchange to the market to boost supply (CBN, 2016). This will bring down the price of the foreign exchange. Similarly, when the price of foreign currency decreases, it buys foreign exchange from the market. This will raise the demand for foreign exchange in the market, and the price will increase to the desired level.

Under the managed floating exchange rate system, the exchange rate is not solely determined by the forces of demand and supply but is manipulated by the monetary authorities to stabilize the inevitable fluctuations in the foreign exchange market. The intervention in the foreign exchange market by the Central Banks is an important venture because it is very important for emerging market economies to calm disorderly markets and relieve liquidity shortages, as well as to correct misalignment and stabilize volatile exchange rates that may cause banking crises, economic instability, slowing growth, and decrease in trade. However, this interventions by the monetary authorities also have some level of challenges since whether it is under the floating exchange rate system or the fixed exchange rate system; the non- stabilization of the foreign exchange market by the Central Banks shows their ineptitude and causes either excess demand or excess supply in the foreign exchange market.

2.2 Theoretical Literature

There are three approaches that lay the foundation for exchange rate determination; they include the traditional flow; purchasing power parity; asset market approach under which come monetary approach, and the portfolio balance approach, and Dornbusch Overshooting Model.

2.2.1 Traditional Flow Model

The model assumes that market forces of demand primarily determine exchange rate, accordingly, equilibrium is reached when demand and supply of foreign currency are equal, thus, exchange rate are determined by trade and capital flows. Furthermore, given that international demand for goods and services is a function of income and demand for financial assets, which is a function of both domestic and foreign interest rates, the model's underlying premise that relative income and interest rate differentials interact to affect exchange rates is justified.

2.2.2 Purchasing Power Parity

The purchasing power parity (PPP) hypothesis is the most popular theoretical justification for the long-term stability and consistency of bilateral exchange rates. While many other macroeconomic models frequently employ PPP to link domestic and international growth, the soundness of long-run PPP theory is crucial to many monetary models, such as Dornbusch (1987). This theory, also known as the law of one price, was first proposed by Cassel (1918) and remains a prominent viewpoint regarding exchange rates. It states in its absolute form that the exchange rate between the currencies of any two countries should equal the ratio of the general price levels in the two countries, and it implies that exchange rates between two countries will be equal to the national price level of these. Thus, the price of an identical good or service in country A should be the exact same price as in country B. The theory excludes real world factors such as transaction costs, taxes, tariffs, and it only applies to tradable goods. The presence of competitive marketplaces for goods and services across all nations is the other presumption.

One fundamental aspect of the PPP theory is its consideration of the exchange rate as being equal to the ratio of the domestic to the foreign price for a certain aggregate bundle of goods, basically a constant real exchange rate (Samuelson, 1964). However, the absolute PPP in practice fails to hold for a certain reason, these limiting its usefulness as a theory in determining the exchange rate. These limiting factors being the existence of non-tradable goods and services exclusive of arbitrage, significant transactions costs for traded goods, including transport costs, tariffs, taxes, information costs, and other non-tariff trade barriers that make arbitrage costly, the composition of the basket of goods and services included in measuring national price levels, and the non-constant of exchange rate in the short run due to aggregate price levels that are sticky; hence, the exchange rate is affected by money or asset market shocks, or in the long run because of persistent real shocks (Lafrance & Schembri, 2002).

2.2.3 Asset Market Approach

Modern exchange rate determination models do not only consider the international trade in goods but also the international trade in financial asset markets. The asset market approach to exchange rate determination postulates that foreign capital inflows could have an impact on both the size of external reserves and exchange rates and demonstrates that the exchange rate is determined based on the willingness of foreign investors to hold a particular country's currency. In this situation, a crucial factor that determines the exchange rate is the projected return on investments. The asset market approach places more importance on the adjustment of

exchange rates to equilibrate financial markets, as the prices of financial fluctuate frequently daily. This suggests that based on the supply of financial assets, changes in exchange rates are highly volatile. This contrasts with the traditional trade in goods in the international market.

In the asset market approach, a fundamental assumption of exchange rates is the perfect mobility of capital, there are no barriers to international flows of capital. In this, covered interest arbitrage will maintain interest rate parity in and the relationship is expected to remain constant over time. Spot and future exchange rates, on the other hand, will quickly adapt to the shifting conditions in the financial markets (Husted & Melvin 2013).

a. The Monetary approach

The monetary method was developed because of the shortcomings of the portfolio balance theory and became more prominent with the collapse of the Bretton Woods system in 1971. Several iterations of the monetary model abound in literature however, they all highlight that movements in the demand and supply of money may be used to explain variations in exchange rates between two currencies. Equilibrium is achieved when the current money stock in the two nations is held willingly (Frankel, 1979). According to Obioma (2000), the asset market or monetary approach relates exchange rate variation primarily to income and expected rates of return as well as to other variables that affect the supply and demand for the various national currencies. The existence of a long run equilibrium relationship between the nominal exchange rate and a country's monetary fundamentals are the hallmarks of the monetary model of exchange rate determination. Basically, in the monetary conditions, the monetary model assumes an equilibrium position between domestic and foreign currencies. Thus, the monetary model postulates three fundamental factors that affect the exchange rate: relative money supplies, relative income, and interest rate differentials. This is because supply and demand for money are determined by the level of income. It has been argued by Dominguez (1998) that the approach captures the situation through which non-sterilized interventions in the foreign exchange market affect the value of domestic currency exchange rate equal to the changes in the relative number of supplies of domestic and foreign exchanges.

