Innovations

Empirics of the Relationship among Macroeconomic Fundamentals in Nigeria

Dr. Owen Affor Maku and Dr. B. O. Ishioro
Department of Economics, Delta State University, Abraka , Nigeria.

Corresponding Author: **Owen Affor Maku, PhD**

Abstract
Problem*: The inter-relationship between and/or among selected key macroeconomic and policy fundamentals such as the levels of output, exchange rate, price, money supply and interest rate have potent impact on the performance, growth pattern and economic stability and development of any economy. Over the years, the Nigerian economy has experienced significant and prolonged fluctuations and instability as a result of the movement of these fundamentals as they affect the economy.* ***Design/Methodology/Approach:*** *This study therefore took a concerted and an in-depth investigation of the inter-relationship and inter-linkages among these macroeconomic fundamentals using annual time series data from the Nigerian economy for the period 1981 to 2021. The Autoregressive Distributed Lag (ARDL) and other estimation techniques were adopted in testing for the long-run relationship among the variables.* ***Findings:*** *The results of the ARDL Bounds test affirmed that a long-run relationship exist among the selected macroeconomic indicators when output, price, interest rate and nominal exchange rate were used as dependent variables. Also, the price level and money supply exhibited more causal relationship among the macroeconomic fundamentals which authenticate further long-held-empirical-intuition of the relevant role these variable play in shaping policy outcomes for the economy.* ***Conclusion****: We concluded that price level and money supply exhibited more potent causal effects with the other macroeconomic fundamentals such as output, interest rate and exchange rate both in the short and long run. The existence of these relationships suggested the relative effectiveness of fiscal and monetary policy as regards the Nigerian economy given that their relative coefficients are greater than the other fundamentals in the various equations specified. Therefore, in order to maintain price stability so as to avoid inflationary pressures in the economy, the Central Bank and monetary authorities should design its monetary policy by targeting the rate of interest and its exchange rate structure. The study recommends that macroeconomic policies regulating each of these fundamentals should consider the related indicators both in the short and long-run periods. This will avert growth-reverting tendencies.*

Keywords: *1.Macroeconomic fundamentals, 2. Money supply, 3. Price level, 4. interest rate, 5. Exchange rate .*
JEL classifications: E51, E31, E43, E62, E52

1. Introduction

Different schools of thoughts ranging from the Classical economists, Monetarists, Keynesians and new Keynesians, and the proponents of the new growth theories have generated upsurge of heightening empirical interest in the assessment of the link and relationship existing among the various macroeconomic fundamentals in both advanced, developing, emerging and in somewhat stagnated economies. This is understandable, given the important role these fundamentals play in determining the performance and developments in the real sectors of the economy, including the behaviour of domestic inflation, real output, exports and imports. Among emerging market economies, this interest is further spurred by the fact that many countries have recently introduced changes in their monetary and exchange rate policies, moving to inflation targeting frameworks which operate officially under flexible exchange rate regimes.

The dynamics and anatomy of the relationships among these macroeconomic fundamentals have always been in the spotlight of macroeconomic theorizing and policy design. The reason for this is not far-fetched . First, the performance of each of the fundamentals and their inter-relationships have formed the pedestal of the study of macroeconomic analysis. Second, the existence of different schools of thoughts and their multi-variate opinions is a major and tenable reason for the diverse views held by different researchers. A group of researchers may be interested in investigating whether the Keynesian views of the economy should be supported and upheld while the other group could be interested in investigating whether Monetarist theory should be applied to an economy when studying these fundamentals. A section of few could be interested in a macroeconomic thematic issue such as: whether inflation is a monetary phenomenon (Grauwe and Polan, 2005) or whether it is connected to the real economy and economic growth (Herwartz and Reimers, 2006). In relation to the aforementioned scenarios, this study thus focuses on investigating the anatomy of the potential relationships between interest rate, money supply, price level, exchange rate and output for a small open economy like the Nigeria economy with a concrete motive of finding out definite implications of its interactions in order to proffer policy recommendations for macroeconomic policy design and implementation.

2. Literature Review

2.1 Theoretical Perspective

These macro fundamentals include but not limited to real output, price level, interest rate, money and exchange rate. As adjudged in most macroeconomic and other empirical studies, these five variables form the basis of macroeconomic objectives, which would further generate ten (10) possible relationships among the fundamentals as illustrated in table 1.

Table 1: Pairs of variables with potential relationships

Variables	Output	Price level	Interest rate	Money supply	Exchange rate
Output	Not Applicable	Output vs. Price level	Output vs. Interest rate	Output vs. Money supply	Output vs. Exchange rate
Price level	Output vs. Price level	Not Applicable	Price level vs. Interest rate	Price level vs. Money supply	Price level vs. Exchange rate
Interest rate	Output vs. Interest rate	Price level vs. Interest rate	Not Applicable	Interest rate vs. Money supply	Interest rate vs. Exchange rate
Money supply	Output vs. Money supply	Price level vs. Money supply	Interest rate vs. Money supply	Not Applicable	Money supply vs. Exchange rate
Exchange rate	Output vs. Exchange rate	Price level vs. Exchange rate	Interest rate vs. Exchange rate	Money supply vs. Exchange rate	Not Applicable

Source: Compiled by Authors

There are different schools of thoughts with different plausible explanations concerning the relationship existing among the fundamentals. This relationship has been decomposed into output versus price level, output versus interest rate, output versus money supply, output versus exchange rate, price level versus interest rate, price level versus money supply, price level versus exchange rate, interest rate versus money supply, interest rate and exchange rate and money and exchange rate. Few of these relationships are discussed below in the empirical review section.

