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Impact of Monetary Policy Shocks on the Output Gap in Nigeria

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Abstract

The paper aims to answer the question on whether the output gap is influenced by the transmission of monetary policy shocks. For Nigeria, using database of time series data from the Central Bank of Nigeria and the National Bureau of Statistics (2002M01 to 2018M12), we estimate time series models using Generalized Method of Moments, Autoregressive Distributed Lag and Differenced Ordinary Least Squares estimation techniques. We analyze the empirical results of the 3 considered approaches and the impact of CBN development finance and the naira exchange rate shocks on output gap are found significant. The results, however, show that inflation and interest rate is insignificant in the determination of the output gap. We also identify exchange rate as a significant and relevant transmission channel for monetary policy.

Keywords: monetary policy, output gap, time series

JEL codes: E52, C32, C51, C52.

1. Introduction

The estimates of the unobservable output gap remain shrouded in methodological controversies, which subsequently result in uncertainties concerning what constitutes the most accurate measurements of the output gap. However, output gap arguably remains the most important macroeconomic indicator that provides the needed guide for decisions concerning the setting of monetary policy. The output gap imbeds valuable information regarding capacity on the supply side of the economy and how much aggregate demand can increase without generating inflationary pressures, which is an important piece of information for monetary policy decisions.

Conceptually, the output gap is appealing as a determinant of inflation developments. An overheating economy is indicated by a positive output gap, with accentuating inflationary pressures, which prompts an increase in the policy rate by the monetary authorities. On the flip side, a slack and deflationary pressure in the economy is indicated by a negative output gap, and the need for policy to reflate the economy through an expansionary monetary policy stance.

Estimates of the output gap play an important role in the monetary policy decision making process, and discussions about the Taylor rule or the link between the real economy and inflation, such that the policy decisions taken are informed by the measurement of the output gap, amongst others. In view of that, to formulate optimal monetary policy there's the need to gauge the state of the business cycle that shows the drift of the economy from its level of equilibrium. Though, McCullum (2001) argued against monetary policy responding strongly to the measured output gap, the output gap is equated to be a theoretically expedient approach of thinking about domestic economic pressures (Citu & Twaddle, 2003).

Monetary policy remains an effective macroeconomic management tool for stabilizing prices as well as for promoting real output growth. Towards this, the Central Bank of Nigeria (CBN) has designed and implemented several measures to manage prices and promote growth, albeit, with mixed outcomes and notable gaps, relative to the policy targets, which raises some questions on the efficacy of monetary policy (CBN, 2015). Broadly speaking, shocks or innovations in monetary policy take various forms; including the reconfiguration and use of existing instruments, developing new instruments, changing strategy, redesigning implementation framework, re-ordering goals and priorities, amongst others. Shocks in monetary policy, therefore, aim at ensuring that monetary policy remains effective; including the maintenance of macroeconomic stability, achieving

CPI-inflation shock dissipation, and remaining on a smooth growth path (Iorember et al., 2018).

While there are growing research efforts focused on evaluating the impact of the output gap as a precursor to shocks to monetary policy (Furlanetto, Gelain, & Sanjani, 2017; Onanuga, Tella, & Osoba, 2016; Smets, 1998), the converse case of the implications of monetary policy shocks to the output gap have not witnessed in-depth analysis in prior studies. This paper aims at filling this gap. In particular, the paper examines the relative influence of monetary policy shocks on the output gap for the Nigerian case. In other words, the study investigates the output path smoothening role of monetary policy and how monetary policy helps to counter the volatility of the growth path. Following this introductory remark, the remainder of the paper is structured as follows. Section 2 discusses related literature. Section 3 describes data and methodology. Section 4 presents results while Section 5 concludes the paper.

2. Literature Review

2.1 Monetary Policy Shocks

This study considers monetary policy shocks as innovations, including measures that complement and enhance the potency of the traditional instruments of monetary policy. Broadly, forms of monetary policy shocks include the adoption of heterodox policies like quantitative easing and credit easing, the use of discount window operations, standing facilities; and shocks in monetary policy communication, among others.

2.1.1 Heterodox Policy

- ***Quantitative Easing***

QE is an unconventional monetary policy instrument designed to shift emphasis from targeting quantitative to qualitative monetary variables. It essentially involves the purchase of large-scale assets of the Deposit Money Banks (DMBs) financed from the balance sheet of the central bank, substantially expanding central bank credit to the banking sector (Joyce et al., 2012) and (Joyce, 2012). First used by the Bank of Japan in the 1990s but with little success, QE became the most popular form of recent monetary policy shocks following the burst of the real estate bubble in the US in 2007/2008 (Joyce et al., 2012). QE operates by influencing short-term interest rates through OMO purchases or sale of securities held by the banks and hence, the ability of the banks to create new lending.

- ***Credit Easing (CE)***

Credit easing entails policy tools, which changed the size and structure of the balance sheet of central banks during the financial crisis (Bernanke, 2009). They were designed to provide easy credit to the financial markets during the crisis, and monetary accommodation to the economy to support rapid economic recovery when conventional monetary policy, at the zero-lower bound, failed to stimulate aggregate demand. The tools are broadly classified into three categories; credit accommodation to financial institutions, provision of liquidity for credit enhancement to the markets and purchase of longer-term securities. Credit easing in the context of this study looks at the Central Bank of Nigeria’s overt monetary financing and sovereign money creation and credit easing operations to unlock lending to the real sector and restore the expectations anchoring function of the monetary policy rate (MPR). The interventions are measures aimed at making cheap financing available to the real sector of the economy. Credit easing included provision of liquidity for credit enhancement to the markets, granting liquidity status to long-term debt instruments held by DMBs, and the targeted purchase of risky assets held by the DMBs (AMCON).

