MODELLING THE EFFECT OF THE CENTRAL BANK BALANCE SHEET POLICY ON DISAGGREGATED INFLATION IN NIGERIA: A NON-LINEAR ARDL APPROACH

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ABSTRACT
Since the onset of the global financial crisis, the central banks have deployed a wide array of unconventional monetary policy measures (including balance sheet policy) to support financial stability, provide further monetary policy accommodation or limit potential adverse effects from international capital flows. Several studies have been conducted on the subject matter but less attention has been given to the effect of the unconventional balance sheet policy on disaggregated inflation. The current study specifically investigates the effects of the unconventional CBN balance sheet policy on disaggregated inflation (changes in prices of Food & Non-Alcoholic Beverages; Housing Water, Electricity, Gas & Other Fuel; Clothing & Footwear; Transportation and Furnishing & Household Equipment Maintenance) in Nigeria for the period 1999 to 2020. Employing the recently developed Non-linear Autoregressive Distributed Lag (NARDL) model, the study showed some far reaching results as against the use of aggregate inflation. Specifically, the results showed that the central bank balance sheet expansion policy has long run positive and significant effect on food and non-alcoholic beverages inflation, housing, water, electricity, gas and other fuel inflation and transport inflation. This would inform policy decision as to which sector of the economy to invest the intervention funds of the Central Bank of Nigeria to enhance price stability, support economic growth and generate employment in the economy.

Keywords: Central Bank Balance Sheet Policy, Disaggregated Inflation, Non-linear ARDL

Jel Code: E51, E52, E58

1. INTRODUCTION

Globally, the pursuit of price stability and sustainable economic growth is the primary functions of the Central Bank. However, promoting sustainable economic growth is more pronounced in developing countries, due to lack of resources of the economies as well as the level of development in the developing countries. The central banks in developed countries have also been intervening in the various economic sectors in one way or the other. For example, the rebuilding of Germany after the Second World War was financed by the Bundesbank, the UK (1694), France (1800) and Spain (1874) (Epstein, 2006). From the 1990s, monetary policy framework changed with the emergence of primacy of price

stability objective. However, certain economic events such as the 2007/2009 Global Financial Crisis (GFC) have exposed the inadequacies of the conventional monetary policy tools to achieve the price stability and growth objectives. Hence, the need for the unconventional monetary policy measures such as central bank balance sheet expansion - quantitative easing, credit easing, and enhanced credit support to achieve the desired objective of price stability. Nevertheless, the unconventional monetary approach does not substitute the conventional monetary policy approach which according to Iorember et al (2021) and Iorember et al (2022) involves the conscious actions embarked upon by the Central bank of a country to influence the aggregate macroeconomic behaviour of the economy, through money supply and interest rate.

Since the onset of the global financial crisis, central banks have deployed a wide array of unconventional monetary policy measures, in addition to conventional interest rate cuts. With these balance sheet measures central banks aimed to either support financial stability, provide further monetary policy accommodation or limit potential adverse effects from international capital flows. As a consequence, central banks have experienced substantial changes in both the size and composition of their balance sheets (Borio and Disyatat, 2010). Central bank balance sheets around the world expanded dramatically during and after the GFC. While some monetary authorities successfully wound down their balance sheet operations post-GFC, others are still engaged in balance sheet expansion tools and facilities to support additional segments of the economy amid COVID-19 pandemic (Cantu et al. 2021). Though, economists are far from having a consensus on exactly how they work, what their long-run consequences may be and how long they should be continued (Bailey et al., 2020).

Bagus and Howden (2016) provided a quality of money-based theoretical foundation and rationale for analysis of central bank balance sheet. A central bank's balance sheet reflects changes to asset holdings or the quality of the assets backing a domestic currency. It is also an indirect measure of future monetary policy as the central bank's assets enable it to pursue its monetary policy objectives. There has been growing interest in central bank balance sheet analysis mostly due to response of monetary authorities to the 2007/8 global financial crisis and persisting shock to the global economy such as COVID-19 pandemic as central bankers have started to use compositional shifts of their assets directly for monetary policy.

Prior to the 2007/2009 GFC, the Central Bank of Nigeria's engagement in developmental activities via central bank balance sheet expansion were aimed at easing credit and bolstering growth. The Central Bank of Nigeria (CBN), therefore, had experience with unconventional policy measures prior to the 2007/09 GFC shock, however. It should be noted that the expansion of central bank balance sheets is only one aspect of unconventional policy measures. In the aftermath of the GFC, the CBN intensified these activities in line with unconventional monetary policy measures, as conventional measures alone had been ineffective in achieving the objectives of monetary policy. This was given statutory backing under section 31 of the CBN Act 2007 (as amended), the bank could engage in developmental functions. This became even more critical as developing the real sector of the Nigerian economy has been identified as a major panacea for employment generation and sustainable economic growth. It is against this backdrop that the size of the CBN balance sheet has continued to expand to intervene in priority sectors of the economy, particularly, the real sector (agriculture and manufacturing), infrastructure development and export promotion.