2.2 Empirical Review

Output versus Price level Relationship

The Friedman's hypothesis is one of the first theoretical propositions that posits that higher nominal inflation raises inflation uncertainty (Frieman,1970). The proposition tends to remain within the confines and ambits of traditional macroeconomics which investigates the relationship between inflation and growth without reference to inflation uncertainty and growth uncertainty (Drukker, Gomis and Hernandez-Verme , 2005; Omay and Kan, 2010; Macchiarelli , 2013; Kremer *et al.,* 2013 and, Eggoh and Khan 2014; Baglan and Yoldas , 2014 ; Ndoricimpa , 2017). However, based on the arguments of the Phillips curve and output gap (defined and described as the difference between actual and potential output), it is presumed that there exist a direct relationship between

inflation and output growth. The underlying reasoning is that if actual output rises above potential output, this will create an upward pressure on wages in the labour market, implying that higher wages, will lead to higher production costs and hence higher prices (Gerloch and Smets ,1999; Mallik and Chowdhury , 2001). On the other hand, with regards to assumptions of real business cycles, it is asserted that inflation negatively affects growth. This is on the theoretical basis that supply shocks (and not demand shocks), are responsible for the inverse relationship, as supply shocks render prices counter-cyclical while demand shocks causes pro-cyclical movements or oscillations in prices towards output (Ball and Mankiw, 1994; Judd and Trehan , 1995; Den Haan and Wouter , 2000).

Output versus Interest rate Relationship

All major economic schools of thought, namely classical (Ricardo, 1817), neoclassical (e.g. Marshall, 1890), Keynesian (Hicks, 1937; Tobin, 1969), monetarist (Brunner and Meltzer, 1971; Friedman, 1970), new classical and 'neo-Wicksellian' (Woodford, 2003), as well as post-Keynesian (Lavoie, 1995), Austrian (Garrison, 1989) and some ecological economics (Horowitz, 1996; Baum, 2009) claim that lower rates stimulate economic growth and vice versa. The same claim is frequently made by central banks.

Within the context of Keynes' theory, investment is assumed to vary inversely with interest rate. This implies that, low interest rates are associated with high investment and high interest rates with low investment. However, business cycles show a two-way relation between business investment and interest rates. The accelerator theory for instance explains both the direct and the inverse relationship between investment and interest rates through income dynamics, such that it would shift the IS curve either to the left or right. As a result, the interest rates will be high when investment is high and vice versa implying that the depressing effect of low output on investment, working through the accelerator, dominates the stimulative effect of low interest rates on investment, at least in the short-run.

Output versus Money supply Interconnectivity

Mckinnon (1973), Shaw (1973), Mathieson (1980), Odedokun (1996), Levine (1997) , Asogu (1998) and other scholars have expressed varied views concerning the linkage between money supply (M2) and output. The Monetarists argue that the changes in the amount of money lead to unexpected changes in nominal income because of the stability of money demand function. Friedman hypothesis assumes that it is the most stable function while the Keynesian theory assumes that the role of money supply is very limited because of the liquidity trap and the low level of the investment elasticity of interest, such that the positive changes in income would lead to a rise in money demand for transactions (meaning that the direction of causality comes from income to money and not the opposite) (Nelson , 2002; Ravn, Psaradakis and Sola , 2005; Favara and Giordani , 2009 ; Canova and Menz , 2011; Caraiani, 2016).

Output versus Exchange Rate

Exchange rate determination theories (including the monetary approach to exchange rates) posit that higher output growth rates in a country would lead to an appreciation of its domestic currency. For some periods, changes in the NEER and output would lead to the appreciation of the naira when output growth rates are higher and, would lead to the depreciation of the naira when the output growth rates are lower .

These theoretical underpinnings highlighted show the connections/interrelatedness among the selected macroeconomic fundamentals as they interact either in the short run or long run , or both short and long-run periods to produce the desired resultant outcomes for the economy. Exchange rates, inflation rates and rates of interest are indispensable variables of macroeconomics which can change the growth pattern and direction of economic stability, growth and / or development in a country (Morosan & Zubas, 2015).

3. Materials and Methods

3.1 Data sources and description

Annual time series data on the macroeconomic fundamentals; output, price, interest rate, money supply and exchange rate were generated from the Central Bank of Nigeria Statistical Bulletin, 2022 edition and the World Bank World Development Indicators (WDI) for the period 1981-2021. Output, measured by the index of industrial production (OUTPUT); price, measured by consumer price index (*price*); interest rate (INTR), money supply

($M2$), and exchange rate; measured by the nominal effective exchange rate ($NEER$) were adopted for this study. Table 2 presents a short description of the variables as used in the analysis.