2.1.2 Interest Rate Corridor

The Interest rate corridor is a channel which defines the range of market interest rates for short-term lending to closely match the target rate or the central bank’s policy rate. It is the window between the overnight deposit (the floor) and lending (the ceiling) rates within which the value of the overnight market rate is expected to oscillate (Drobyshevsky, Kiyutsevskay, & Trunin, 2018, Bulut, 2015, Binici et al., 2013, Usman et al., 2021b). The deposit component of the interest rate corridor is administered through the standing deposit facility, while the lending component is administered through the standing lending facility. The interest rate corridor was designed to enhance the central bank’s liquidity management operations by encouraging market participants to trade among themselves around the anchor rate in the short-term money market. It also serves as a means by which excess liquidity can be removed from the system, while new liquidity could be injected when needed. In addition, it seeks to deepen the short-term money market, enhance and deepen the market and provide short-term rate stability. In this study, the corridor ceiling is the MPR of the CBN plus the standing lending margin (standing lending facility rate), while the corridor floor is the MPR of the CBN minus the standing deposit margin (standing deposit facility rate).

2.1.3 Money Supply

Money supply is the quantity of currency in circulation plus the amount of demand deposits (Adak, 2017). Generally, money supply is classified into narrow (M0 and M1) and broad money (M2, M3, M4, and M5). Narrow money includes coins and notes in circulation as well as their equivalents that are highly liquid, while broad money is narrow money plus short-term time deposits in banks, money market funds, and longer-term time deposits. However, what constitutes either of these components varies with countries. The broad money supply (M3) in the United States, for example, comprises M2 plus treasury bills, bonds and commercial paper (Maitra, 2018). In the OECD, broad money (M3) includes currency, deposit with an agreed maturity of up to 2 years, deposits redeemable at a notice of up to 3 months, repurchase agreements, money market funds, and debt securities up to 48 months (OECD, 2018). In the United Kingdom, the wide monetary base is defined as M0, which includes notes and coins in circulation with the public plus banks' till money and operational balances with the BoE (Bank of England, 2003).The CBN has two measures of money supply, the first being narrow money (M1) which is the aggregation of currency in circulation (CIC) with the non-bank public and demand deposits or current accounts in the banks (CBN, 2006). The second, broad money (M2) includes narrow money plus savings, and time deposits. It has however, added a new definition of money supply to include (M3), which comprises (M2) and foreign currency deposits (domiciliary accounts). The study adopts M3 as the working definition of money supply.

2.2 Output Gap

The output gap is a key notion in macroeconomics and policy making that measures the difference between the actual output (supply-side) and the production endowment or potential output i.e. the percentage deviation of current output from the natural output level (Svensson, 2000, Jahan & Mahmud, 2013). The derivation of the output gap is theoretically plausible; however, it remains one of the most debated themes in empirical studies. This is due to the biasness of estimates and absence of homogeneity in the measurement of potential output, which some authors argue is not observable (Borio, Disyatat, & Juselius, 2013 and Croitoru, 2016, Dabwor et al., 2022).

Notwithstanding, central banks (CBN inclusive) continue to rely on the policy reaction function of Taylor (2003) which *inter alia* is built on de-trending the cyclical component of actual GDP as a measure of potential output. As such, measures of the potential output require assumptions about how the economy works and are model-dependent. The basic idea is that, ceteris paribus, inflation tends to rise when output is above potential and falls when output is below potential (Iorember et al., 2018). In order to ensure the accurate approximation of potential output, the emerging literature like Borio, Disyatat, and Juselius (2013) and Scalone (2014), further refined it to include financial cycle and liquidity information, while others like Palumbo (2014) propose the setting of policy targets on unemployment rather than potential growth. Potential output is usually generated by de-trending or removing the cyclical component of the actual output using five methods: the linear trend method, quadratic trend method, Hordrick-Prescott (HP) filter, production function, and structural VAR (Satti & Malik, 2017).

Despite the criticisms, the current study aligns with the position that an empirical model should at least replicate co-movement in the data generating process of the group of variables and avoid methods of estimating the output gap that are sensitive to end-sample observations (Zeng, 2001; Satti & Malik, 2017). Moreover, the accuracy or otherwise of the measurement of the potential output will be absorbed in the monetary policy random shock as a measurement error, and this can be tested in the course of evaluating the model efficiency (Cochrane, 2011).

2.3 Empirical Review

Grigoli et al. (2015) in a study on output gap uncertainty and real-time monetary policy showed that only a small share of output gap revisions is predictable based on output dynamics, data quality, and policy frameworks. The results also revealed that for a group of Latin American inflation targeters the prescriptions from monetary policy rules are subject to large changes due to revised output gap estimates. This finding resonates with the findings of Vitor (2003) and Gerlach and Smets (1999) who established that a single goal of the central bank can facilitate the process of stablizing both inflation and the output gap. Alp et al. (2012) estimated an output gap measure for Turkey using the Bayesian framework. The results suggest that Turkey experienced a notable divergence between domestic and external demand with no sign of overheating for the whole economy in the post-Lehman crisis period. Under these circumstances, conventional monetary policy practice focusing solely on aggregate output gap may suggest policy prescriptions inconsistent with financial stability.

In Nigeria, Onanuga et al. (2016) examined the relationship between output gap uncertainty andmonetary policy rate in Nigeria from 1991 to 2014. Using the Generalised Method of Moments econometric technique, the empirical results indicate a significant relationship between output gap and monetary policy in Nigeria. Similarly, Iorember et al. (2021) examined the impact of monetary policy shocks on domestic output growth in Nigeria over the period 1981 to 2019, using ARDL and VECM Granger causality. The empirical results revealed that shocks in money supply have positive impact on domestic output growth in the long-run, while shocks in interest rate and exchange rate have negative impact on domestic output growth in the long-run. Furthermore, the results affirm a unidirectional causality from money supply to real gross domestic product, and from real gross domestic product and interest rate to exchange rate in Nigeria.