In the monetary approach, there is an assumption on the perfect substitution between domestic and foreign money meanwhile between the domestic and foreign bonds. This implies uncovered interest rate parity and zero risk premium in forward exchange rate (Husted & Melvin 2013). Monetary approach assumes prices are completely flexible, PPP holds at all the times and therefore no change in the real exchange rate (Levich 2001).

b. The Portfolio-balance approach

This postulates an asset pricing perspective of exchange rates in which a choice of local and foreign asset portfolios is available, the individual assets in the portfolio provide an arbitrage from projected returns, and this is what controls the exchange rate process (Dornbusch, 1988). According to MacDonald and Taylor (1994), the exchange rate is not fixed and is instead affected by the supply and demand for a variety of financial assets, at least in the short-run. The Portfolio-balance approach assumes that the exchange rate is determined by the relative supplies and demands of bonds, as well as the relative conditions of money market. Here, it is required a risk premium in forward exchange rate since it is considering the imperfect substitutionally of assets internationally (Husted & Melvin 2013).

c. Dornbusch Overshooting Model

The Dornbusch (1976) Overshooting Model is one of these models constructed on the foundation of the monetary approach framework for exchange rate determination. Under flexible exchange rate regimes, the PPP does not keep well. The prices are much less volatile than Exchange rates and interest rates are. Time shows the financial market responds the exogenous shocks promptly, while in a goods market there is a slow adjustment response over the time (Levich, 2001). Then, overshooting model is assuming that spot rates volatility are much more than the forward exchange rates and the PPP does not hold in the short run (Husted & Melvin 2013). It is assumed there is perfect capital mobility and slow price adjustment, hence, there are PPP deviations and real exchange rate changes in the short run, PPP can just revert to its original in the long run (Levich, 2001). The Dornbusch overshooting model (1976) is path-breaking in determining exchange rate overshooting, "Dutch disease" inherence, choice of exchange rate regime, and commodity price volatility (Rogoff 2002). The Dornbusch model was developed to examine the effect of exchange rates on real variables. Additionally, when nominal exchange rates are fixed as opposed to fluctuating, actual exchange rates are far less volatile (Kanamori and Zhao, 2006). Uncovered interest rate parity and the simple monetary model's monetary equilibrium are both kept in the Dornbusch model. However, sticky prices are used in place of the flexible pricing assumption.

2.3 Empirical Literature

The importance of the intervention of the Central bank of Nigeria (CBN) in operations of the foreign exchange market cannot be over-emphasized. The Central bank of Nigeria (CBN) helps in making sure that there is enough foreign exchange to avoid the state of excess demand or excess supply of foreign exchange in the market. Siba *et al.*, (2016) opined that the CBN have engaged in various interventions in the foreign exchange

market over the years to strengthen and stabilize the value of the Nigerian naira and to ensure the steady growth of her economy. Basu and Varoudakis (2013) assert that the prevention of exchange rate depreciation, management of foreign exchange reserve, controlling inflation, maintaining competitiveness, or maintaining financial stability, and the stabilization of foreign exchange rate towards equilibrium, are the main objectives of the intervention in the foreign exchange market by the CBN. Helena and Hedieh (2018) opined that Central banks in many developing market economies intervene in currency markets to mitigate volatility and counter appreciation or depreciation pressure.

Overall, the CBN monitors the foreign exchange market to maintain equilibrium in the demand for and supply of foreign exchange in the country. Furthermore, frequent fluctuations in foreign exchange which is responsible for fluctuation in prices and other economic indices is curtailed with the help of the intervention by the CBN. The CBN also through its intervention role in the foreign exchange market, guard against the excesses of the operators of foreign exchange in the country which may affect macroeconomic variables negatively. The stabilization role played by the CBN helps to boost the confidence of investors in the country and, by extension, enhances economic growth and development of the country.

However, for effective intervention, central banks must build their reserves. Reserves are, among other things, accumulated as an outcome of intervention strategies to keep the international value of the domestic currency stable and low to boost export growth (Dooley, *et. al* 2003). Dominguez *et. al*, (2011) argued that precautionary and exchange rate stability motives for reserve accumulation may have been significant drivers of foreign exchange accumulation for some countries in the pre-2007–2008 crisis period, and may have contributed to global imbalances, as countries that experienced foreign reserve depletion in the 1990s started rebuilding their stock of foreign reserves. These imbalances are argued to have contributed to the crisis. Various studies have attempted to determine if the precautionary or exchange rate stability motive better explains international reserve accumulations by both developed and developing countries. The findings of these studies confirm that both precautionary and exchange rate stability motives are significant determinants of reserve accumulation (Aizenman and Lee, 2007). However, findings from other studies reveal that neither of those motives is wholly responsible for the upsurge in reserve accumulations by developing countries starting in the earlier 2000s (Jeanne 2007; Jeanne and Ranciere 2008).

Findings from studies on the relationships between exchange rate and foreign reserve seem to reach divergent conclusions. For example, India has been accumulating large volumes of foreign exchange reserve while experiencing significant depreciation of its currency, relative to the US dollar. This prompted the need to understand the impact of foreign exchange reserves on the exchange rate. The study by Gokhale and Raju (2013) investigated this trend and finds the absence of long and short run association between exchange rate and foreign exchange reserves. Thus, the depreciation of the Rupee is not attributable to accumulation of foreign exchange. Findings from the study by Aizenman and Riera-Crichton (2008) indicate that the effect of terms-of-trade shocks on the real exchange rate (REER) is moderated by a large foreign reserve, and this is associated with developing, and not developed economies. However, this shock-absorbing role of foreign reserve is determined by the level of financial depth.