Table 2: Nomenclature and Description of Variables

S/N	Variable	Symbols	Conceptual/Operational Definition	Unit of measurement
1	Output	OUTPUT	Output proxied as Index of Industrial Production (IIP) represents an index which shows the growth rates in different industry groups of the economy in a stipulated period of time.	weighted average
2	Price	price	Price as proxied by consumer price index measures of changes in the purchasing-power of a currency and the rate of inflation	weighted average of prices
3	Interest Rate	INTR	Interest rates are the costs of capital	Percentage
4	Money Supply	M2	Money supply is represented by broad money supply (M2) is defined as the entire stock of currency and other liquid financial instruments circulated in an economy at a particular point in time	N' Billion
5	Exchange Rate	NEER	Exchange rate proxied by nominal effective exchange rate (NEER) refers to an unadjusted weighted average rate at which one country's currency exchanges for a basket of multiple foreign currencies. It measures a country's international competitiveness in terms of the foreign exchange market	Index

Source: Author's compilation

NOTE: Fundamentals are expressed in logarithmic forms

3.2 Estimation Technique

Unit Root Tests

We adopted the Augmented Dickey-Fuller,ADF (Dickey and Fuller, 1979), Phillips-Perron, PP (Phillips and Perron 1988), and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) tests in the determination of the order of integration of the selected fundamentals (Gujarati, 2004; Ishioro,2022a; Ishioro, 2022b; Ishioro,2022c and Ishioro, 2022d).

Cointegration Test

Once the series have a unit root it is necessary to verify the existence of cointegration (Ishioro, 2022b). If a time series variable has a unit root, the first differences of such time series are stationary and they are known to be integrated of order one or I(1) (Bahmani-Oskooee,1998; Ishioro and Maku, 2022).

Autoregressive Distributed Lag (ARDL) Testing Procedure

Pesaran and Shin (1995),and Pesaran *et al.* (2001) advanced a new estimation technique known as Autoregressive Distributed Lag (ARDL) test for cointegration. ARDL test has the advantage of disregarding the order of integration of the series (Ishioro, 2017). Furthermore, Pesaran and Shin (1995) demonstrated that estimates based on ARDL are super-consistent, and valid inferences on the long-run parameters can be drawn using the standard normal asymptotic theory as it provides both long-run cointegration and long-run coefficients. But this is not the case with the two-step cointegration method like Engle and Granger (1987).

We established the existence of the long-run relationship between the underlying fundamentals using F-test on the joint null hypothesis that the coefficients of the lag levels of the variables are jointly equal to zero, against the alternative that they are jointly different from zero; that is:

$H_0 : \varpi_1 = \varpi_2 = \varpi_3 = \varpi_4 = \varpi_5 = 0$ against the alternative one;

$H_1 : \varpi_1 \neq \varpi_2 \neq \varpi_3 \neq \varpi_4 \neq \varpi_5 \neq 0$ for $i = 1,2,3,4,5$.

Therefore, the ARDL adopted for this study is specified as;

$$D(\ln(OUTPUT_t)) = \varpi_0 + \varpi_1 \ln(OUTPUT_{t-1}) + \varpi_2 \ln(\Pr ice_{t-1}) + \varpi_3 \ln(INTR_{t-1}) + \varpi_4 \ln(M2_{t-1}) + \varpi_5 \ln(NEER_{t-1}) + \sum_{t=1}^{m} \ell_{1i} D(\ln(OUTPUT_{t-i}))$$

$$+ \sum_{t=1}^{n} \ell_{2i} D(\ln(\Pr ice_{t-i})) + \sum_{t=1}^{n} \ell_{3i} D(\ln(INTR_{t-i})) + \sum_{t=1}^{n} \ell_{4i} D(\ln(M2_{t-i})) + \sum_{t=1}^{n} \ell_{5i} D(\ln(NEER_{t-i})) + \varepsilon_{1t} \quad (1)$$

$$D(\ln(price_t)) = \varpi_0 + \varpi_1 \ln(price_{t-1}) + \varpi_2 \ln(OUTPUT_{t-1}) + \varpi_3 \ln(INTR_{t-1} + \varpi_4 \ln(M2_{t-1}) + \varpi_5 \ln(NEER_{t-1}) + \sum_{t=1}^{m} \ell_{1i} D(\ln(price_{t-i}))$$
$$+ \sum_{t=1}^{n} \ell_{2i} D(\ln(OUTPUT_{t-i})) + \sum_{t=1}^{n} \ell_{3i} D(\ln(INTR_{t-i})) + \sum_{t=1}^{n} \ell_{4i} D(\ln(M2_{t-i})) + \sum_{t=1}^{n} \ell_{5i} D(\ln(NEER_{t-i})) + \varepsilon_{2t} \quad (2)$$