Similarly, the central bank acquires assets from the foreign sector (NFA) and claims on the domestic economy (NDA) and issues such liabilities as reserve money, comprising currency-in-circulation (CIC) and bank reserves that invariably constitute the two main means of payments (Kure, et. al., 2019). According to scholars, both assets and reserve money are influenced by the central bank, but equilibrium values are largely determined by the demand of counter parties, which arguably makes the balance sheet policies of the central bank partly endogenous. The NFA is the net amount of foreign assets that a country owns and is influenced by the trade balance, which fluctuates according to the dynamics of foreign trade, under full capital account mobility, and also domestic monetary policy. Claims on the domestic economy (NDA) comprise net lending to Government (GC), the banks, and non-financial private sector (CPS). Accordingly, any adjustment in these instruments modifies central bank's balance sheet. It increases the size in the case of a large purchase of traditional securities (quantitative easing) or changes its composition when the Bank acquires nonbanks securities (credit easing). It should be expected too that when the central bank finances its purchases with its liabilities, the resultant surge in bank reserves is expected to smoothen operations in the money market, facilitate inter-bank settlements and create a fulcrum for credit expansion, and promote economic growth.

Analysing developments in balance sheets across central banks can be an astute exercise. Accordingly, most of the analysis of the central bank balance sheets often remains limited to a discussion of total assets. However, such discussions are often reduced to qualitative discussions of recent policy measures. Because of the peculiarity in monetary authority operations, every central bank's balance sheet is different, showing both history and the peculiar operational structure in that economy (Doguwa & Essien, 2013; Iorember et al 2018). This study explored the empirical approach to the effect of central bank balance sheet expansion on disaggregated consumer prices in Nigeria.

Interest in the role of central bank balance sheets is typically low during tranquil times and high during financial crises (Caruana, 2012). Therefore, it is not surprising that the literature on central bank balance sheets has surged following the global financial crisis. However, discussions of central bank balance sheet policies are often hampered by inconsistent definitions as well as differences in central banks' operational frameworks (Borio and Disyatat, 2010; Jobst and Ugolini, 2014). In particular, there are differences in the design of central bank assets and liabilities that can affect the findings of a study of one central bank or group to be generalized to and across other banks, geography, situations, and times.

According to Stone, Ishi, & Fujita (2011), most of the unconventional balance sheet policies used by the central banks appear to have been somewhat effective, albeit to varying degrees. Thus, these apparent benefits must be weighed against the risks posed by the overlaps of these policies with other policy spheres. Also, there is no consensus on the monetary transmission of central bank balance sheet expansion, especially in the long run (Bailey et al., 2020; Behrendt, (2013), hence the empirical literature on the efficacy of unconventional balance sheet policy is incomplete and unclear.

This study therefore seeks to assess the effects of the unconventional CBN balance sheet policy on disaggregated inflation (changes in prices of Food & Non-Alcoholic Beverages; Housing Water, Electricity, Gas & Other Fuel; Clothing & Footwear; Transportation and Furnishing & Household Equipment Maintenance) in Nigeria.

The contributions of this study are two folds. First, the literature regarding the effect of unconventional monetary policy is active. For example, Kure, et al., (2019), Zakaree, et al.,

(2018), and Olowofeso, et al. (2014) conducted quantitative studies in Nigeria on the relationship between macroeconomic variables and the unconventional monetary policy indicators including the central bank balance sheet, however, their analysis focused mainly on the broad measurement of inflation. The current study investigates the impacts of enlarged central bank balance sheet policy on disaggregated inflation in Nigeria. The use of disaggregated inflation is considered important as it would aid policy makers in ascertaining the particular component that is driving the rise in inflation with the view of tackling it. Second, the current study adds to the extant literature by employing a non-linear approach (non-linear ARDL) rather than the conventional linear approaches applied in most of the studies. The application of the NARDL is suitable in this study given that the effects of the unconventional monetary measures on the economy are indirect. More so, there is the likelihood of asymmetries in both the procedures of disaggregated inflation and the unconventional monetary policy tools.

The rest of the study is organized as follows; section two deals with the literature review, section three focuses on the methodology and data; section four presents the results and discussion, and section five presents the conclusion and policy implications.

2. LITERATURE REVIEW (Theoretical and Empirical)

2.1 The Monetary Transmission Mechanism

 In theory, monetary policy can be transmitted through the economy in several channels: the interest rate, the bank credit, the balance sheet, the exchange rate, the asset price, and the expectations channels. The transmission of monetary impulses to the final variables had been regarded in a context that implicitly assumed a smooth functioning of financial markets. In such a context, monetary policy works by inducing changes in the prices of alternative financial assets which, in turn, give rise to shifts in expenditure among different periods or countries.

The 2007/2009 global financial crisis is the beginning of a chapter in the history of central banking, creating the path for unconventional monetary policy, to influence otherwise, dysfunctional financial markets (Kure, et. al., 2019). Unlike conventional monetary policies defined as routine management of interest rate and open market operations conducted in "normal times" (Borio & Disyatat, 2009), unconventional policies according to Fioreli and Meliciani, (2019) are all other actions carried out in "abnormal times", linked to balance sheet policy. UMP literarily expands the central bank's balance sheet, and/or shifts its asset portfolio holdings to non- treasuries that ultimately expose the Bank's balance sheet to different market risks (Caruana, 2012). The introduction of unconventional measures has had positive implications for the transmission of monetary policy both to financial markets and the real economy (Lenza, Pill & Reichlin, 2010). There are several empirical evidences for financial benefits (Altavilla, et al., 2014; Acharya, et al., 2016). The effects of the unconventional approach on the real economy are more visible and immediate, as the impact of these measures acts indirectly on macroeconomic variables including inflation (Fioreli & Meliciani, 2019). The monetary transmission mechanism theory is relevant to this study given that it tracks the effects of the unconventional monetary policy on macroeconomic variables such as inflation.