Kasman and Ayhan (2008) investigated the relationship between exchange rates (nominal and real) and foreign exchange reserves in Turkey. After accounting for structural breaks, the results revealed the existence of long run relationship between foreign exchange reserves and the exchange rates, with the direction of causality running from foreign exchange reserves to real effective exchange rate, while the reverse is the case with nominal exchange rate. In Nigeria, Onwuka and Igweze (2014) examined the effect of foreign reserve on USD/Naira exchange rate. Their results confirmed the existence of a direct relationship between USD/Naira exchange rate and external reserve – a growing foreign reserve erodes the international value of the Naira.

Keefe and Shadmani (2019) ascertained the asymmetric response of foreign exchange intervention on exchange rate volatility from January 2000 to December 2016. The variables modelled include foreign exchange intervention, exchange rate change, and ratio of domestic currency to foreign currency, policymakers' asymmetric response, as well as a dummy representing. The dynamic threshold panel methodology and Generalized Method of Moments (GMM) were employed within the context of an asymmetric policy reaction in accessing the function of volatilities in the exchange rate to interventions in the foreign exchange. Findings revealed that the non-linear aversion towards appreciation holds only in scenarios below-threshold volatility. The outcome revealed that volatilities in the exchange rate influenced the degree of response from policymakers to exchange rate dynamics. The study by Kayode et. al. (2021), investigated the relationship between Foreign Exchange Market Intervention and Exchange Rate Stability in Nigeria, and found that foreign exchange intervention in Nigeria has been effective in stabilizing the Naira in both in the short and long-run. The work by Dayyabu et. al (2016) supports the findings of Kayode et. al. (2021). Dayyabu et. al (2016) investigated the Effectiveness of Foreign Exchange Market Intervention in Nigeria using annual series data spanning from 1970 to 2013 and concluded that the CBN's intervention in the foreign exchange market results in exchange rate appreciation in Nigeria.

On the contrary, however, earlier study by Adebiyi (2007) fails to support the outcomes of Dayyabu et. al (2016) and Kayode et. al. (2021). In his work, Adebiyi (2007) suggests that foreign exchange intervention in Nigeria is sterilized because the cumulative aid, which constitute part of foreign exchange inflows, and net foreign assets variables, which are proxies for intervention, are not significant. Consequently, he argues that the CBN should stop intervening in the foreign exchange market, as its resultant depletion of the country's external reserves does not yield the desired results of stabilizing the market.

The rise in reserve accumulation in developing countries has prompted enquiries to understand the possible factors driving the demand for it. A conducted in West Africa, using the buffer stock model, suggests that determinant of reserves vary by time horizon. In the short, income per capita, volatility of real export receipts, population, volatility of the nominal effective exchange rate, and imports influence the region's demand for foreign exchange reserve accumulation. Only the influence of population and per capita income are sustained in the long run (Olomola and Ajayi, 2018).

The objective of the study by Irefin and Yaaba (2011) was to confirm the determinants of foreign reserve in Nigeria. They employed the ADRL to estimate a modified buffer stock model. Findings reveal that the buffer stock model does not explain reserve accumulation, instead, income is a significant determinant of reserves holdings. A similar study was conducted in Nigeria using the ECM approach. Findings indicate differential effects of significant variables. While real GDP, oil export and foreign direct investment exert positive effects on foreign exchange reserve with a lag, the effects of lending rate and inflation are negative (Osigwe et al. 2015).

III. METHODOLOGY

3.1 Data and Sources of Data

The study covers the foreign exchange market in Nigeria, particularly activities at the official windows of the market. It utilises key indicators of the market, to cover the period of the introduction of the investors' and exporters' (I&E) segment of the market. Consequently, the main exchange rates analysed is in the I&E window. The data requirement for this study is strictly monthly time series data, covering the periods 2017M4 and 2022M6, sourced mainly from the Central Bank of Nigeria (CBN) Statistical Bulletin. The start-date of 2017M4 is significant, as it coincides with the introduction of the investors' and exporters' window of the foreign exchange market by the CBN. The end-date of 2022M6 is strictly due to data availability. This period coincides with the period of significant volatility in the foreign exchange market in Nigeria, resulting in the most depreciation in the history of exchange rate. Table 1 presents a brief description of the variables, their unit of measurement, and source.

Table 1: Description of the Variables

S/N	Variable	Notation	Measurement	Data source
1	Exchange Rate at I&E window	EXR	Exchange rate at the investors' and exporters' window, measured as ratio of the Naira to US dollars.	CBN
2	Terms of Trade	TOT	Terms of trade is measured as the ratio of exports to import.	Self-Constructed
3	CBN' intervention in the foreign exchange market (Foreign Exchange Supply)	CBNI	Total intervention (supply) of foreign exchange at the official windows, measured in millions of US dollars.	CBN
4	External Reserves	XT	The stock of external reserves, measured in millions of US dollars.	CBN

Source: Authors' compilation

3.4 Techniques for Data Analysis

This study utilises the framework of the Autoregressive Distributed Lag (ARDL) model in measuring the relationship between CBN interventions in the foreign exchange market, and exchange rate movement in Nigeria. The ARDL model is a single equation time series model that incorporates lags of both the dependent and independent variables in its estimation.