$$D(\ln(INTR_t)) = \varpi_0 + \varpi_1 \ln(INTR_{t-1}) + \varpi_2 \ln(OUTPUT_{t-1}) + \varpi_3 \ln(price_{t-1} + \varpi_4 \ln(M2_{t-1}) + \varpi_5 \ln(NEER_{t-1}) + \sum_{t=1}^{m} \ell_{1i} D(\ln(INTR_{t-i}))$$
$$+ \sum_{t=1}^{n} \ell_{2i} D(\ln(OUTPUT_{t-i})) + \sum_{t=1}^{n} \ell_{3i} D(\ln(price_{t-i})) + \sum_{t=1}^{n} \ell_{4i} D(\ln(M2_{t-i})) + \sum_{t=1}^{n} \ell_{5i} D(\ln(NEER_{t-i})) + \varepsilon_{3t} \quad (3)$$

$$D(\ln(M2_t)) = \varpi_0 + \varpi_1 \ln(M2_{t-1}) + \varpi_2 \ln(OUPUT_{t-1}) + \varpi_3 \ln(INTR_{t-1}) + \varpi_4 \ln(price_{t-1}) + \varpi_5 \ln(NEER_{t-1}) + \sum_{t=1}^{m} \ell_{1i} D(\ln(M2_{t-i}))$$
$$+ \sum_{t=1}^{n} \ell_{2i} D(\ln(OUTPUT_{t-i})) + \sum_{t=1}^{n} \ell_{3i} D(\ln(INTR_{t-i})) + \sum_{t=1}^{n} \ell_{4i} D(\ln(price_{t-i})) + \sum_{t=1}^{n} \ell_{5i} D(\ln(NEER_{t-i})) + \varepsilon_{4t} \quad (4)$$

$$D(\ln(NEER_t)) = \varpi_0 + \varpi_1 \ln(NEER_{t-1}) + \varpi_2 \ln(OUTPUT_{t-1}) + \varpi_3 \ln(INTR_{t-1}) + \varpi_4 \ln(price_{t-1}) + \varpi_5 \ln(NEER_{t-1}) + \sum_{t=1}^{m} \ell_{1i} D(\ln(NEER_{t-i}))$$
$$+ \sum_{t=1}^{n} \ell_{2i} D(\ln(OUTPUT_{t-i})) + \sum_{t=1}^{n} \ell_{3i} D(\ln(INTR_{t-i})) + \sum_{t=1}^{n} \ell_{4i} D(\ln(price_{t-i})) + \sum_{t=1}^{n} \ell_{5i} D(\ln(M2_{t-i})) + \varepsilon_{5t} \quad (5)$$

Where all variables are as previously defined, $\ln(.)$ is the logarithm operator, D is the first difference, and $\varepsilon_{1t} \ldots \varepsilon_{5t}$ are the error terms.

4. Empirical Findings and Discussions

First step was to determine the order of integration for each fundamental under study in order to find out potential correlations between consecutive indicators. The results displayed in table 3 shows that all the fundamentals were not stationary at level (when the ADF and the PP unit root techniques were adopted). The ADF and PP tests applied to the first difference of the data rejected the null hypothesis of non-stationarity for all variables adopted.

Table 3: Results of Unit Root Tests

Variable	ADF Test		PP Test		KPSS Test	
	Level	1st Difference	Level	1st Difference	Level	1st Difference
Price	-0.804	-3.782*	-0.756	-2.767***	0.169***	0.101
OUTPUT	-3.500**	-5.324*	-3.500***	-5.319**	0.695**	0.111
INTR	-2.001	-2.257*	-2.012	-5.910**	0.170**	0.072
M2	-1.059	-3.273*	-1.675	-3.256***	0.111	0.157**
NEER	-2.134	-7.114*	-2.109	-7.045**	0.121***	0.093

Source: Author's Computation

NOTE: ** indicates significant at the 0.05 level, *** indicates significant at the 0.1 level

The results from the KPSS unit root test suggests different orders of integration with majority of the fundamentals integrated at level. Based on the results above, it is worth concluding that all the null hypothesis of unit test process using the ADF and Phillips-Perron is rejected and the null hypothesis is accepted as in the case of KPSS .

Results of the ARDL Tests

Table 4 reports the results of the ARDL bounds test for cointegration of the selected macroeconomic fundamentals. A critical examination of FOUTPUT in table 4 reveals that the calculated F-statistics (4.501) is higher than the upper and lower bound critical value of 2.45 and 3.52 at the 10 percent significant level respectively. This is also true for the t-statistic at 10 percent level. This validates the assertion that, there exists a

long run associativity between output, price, INTR, M2, and NEER with output as the dependent variable. This suggests that all the fundamentals tend to a common simultaneous long-run equilibrium.