2.2 Empirical Literature

Inoue and Rossi, (2018) examines the effects of conventional and unconventional monetary policy in US covering the period January 1995 to June 2016 using impulse response under the Vector Autoregressive (VAR) model with functional shocks approach. The findings

show that unconventional monetary policy has similar effects to conventional expansionary monetary policy, leading to an increase in both output growth and inflation. Abhoff, Belke & Osowski (2021) conducted a study on the impact of unconventional monetary policy on inflation expectations in Europe over the periods of 2009–2018. The results of the study showed that an unanticipated unemployment (UMP) shock raises inflation expectations in the short-term. The scholars further emphasized that, as higher inflation expectations do not boost GDP nor realized inflation. Using a meta-analysis framework, Papadamou, et al., (2018) investigated how unconventional monetary policy practices exert on output and on inflation in European countries. The study relies on the Vector Auto regression (VAR) specifications and the results of the Factor-Augmented Vector Autoregressive model (FAVAR) indicated that increase output response in all horizons, whereas prices only in the short run. Furthermore, the findings showed that, estimates about European countries and sign restrictions in impulse responses negatively affect output.
Cole, (2018) conducted a study on the effectiveness of central bank forward guidance under inflation and price-level targeting using VAR framework. The study revealed that the effectiveness of forward guidance increases when a central bank pursues price-level targeting instead of inflation targeting. Furthermore, output and inflation respond more favorably to forward guidance with price-level targeting than inflation targeting.

In a study conducted in United Kingdom on the effect of quantitative easing (QE) and other unconventional monetary policies on inflation and wage expectations of manufacturing firms by Boneva, Cloyne, Weale & Wieladek, 2016 covering the period of 2008Q2 to 2014Q4 using fixed effects regression under the panel data models. The outcome of the study show that firms' inflation expectations increase in response to increase in QE, implying that inflation expectations are part of the transmission mechanism of QE. However, the study further revealed a positive but small and insignificant effect of forward guidance on inflation and wage expectations. Van den End, and Pattipeilohy (2017) empirically investigate the effect of credit easing on and inflation expectations and exchange rates in Japan using VAR model. The outcome of the study shows that changes in balance sheet size exert positive, although weak effects on inflation expectations while that of European area reveals a negligible result. However, an increase in balance sheet size is connected with reduced short-term inflation expectations in the US and UK. Importantly, composition have no ample effects on long-term inflation expectations in the European area, US and UK. Overall, expansion in balance sheet size is connected with a drop of the Euro, Pound Sterling and Yen.

Ciccarelli, Garcia, and Montes-Galdon, (2017) determine the effects of the unconventional monetary policy (UMP) measures undertaken by the U.S. Federal Reserve (and other major central banks) using Structural Vector Autoregressive (SVAR) models. To make the research robust, the scholars incorporate policy news that accounts for the predictable path of the balance sheet. The findings revealed that anchoring inflation expectations deteriorate significantly while expansion of the Fed's balance sheet contributed decisively to prevent and gradually reverse that de-anchoring during the great recession. In a cross-country analysis, Gambacorta, Hofmann and Peersma, (2014) conducted research on the effectiveness of unconventional monetary policy at the zero lower bound using a panel vector autoregression (VAR) with monthly data from eight advanced economies. The study findings indicate that an exogenous increase in central bank balance sheets at the zero lower bound leads to a temporary rise in economic activity and consumer prices. The impact on the price level is weaker and less pushy. For the outcome of individual country, there are no major differences in the macroeconomic effects of unconventional monetary

policies. Behrendt (2013) applied the impulse response functions, the Cholesky decomposition under the VAR framework to estimates the effects of unconventional monetary policies on the consumer as well as asset price inflation, economic activity, and bank lending, covering the episodes of balance sheet policies of 9 countries. The results of this study showed that the balance sheet policies, in response to a collapse of asset price bubbles, can ensure a short run stabilisation of economic activity but are not able to lift the economy out of the ensuing deflationary slump alone. Additionally, the outcome does not pose severe problems associated with inflation.

Aysun and Hepp, (2013) estimates the importance of the balance sheet and lending channels in monetary policy transmission in the US covering the period of 1995Q1 to 2009Q4 using the General Method of Moments (GMM) estimation strategy. Empirical results showed that the balance sheet channel is the main mechanism through which monetary policy shocks are transmitted to the economy and that the lending channel does not play a significant role. The study of Puonti, (2019) applied data driven structural BVAR to estimate the macroeconomic effects of the Bank of Japan's, the Federal Reserve's, and the European Central Bank's balance sheet operations covering the period of 2009M3 to 2014M5. The study findings revealed that an expansionary unconventional monetary policy shock to have different macroeconomic (output and price) effects in the three geographical areas. For instance, unconventional monetary policy shocks had a stronger output effect in the US and the euro area. The findings also show that unconventional monetary policy shocks lead to relatively larger output effects and weaker price effects than conventional monetary policy shocks. The submission of the scholar is that there is more evidence of the effectiveness of UMP measures in stimulating economic activity than in stimulating inflation.

Fratzscher, Duca, and Straub, (2016) examined the impacts generated by the unconventional monetary policy of the European Commission Bank using panel regression models. The study findings revealed that these unorthodox policies made beneficial impressions and positive spillovers on global financial markets in the short term with increasing asset prices, and reduced market fragmentation in bond markets while lowering the global price of risk. Chen, et al., (2016) estimated a global vector error-correction model (GVECM) to trace the spillover effects of the US quantitative easing (QE) on both emerging and advanced economies. They focused on the effects of reductions in the US term and corporate spreads and found effects of QE to be sizeable and vary across economies; estimated effects on the emerging economies were diverse but generally larger than those found for the United States and other advanced economies. These heterogeneous effects pointed to unevenly distributed benefits and costs of cross-border monetary policy spillovers.