Employing the asymmetric ARDL model over the period 2000-2018, Goshit and Iorember (2020) found dissimilar long-run effects of tightening and easing the monetary policy shock (monetary policy rate on unemployment). While tightening the MPR had positive, elastic and statistically significant effect on unemployment, implying complete pass-through, easing the MPR had negative, inelastic and statistically insignificant effect on unemployment, suggesting incomplete pass-through. Similarly, the short-run effects of tightening or easing the MPR were dissimilar. Furthermore, the result of the cumulative multiplier indicated that the cumulative effects of tightening the MPR on unemployment dominated the cumulative effects of easing the MPR on unemployment in Nigeria. Similarly, Goshit et al. (2022) using the nonlinear ARDL, and the Hatemi-J causality tests established the presence of long-run and short-run asymmetries in the effect of monetary policy shocks on output growth in Nigeria.

Iorember et al. (2022) in a study on reconsidering the impact of monetary policy via interest rate, money supply, and financial inclusion on economic growth in Nigeria using the dynamic simulation autoregressive distributed lag (ARDL) model on quarterly data from 2004 to 2020 established that in the short run, only the effect of money supply on economic growth is statistically significant. However, in the long run, interest rate, money supply, and financial inclusion have statistically significant effects on economic growth. The results are supported by the plots of the dynamic simulated ARDL, where economic growth response is predicted at various time periods after forcing a ±1% change (positive and negative shocks) in interest rate, money supply, and financial inclusion.

Ajisafe et al. (2022) in a study on the effects of anticipated and unanticipated monetary policy on output in Nigeria employs the Autoregressive Distributed Lag (ARDL) model to estimate how anticipated and unanticipated monetary policy affects output in Nigeria. The results show that there exists a long run level relationship among anticipated and unanticipated monetary policy and output in Nigeria. The results also show that the effect of anticipated monetary policy is neutral on output while unanticipated monetary policy has a significant positive effect on output.

3. Research Methodology

3.1 Model Specification

This study adapts from the model developed by Grigoli et al. (2015) which looks at whether output gap can be predicted based on either country-specific characteristics or country's position in the business cycle at the time of the initial estimate:

$$\left|\bar{y}_{i,t|t+1} - \bar{y}_{i,t|t+7}\right| = \alpha + \beta X_{i,t|t+1} + \delta D_i + \varepsilon_{it} \quad (1)$$

Such that; $\left|\bar{y}_{i,t|t+1} - \bar{y}_{i,t|t+7}\right|$ denotes the absolute value of the cumulative output gap for country i at time t, α is the intercept, $X_{i,t|t+1}$ represents the matrix of variables including the set of covariates for country i at time t and measured at time t+1 (such as; absolute output gap_{t+1}, absolute real GDP growth_{t+1}, absolute world real GDP growth_{t+1}, real GDP growth_{t+1}, rents/GDP, inflation, inflation targeting and cyclical fiscal rule), D_i is a matrix including other time-invariant covariates measured at the most recent point of time, β and δ are the coefficients on these matrices (such as; member of OECD, LIC and small economy), and ε_{it} is a mean zero error term that captures unexplained heterogeneity.

However, this study differs from theirs in that it is a country specific study, specifically Nigeria and will drop most of the variables except for headline inflation rate in addition to interest rate proxy by monetary policy rate, Central Bank of Nigeria development finance and interbank exchange rate serving as monetary policy shock. Thus, this is formulated as:

$$\text{Output Gap}_t = \alpha + \beta\text{Inflation Rate}_t + \varphi\text{Interest Rate}_t + \phi\text{CBNDF}_t + \lambda\text{Log of Exchange Rate}_t + \varepsilon_t \quad (2)$$

Where; α , is the constant value of the model while, β, φ , ϕ and λ are the parameter estimates and ε is the error term as well as t been time. Data sourced from the database of the Central Bank of Nigeria and the National Bureau of Statistics for the period January 2002 to December 2018 based on data availability.

Also, this study will not consider the absolute value of the output gap but the growth rate of the output gap which was estimated using both the linear trend approach and the Hodrick-Prescott (HP) filter approach.

3.2 Estimation Techniques

Before the estimation of the monetary policy shock on the output gap in Nigeria first, the output gap is estimated and then the test for the stationarity of the variables in the model was carried out. Thus, the approaches employed in estimating the output gap are; the linear trend approach and the Hodrick-Prescott (HP) filter approach. The trend approach estimates;

$$LRGDP_t = \alpha_0 + \alpha_1 t + \mu_t \quad (3)$$

However, the estimated error term is taken as a proxy for the output gap. Also, following the HP filter approach, the trend value (taken as potential RGDP) was obtained from the filter process from which the output gap is calculated thus;

$$\left(\frac{LRGDP - Potential\ RGDP}{Potential\ RGDP} \right) *100 \quad (4)$$

It should be noted that the output gap from the trend approach is represented as output gap1 while the output gap gotten from the HP filter process is represented with output gap 2.

Therefore, to estimate the impact of monetary policy shocks on the output gap in Nigeria, three models were employed; the ARDL model, the General Methods of Moments (GMM) developed by Hansen (1982) and the differenced OLS were employed. These models have been used in literature are believed to have good predictive powers and are suitable for linear equations estimations (Usman et al., 2020; Iorember et al., 2022). GMM estimators choose the estimates that minimize a quadratic form of the sample moment conditions; it gets as close to solving the over-identified system of sample moment equations as possible but reduces to Method of Moments (MM) when the number of parameters equals the number of moment conditions. Furthermore, the system GMM addresses the simultaneous problem usually found in the explanatory variables by employing adequate instruments that are time-invariant (Musa et al., 2021; Usman et al., 2021b). This is justified given the researcher's suspicion of a likely simultaneity arising from the equilibrium condition from the money market as well as the application of the partial adjustment process. The GMM is a technique of estimating models by exploiting moment conditions. The GMM estimator is defined as:

$$\hat{\theta}_{GMM} = \arg min_{\theta} \left\{ \bar{m}(\theta)' W^{-1} \bar{m}(\theta) \right\} \quad (5)$$

where $\bar{m} = (\bar{m}_1, \bar{m}_2, ..., \bar{m}_n)$ and W is a weighting matrix which is chosen as;

$$W = \left(\frac{1}{T} \sum_{t=1}^{T} f(X_t, \theta) f(X_t, \theta)' \right)^{-1} \quad (6)$$

4. Results and Discussions

The results presented for the impact of the monetary policy shocks on the output gap in Nigeria follows the presentation of the unit root test results followed by the results of the estimated model.