Table 4: Results of the ARDL Bounds Tests

Models	AIC Lags	F-Statistics	T-statistics	Decision
$F_{OUTPUT}(F_{OUTPUT} \mid price, INTR, M2, NEER)$	1	4.501**	-3.589**	Cointegration
$F_{price}(F_{price} \mid OUTPUT, INTR, M2, NEER)$	4	13.480**	0.198	Cointegration
$F_{INTR}(F_{INTR} \mid OUTPUT, price, M2, NEER)$	4	3.248**	-3.135**	Cointegration
$F_{M2}(F_{M2} \mid OUTPUT, price, INTR, NEER)$	3	1.219	-1.222	No Cointegration
$F_{NEER}(F_{NEER} \mid OUTPUT, price, INTR, M2)$	2	4.951**	-2.71***	Cointegration

Source: Author's Computation

NOTE: ** indicates significant at the 0.05 level, *** indicates significant at the 0.1 level

Similarly, using price as the dependent variable, the calculated F-statistics (13.480) is higher and statistically significant than the upper and lower bound values. This is also true for the t-statistic at 10 percent significant level. Therefore, the price , OUTPUT, INTR, M2 and NEER are found to be cointegrated, implying that there exists a long-run simultaneous cointegration among the aforementioned fundamentals.

Model 3, with INTR being the dependent variable shows a long run cointegration relationship with output, price index, money supply and nominal exchange rate.

Models 4 portray a different result as shown in table 4, as the calculated F-statistics with M2 as the dependent variable (FM2) is 1.219 and, it is less than the lower bound value at 10 percent significance level, implying that there is no reverse cointegration between money supply, output, price index, interest rate and nominal effective exchange rate. On the contrary, with nominal exchange rate (FNEER) as the dependent variable, there exist a long run cointegration with F-statistics (4.951) which is greater than the upper bound value at 10 percent significance level.

Based on the above cointegration results for models 1, 2, 3 and 5, the long-run coefficients are estimated using the ARDL model with long-run cointegrating relationships.

Results of Short-run and Long-Run coefficients of the ARDL Test

Table 5 shows the short-run and long run relationships of the fundamentals using output and price as dependent variables. First, with output as the dependent variable, it is observed that price in the output equation is found to be positive but statistically insignificant in the long run; implying that in the long run, rising prices might permanently increase output or the growth of output by stimulating capital accumulation because in response to rising prices (inflation), households would hold less in money balances and more in other assets; while in the short run, output falls in reaction to rising prises.

Second, in the long run, interest rate is found to be positive but insignificant as against the short run effect which is found to be negative in relation to the price level in model two with price as the dependent variable. As such, an increase in the interest rate will have a positive effect on output, by increasing aggregate demand for the period under study; though this is in contrast with the Mundell-Fleming model, Mundell (1961) on IS-LM framework posited a negative relationship. The same is applicable to the exchange rate as it shows a positive and insignificant relationship to output

On the whole, the coefficient of the lagged error term is significant at 5 percent with the expected sign, which confirms the result of the bound test for cointegration. Its value is estimated to be -0.57 which implies that the speed of adjustment to equilibrium after necessary shocks is relatively high. Approximately, 57 percent of disequilibria from the previous year's shocks converge back to the long run equilibrium in the current year.

From table 5 and from the results of the price equation, the coefficient of output in the second lagged period is found to be negative and statistically significant which implies that increase in aggregate demand tend to reduce the price or inflationary level in Nigeria. The coefficient of exchange rate is also found to be negative and statistically significant with an indication that appreciation in interest rate has every tendency to decrease the price level within the domestic economy through reduced imports prices of goods and services.

Table 5: Estimated Short-run and Long-Run coefficients using the ARDL technique

Variables	Model 1 (Dependent Variable: Output)		
	Short-run coefficients		Long-run coefficients
LNPRICE(-1)	-0.093 (-2.358)**	D(LNPRICE(-1))	0.053 (0.644)
LNINTR(-1)	0.182 (2.568)**	D(LNINTR(-1))	0.063 (0.897)
LNM2(-1)	0.197 (6.621)**	D(LNM2(-1))	0.004 (0.040)
LNNEER(-1)	0.016 (1.214)	D(LNNEER(-1))	0.004 (0.343)
C	23.314 (89.692)**	C	0.014 (0.644)
		ECM(-1)	-0.570 (-3.647)**
Model Diagnostics			
		Chi-square stat.	Prob.
Breusch-Godfrey Serial Correlation Test		3.782	0.061
Breusch-Pagan-Godfrey Heteroskedasticity Test		0.642	0.669
Normality Test		0.881	0.643
	Model 2 (Dependent Variable: (Price Index)		
	Short-run coefficients		Long-run coefficients
LNPRICE(-1)	1.045 (3.766)**	D(LNPRICE (-1))	1.355 (6.047)**
LNPRICE (-2)	-0.944 (-2.049)	D(LNPRICE (-2))	-1.185 (-4.561)**
LNPRICE (-3)	0.853 (1.601)	D(LNPRICE (-3))	1.237 (4.165)**
LNOUTPUT	-0.258 (-0.624)	D(LNOUTPUT(-1))	-0.646 (-2.236)**
ININTR(-1)	-0.123 (-0.574)	D(ININTR(-1))	0.195 (1.269)
LNM2(-1)	-0.298 (-1.035)	D(LNM2(-1))	-0.148 (-0.798)
LNNEER(-1)	-0.098 (-2.260)**	D(LNNEER(-1))	-0.067 (-2.256)**
C	10.911 (0.912)	C	-0.042 (-0.957
		ECM(-1)	-1.737 (-5.005)**
Model Diagnostics			
		Chi-square stat.	Prob.
Breusch-Godfrey Serial Correlation Test		0.112	0.973
Breusch-Pagan-Godfrey Heteroskedasticity Test		1.547	0.241
Normality Test		0.034	0.982

Source: Author's Computation

N.B: ** indicates significant at the 0.05 level, *** indicates significant at the 0.1 level

With the coefficient of the error term which is estimated to be -1.73, it shows that the deviation from the long run is corrected by 1.73 percent over the following period. This result depicts that adjustment takes place quickly in its correction.