In the studies of Gambacorta, *et. al.,* (2014), Meinusch and Tillmann (2016), Weale and Wieladek (2016) on the macroeconomic effects of the Fed's balance sheet operations using different Bayesian VAR specifications such as panel VAR, Qual VAR, and SVAR, respectively. Based on the outcome of the study, findings revealed that an expansionary *UMP* shock leads to a temporary significant rise in output and prices.
Miles and Schanz (2014) assessed whether shifts in the balance sheet of the central bank have a significant impact on real variables. The researchers created and calibrated a simple Overlapping Generation (OLG) model in which risk-averse households hold money and bonds to protect themselves from risk. The findings of the study revealed that the balance sheet has a limited effect and that its size is dependent on how fiscal policy is implemented. Other findings show that the portfolio balance channel is weak when tested in an

environment with normally functioning (but still incomplete) asset markets. According to the scholar, the study findings are relevant to those purchases because they could be unwound in a world in which financial markets are no longer dysfunctional.

Miyagawa and Morita (2013) assessed unconventional monetary policy of the Bank of Japan and confirmed that the monetary policy had contributed to the recovery of the prolonged deflation. The study found a quantitative-easing shock to increase transaction money that raised output and price, which dispelled the anxiety. Tatiana (2013) examined the impact of unconventional monetary policy measures adopted in developed countries (the US, UK, Euro Area and Japan) and developing economies (Brazil, China, India, and Russia), using a series of event studies. It was found that quantitative easing (QE) by the FED, BoE, ECB, and BoJ influenced long-term yields, equity prices, and possibly exchange rates, both in developed and developing countries.

Regarding Nigeria, Zakaree, et al., (2018), examined the effect of the Anchor Borrower Programme (ABP) on agricultural commodity prices and employment generation in Kebbi State, Nigeria. The study leveraged on the Ordinary Least Square (OLS) approach to analyse the data obtained through interview and structured questionnaire. The results depicted the existence of a positive and statistically significant impact of the ABP on agricultural commodity prices and employment generation in Kebbi State. The authors recommended that the Central Bank of Nigeria should increase its intervention programme to increase employment generation as well as stabilize agricultural commodity prices in Kebbi State.

In a study on the causes and effects of inflation in Nigeria using time series data between 1996 and 2009 and co-integration technique, Adeyeye and Kola (2012), observed that the conventional monetary and fiscal policies measures in Nigerian are ineffective because of the weak relationship among government expenditure, money supply and inflation. The study recommended the need for increased synergy between the monetary and the fiscal authorities as well as intensify institutional interventions with a view to avert unexpected and unplanned price reactions. Tule, Obioma, Okpanachi, Odeniran, and Olaoye (2015), investigated the relationship between money growth and inflation in Nigeria, including the impact on monetary policy in Nigeria, by testing the proportionality and orthogonality assumptions of the quantity theory of money. Growth in money supply was found to be a significant predictor of inflation, stressing, however, that the predictive power of broad money supply (M2) growth on inflation has waned. This weak relationship, they argued could be as a result of recent developments in the financial system such as new products and asset classes. Orimogunje (2017) and Nwala and Saleh (2021), argued that interventions through credits affect inflation.

Abeng, Itodo and Nwafor (2018) re-assessed the nexus between money supply and inflation. Their paper reassessed the traditional interaction between the traditional money supply and inflation within the framework of Fisher's equation but constrained the assumption of constant output level in order to reveal the level of asymmetry between the nexus under various levels of economic growth. The study leveraged the two-regime Threshold Autoregressive Distributed Lag (TARDL) technique and found that although money supply impacted positively and significantly on inflation during episodes of low economic growth, the reverse was the case during periods of high economic growth. Similarly, Amassoma, Keji and Emma-Ebere (2018), used the Co-integration and Autoregressive Dynamic Error Correction Model (ADECM) to evaluate the interaction between money supply and inflation in both the short-run and long -run using annual time

series data between 1970 and 2016. The outcome of the study depicts a weak influence between money supply and inflation in both the short-run and long-run, attributed to the likely impact of recession.

Ogunmuyiwa (2020), examined the impact of conventional monetary and fiscal policy management on inflation in Nigeria using the Autoregressive Distributed Lag (ARDL) on monthly time series data that ranged between January 2010-October 2016. The study found that broad money supply (M2) and capital expenditure were significant and positively related to inflation in both the short- and long-run, while exchange rate was significant and positively related to inflation only in the long-run.

From the reviewed empirical studies, it is established that none of the studies investigated the effect of the unconventional monetary policy on disaggregated inflation as done by this current study.

3. **METHODOLOGY**

3.1 Data
The study utilized time series data covering the period 1999 to 2020. The monetary and financial data is obtained from the CBN statistical bulletin/database and financial transaction administrative records. The GDP data is collected from the National Bureau of Statistics' (NBS) data portal, and the output gap is calculated using one of two widely used estimators: Christiano-Fitzgerald (1999; 2003) and Hodrick-Prescott (1981) filter detrending approaches.