4.1 Unit Root

The result of the unit root test is based on the three possible unit root test models such as; models with Intercept, Intercept and Trend and no Intercept and no Trend (None).

The results are presented in Tables 1-3, respectively. From Tables 1 and 2, it can be seen that there is a combination of variables with different integration order such that output gap 2, inflation rate and exchange rate are stationary at level (that is I(0)) while CBN development finance (CBNDF) and the Log of exchange rate are stationary after the first difference (that is I(1)) but output gap 1 reveals to be stationary after the second difference (that is I(2)). In Table 3, the unit root tests for the variables suggests only a combination of I(0) and I(1) such that; output gap 1 and output gap 2 are I(0) while inflation rate, exchange rate, CBN development finance (CBNDF) and the Log of exchange rate are I(1).

Table 1. Result of unit root model with intercept

Variables	I(0)	I(1)	I(2)	Conclusion
Output Gap 1	-2.132	-2.091	-7.627	I(2)
	(0.233)	*(0.249)*	*(0.000)*	
Output Gap 2	-4.159	-	-	I(0)
	(0.001)			
Inflation Rate	-2.614	-	-	I(0)
	(0.093)			
Interest Rate	-3.391	-	-	I(0)
	(0.013)			
CBNDF	-1.140	-7.174	-	I(1)
	(0.698)	*(0.000)*		
Log of Exchange Rate	-1.683	-9.898	-	I(1)
	(0.437)	*(0.000)*		

Source: Extract from results.

Table 2. Result of Unit Root Model with intercept and trend

Variables	I(0)	I(1)	I(2)	Conclusion
Output Gap 1	-2.032	-1.859	-7.718	I(2)
	(0.577)	*(0.669)*	*(0.000)*	
Output Gap 2	-4.114	-	-	I(0)
	(0.008)			
Inflation Rate	*-3.329*	-	-	I(0)
	(0.067)			
Interest Rate	-4.288	-	-	I(0)
	(0.005)			
CBNDF	-1.628	-7.188	-	I(1)
	(0.776)	(0.000)		
Log of Exchange Rate	-2.018	-9.934	-	I(1)
	(0.585)	(0.000)		

Source: Extract from results.

Comparing these results, only output gap 2 showed to be I(0) as well as CBNDF and the Log of exchange rate can be directly said to be I(1) variables while, inflation rate and interest rate are divided between been I(0) and I(1) whereas output gap 1 is seen to be divided along the lines of I(2) and I(0), as given in the results. Thus, it is concluded that; output gap 1 is taken as I(2), output gap 2 is I(0), inflation is taken as I(0) as well as Interest rate while CBNDF and log of exchange rate are taken as I(1).

Table 3. Result of Unit Root Model with no Intercept and no Trend (None)

Variables	I(0)	I(1)	I(2)	Conclusion
Output Gap 1	-2.099	-	-	I(0)
	(0.035)			
Output Gap 2	-4.177	-	-	I(0)
	(0.000)			
Inflation Rate	-1.594	-7.584	-	I(1)
	(0.104)	*(0.000)*		
Interest Rate	-1.541	-7.040	-	I(1)
	(0.115)	*(0.000)*		
CBNDF	1.362	-6.961	-	I(1)
	(0.956)	*(0.000)*		
Log of Exchange Rate	1.942	-9.472	-	I(1)
	(0.987)	*(0.000)*		

Source: Extract from results.

4.2 Estimation Results

There are two models that was used in the estimations such that one model uses the output gap 1 as dependent variable while the other model uses output gap 2 as dependent variable (as given by the different output gap approaches employed). The independent variables in the models are common and they include; inflation rate, interest rate, CBNDF and log of exchange rate. The result of the unit root for model one however has made the choice of estimation technique difficult. However, the differenced Ordinary Least Squares (OLS) technique was employed. The differenced OLS means that after the variables are difference a few times as required to bring it to stationarity, a simple OLS is estimated, as given in column 1 of Table 4. Followed by the differenced OLS are the estimates of the General Methods of Moments (GMM) and Generalized Linear Model (GLM) as robustness checks.

The diagnostic tests reveal that the included variables only explain changes in the double differenced output gap to the tune of 13.15% as seen in the R-squared while, considering the degree of freedom, they only explain 8.93% (Adjusted R-squared). Also, the F-statistics (3.118) and its probability (0.012) revels that all variables are jointly significant in explaining variations in the double differenced output gap. The first order autocorrelation test as prescribed by Durbin Waston presents that the model does not suffer from the type of serial correlation tested (1.93) as well as the second order serial correlation as given by the LM test in Table 5 (LM Test = 0.707; prob. = 0.496). The model is also free from heteroskedasticity (Test = 1.848; Prob. = 0.110) however, the residual of the model does not follow a normal distribution hence not normal (Jarque-Bera Test = 33.384; Prob. = 0.000).

Table 4. Result of the impact of monetary policy shock on output gap in Nigeria

Dependent Variable: Output Gap 1

Variables	**Differenced OLS**	**GMM**	**GLM**
D(D(Output Gap(-1)))	-0.280***		
	(-3.014)		
	[0.003]		
Inflation Rate	-1.520	0.0001	0.0004
	(-0.481)	(0.232)	(1.112)
	[0.631]	[0.817]	[0.266]
Interest Rate	0.000**	0.011***	0.009***
	(2.024)	(3.173)	(5.550)
	[0.046]	[0.002]	[0.000]
D(LCBNDF)	-0.001	0.010***	0.092***
	(-0.494)	(10.145)	(14.040)
	[0.622]	[0.000]	[0.000]
D(Log of Exchange Rate)	-0.007*	-0.154***	-0.144***
	(-1.906)	(-8.321)	(-13.649)
	[0.060]	[0.000]	[0.000]
Constant	-0.003*	-0.736***	-0.661***
	(-1.730)	(-5.436)	(-9.810)
	[0.087]	[0.000]	[0.000]

***, ** and * represents the level of significance at 1%, 5% and 10%, respectively.

() and [] represents the standard error and probability level.