The regression estimates from the two models shows that it passes all diagnostic tests. The stability of the long run coefficients shows that the plots of the results of the recursive residuals (CUSUM and the CUSUMQ) statistic fall within the critical bounds of 5 percent confidence interval of the parameter stability (Pesaran and Pesaran, 1997).

Table 6: Estimated Short-run and Long-Run coefficients using the ARDL technique

Variables	Model 3 (Dependent Variable: Interest Rate)		
	Short-run coefficients		Long-run coefficients
LNINTR(-1)	0.204 (1.128)	DLNINTR(-1))	0.176 (0.966)
LNINTR(-2)	-0.227 (-1.468)	D(LNINTR(-2))	-0.223 (-1.842)***
LNINTR(-3)	0.299 (1.662)	D(LNINTR(-3))	0.365 (2.667)**
LNINTR(-4)	-0.639 (-4.071)**	D(LNINTR(-4))	-0.562 (-2.844)**
LNOUTPUT	0.470 (1.355)	D(LNOUTPUT)	0.270 (1.013)
LNPRICE	-0.013 (-0.056)	D(LNPRICE)	-0.101 (-0.567)

LNMS(-1)	0.547 (2.262)**	D(LNMS(-1))	0.578 (3.261)**
LNNEER	-0.027 (-0.753)	D(LNNEER)	-0.014 (-0.485)
C	8.639 (0.859)	C	0.039 (0.761)
		ECM(-1)	-1.057 (0.050)***
Model Diagnostics			
		Chi-square stat.	Prob.
Breusch-Godfrey Serial Correlation Test		1.2169	0.377
Breusch-Pagan-Godfrey Heteroskedasticity Test		0.758	0.716
Normality Test		0.012	0.993
	Model 5 (Dependent Variable: (Nominal Effective Exchange rate)		
	Short-run coefficients		Long-run coefficients
LNNEER(-1)	0.488 (2.729)**	D(LNNEER(-1))	0.404 (1.713)
LNNEER(-2)	0.296 (1.773)***	D(LNNEER(-2))	0.170 (1.069)
LNOUTPUT	0.857 (0.432)	D(LNOUTPUT)	1.447 (0.901)
LNPRICE	3.169 (2.266)**	D(LNPRICE)	2.749 (1.968)***
LNINTR(-1)	0.164 (0.195)	D(LNINTR(-1))	0.018 (0.023)
LNM2	-1.395 (-1.151)	D(LNM2)	-0.628 (-0.476)
C	-10.068 (-0.241)	C	-0.081 (-0.296)
		ECM(-1)	-0.897 (-2.921)**
Model Diagnostics			
		Chi-square stat.	Prob.
Breusch-Godfrey Serial Correlation Test		0.057	0.944
Breusch-Pagan-Godfrey Heteroskedasticity Test		2.808	0.018
Normality Test		0.349	0.839

Source: Author's Computation.

NOTE: ** indicates significant at the 0.05 level, *** indicates significant at the 0.1 level

From the estimated coefficients in table 6, interest rate and money supply are insignificant determinants in the exchange rate equation, while price plays a significant role in the determination of its effectiveness in the long run. It can be deduced also that the coefficient of price or price level is higher (2.749), indicating that inflation influences the rate of exchange in Nigeria.

Table 7: Granger causality Test results

Dependent variable/regressors	**OUTPUT**	**PRICE**	**INTR**	**M2**	**NEER**
	F-stat (p-value)				
OUTPUT	Not applicable	14.363 (0.175)	0.093 (0.846)	2.832 (1.433)	-2.391 (-0.633)
PRICE	-0.147 (-2.023)***	Not applicable	0.334 (3.271)**	0.662 (1.740)***	2.100 (1.347)
INTR	0.436 (2.422)**	3.571 (0.261)	Not applicable	1.219 (0.583)	-2.767 (-1.807)***
M2	0.226 (4.333)**	-1.832 (-0.130)	-0.204 (-1.780)***	Not applicable	-0.916 (-0.718)
NEER	0.026 (0.301)	8.426 (0.203)	-0.060 (-1.845)***	0.048 (0.210)	Not applicable
ECM($_{t-1}$)	-0.491 (-5.071)**	0.010 (8.842)**	-0.781 (-4.366)**	-0.082 (-2.646)**	-0.397 (-5.331)**
Direction of Causality					
	OUTPUT	**PRICE**	**INTR**	**M2**	**NEER**
OUTPUT	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
PRICE	PRICE → OUTPUT	Not applicable	PRICE → INTR	Not applicable	PRICE → NEER

