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Bounds Testing Approaches to the Analysis of Macroeconomic Relationships In Nigeria

Bayo Fatukasi, Ph.D[1] Gabriel Kola Olorunleke, Ph.D[2] Gbenga F. Olajide[1] R. Santos Alimi[1]*
1.Department of Economics, Adekunle Ajasin University, Akungba-Akoko, Ondo State, Nigeria
2.Department of Business Administration, Adekunle Ajasin University, Akungba-Akoko, Ondo State
* E-mail of the corresponding author: santos4rd@ngmail.com

Abstract
The main objective of the paper is to estimate the dynamic interrelation among the macroeconomic variables viz., real output, money supply, government expenditure, inflation, exchange rate, interest rate, trade openness and financial deepening using annual data for Nigeria covering the period from 1970 to 2013 using ARDL approach to cointegration. The bounds test revealed that there exists a long-run relation between real output, money supply, interest rate and exchange rate when the price and financial deepening variables were the dependent variables. However, reverse cointegration relationships were not found when real output, money supply, government expenditure, exchange rate, interest rate and trade openness were the dependent variables. This study finds feedback effect from the short run dynamics between government spending and money supply, trade openness and government spending, trade openness and real output, trade openness and financial deepening, real output and financial deepening, and finally financial deepening and nominal effective exchange rate. Furthermore, the short run dynamics revealed a unidirectional causality from money supply to inflation, from government spending to exchange rate and to financial deepening, and from interest rate to financial deepening. The policy implication that can be deduced from the above findings are: Interest rate will not serve as an efficient intermediate target for the monetary policy; policy should be geared towards promotion of international trade and financial development; government spending should be checked especially extra budgetary spending in order to reduce money in circulation and subsequently control inflationary tendency in the economy.
Keywords: Real Output, Money, Price, Interest Rate, Exchange Rate, ARDL
JEL Classifications: E41, E52, C22

1. Introduction

It is well documented in empirical literature the dynamic interrelation among the macro-economic variables such as money, income, the level of prices, interest rate and exchange rate (Yadav and Lagesh, 2011). The existence of such inter-relationship and causality between these macroeconomic variables however differs with different schools of thought such as the Classical, the Keynesians, the New Growth Theorists have propounded different explanations for the relationship among these variables. In an emerging economy like Nigeria, central bank seek to understand the causal relationship between money, income and other macroeconomic variables and understand the dynamics of future movements of some relevant aspects of the real economy in order to frame a formidable monetary policy. There are plethora of studies in Nigeria such as Chimobi (2010), Okwo et al (2012), Torruam et al (2013), Alimi (2013) that looked into inter-relation between two or among three of these macroeconomics variables but no study exist that examined the macroeconomic relationship between the selected eight variables in a single study using an up to date annual and recent autoregressive distributed lag approach to cointegration. Detecting the true causal directions among macroeconomic variables between money, income and other macroeconomic variables therefore assumes importance and is essential for effectiveness of its monetary policy and design of an appropriate policy. Therefore, this study attempts to investigate the causal relationship specifically between money, income, price, interest rate, exchange rate, trade openness and financial deepening in Nigeria using annual data for the period 1970 to 2013. The paper is organized as follows. Section 2 presents the data used and the methodology adopted. Section 3 presents empirical results and discussion and Section 4 provides concluding remarks of the paper.

2. Data and Methods

The study uses macroeconomic series that consist of yearly observations between 1970 and 2013, namely real output, money supply, government expenditure, inflation, exchange rate, interest rate, trade openness and financial deepening. We use the natural log of all the series in this paper because natural logarithm of a series effectively linearizes the exponential trend (if any) in the time series data – since the log function is the inverse of an exponential function (Asteriou and Price, 2007). Moreover, opting for log of the variables may prevent cumbersomeness in the modelling and inference and it allows the regression coefficients to be interpreted as elasticity (Rahaman and Salahuddin, 2010). Annual data of all variables have been collected from CBN Statistical Bulletin, various issues.