3.4.1 The General Form of the Autoregressive Distributed Lag (ARDL) Model

The general form of ARDL model can expressed in two ways. The first is as a level relationship, which assumes that all the variables are stationary, and the second, as a co-integrated ARDL. In the second case, the variables are assumed not be stationary but co-integrated.

3.4.1.1The Level ARDL Model

In its general form, the level ARDL model can be expressed as follows:

$$Y_t = a_0 + \sum_{i=1}^{o} a_{1i} Y_{t-i} + \sum_{i=0}^{p} a_{2i} X_{t-i} + e_t \quad (1)$$

Where Y_t is exchange rate; and X_t are vector of regressors. The parameters a_{1i} and a_{2i} are the coefficients of the level relationships to be estimated, and e_t is the error term, and o and p are the optimum lags for Y_t and X_t , respectively.

Estimating level relationships using the ARDL model, like other time series regression models, is preconditioned on the unit root properties of the variables, which are all required to be stationary. Where the variables are rather integrated, there is need to verify if there exist a long-run co-movement between the variables or not. This can be done by evaluating the co-integrating properties of the variables using the Bounds testing approach of Pesaran et. al (2001). However, the Bound testing approach is also preconditioned on the order of integration of the variables. Specifically, the application of the Bound test technique requires that none of the variables of the ARDL model should be integrated of order $d > 1$. This, consequently, underscores the imperativeness of invariably evaluating the unit root properties of all the variables before estimating the model, to ensure this condition is met.

3.4.1.2 The Co-integrated ARDL Model

Equation 1 can be expressed in a co-integrating form to capture both the short- and long-run dynamics in the relationship between the variables, as expressed in Equation 2:

$$\Delta Y_t = a_0 + \sum_{i=1}^{o} a_{1i} \Delta Y_{t-i} + \sum_{i=0}^{p} a_{2i} \Delta X_{t-i} + \delta(Y_{t-1} - c - b_1 X_{t-1}) + e_t \quad (2)$$

Where Y_t and X_t are as earlier defined, Δ is a first difference operator, and a_{1i} and a_{2i} are the coefficients of the short-run relationship, and b_1 is the long-run coefficient. The error correction term δ, also called the speed of adjustment, explains degree the convergence to long-run equilibrium. Finally, o and p are the short-run optimum lags for Y_t and X_t , respectively, which would be determined based on the Akaike Information Criteria (AIC).

3.4.1.3 The ARDL Bounds Test

The bounds test of Pesaran et al. (2001) is a Wald test conducted under the null hypothesis of "no level relationship". This is like equating the long-run coefficient in Equation 6 to zero ($b_1 = 0$). This test is used to verify the presence of co-integration between the dependent variable and its regressors in an ARDL model. Under the specified null hypothesis, when the test statistic lies above the upper bound at a chosen level of significance, the null hypothesis is rejected, and if it lies below the lower bound, it cannot be rejected. The test is considered inconclusive, however, if it lies within the upper and lower bound at a chosen level of significance.

3.4.2 Model Specification

3.4.2.1 The ARDL Forms of the Models

The proposed model for this study, in its level forms, can be expressed as Equation 3:

$$EXR_t = \alpha_0 + \sum_{i=1}^{o2} \alpha_{1i} EXR_{t-i} + \sum_{i=0}^{p2} \alpha_{2i} CBNI_{t-i} + \sum_{i=0}^{q2} \alpha_{3i} XT_{t-i} + \sum_{i=0}^{r2} \alpha_{4i} TOT_{t-i} + e_{t2} \quad (3)$$

Where EXR, CBNI, XT and TOT are as already defined. The parameters $\alpha_{0\ to\ 4}$ are the coefficients of the level relationships to be estimated. e_{t2} is the error term. The parameters $o2, p2, q2\ and\ r2,$ are the optimal lags of EXR, CBNI, XT and TOT, respectively.

In its cointegrating forms, Equation 3 can be expressed as Equation 4:

$$\Delta EXR_t = \alpha_0 + \sum_{i=1}^{o2} \alpha_{1i} \Delta EXR_{t-i} + \sum_{i=0}^{p2} \alpha_{2i} \Delta CBNI_{t-i} + \sum_{i=0}^{q2} \alpha_{3i} \Delta XT_{t-i} + \sum_{i=0}^{r2} \alpha_{4i} \Delta TOT_{t-i} + \delta(EXR_{t-1} - c - b_{21} CBNI_{t-1} - b_{22} XT_{t-1} - b_{23} TOT_{t-1}) + e_{t2} \quad (4)$$

Again, TOT, EXR, CBNI and XT are as already defined, and Δ is a first difference operator. The parameters $\alpha_{0\ to\ 4}$ are the short-run coefficients of relationships to be estimated. e_{t2} is the error term. The optimal lags of EXR, CBNI, XT and TOT are $o2, p2, q2\ and\ r2,$ respectively. The long-run coefficients are $b_{21\ to\ 23}$, respectively.

- **A-priori Expectation**

Theoretically, foreign exchange intervention is expected to moderate the pressure in the foreign exchange market, thereby reducing the depreciation of exchange rate. Consequently, CBNI is expected to be inversely related to EXR, as increase in CBNI will lead to fall (appreciation) in EXR and vice versa. Similarly, both increases external reserves and terms of trade are expected to drive appreciations in exchange rate. Therefore, both XT and TOT are expected to have an inverse impact on EXR.