Table 1: Definition and metrics of Variables and Parameters used in the Equations

No	Model code	Series Name	Metric of measurement	Data source
1	(BSP)	Central Bank balance sheet (asset)	Naira	CBN
2	(fb_INF)	Food & non-alcoholic beverages price level	index	NBS
3	(hwe_INF)	Housing, water, elect.& fuel price level	Naira	NBS
4	(cf_INF)	Clothing & footwear price level	index	NBS
5	(t_INF)	Transportation price level	index(percent)	NBS
6	(fhe_INF)	Furnishing & h/hold equip./maint. Price level	index	NBS
7	(GDP)	Actual output (GDP)	Naira	NBS/CBN
8	(GDP^p)	Potential output (GDP)	Naira	Estimated
9	(OG)	Output deviation (output gap)	Index (percent)	Estimated
10	(EXR)	Exchange rate (USD/NGN – BDC window)	Naira	CBN
11	(PMS)	Premium motor spirit (petrol) pump price	Naira	NBS

Source: Author's construction

Table 1 displays a list of all the variables in the model with their model symbols. It also displays the symbol's metric of measurement and data sources.

3.2 Model Specification

In order to address the research objectives, this section models the effect of central bank balance sheet policy on disaggregated inflation. The disaggregated inflation - balance sheet policy relationship is specified as;

$$dsg\_INF_t = f(OG_t, EXR_t, PMS_t, BSP_t) \qquad (1)$$

Where *dsg_INF* is the disaggregated inflation including food & non-alcoholic beverages; housing, water, electricity, gas & other fuel; clothing & footwear; transportation and furnishing; and household equipment/maintenance inflation. OG is output gap reflecting unemployment and economic activity, EXR is exchange rate, PMS is average fuel pump price which serve as a proxy of economic infrastructure, and BSP is central bank balance sheet policy that denotes supply of high-powered money and a form of unconventional monetary policy.

3.3 Method of Analysis

To achieve the objective of the study, we applied the asymmetric model to see the extent to which each innovation exhibits both increasing and decreasing effect on the CBN policy targets. The Nonlinear Auto-Regressive Distributed Lag (NARDL) is an extension of Pesaran and Shin (1999) and Pesaran et. al (2001), and applied by Usman et al (2021); . The NARDL model proposed by Shin, Yu, and Greenwood-Nimmo (2014) is a clear departure from the traditional co-integration, error-correction and the Granger Causality/Marginalisation framework that assumes symmetric relationship between the dependent and the explanatory variables. The NARDL model enables the assessment of the long-term association between the variables of interest including their short-run dynamics and symmetric (i.e. linear) relationship. Related, the NARDL has also been applied in monetary policy related studies (Goshit et al. 2020; Goshit and Iorember, 2020; Usman et al 2020). The literature exploring the non-linear cointegration includes, development of a threshold Error Correction Mechanisms (ECM) through Engle-Granger two-step procedure to test the threshold and cointegration relationship (Balke and Fomby,1997), the two error correction models through the Markov regime-switching process (Psaradakis, Sola & Spagnolo, 2007) and the Bayer and Hanck cointegration approach (Dabwor et al 2020; and Iorember et al 2020). These methods, however, are restrictive in the sense that the long-term cointegration is specified with the nonstationary variables in a linear form (Mert & Demir, 2015). In addition, there is a challenge in identifying the threshold variables to formulate the short-term and long-term dynamics at the same time (Shin, Yu, and Greenwood-Nimmo, 2011).

Therefore, Shin et al. (2014) NARDL framework, which simultaneously represents the asymmetries and cointegration dynamics in a single step and is also beneficiary to the cointegration test in small samples. Besides providing asymmetric cumulative dynamic multipliers to trace out asymmetric adjustment patterns of the positive and negative shocks, it relaxes the ECM requirement that the time series variables be integrated in the same order.

The general form of the NARDL model is presented in equation (5) as:

$$cT_t = a_i + \alpha x \pm \beta_j z + e \qquad (2);$$

where (cT) is the CBN monetary policy target (operational, intermediate, and ultimate targets), (a) is the vector of constant terms, (x) is vector of domestic output as control for domestic macroeconomic environment, while (z) is a vector of monetary innovations that

shares two long run identities – direct $(+\beta_1)$ and reverse $(-\beta_2)$ effect. Increasing in one effect and decreasing in another in the same variable (3.13).

$$+ z_t = \sum_{i=1}^{p} \Delta(+ z_i) = \sum_{i=1}^{p} max\,(\Delta z_i, 0) \qquad (3);$$

$$- z_t = \sum_{i=1}^{p} \Delta(- z_i) = \sum_{i=1}^{p} max\,(\Delta z_i, 0) \qquad (4);$$

The asymmetric effect of (z) can be summarized in case (3 and 4) as partial sums of the positive and the negative effects. Note that the long run parameters $(+\beta_1)$ and $(-\beta_2)$ move in the same direction with the policy targets, but the *a priori* magnitude switches when the impact reverses from negative to positive effect and vis-vasa.