Definition of Variables

RGDP – is real gross domestic product used to capture the real output

MS – The component of money supply used in the study is Broad Money (M2), which consists of currency with public and demand deposits of banks (M1) plus time and saving deposits of banks.

GOV – is total government spending

INFL – is inflation rate

NEER – is nominal exchange rate

TBR – is interest rate proxied by treasure bill rate.

TOPN – is trade openness measured as the ratio of the sum of export and import to GDP

FD – is financial development, defined as credit to private sector as share of GDP.

Methodological Framework

This paper applies recently developed the autoregressive distributed lag model (ARDL) approach introduced in Pesaran *et al*. (2001). Traditionally, the cointegration approach [such as Johansen (1992) and Johansen-Juselius (1990)] has widely been used to establish long–run relationship among certain variables. The method of cointegration requires that variables be integrated of the same order. If the order of integration among variables is not the same, then long–run relationship among them cannot be established. The order of integration is, however, established by using unit root tests which might suffer from low powers failing to reject the null of nonstationarity. Moreover, the results of these tests largely depend on the choice of optimal lag length, which cannot be conclusively determined. The ARDL model overcomes this problem by introducing bounds testing procedure to establish long run relationship among variables. It does not require, as such, that variables of interest have the same order of integration to model long run relationship.

ARDL bounds testing approach has some advantages over the other cointegration technique, such as: Engle and Granger (1987), Johansen (1992), Johansen-Juselius (1990), Gregory and Hansen (1996), Saikkonen and Lutkepohl (2000). For instance, this approach can be applicable if running variables have ambiguous order of integration i.e. purely I(0), purely I(1) or I(0) / I(1) which is not acceptable in traditional approaches. However, it requires that the dependent variable is of I(1) in levels and none of the explanatory variables is I(2) or higher. The ARDL bounds testing approach is more suitable and provides better results than multivariate cointegration approaches in case of small sample properties (Haug, 2002; Halicioglu, 2007). For details on econometric advantages of bounds testing in comparison to other single cointegration procedures, see Bahmani-Oskooee and Tanku (2008).

The ARDL representation of the macroeconomic relationship between the selected variables can be constructed as:

$$\Delta RGDP_t = \gamma_0 + \gamma_1 RGDP_{t-1} + \gamma_2 MS_{t-1} + \gamma_3 GOV_{t-1} + \gamma_4 INFL_{t-1} + \gamma_5 NEER_{t-1} + \gamma_6 TBR_{t-1} + \gamma_7 TOPN_{t-1} + \gamma_8 FD_{t-1} + \sum_{i=1}^{n} \xi_{i1}\Delta RGDP_{t-i} + \sum_{i=0}^{n} \xi_{i2}\Delta MS_{t-i} + \sum_{i=0}^{n} \xi_{i3}\Delta GOV_{t-i} + \sum_{i=0}^{n} \xi_{i4}\Delta INFL_{t-i} + \sum_{i=0}^{n} \xi_{i5}\Delta NEER_{t-i} + \sum_{i=0}^{n} \xi_{i6}\Delta TBR_{t-i} + \sum_{i=0}^{n} \xi_{i7}\Delta TOPN_{t-i} + \sum_{i=0}^{n} \xi_{i8}\Delta FD_{t-i} + \eta_1 ECM_{t-1} + \varepsilon_t \quad (1)$$

$$\Delta MS_t = \gamma_0 + \gamma_1 MS_{t-1} + \gamma_2 RGDP_{t-1} + \gamma_3 GOV_{t-1} + \gamma_4 INFL_{t-1} + \gamma_5 NEER_{t-1} + \gamma_6 TBR_{t-1} + \gamma_7 TOPN_{t-1} + \gamma_8 FD_{t-1} + \sum_{i=1}^{n} \xi_{i1}\Delta MS_{t-i} + \sum_{i=0}^{n} \xi_{i2}\Delta RGDP_{t-i} + \sum_{i=0}^{n} \xi_{i3}\Delta GOV_{t-i} + \sum_{i=0}^{n} \xi_{i4}\Delta INFL_{t-i} + \sum_{i=0}^{n} \xi_{i5}\Delta NEER_{t-i} + \sum_{i=0}^{n} \xi_{i6}\Delta TBR_{t-i} + \sum_{i=0}^{n} \xi_{i7}\Delta TOPN_{t-i} + \sum_{i=0}^{n} \xi_{i8}\Delta FD_{t-i} + \eta_2 ECM_{t-1} + \varepsilon_t \quad (2)$$