3.4.2.3 Preliminary Tests

3.4.2.3.1 Unit Root Test

The unit root properties of the variables are verified using the Augmented Dickey-Fuller (1979), Phillips-Perron (1988) and Kwiatkowski, Phillips, Schmidt, and Shin (1992) tests for unit root. These tests are conducted under null hypotheses of 'unit root' for both the ADF and PP tests, and "stationarity", for the KPSS test. This is necessary, as the application of the proposed ARDL Bound testing approach requires that no variable of the ARDL model be integrated of order $d > 1$.

3.4.2.3.2 Trend Analysis and Descriptive Statistics

The individual plot of all the variables used in the study are presented. This is necessary to reveal turning points, boom and bursts cycles, structural-breaks, and outliers in series. In addition, a table of descriptive statistics, such as mean, median, mode, range, kurtosis, skewness, and deviations, is provided.

3.4.2.4 Diagnostic Tests

The goodness of fit of the estimated ARDL model is diagnosed using the residual-based tests for serial correlation, Heteroskedasticity and Normality. This is necessary to ensure the relative stability, and subsequent reliability of the model. Specifically, the study performs the Breusch-Godfrey Serial Correlation LM Test, Breusch-Pagan-Godfrey Heteroskedasticity Test, and the Jacque-Bera Test for Normality. In addition, both the CUSUM and CUSUM Square tests are performed on the estimated model.

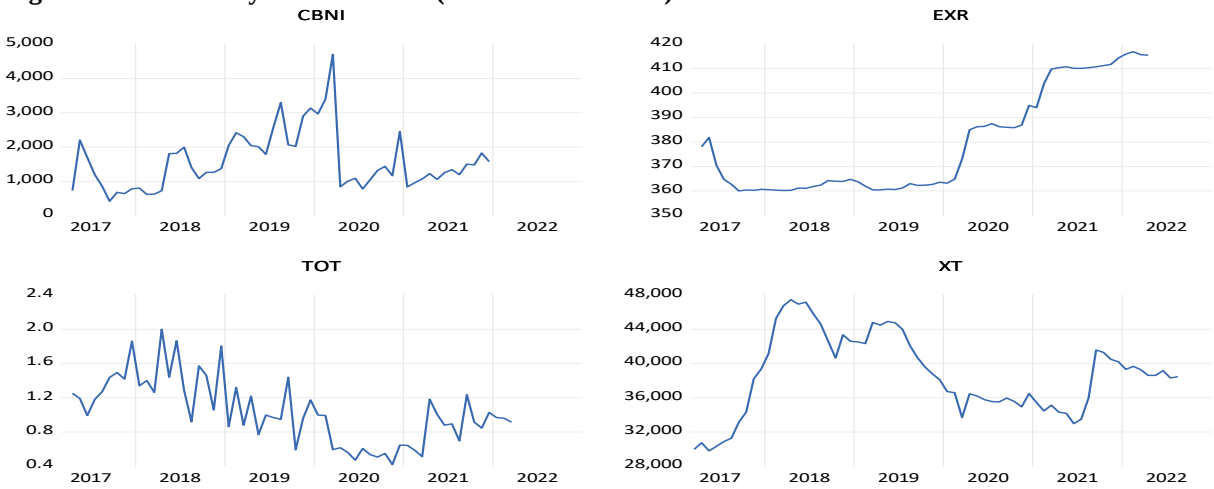
IV. RESULTS AND ANALYSIS

4.1 Preliminary Tests

4.1.1 Trend Analysis

Figure 1 presents the graphical plots of CBNI, EXR, TOT and XT. The graph of CBNI reveals an upward trend in the series out to 2019, before experiencing a structural break. However, CBNI began trending upwards again, raising steadily towards the end of 2021. The chart of EXR shows that exchange rate was relatively stable up on till the end of 2019, before it began an upward trend. TOT, on the other hand, appears to be trending downwards up till 2020, before increasing steadily towards the 2022. XT rose significantly from about 28 billion US in 2017 to over 44 billion USD in 2018. It began a falling steadily, reaching a value of about 38 billion USD in 2022.

Figure 1: Trend Analysis of variables (2017M4 to 2022M6)



Source: Authors' Estimation

4.1.2 Descriptive Statistics

The descriptive statistics of the variables of the model is presented in Table 2. This result shows that EXR has a mean value of 376.86, ranging from 359.99 to 414.34, over the period 2017M4 to 2022M6. CBNI has a mean of 1,576.72 million USD, with a range of 413.44 and 4,703.37 million USD, over the scope of the data. The mean of TOT stands at 1.05, while it ranges from 0.42 to 2, over the period 2017M4 to 2022M6. XT has a mean of 38,745.17 million USD, with a range of 29,811.85 to 47,438.22 million USD. The result further reveals that while TOT and XT are normally distributed, EXR and CBNI are not normally distributed.