Source: Extract from results.

The Differenced OLS is a serial correlation corrected model which justifies the inclusion of the lagged value of the dependent variables. It is shown that holding all factors constant, the average output gap stands at a negative of 0.003% which is significant at 10% level of significance. Also, the immediate past value of output gap is significant at 1% as it impacted the current level of output gap negatively by 0.28% of a unit increase. In slightly dissimilar manner, inflation rate, interest rate, CBN development finance and exchange rate do not exert any impact on the output gap in Nigeria such that a percentage change in inflation rate, CBN development finance and exchange rate reduces output gap by 0.000015%, 0.0014% and 0.0066%, respectively although inflation rate CBN development finance were not statistically significant, exchange rate showed 10% level of significance. However, interest rate increases output gap by 0.0003% and significant at 5% level of significance.

Table 5. Post-Estimation Test for Differenced OLS, GMM and GLM estimation techniques

Test	Differenced OLS	GMM	GLM
Normality: Jarque-Bera	33.384	3.089	
(Probability)	(0.000)	(0.214)	
Serial Correlation Test:	0.707	124.38	138.07
(Probability)	(0.496)	(0.000)	(0.000)
Heteroskedasticity Test:	1.848	-	-
(Probability)	(0.110)		
Stability Test (CUSUM)	Stable	-	-

Source: Extract from results.

The models suffer from serial correlation although the residuals are normally distributed in the case of GMM (Table 5).

For the second model in this analysis, the unit root results stipulates the possibility of ARDL model since the variables are a combination of I(0) and I(1). Hence, before proceeding to estimating the model, the Bounds approach to cointegration test is necessary to be carried out whose result is presented in Table 6. The result shows that there is long run relationship among the variables since the value of the F-statistics (6.215) is greater that the upper bound of the critical statistics (4.44) of the Persaran, Chinn and Smith table at 1% level of significance. Therefore, the ARDL model can be employed to estimate the parameters of the variables.

Table 6. Result of Bounds Test for ARDL

Test Statistic	Value	K
F-statistic	6.2150	4
Significance	I(0) Bound	I(1) Bound
1%	3.07	4.44

Source: Extract from results.

Table 7 presents the result of the short run of the ARDL model after eliminating the insignificant variables form the result. It suggests that in the short run, the last five lags (with the exception of lag 2) of the output gap are significant in explaining current variations in output gap. Thus, a percentage change in the output gap five periods ago brings an increase of 0.35% in current output gap at 1% level of significance. However, a percentage change in the output gap four periods ago brings a decrease of 0.41% in current output gap at 1% level of significance while, a percentage change in the output gap three periods ago brings about an increase of 0.165% in current output gap at 10% level of significance whereas, a percentage change in the output gap in the immediate past period brings an increase of 0.452% to current output gap at 1% level of significance.

Table 7. Short Run Result of the Impact of CB policy shock on output gap in Nigeria

Dependent Variable: Output Gap

Variable	Coefficient	t-Statistic	Prob.
D(Outputgap2(-1))	0.452	4.565	0.000***
D(Outputgap2(-3))	0.166	1.786	0.079**
D(Outputgap2(-4))	-0.410	-4.411	0.000***
D(Outputgap2(-5))	0.346	3.597	0.001***
D(Inflation)	-0.002	-2.278	0.026**
D(Inflation(-4))	-0.002	-1.853	0.069*
D(Int_Rate)	0.007	2.403	0.019**
D(Int_Rate(-3))	-0.010	-2.074	0.042**
D(Int_Rate(-6))	-0.008	-1.782	0.079*
D(Int_Rate(-7))	0.011	2.511	0.015**
D(Int_Rate(-8))	-0.008	-1.734	0.088*
D(Int_Rate(-11))	0.008	2.812	0.007***
D(LER)	-0.114	-4.232	0.000***
D(LER(-8))	-0.101	-3.808	0.000***
CointEq(-1)	-0.129	-3.647	0.001***

***, ** and * represents the level of significance at 1%, 5% and 10%, respectively.

() and [] represents the standard error and probability level.

Source: Extract from results.

In the case of inflation and interest rate, only the current period inflation rate as well as the inflation rate four periods ago is significant while, interest rate in the third period, sixth period, seventh period, eight periods and eleventh period were the only significant variables in explaining changes in the output gap. Howbeit, from the result, it is depicted that a percentage change in inflation rate and interest rate for these periods had little or no impact on the output gap in that the impacts from the changes in these variables are not different from zero. Nonetheless; these results are significant between 1% and 10% as seen in Table 7. The result of the error term reveals that at 1% level of significance, only 12.93% errors in the past are corrected in the current period.

The result of the long run model is presented in Table 8. As like the short run model, all the variables have dismissible impact on the output gap in Nigeria. This is suggested by the results presented for the variables such that a percentage change in these variables produced a zero or near zero impact on the output gap. Further, the CBNDF has a negative and insignificant impact meanwhile, inflation rate, interest rate and exchange rate have a positive impact but insignificant.

It is given that these variables explain 97.65% variation in the output gap. Considering the level of degree of freedom, 96.36% variation in output gap was explained by the included variables. It is also seen that the model is free from the first order serial correlation as observed from the statistics provided by the Durbin-Watson (2.107). Further, although the residual of the model is not normally distributed (Jarque-Bera= 47.075; prob.=0.000), the second serial correlation is not a problem (Test=0.507; Prob.=0.605) as well as not suffering from heteroskedasticity (LM Test=0.349; Prob.=0.9995) and the model reflects stability (in its CUMSUM and CUSUM Squared graph).