$$\Delta GOV_t = \gamma_0 + \gamma_1 GOV_{t-1} + \gamma_2 MS_{t-1} + \gamma_3 RGDP_{t-1} + \gamma_4 INFL_{t-1} + \gamma_5 NEER_{t-1} + \gamma_6 TBR_{t-1} + \gamma_7 TOPN_{t-1} + \gamma_8 FD_{t-1} + \sum_{i=1}^{n} \xi_{i1}\Delta GOV_{t-i} + \sum_{i=0}^{n} \xi_{i2}\Delta MS_{t-i} + \sum_{i=0}^{n} \xi_{i3}\Delta RGDP_{t-i} + \sum_{i=0}^{n} \xi_{i4}\Delta INFL_{t-i} + \sum_{i=0}^{n} \xi_{i5}\Delta NEER_{t-i} + \sum_{i=0}^{n} \xi_{i6}\Delta TBR_{t-i} + \sum_{i=0}^{n} \xi_{i7}\Delta TOPN_{t-i} + \sum_{i=0}^{n} \xi_{i8}\Delta FD_{t-i} + \eta_3 ECM_{t-1} + \varepsilon_t \quad (3)$$

$$\Delta INFL_t = \gamma_0 + \gamma_1 INFL_{t-1} + \gamma_2 MS_{t-1} + \gamma_3 GOV_{t-1} + \gamma_4 RGDP_{t-1} + \gamma_5 NEER_{t-1} + \gamma_6 TBR_{t-1} + \gamma_7 TOPN_{t-1} + \gamma_8 FD_{t-1} + \sum_{i=1}^{n} \xi_{i1}\Delta INFL_{t-i} + \sum_{i=0}^{n} \xi_{i2}\Delta MS_{t-i} + \sum_{i=0}^{n} \xi_{i3}\Delta GOV_{t-i} + \sum_{i=0}^{n} \xi_{i4}\Delta RGDP_{t-i} + \sum_{i=0}^{n} \xi_{i5}\Delta NEER_{t-i} + \sum_{i=0}^{n} \xi_{i6}\Delta TBR_{t-i} + \sum_{i=0}^{n} \xi_{i7}\Delta TOPN_{t-i} + \sum_{i=0}^{n} \xi_{i8}\Delta FD_{t-i} + \eta_4 ECM_{t-1} + \varepsilon_t \quad (4)$$

$$\Delta NEER_t = \gamma_0 + \gamma_1 NEER_{t-1} + \gamma_2 MS_{t-1} + \gamma_3 GOV_{t-1} + \gamma_4 INFL_{t-1} + \gamma_5 RGDP_{t-1} + \gamma_6 TBR_{t-1} + \gamma_7 TOPN_{t-1} + \gamma_8 FD_{t-1} + \sum_{i=1}^{n} \xi_{i1}\Delta NEER_{t-i} + \sum_{i=0}^{n} \xi_{i2}\Delta MS_{t-i} + \sum_{i=0}^{n} \xi_{i3}\Delta GOV_{t-i} + \sum_{i=0}^{n} \xi_{i4}\Delta INFL_{t-i} + \sum_{i=0}^{n} \xi_{i5}\Delta RGDP_{t-i} + \sum_{i=0}^{n} \xi_{i6}\Delta TBR_{t-i} + \sum_{i=0}^{n} \xi_{i7}\Delta TOPN_{t-i} + \sum_{i=0}^{n} \xi_{i8}\Delta FD_{t-i} + \eta_5 ECM_{t-1} + \varepsilon_t \quad (5)$$