Table 2: Descriptive statistics of variables (2017M4 to 2022M6)

	EXR	CBNI	TOT	XT
Mean	376.86 M$	1,576.72 M$	1.05	38,745.17 M$
Maximum	414.34 M$	4,703.37 M$	2	47,438.22 M$
Minimum	359.99 M$	413.44 M$	0.42	29,811.85 M$
Skewness	0.82	1.3	0.41	0.08
Jarque-Bera	8.3	25.27	2.04	2.85
Probability	0.02	0.00	0.36	0.24

Source: Authors' Estimation

4.1.3 Unit Root Test

The results of the unit tests are presented in Table 3. Under the null hypothesis of unit root for the ADF test, all the variables (EXR, CBNI, TOT and XT) are first difference stationary processes, as the p-values of their respective ADF statistics are only significant, at 5 per cent level of significance, at first difference. This result is similar in the PP test, except for TOT that is stationary at levels. The results of the KPSS test further validates the unit root properties of the variables. Here, under the null hypothesis of "no unit root", all the variables are first difference stationary processes, except for EXR. This is because the p-values of the all the variables, except EXR, are significant at 5 per cent level of significance, at levels. However, the p-values of the all the variables, are not significant at 5 per cent level of significance, at first difference. In conclusion, none of the variables is a second difference stationary process. As a result, all the variables are suitable for inclusion in the proposed ARDL bound testing technique.

Table 3: Unit Root tests (2017M4 to 2022M6)

ADF TEST					
At Level		LOG(EXR)	LOG(CBNI)	LOG(TOT)	LOG(XT)
	t-Statistic	0.83	0.54	-1.41	0.40
	Prob.	0.89	0.83	0.15	0.80
At First Difference		d(LOG(EXR))	d(LOG(CBNI))	d(LOG(TOT))	d(LOG(XT))
	t-Statistic	-5.26	-3.24	-8.68	-4.31
	Prob.	0.00	0.00	0.00	0.00
PP TEST					
At Level		LOG(EXR)	LOG(CBNI)	LOG(TOT)	LOG(XT)
	t-Statistic	1.08	0.28	-3.48	0.57
	Prob.	0.93	0.76	0.00	0.84
At First Difference		d(LOG(EXR))	d(LOG(CBNI))	d(LOG(TOT))	d(LOG(XT))
	t-Statistic	-5.46	-10.08	-17.65	-6.58
	Prob.	0.00	0.00	0.00	0.00
KPSS TEST					
At Level		LOG(EXR)	LOG(CBNI)	LOG(TOT)	LOG(XT)
	t-Statistic	0.23	0.16	0.15	0.13
	Prob.	<0.10	<0.05	<0.01	<0.01
At First Difference		d(LOG(EXR))	d(LOG(CBNI))	d(LOG(TOT))	d(LOG(XT))
	t-Statistic	0.11	0.07	0.11	0.11
	Prob.	>0.05	>0.05	>0.05	>0.05

Source: Authors' Estimation

4.2 The Estimated ARDL Models

Following the Akaike Information Criteria (AIC), the optimum lags of 2, 8, 6, and 3 are selected for LOG(EXR) LOG(CBNI) LOG(XT) and TOT, respectively (see Appendix 1). Consequently, the estimated model is an ARDL ARDL(2, 8, 6,3).

4.2.1 The Bound Test

The result of the Bound test on the selected presented in Table 4, reveals the presence of long-run relationship among the variables. Specifically, the F-statistic of 4.859, lies above the upper bound of I(1), at 5 per cent level of significance. Consequently, the long-run relationship can be captured by the co-integrating ARDL model proposed in Equation 4.

Table 4: Result of the ARDL Bound Test

			Bounds	
	Value	**Sig.**	**I(0)**	**I(1)**
F-Statistic	4.859	10%	2.37	3,2
		5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Source: Authors' Estimate

4.2.2 The Short- and Long-Run Results

The result of the short-run relationship between EXR, CBNI and the selected drivers (XT and TOT), which is captured by the estimated co-integrated ARDL model, is presented in Table 5. This result shows that the autoregressive term is positive but not statistically significant, as the p-value is greater than 0.05. The short-run contemporaneous impact of CBNI on EXR is positive but statistically insignificant, as the p-values are all greater than 0.05. However, the impact of the first to the seventh lags of CBNI on EXR are positive and statistically significant. This outcome is against a-priori expectation, as CBNI appears to result in exchange rate depreciation in the short-run. The short-run impact of XT on EXR is mixed. Contemporaneously, the impact of XT on EXR is negative but statistically insignificant at 5 per cent. While this is similar for the first lag, second, third and fourth lags, however, are positive. The short-run impact of TOT on EXR is negative and statistically significant for but contemporaneous and lagged parameters. This is in line with a-priori expectations, which suggests that increased terms of trade increases net foreign exchange inflow, leading to currency appreciation. Finally, the speed of adjustment parameter (CointEq= -0.09) is negative and significant, implying that the variables are truly co-integrated, as a result, about 9 per cent of disequilibrium is corrected for every month.