Comparing the result with that of GMM, it is observed that the same result is presented for inflation rate and interest rate where a percentage increase in inflation and interest rate made zero or near zero impact on the output gap. Also, the said variables are not statistically significant in explaining the output gap. However, the reverse is the case for CBNDF and the exchange rate. A percentage increase in the CBNDF made the output gap increase by 0.091% which is significant at 5% level of significance while at 10% level of significance, a percentage change in exchange rate makes the output gap reduce by 0.139% on the average. Thus, at 10% level of significance, when all variables are held constant, the output gap stands at 0.668%. The R-squared reveals that the variables were only able to explain 17.13% variation in the output gap whereas, only 14% variation in the output gap is explained when additional variable are added or removed from the model as shown in the adjusted R-squared. The Durbin-Watson statistics (2.27) puts it that there is no first order serial correlation in the model also, the Jarqu-Bera statistics (2.79) with its prob. (0.25) reveals that the residual is normally distributed however, the LM test (Test=164.25; prob.=0.000) portrays that there is the second order serial correlation in the model.

Table 8. Long Run Result of the Impact of CB policy shock on output gap in Nigeria

Dependent Variable: Output Gap 1

Variable	**ARDL**	**GMM**	**Differenced OLS**
			1.361***
	-	-	(14.859)
OUTPUTGAP2(-1)			[0.000]
			-0.273*
	-	-	(-1.745)
OUTPUTGAP2(-2)			[0.084]
			-0.210**
	-	-	(-2.296)
OUTPUTGAP2(-3)			[0.024]
	0.003	0.0004	-3.610
	(1.046)	(0.353)	(-0.146)
INFLATION	[0.299]	[0.725]	[0.884]
	0.005	0.009	0.0005
	(0.446)	(1.011)	(0.987)
INT_RATE	[0.657]	[0.314]	[0.326]
	-0.003	0.091**	
	(-0.076)	(2.234)	-
LCBNDF	[0.940]	[0.028]	
	0.007	-0.139*	
	(0.071)	(-1.957)	-
LER	[0.944]	[0.053]	

D(LCBNDF)	-	-	-0.013 (-0.567) [0.572]
D(LER)	-	-	-0.0903*** (-3.245) [0.002]
Constant	-	-0.668* (-1.747) [0.084]	-

***, ** and * represents the level of significance at 1%, 5% and 10%, respectively.

() and [] represents the standard error and probability level.

Source: Extract from results.

When the model is subjected to a differenced OLS (as given by the description of its unit root test), it is noted that only the lagged values of the output gap were statistically significance alongside the exchange rate however, inflation rate, interest rate and the CBNDF were not only seen to contribute next to zero impact on the output gap but also do not show statistical significance in explaining the output gap. At 5% level of significance, a percentage increase in the output gap three periods ago reduces current period's output by 0.21%. Similarly, the the output gap two periods ago, with a 1% increase, produced a reduction in current output gap by 0.27%. It is notable to express that a percentage increase in the immediate past period increases current period's output gap by over a percentage to stand at 1.36% which is significant at 1%.

Thus, the explanatory variables were able to explain 93.61% variation in the output gap as presented by the R-squared while, adjusting for the degree of freedom; the adjusted R-squared reveals that 93.23% of variation in output gap will be explained. Strikingly, the Durbin-Watson statistics (2.00) suggests that there is no first order serial correlation in the model as well as the second order serial correlation as presented by the LM test (Test=0.078; prob.=0.925) in Table 8 while, the model also passed the heteroskedasticity test (test=1.602; prob.=0.143) and the model through the CUSUM and CUSUM squared test showed the model is stable. Nonetheless, the residual of the model is not normally distributed as seen in the Jarque-Bera statistics (265.09) and its probability of (0.000).

Table 9. Post-Estimation Test for ARDL, GMM and Differenced OLS estimation techniques

	ARDL	**GMM**	**Differenced OLS**
Normality: Jarque-Bera	47.0752	2.7870	265.0937
(Probability)	(0.0000)	(0.2482)	(0.0000)
Serial Correlation Test:	0.5067	164.25	0.0782
(Probability)	(0.6049)	(0.0000)	(0.9249)
Heteroskedasticity Test:	0.3486		1.6025
(Probability)	(0.9995)		[0.1432]
Stability Test (CUSUM)	Stable		Stable

Source: E-Views Result, 2018.

5. Conclusion and Policy Recommendations

An economy is typically exposed to economic shocks originating within the domestic economy. In this context, it is reasonable to argue that the dynamic of the output gap can be linked with monetary policy induced endogenous shocks. Hence, the shock of stabilization policy is thus a practical concern for the monetary authorities. In this paper, we estimated output gap predicated on country-specific characteristics and documented that among the monetary policy shocks, the CBN's management of exchange rate exerts more influence to movements in Nigeria's output gap. Our main finding is that a percentage change in exchange rate makes the deviations of output from its natural level to reduce by 0.139% on the average. This implies that the exchange rate drive adjustments in relative prices, which in turn, influence domestic aggregate demand. Thus, in part, emphasizing the output gap channel of the central bank exchange rate management towards stabilizing domestic price level (Svensson, 1997). Consequently, it is preferable to implement a credible monetary policy regime to address a desirable national target objective gradually. The key point of this paper is to show that the monetary policy shock has important policy implications.

In the long run (relying on the GMM results), the results indicate that the management of exchange rate by the monetary authority is very crucial to close the output gap in the economy; in that as exchange rate depreciates, the amount by which the actual output falls short of its potential output expands. Therefore, it is imperative for the CBN to focus on the management of the exchange rate so as to help the economy reach its potential output. Whereas, monetary policy on inflation, interest rate and CBN development finance while possessing a positive effect on the output gap however, do not exert a prominent effect on output gap, while interest rate is insignificant in the determination of the output gap.

In the short run, similarly, the exchange rate is a prominent actor in determining Nigeria's output gap alongside the previous output gaps up to the fifth month. Hence, it stresses the importance of action of the monetary authority on making exchange rate stable so as to close up the gap between Nigeria's actual and potential output. When this is done, and the current output gap is reduced, it will decrease future gaps in output. Inflation has unrecognizable negative effect on the output gap, while interest rate has an unrecognizable but mixed effect on the output gap.