4 RESULTS AND DISCUSSIONS

4.1 Trend Analysis
This section presents the visual properties of the time series (variables) employed in this study. The aim is to assess the behavior of the variables over time and check for the existence of possible drift, trend, seasonality and structural breaks. Figures 1 represent the time plot for the disaggregated inflation- balance sheet models.
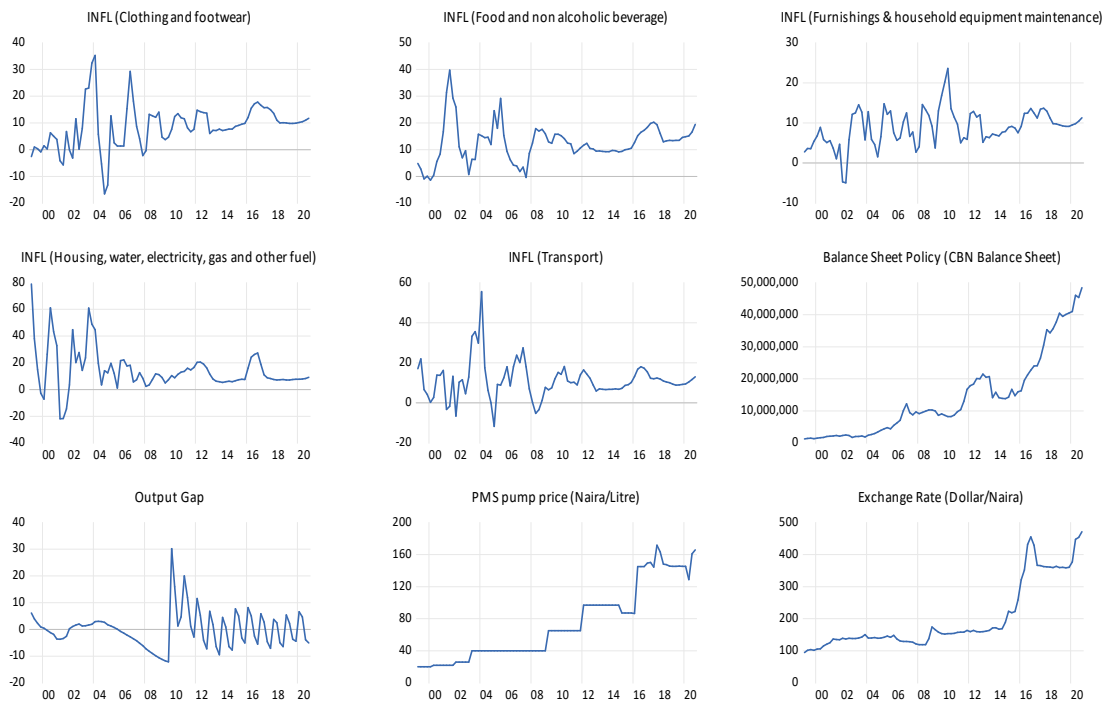
Figure 1: Historical movement of disaggregated inflation, balance sheet policy, output gap, PMS Price, and exchange rate (1991q1-2020q4)

Figure 1 depicts the movement of inflation variables, CBN balance sheet policy (BSP), output gap, price of Premium Motor Spirit (PMS)or fuel, and the exchange rate at the BDC window from 1991q1-2020q4. The first five graphs are for disaggregated inflations, and it is clear that the variables do not have a clear upward trend. While inflation for clothing and

footwear, food and non-alcoholic beverages, and transport all followed the same pattern, inflation for furniture and household equipment maintenance has a slight trend with a break around 2011. Balance sheet policy has been increasing over the decades; between the first quarter of 1999 and the last quarter of 2004, BSP increased by about 2.92 percent, and by the third quarter of 2013, it had increased by about 3.95 percent. Furthermore, by the end of 2020, BSP will have risen by about 5.1 percent.

The output gap reveals that the economy experienced greater slack around 2009, during the global financial crisis. In the aftermath of the global financial crisis, the Nigerian economy began to experience a correction that tends to exceed its long-run potential, but the final part of the movement followed a regular business cycle pattern. The PMS pump price has risen steadily over the years, but in a stepwise pattern; the price of PMS was more stable between the third and fourth quarters of 2003 and the fourth and final quarter of 2009. It became more expensive in the fourth quarter of 2017. The real exchange rate has an upward trend, indicating that the Naira has been losing value (depreciating) against the US dollar over the years.

More so, the figure showed that the inflation variables, which are the dependent variables, are most likely to be stationary around a mean. This implies that the regressors should be introduced into the model in a stationary form. There is, however, clear evidence that the balance sheet policy, PMS pump price, and exchange rate all exhibit a stochastic trend. Because this situation violates the cointegration principle, we must convert these three variables to percentages. As a result, all of the variables in the model, as well as the resulting error term, become stationary, allowing standard inferences to be made.

4.2 Descriptive Statistics

Table 2 presents the descriptive statistics of the variables used in the models for this study.

Table 2: Descriptive/Summary Statistics

	Mean	Max.	Min..	S.D
Inflation[1]	8.700	35.253	-16.537	8.254
Inflation[2]	12.549	39.722	-1.438	7.098
Inflation[3]	8.952	23.608	-4.929	4.502
Inflation[4]	13.650	61.147	-21.932	14.030
Inflation[5]	11.152	55.553	-11.721	9.140
Balance sheet policy (%)	4.196	34.806	-38.104	11.596
[+]Balance sheet policy (%)	6.826	34.806	0.000	7.273
[-]Balance sheet policy (%)	-2.630	0.000	-38.104	6.726
Output gap	-0.154	30.186	-12.172	6.786
Exchange rate (%)	1.850	23.618	-15.926	6.256
PMS pump price (%)	2.430	51.659	-12.061	10.541

More so, Table 2 shows the descriptive statistics of the variables used in both the symmetric and asymmetric ARDL models. Inflation[1] refers to clothing and footwear inflation, inflation[2] pertains to food and non-alcoholic beverage inflation, inflation[3] alludes to furnishings and household equipment maintenance inflation, inflation[4] is housing, water, electricity, gas, and other fuel inflation, and inflation[5] relates to transport inflation. In the asymmetric model, the positive and negative signs prefixing the balance sheet policy variables represent the positive and negative growth components that replace the original balance sheet policy

4.3 Unit Root Test

Prior to the estimation and analysis of the NARDL model, the study conducted unit root test on the variables using the Augmented Dickey Fuller (ADF) test to determine the stationarity properties of the series, and the results is presented in Tables 3.