Table 5: The Short-run Result

Dependent Variable: D(EXR)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
DLOG(EXR(-1))	0.20	0.14	1.41	0.17
DLOG(CBNI)	0.00	0.00	1.30	0.20
DLOG(CBNI(-1))	0.01	0.00	2.10	0.05
DLOG(CBNI(-2))	0.01	0.00	4.03	0.00
DLOG(CBNI(-3))	0.01	0.00	2.72	0.01
DLOG(CBNI(-4))	0.01	0.00	2.88	0.01
DLOG(CBNI(-5))	0.01	0.00	4.02	0.00
DLOG(CBNI(-6))	0.01	0.00	3.74	0.00
DLOG(CBNI(-7))	0.01	0.00	3.06	0.01
DLOG(XT)	-0.02	0.02	-0.88	0.39
DLOG(XT(-1))	-0.01	0.02	-0.56	0.58
DLOG(XT(-2))	0.08	0.02	3.65	0.00
DLOG(XT(-3))	0.04	0.02	1.53	0.14

DLOG(XT(-4))	0.00	0.03	0.04	0.96
DLOG(XT(-5))	0.07	0.03	2.52	0.02
D(TOT)	-0.01	0.00	-2.20	0.04
D(TOT(-1))	-0.01	0.00	-2.39	0.02
D(TOT(-2))	-0.01	0.00	-2.34	0.03
CointEq(-1)	-0.09	0.02	-5.29	0.00

Source: Authors' Estimate

The result of the long-run relationship between the EXR and CBNI is presented in Table 6. This result reveals that the impact of CNB Intervention (CBNI) on Exchange Rate (EXR) is negative but statistically insignificant. Here, the coefficient of -0.01 is statistically insignificant, as the p-value of 0.75 is smaller than 0.05. This finding raises questions about the need to sustain the interventions, given the impact it has on the external reserves of the country. Similarly, the impact of Terms of Trade (TOT) on EXR is negative and statistically insignificant, as the p-value its coefficient (-0.01) is 0.22. However, the long-run impact of external reserves (XT) on exchange rate suggests that reserves accumulation is consistent with currency appreciation. This, however, is the not the case in the short-run, as the short-run impact of external reserves on exchange rate is insignificant, both contemporaneously and for most of its lags. Terms of trade, on the other hand, appears to drive appreciation of exchange rate in the short run, though its impact on exchange rate in the long run is statistically insignificant.

Table 6: The Long-run Result

Dependent Variable: EXR				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(CBNI)	-0.01	0.05	-0.32	0.75
LOG(XT)	-0.91	0.28	-3.28	0.00
TOT	-0.06	0.05	-1.25	0.22
C	15.74	2.78	5.66	0.00

Source: Authors' Estimate

4.2.3 Discussion of Findings

The key finding of this study is that the foreign exchange intervention of the CBN has been effective in stabilizing the exchange rate in Nigeria. This outcome contradicts the works of Dayyabu et. al (2016) and Kayode et. al. (2021) but aligns with Adebiyi (2007). Nigeria's insatiable appetite for imported goods, to the detriment of enhancing local production, has continued to worsen the foreign exchange market pressure in the country. The efforts of the CBN to moderate the pressure through her direct intervention in the market has resulted in a flourishing parallel market, which continues to create room for arbitrage. Most of the foreign exchange injected at the Banks official windows end up in private pockets, which are eventually sold in the streets. The result is the widening gap between the official and black-market exchange rate. The interventions have also resulted in external reserves depletion, which has put the country just at the brink of meeting her international trade obligations, as revealed by various measures of reserves adequacy.

4.2.4 The Diagnostic Tests

The diagnostic tests of the ARDL model using the Breusch-Godfrey Serial Correlation LM Test, Breusch-Pagan-Godfrey Heteroskedasticity Test, and the Jarque-Bera Test for Normality are presented in Table 7. The result shows that the estimated models free of serial correlation, as the test, under the null hypothesis of "no serial correlation", has a F-statistic of 0.53, which is insignificant, with a p-value of 0.59. Similarly, the model is homoscedastic, as the F-statistic of the Breusch-Pagan-Godfrey Heteroskedasticity (1.74), conducted under the null hypothesis of "homoscedasticity", is insignificant, with a p-value of 0.08. Similarly, the residuals of he estimated model are normally distributed, as the Jarque-Bera statistic of 4.98, is insignificant, with a p-value of 0.08.

Table 7: Residual-Based Diagnostic Tests

Breusch-Godfrey Serial Correlation LM Test	
F-statistic	0.53
p-values	0.59
Heteroskedasticity Test: Breusch-Pagan-Godfrey	
F-statistic	1.74
p-values	0.08
Jarque-Bera Test for Normality of Residual	
Jarque-Bera	4.98
p-values	0.08

Source: Authors' Estimate

Finally, both the CUSUM points and the CUSUM of squares (Appendix 2 and 3, respectively) suggest that the estimated model is relatively stable, as the plotted CUSUM points appear to fluctuate randomly around zero (0) and lying within the control limits of 5 per cent confidence intervals, while the CUSUM of squares lies within the confidence bands.

V. Conclusion and Policy Recommendations

Against the backdrop of the prevailing instability in the foreign exchange market in in Nigeria, even in the face of enhanced intervention of the Central Bank in the market, this study was set to evaluate the impact of the foreign exchange intervention of the Central Bank of Nigeria on exchange rate movement in Nigeria. The study adopts the framework of a co-integrating autoregressive distributed lag (ARDL) model. Specifically, the ARDL model was estimated monthly data, spanning 2017M4 to 2022M6, and sourced from the statistical bulletin of the CBN. Findings from the study suggest that the CBN interventions in the foreign exchange market do not have significant impact on movement in exchange rate in Nigeria both in the short- and long-run. This finding raises questions about the need to sustain the interventions, given the impact it has on the external reserves of the country. However, the long-run impact of external reserves on exchange rate suggests that reserves accumulation is consistent with currency appreciation. This, however, is the not the case in the short-run, as the short-run impact of external reserves on exchange rate is insignificant, both contemporaneously and for most of its lags. Terms of trade, on the other hand, appears to drive appreciation of exchange rate in the short-run, though its impact of exchange rate in the long-run is statistically insignificant.