5.1 Limitation and Suggestions for Further Studies

One limitation of the study is the choice of the monetary policy shock. We used interest rate as a measure of monetary policy alongside inflation rate which could provide new insights. However, the problem with using interest rate as a measure of monetary policy in a country such as Nigeria with a huge percentage of unbanked people of financially excluded persons is that it may not be a correct proxy for monetary policy. Since the economy may not respond to shocks in the interest rate. We therefore suggest that, further studies in this area should consider more instruments of the monetary policy including money supply in examining the effect of monetary policy shocks on output gap.

References

Adak, N. K. (2017). Banks Cannot Either Multiply or Increase the Amount of Money or Create Deposits Without Backing of Matching Reserve; Only Central Bank Creates Money. Proceedings of *International Academic Conferences 5808261*, International Institute of Social and Economic Sciences. https://doi.org/10.20472/IAC.2017.33.001

Ajisafe, R. A., Adesina, K. E., & Okunade, S. O. (2022). Effects of Anticipated and Unanticipated Monetary Policy on Output in Nigeria. *African Journal of Economic Review, 10*(2), 40-55.

Alp, H., Ogunc, F., & Sarikaya, C. (2012). *Monetary policy and output gap: Mind the composition* (No. 1207). Research and Monetary Policy Department, Central Bank of the Republic of Turkey.

Bank of England. (2003). *Further details about M0 data.* Retrieved from https://www.bankofengland.co.uk/statistics/details/further-details-about-m0-data

Bernanke, B. (2009). *Financial regulation and supervision after the crisis: The role of the Federal Reserve*. A speech at the Federal Reserve Bank of Boston's 54th Economic Conference, Chatham, Massachusetts, October 23, 2009 (No. 483). Board of Governors of the Federal Reserve System (US).

Binici, M., Kara, H., & Özlü, P. (2016), Unconventional Interest Rate Corridor and the Monetary Transmission: Evidence from Turkey. *Central Bank of the Republic of Turkey Working Paper No:16/08*.

Borio, C., Disyatat, P., & Juselius, M. (2013). Rethinking potential output: Embedding information about the financial cycle. *BIS Working Papers,* no 404.

Borio, C., Disyatat, P., & Juselius, M. (2014). A parsimonious approach to incorporating economic information in measures of potential output. *BIS Working Papers*, No. 442.

Bulut, U. (2015). The Interest Rate Corridor as a Macroprudential Tool to Mitigate Rapid Growth in Credits: Evidence from Turkey. *Theoretical and Applied Economics*. *4*(605).

CBN. (2006). *How Does the Monetary Policy Decisions of the Central Bank of Nigeria affect You?* Part One, Monetary Policy Series, CBN/MPD/Series/02/2006.

Citu, F., & Twaddle, J. (2003). The output gap and its role in monetary policy decision-making. *Reserve Bank of New Zealand: Bulletin, 66*(1).

Cochrane, J. H. (2011). Determinacy and Identification with Taylor Rules. *Journal of Political Economy, 119*(3), 565-615. https://doi.org/10.1086/660817

Croitoru, L. (2016), Are we Systematically Wrong when Estimating Potential Output and the Natural Rate of interest? *Romanian Journal of Economic Forecasting, XIX*(2).

Dabwor, D. T., Iorember, P. T., & Yusuf Danjuma, S. (2022). Stock market returns, globalization and economic growth in Nigeria: Evidence from volatility and cointegrating analyses. *Journal of Public Affairs*, *22*(2), e2393. https://doi.org/10.1002/pa.2393

Drobyshevsky, S. M., Kiyutsevskaya, A. M., & Trunin, P. V. (2018). Scope of Interest Rate Policy of Central Banks [Возможности Процентной Политики Центральных Банков]. *Economic Policy, Russian Presidential Academy of National Economy and Public Administration, 4*, 42-61. https://doi.org/10.18288/1994-5124-2018-4-03

Furlanetto, F., Gelain, P., & Sanjani, M. T. (2017). Output Gap, Monetary Policy Trade-offs and Financial Frictions. *Norges Bank Research Working Paper No.8*. https://doi.org/10.2139/ssrn.2961667

Gaspar, V., & Smets, F. (2002). Monetary policy, price stability and output gap stabilization. *International Finance, 5*(2), 193-211. https://doi.org/10.1111/1468-2362.00094

Gerlach, S., & Smets, F. (1999). Output gaps and monetary policy in the EMU area. *European Economic Review, 43*(4-6), 801-812. https://doi.org/10.1016/S0014-2921(98)00095-6

Gorton, G., & Metrick, A. (2013). The Federal Reserve and Panic Prevention: The Roles of Financial Regulation and Lender of Last Resort. *Journal of Economic Perspectives, 27*(4), 45-64. https://doi.org/10.1257/jep.27.4.45

Goshit, G. G., & Iorember, P. T. (2020). Measuring the asymmetric pass-through of monetary policy rate to unemployment in Nigeria. *Nigerian Journal of Economic and Social Studies, 62*(3), 369-387.

Goshit, G. G., Jelilov, G., Iorember, P. T., Celik, B., & Davd-Wayas, O. M. (2022). Asymmetric effects of monetary policy shocks on output growth in Nigeria: Evidence from nonlinear ARDL and Hatemi-J causality tests. *Journal of Public Affairs, 22*(2), e2449.

Grigoli, F., Herman, A., Swiston, A., & Di Bella, G. (2015). Output gap uncertainty and real-time monetary policy. *Russian Journal of Economics, 1*(4), 329-358. https://doi.org/10.1016/j.ruje.2016.02.001

Iorember, P. T., Gbaka, S., Jelilov, G., Alymkulova, N., & Usman, O. (2022). Impact of international trade, energy consumption and income on environmental degradation in Africa's OPEC member countries. *African Development Review, 34*(2), 175-187. https://doi.org/10.1111/1467-8268.12629

Iorember, P. T., Jelilov, G., Alymkulova, N., & Gbaka, S. (2021). Analysis of the impact of monetary policy shocks on domestic output growth in Nigeria: Evidence from dynamic ARDL and VECM tests. *International Journal of Public Policy, 16*(1), 13-25. https://doi.org/10.1504/IJPP.2021.121955

Iorember, P. T., Jelilov, G., Alymkulova, N., & Yua, P. M. (2022). Reconsidering the nexus between monetary policy and economic growth in Nigeria: The role of interest rate, money supply, and financial inclusion. *International Social Science Journal, 72*(244), 339-351. https://doi.org/10.1111/issj.12324

Iorember, P. T., Usar, T., & Ibrahim, K. H. (2018). Analyzing inflation in Nigeria: A fractionally integrated ARFIMA-GARCH modelling Approach. *African Journal of Economic Review, 6*(1), 33-46.