Table 3: Unit root test result for the Disaggregated Inflation Models

Variable	t-Stat		remark
	c	c & t	
Inflation[1]	-4.132***	-5.222***	$I(0)$
Inflation[2]	-5.489***	-5.652***	$I(0)$
Inflation[3]	-4.294***	-4.577***	$I(0)$
Inflation[4]	-3.059**	-3.506**	$I(0)$
Inflation[5]	-5.451***	-5.446***	$I(0)$
Balance sheet policy (%)	-9.060***	-9.010***	$I(0)$
[+]Balance sheet policy (%)	-7.577***	-7.663***	$I(0)$
[-]Balance sheet policy (%)	-9.570***	-9.642***	$I(0)$
Output gap	-3.391**	-3.372*	$I(0)$
Exchange rate (%)	-6.291***	-6.333***	$I(0)$
PMS pump price (%)	-10.021***	-9.965***	$I(0)$

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$
Note: c (constant), t(trend)

The Augmented Dickey-Fuller unit-root test result is shown in Table 3. There are two types of tests: constant-only tests and constant-and-trend tests. The trend is included to account for any hidden underlying trend in the variables. The variables are stationary, as can be seen in Table 3.

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[1] Clothing and footwear inflation
[2] Food and non-alcoholic beverage inflation
[3] Furnishings and household equipment maintenance inflation
[4] Housing, water, electricity, gas and other fuel inflation
[5] Transport inflation

4.4 Asymmetric Effect Test

In order to determine the appropriateness of the approach to use (i.e between ARDL and NARDL), we conducted the asymmetry test to investigate the long-run and short-run asymmetric properties of the various models under study, and the result is presented in Table 4. The null hypothesis of the test is that the inclusion of partial sums of positive and negative changes in BSP is not significant (i.e., no asymmetries), and the alternative is that the decomposition of the changes matters (i.e., there is asymmetries). The hypothesis is functionally stated as;

$H_0: bsp_t^+ = bsp_t^-$

$H_1: bsp_t^+ \neq bsp_t^-$

Table 4: Result of the Asymmetrical Effect Test

		short-run (s)	long-run (l)	Remark
Model 1	F-stat	0.003	0.002	no asymmetric effect
	Prob.	0.959	0.961	
Model 2	F-stat	0.226	3.157*	*l* asymmetric effect
	Prob.	0.636	0.080	
Model 3	F-stat	0.001	0.001	no asymmetric effect
	Prob.	0.976	0.976	
Model 4	F-stat	4.356**	4.592**	*s* & *l* asymmetric
	Prob.	0.041	0.0036	effects
Model 5	F-stat	4.356**	6.312**	*s* & *l* asymmetric
	Prob.	0.041	0.014	effects

*** p < 0.01; ** p < 0.05; * p < 0.1, *s* and *l* stand for short-run and long-run respectively

The result of the asymmetry test in Table 4 shows that the null hypothesis of no asymmetry in the coefficient of BSP ($bsp_t^+ = bsp_t^-$) for models 1 and 3 cannot be rejected, implying that there are no asymmetries in the effect of BSP on inflation[1] and inflation[3]. That is, changes in balance sheet policy have symmetrical impact on clothing and footwear inflation, and on furnishing and household equipment maintenance inflation. Hence, it is more appropriate to adopt the estimates of the symmetric ARDL approach in testing the relationship. On the other hand, the null hypothesis of no asymmetry in the coefficient of BSP ($bsp_t^+ = bsp_t^-$) for models 2, 4 and 5 can be rejected, suggesting that there are asymmetries in the effect of BSP on inflation[2], inflation[4] and inflation[5]. That is, changes in balance sheet policy do not have symmetrical impact on food and non-alcoholic beverage inflation, on housing, water, electricity, gas and other fuel inflation, and on transport inflation. Hence, it is more appropriate to adopt the estimates of the asymmetric ARDL (NARDL) for these models and the results are presented in Table 5.

Table 5: Long and Short-Run Estimates (Asymmetric Effect)

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
bsp_t^+	0.049	-0.075	-0.020	0.379*	0.415***
	(0.147)	(0.114)	(0.090)	(0.207)	(0.098)
bsp_t^-	0.064	0.421*	-0.024	-0.194	-0.110
	(0.210)	(0.230)	(0.111)	(0.143)	(0.149)
exr_t	0.001	0.350*	-0.035	-0.075	-0.273
	(0.121)	(0.206)	(0.079)	(0.366)	(0.187)
$ogap_t$	0.125	-0.005	0.083	0.308	0.190**
	(0.117)	(0.083)	(0.120)	(0.241)	(0.094)
pms_t	0.360*	-0.016	0.399***	0.815*	0.671*
	(0.211)	(0.068)	(0.139)	(0.466)	(0.362)
Δinf_{t-1}	0.372***	0.181**	0.175*	0.381***	0.257**
	(0.108)	(0.091)	(0.103)	(0.091)	(0.100)
Δinf_{t-2}	0.121	0.483***	-	0.268***	0.330***
	(0.107)	(0.093)		(0.094)	(0.096)
Δinf_{t-3}	0.246**	-	-	-	0.504***
	(0.105)				(0.091)
Δbsp_t^+	0.032	-0.032	-0.009	0.272*	0.190**
	(0.095)	(0.046)	(0.042)	(0.155)	(0.077)
Δbsp_t^-	0.040	0.020	-0.011	-0.139	-0.094
	(0.134)	(0.044)	(0.050)	(0.101)	(0.129)
Δexr_t	0.000	-0.013	-0.017	-0.158	0.013
	(0.077)	(0.062)	(0.036)	(0.170)	(0.109)
Δexr_{t-1}	-	-1.000	-	0.213	0.302**
		(0.064)		(0.175)	(0.118)
Δexr_{t-2}	-	-0.167**	-	-0.221	-
		(0.065)		(0.170)	
Δexr_{t-3}	-	-	-	-0.454**	-