INTR	Not applicable	INTR ⟶ PRICE	Not applicable	Not applicable	Not applicable
M2	M2 ⟶ OUTPUT	Not applicable	M2 ⟶ INTR	Not applicable	M2 ⟶ NEER
NEER	Not applicable	NEER ⟶ PRICE	Not applicable	Not applicable	Not applicable

Source: Author's Computation

NOTE: ** indicates significant at the 0.05 level, *** indicates significant at the 0.1 level

The estimated coefficients of both the short and the long run relationships as evident in table 7 show that there exist a cointegrating relationship as specified in the ARDL bound test for output on price, interest rate, money supply and nominal effective exchange rate in the long run. However, the output equation suggests that price and money supply granger causes output. Therefore, there exist a uni-directional causality in the output equation.

For the price equation, there exist no cointegrating relationship for price on output, interest rate, money supply and exchange rate in the long run. However, the result shows that there exists a short-run relationship which suggests that interest rate and exchange rate granger causes price. From the interest rate equation, there exist cointegration relationship for interest rate on price, money supply, exchange rate and output in the long run. The short-run interest rate equation suggests that price and money supply granger causes the rate of interest.

For the money supply equation, a cointegration relationship exists for money supply on output, interest rate, price and exchange rate in the long run, but experiences no causal relationship in the short-run. Lastly, from the exchange rate equation, cointegration relationship exists for exchange rate on output, price, interest rate and money supply in the long run with price index and money supply granger causing exchange rate in one direction as suggested by the calculated F-statistics.

5. Conclusion

The long-run and causal relationship between and / or among the five macroeconomic fundamentals; output, price, interest rate, money supply and exchange rate for the period 1981-2021 was investigated in this paper. The study adopted the ARDL Bounds test to investigate the existence of a long run relation among the series and the Granger causality within the error correction to test for the direction of causality. The results of the bounds test revealed that there exists a long run relation between output, price, interest rate, money supply and nominal exchange rate with output as the dependent variable. However, reverse cointegration was not found when money supply was used as dependent variable. Furthermore, there existed a long-run relation between price, output, money supply, interest rate and exchange rate with price as the dependent variable. Also, long-run relationship existed between interest rate; nominal exchange rate and the other selected macroeconomic fundamentals with interest rate and nominal exchange rate as dependent variables.

From the output equation, there exist a one way causal relation to money supply and price level in the long run. From the price equation, interest rate and exchange rate exhibited a one-way causation to price, but only in the long-run period. For the interest rate equation, price and money supply granger caused the rate of interest in the long run and lastly, from the exchange rate equation, price and money supply granger caused the nominal exchange rate in the long run. A critical view of the regressed estimates, it is evident that price level and money supply exhibited more potent causal effects with the other macroeconomic fundamentals such as output, interest rate and exchange rate both in the short and long run. The existence of these relationships suggests the relative effectiveness of fiscal and monetary policy as regards the Nigerian economy as their relative coefficients are greater than the other fundamentals in the various equations specified. Therefore, in order to maintain price stability so as to avoid inflationary pressures in the economy, the Central Bank should design its monetary policy by targeting the rate of interest and it exchange rate structure.