In line with the findings of this study, it is recommended that the CBN discontinues the interventions in the market, and rather explore better options of sustaining the net inflow of foreign capital to Nigeria. This may include providing foreign currency dominated securities, with very competitive naira-based interest rates, for retail investor. This would attract inflow of foreign exchange, for Nigerians both resident in the country and abroad, resulting in a moderation in the foreign exchange market pressure. In the interim, however, before a full ban on the Bank's intervention in the market, the Bank should explore ways of integrating the recently launched Central Bank Digital Currency (CBDC), called the e-Naira, to her existing cross-border payments, by leveraging the existing bilateral currency swap agreements of the Bank. This would enable effective monitoring of cross-border transactions local merchants who import from those countries, using foreign exchange interventions of the Bank. This would reduce the possibility of roundtripping, which has resulted in huge volumes of CBN foreign exchange ending up in the black-market.

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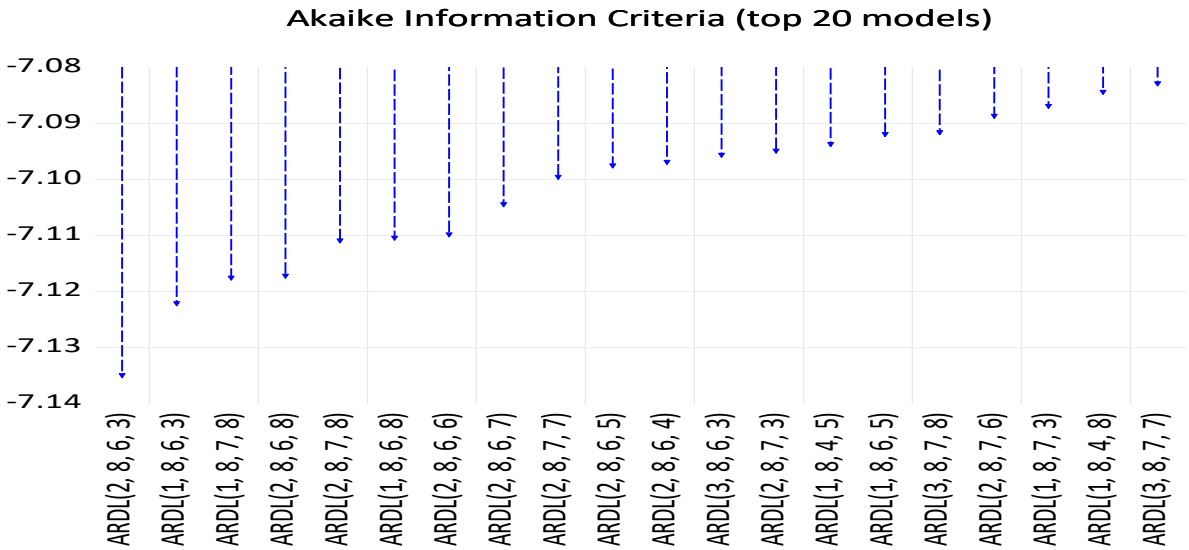
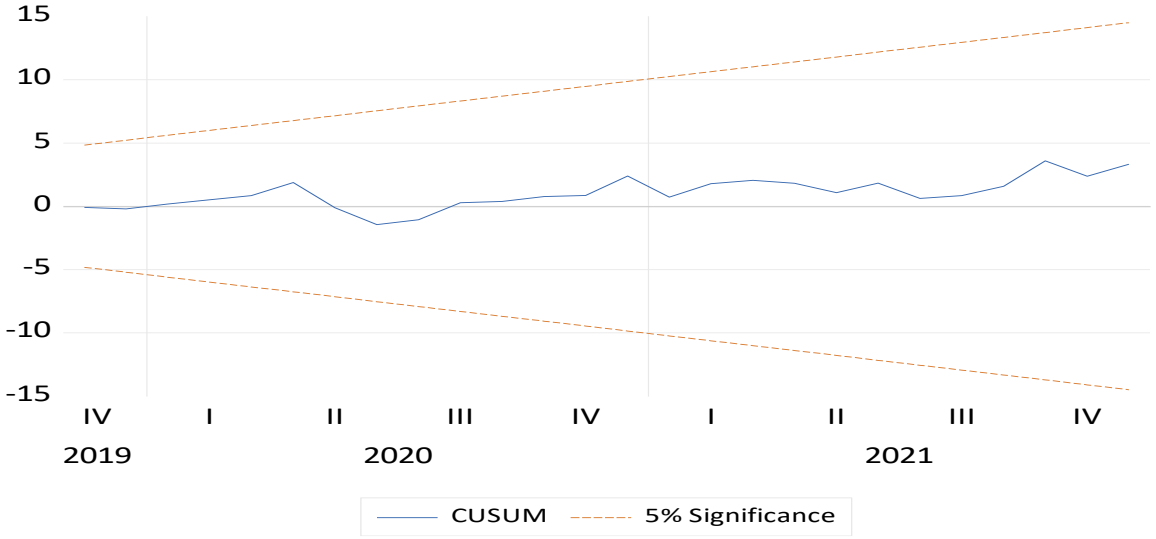
APPENDIX 1



APPENDIX 2: CUSUM Test



APPENDIX 3: CUSUM of Squares Test