Jahan, S., & Ahmed, S. M. (2013). What Is the Output Gap? *Finance and Development, 50*(3), 38-39.

Maitra, B. (2018). Determinants of Nominal Interest Rates in India. *Journal of Quantitative Economics, 16*(1), 265-288. https://doi.org/10.1007/s40953-017-0079-2

McCallum, B. T. (2001). Should Monetary Policy Respond Strongly to Output Gaps? *American Economic Review, 91*(2), 258-262. https://doi.org/10.1257/aer.91.2.258

Musa, M. S., Jelilov, G., Iorember, P. T., & Usman, O. (2021). Effects of tourism, financial development, and renewable energy on environmental performance in EU-28: Does institutional quality matter? *Environmental Science and Pollution Research*, 1-12. https://doi.org/10.1007/s11356-021-14450-z

OECD. (2018). *Broad money (M3) (indicator)*. https://doi.org/10.1787/1036a2cf-en

Onanuga, A. T., Tella, S. A., & Osoba, A. M. (2016). Uncertainty of Output Gap and Monetary policy Making in Nigeria. *Acta Universitatis Danubius. Œconomica, 12*(5).

Rudan, W., Bruce, M., & Javier, O. (2016). The Taylor Rule, Wealth Effects and the Exchange Rate. *Review of International Economics, 24*(2), 282-301. https://doi.org/10.1111/roie.12213

Sanusi, S. L. (2010). *Global Financial Meltdown and The Reforms in the Nigerian Banking Sector.* Public Lecture delivered at the Convocation Square, Abubakar Tafawa Balewa University, Bauchi.

Satti, A. U. H., & Malik, W. S. (2017). The Unreliability of Output-Gap Estimates in Real Time. *The Pakistan Development Review, 56*(3), 193-219. https://doi.org/10.30541/v56i3pp.193-219

Smets, F. (1998). Output Gap Uncertainty does it Matter for the Tailor Rule? *BIS Working Paper,* No 60. https://doi.org/10.2139/ssrn.850065

Svensson, L. E. (1999). Defining and Maintaining Price Stability. *NBER Working Paper 7276*.

Svensson, L. E. (1999). How should monetary policy be conducted in an era of price stability? In *New Challenges for Monetary Policy* (pp. 195-259). Kansas City: Federal Reserve Bank of Kansas City. https://doi.org/10.3386/w7516

Svensson, L. E. (2000). Open-economy inflation targeting. *Institute for International Economic Studies*, *50*(1), 155-183. https://doi.org/10.3386/w6545

Svensson, L. E. O. (1997). *Open-economy inflation targeting.* Forthcoming Reserve Bank of New Zealand, Discussion Paper, Wellington.

Taylor, J. B. (1993). Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series on Public Policy, 39*, 195-214. https://doi.org/10.1016/0167-2231(93)90009-L

Taylor, J. B. (1995). The Monetary Transmission Mechanism: An Empirical Framework. *Journal of Economic Perspectives*, *9*(4), 11-26. https://doi.org/10.1257/jep.9.4.11

Taylor, J. B. (1998). *The Robustness and Efficiency of Monetary Policy Rules as Guidelines for Interest Rate Setting by the European Central Bank.* Conference on Monetary Policy Rules, Seminar Paper No. 649, June 12-13, 1998. Stockholm, Sweden: Sveriges Riksbank and Institute for International Economic Studies.

Taylor, J. B. (1999b). The robustness and efficiency of monetary policy rules as guidelines for interest rate setting by the European central bank. *Journal of Monetary Economics*, *43*(3), 655-679. https://doi.org/10.1016/S0304-3932(99)00008-2

Taylor, J. B. (2001). The Role of the Exchange Rate in Monetary-Policy Rules. *American Economic Review, 91*(2), 263-267. https://doi.org/10.1257/aer.91.2.263

Taylor, J. B. (2002). The Monetary Transmission Mechanism and Evaluation of Monetary Policy Rules. In N. Loayza, & K. Schmidt-Hebbel (Eds.), *Monetary Policy: Rules and Transmission Mechanisms* (pp. 21-46). Santiago: Central Bank of Chile.

Turner, A. (2013). Debt, Money, and Mephistopheles: How Do We Get Out of This Mess? *Group of Thirty Occasional Paper 87*.

Usman, O., Iorember, P. T., & Jelilov, G. (2021b). Exchange rate pass-through to restaurant and hotel prices in the United States: The role of energy prices and tourism development. *Journal of Public Affairs*, *21*(2), e2214. https://doi.org/10.1002/pa.2214

Usman, O., Iorember, P. T., & Uzner, G. (2020). Measuring the pass-through of disaggregated energy prices in the US: Evidence from a nonlinear ARDL approach. *International Journal of Strategic Energy and Environmental Planning, 2*(3), 60-77.

Usman, O., Iorember, P. T., Jelilov, G., Isik, A., Ike, G. N., & Sarkodie, S. A. (2021a). Towards mitigating ecological degradation in G-7 countries: accounting for economic effect dynamics, renewable energy consumption, and innovation. *Heliyon, 7*(12), e08592. https://doi.org/10.1016/j.heliyon.2021.e08592

Van Lerven, F. (2016). Quantitative Easing in the Eurozone: a One-Year Assessment. *Intereconomics, 51*(4), 237-242. https://doi.org/10.1007/s10272-016-0608-9