References

1. *Baglan, D. and Yoldas, E.(2014). Non-linearity in the inflation-growth relationship in developing economies: Evidence from a semi-parametric panel model. Economic Letters, 125 (1): 93-96.*
2. *Bahmani- Oskooee, M. (1998) Do Exchange Rates Follow a Random Walk Process in Middle Eastern Countries?, Economics Letters, 58 (3): 339-344.*
3. *Ball, L. and G. Mankiw, (1994). What Determines Sacrifice Ratio? Monetary Policy. 1st Edition., University of Chicago Press, Chicago.*
4. *Brunner, K. and Meltzer, A.(1971). The uses of money: money in the theory of an exchange economy. Am. Econ. Rev. 61 (5), 784-805.*
5. *Canova, F. and Menz, T. (2011). Does money matter in shaping domestic business cycles. An international investigation. Journal of Money Credit & Banking, 43: 577-607.*
6. *Caraiani, P. (2016). Money and output causality: A structural approach. International Review of Economics & Finance, 42: 220-236.*
7. *Dickey, D.A. and Fuller, W.A. (1979). Distribution of estimators for time series regressions with a unit root. Journal of the American Statistical Association, 74: 427-431.*
8. *Drukker, D., Gomis, P.P. and Hernandez-Verme, P.(2005). Threshold effects in the relationship between inflation and growth: a new panel-data approach. MPRA Working Paper Series, No. 38225.*
9. *Eggoh, J. C. and Khan, M. (2014). On the nonlinear relationship between inflation and economic growth. Research in Economics, 68(2): 133-143.*
10. *Engle, R. F. and Granger, C.W.J. (1987) Cointegration and Error-Correction: Representation, Estimation, and Testing, Econometrica, 55: 251-276*
11. *Favara, G. and Giordani, P. (2009). Reconsidering the role of money for output, prices and interest rates. Journal of Monetary Economics, 56(3): 419-430.*
12. *Garrison, R.W. (1989). The Austrian theory of the business cycle in the light of modern macroeconomics. Rev. Austrian Econ. 3 (1), 3-29.*
13. *Grauwe, P. D. and Polan, M. (2005). Is Inflation Always and Everywhere a Monetary Phenomenon? Scand. Journal of Economics, 107(2): 239-59.*
14. *Herwartz, H. and Reimers, H.E. (2006). Long-Run Links among Money, Prices and Output: Worldwide Evidence. German Economic Review, 7: 65-86.*
15. *Ishioro, B.O.(2017) Banking Sector Reforms and Economic Growth: Recent Evidence from a Reform-Bound Economy. Binus Business Review, Vol.8 (1): 46-60*
16. *Ishioro, B. O.(2022a) Dynamic Effects of Health Expenditure Shocks on HIV Prevalence in sub-Saharan Africa. Journal of Academic Research in Economics. Vol.14 (3):November.*
17. *Ishioro, B. O.(2022b) Deposit Money Bank-based Financial Inclusion and Economic Growth in Nigeria: The Role of a Dual Folded Proxy, Gusau International Journal of Management and Social Sciences, Vol.5(3):1-23.*
18. *Ishioro, B. O.(2022c) Unit Root and Stationarity Tests in Expenditure on Health and Economic Growth Series: Maximizing the Power of Breakpoints. Himalayan Journal of Community Medicine and Public Health, Vol.3(6):14-21*
19. *Ishioro, B.O.(2022d). The Long-run Macroeconomic Determinants of Banks' Performance in Nigeria, KIU Journal of Social Sciences, Uganda National University, Vol.8(4):25-37.*
20. *Ishioro, B.O. and Maku, O.A.(2022) Health Care Expenditure-GDP Nexus in Sub-Saharan Africa, Journal of Positive School Psychology, Vol.6 (12):1649-1664.*
21. *Judd, J.P. and B. Trehan, (1995). The cyclical behaviour of prices: Interpreting the evidence. J. Money Credit Bank, 27: 789-797.*
22. *Kremer, S., Bick, A. and Nautz, D. (2013). Inflation and growth: new evidence from a dynamic panel threshold analysis. Empirical Economics, 44: 861-878.*
23. *Levine, R. (1997) Financial development and economic growth: views and agenda. Journal of Economic Literature, XXXV: 688-726.*
24. *Macchiarelli, C. (2013). Similar GDP-inflation cycles. An application to CEE countries and the euro area. Research in International Business and Finance, 27(1): 124-144.*

25. *Mallik, G. and A. Chowdhury (2001). Inflation and economic growth: Evidence from four South Asian countries. Asia Pac. Dev. J., 8: 123-134.*
26. *Mathieson D.J (1980). Financial Reforms and Stabilization Policy in Developed Economies. Journal of Development Economics, 7(3): 359-395.*
27. *Morosan, G. and Zubas, I.M. (2015) Interest Rate, Exchange Rate and Inflation in Romania. Correlates and Interconnection. Journal of Public Administration, Finance and Law, 8, 146-160*
28. *Mundell, R.A. (1961). A Theory of Optimum Currency Areas. American Economic Review, 5 1(4): 657-665. Munich: MPRA.*
29. *Ndoricimpa, A. (2017) Threshold Effects on Inflation on Economic Growth in Africa: Evidence from a Dynamic Panel Threshold Regression Approach. Working Paper No. 249, African Development Bank*
30. *Nelson, E. (2002). Direct effects of base money on aggregate demand: theory and evidence. Journal of Monetary Economics, 49(4): 687-708.*
31. *Odedokun (1996). Alternative Economic Approaches for Analyzing the Role of the Financial Sector in Economic Growth. Time Series Evidence from LDCs. Journal of Development Economics, 50(1): 119-146*
32. *Omay, T. and Kan, E.O. (2010). Re-examining the threshold effects in the inflation-growth nexus with cross-sectionally dependent non-linear panel: Evidence from six industrialized economies. Economic Modelling, 27(5): 996-1005*
33. *Pesaran, M.H. and Shin, Y. (1995) Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis. DAE Working Paper Series No. 9514, Department of Economics, University of Cambridge, Cambridge*
34. *Pesaran, M.H., Shin, Y., and Smith, R.J. (2001) Bounds Testing Approaches to the Analysis of level relationships. Journal of Applied Econometrics, 16, 289-326*
35. *Phillips, P.C.B. and Perron, P. (1988) Testing for a unit root in a time series regression. Biometrika, Vol. 75, No. 2, pp. 335–346.*
36. *Ravn, M. O., Psaradakis, Z. and Sola, M. (2005). Markov switching causality and the money-output relationship. Journal of Applied Econometrics, 20: 665-683.*
37. *Woodford, M.(2003). Interest and Prices: Foundations of a Theory of Monetary Policy. Princeton University Press, Princeton.*