					0.179)
$\Delta ogap_t$	0.080	-0.002	0.039	-0.038	-0.031
	(0.068)	(0.035)	(0.054)	(0.143)	(0.093)
Δpms_t	0.053	-0.007	0.019	0.128	0.118*
	(0.050)	(0.029)	(0.029)	(0.083)	(0.063)
Δpms_{t-1}	-0.114**	-	-0.114***	-	-0.269***
	(0.051)		(0.039)		(0.078)
Δpms_{t-2}	-	-	-0.081**	-	-0.235***
			(0.031)		(0.064)
ΔECM_{t-1}	-0.637***	-0.419***	-0.466***	-0.718***	-0.856***
	(0.107)	(0.064)	(0.085)	(0.086)	(0.105)
constant	5.057***	5.935***	3.904***	8.170***	6.024***
	(1.041)	(0.960)	(0.792)	(1.422)	(0.982)
R^2	0.34	0.43	0.29	0.53	0.54
$s.e$	5.90	3.80	3.31	9.07	6.04
χ^2_{LM}	5.92[0.12]	0.30[0.58]	0.21[0.64]	0.27[0.60]	1.25[0.26]
χ^2_{ARCH}	6.56[0.11]	3.57[0.26]	0.06[0.81]	0.61[0.74]	0.53[0.47]

*** p < 0.01; ** p < 0.05; * p < 0.1

Note: Standard errors ( ) are corrected using HAC

[ ] contains probability value

The asymmetric ARDL results for the five inflation variables are shown in Table 5. The results shows that positive balance-sheet policy had a positive and significant impact on housing, water, electricity, gas, and other fuel inflation, as well as transportation inflation, in both the short and long runs. This corresponds to a priori expectations via the monetary supply transmission channel. The negative balance sheet policy, on the other hand, only has a significant long-run effect on food and non-alcoholic beverage inflation; there is no evidence that it has a significant short-run impact on disaggregated inflations.

In the long run, Naira rate depreciation causes a significant increase in food and non-alcoholic beverage inflation, possibly through imported food component transmission and consistent with prior analysis of exchange-rate depreciation and inflation (Imimole and Enoma, 2011; Monfared & Akin, 2017); however, only exchange rate lags play a significant role in determining the inflation rate. Evidently, the lags of exchange rate cause a decline in food and nonalcoholic beverage inflation as well as housing, water, electricity, gas, and other fuel inflation while contributing to a rise in transport inflation. In the long run, an increase in the PMS pump price has been shown to significantly increase all forms of inflation except food and non-alcoholic beverage inflation. This conforms to

expectations given that PMS is a major tradeable and consumption good in Nigeria. In the short run, the story is slightly different; only the rise in PMS pump price drives up transport inflation at the same time. Nonetheless, the PMS pump price lags play a significant role in lowering some of the inflation variables. For example, PMS pump price lags had a negative impact on clothing and footwear inflation, furnishings and household equipment maintenance inflation, and transport inflation, in that order. The error correction terms in the five models are correctly signed which suggest that disaggregated inflation rates in Nigeria adjust back to equilibrium after an exogenous shock, with approximately 41.9 percent to 85.6 percent corrected within a four-quarter period.

5. CONCLUSION AND POLICY IMPLICATIONS

The results of the study clearly indicate that the CBN's balance-sheet policy has significant effect on housing, water, electricity, gas and other fuel inflation, and on transport inflation. While the effect on the other components of disaggregated inflation such as clothing and footwear, food and non-alcoholic beverage inflation is not significant in the short-run. The implication of this finding is that the balance-sheet policy as an unconventional monetary tool can be applied to achieve short-term monetary policy objective of price stability, especially with respect to housing, water, electricity, gas and other fuel inflation, and as well as transport inflation. Further, this finding makes a case for the unconventional monetary policy towards addressing the current situation in Nigeria, where prices of housing, electricity, fuels, and transport are rapidly rising. Perhaps, the situation could be abated by the deployment of the balance-sheet policy. This finding reinforces the existence of the balance-sheet channel of monetary policy transmission in Nigeria which was previously established by Olowofeso et al (2014).

Regarding the long-run, the results showed that the CBN's balance-sheet policy has significant long-run effect on three disaggregated inflation – food and non-alcoholic beverage inflation; housing, water, electricity, gas and other fuel inflation; and on transport inflation, while the effect on the other components of disaggregated inflation such as clothing and footwear, and on furnishings and household equipment maintenance inflation is statistically not significant. This finding also reinforces the balance-sheet channel of monetary policy transmission in Nigeria. This finding is also consistent with *a priori* expectations via the monetary supply transmission channel. Further, the finding of significant long-run impact of the balance sheet policy on food and non-alcoholic beverage inflation, is very striking and deserves attention. This is because in recent times, food inflation has been one of the major drivers of inflation in Nigeria. This has been partly attributed to the prevailing insecurity situation in the country that deters farmers in some rural areas from accessing their farms. Evidently, the deployment of the unconventional monetary policy such as the balance sheet policy will contribute to controlling inflation.

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