$$\Delta TBR_t = \gamma_0 + \gamma_1 TBR_{t-1} + \gamma_2 MS_{t-1} + \gamma_3 GOV_{t-1} + \gamma_4 INFL_{t-1} + \gamma_5 NEER_{t-1} + \gamma_6 RGDP_{t-1} + \gamma_7 TOPN_{t-1} + \gamma_8 FD_{t-1}$$

$$+ \sum_{i=1}^{n} \xi_{i1}\Delta TBR_{t-i} + \sum_{i=0}^{n} \xi_{i2}\Delta MS_{t-i} + \sum_{i=0}^{n} \xi_{i3}\Delta GOV_{t-i} + \sum_{i=0}^{n} \xi_{i4}\Delta INFL_{t-i} + \sum_{i=0}^{n} \xi_{i5}\Delta NEER_{t-i} + \sum_{i=0}^{n} \xi_{i6}\Delta RGDP_{t-i} + \sum_{i=0}^{n} \xi_{i7}\Delta TOPN_{t-i} + \sum_{i=0}^{n} \xi_{i8}\Delta FD_{t-i} + \eta_6 ECM_{t-1} + \varepsilon_t \quad (6)$$

$$\Delta TOPN_t = \gamma_0 + \gamma_1 TOPN_{t-1} + \gamma_2 MS_{t-1} + \gamma_3 GOV_{t-1} + \gamma_4 INFL_{t-1} + \gamma_5 NEER_{t-1} + \gamma_6 TBR_{t-1} + \gamma_7 RGDP_{t-1} + \gamma_8 FD_{t-1} + \sum_{i=1}^{n} \xi_{i1}\Delta TOPN_{t-i} + \sum_{i=0}^{n} \xi_{i2}\Delta MS_{t-i} + \sum_{i=0}^{n} \xi_{i3}\Delta GOV_{t-i} + \sum_{i=0}^{n} \xi_{i4}\Delta INFL_{t-i} + \sum_{i=0}^{n} \xi_{i5}\Delta NEER_{t-i} + \sum_{i=0}^{n} \xi_{i6}\Delta TBR_{t-i} + \sum_{i=0}^{n} \xi_{i7}\Delta RGDP_{t-i} + \sum_{i=0}^{n} \xi_{i8}\Delta FD_{t-i} + \eta_7 ECM_{t-1} + \varepsilon_t \quad (7)$$

$$\Delta FD_t = \gamma_0 + \gamma_1 FD_{t-1} + \gamma_2 MS_{t-1} + \gamma_3 GOV_{t-1} + \gamma_4 INFL_{t-1} + \gamma_5 NEER_{t-1} + \gamma_6 TBR_{t-1} + \gamma_7 TOPN_{t-1} + \gamma_8 RGDP_{t-1} + \sum_{i=1}^{n} \xi_{i1}\Delta FD_{t-i} + \sum_{i=0}^{n} \xi_{i2}\Delta MS_{t-i} + \sum_{i=0}^{n} \xi_{i3}\Delta GOV_{t-i} + \sum_{i=0}^{n} \xi_{i4}\Delta INFL_{t-i} + \sum_{i=0}^{n} \xi_{i5}\Delta NEER_{t-i} + \sum_{i=0}^{n} \xi_{i6}\Delta TBR_{t-i} + \sum_{i=0}^{n} \xi_{i7}\Delta TOPN_{t-i} + \sum_{i=0}^{n} \xi_{i8}\Delta RGDP_{t-i} + \eta_8 ECM_{t-1} + \varepsilon_t \quad (8)$$

In the above models, Δ is the first-difference operator, and RGDP, MS, GOV, INFL, NEER, TBR, TOPN and FD are the eight macroeconomic variables selected in the study. In equation (1), RGDP is the dependent variable, with MS, GOV, INFL, NEER, TBR, TOPN and FD as the long run regressors. Accordingly, a joint significance test that implies no cointegration hypothesis, (H_0: $\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = \gamma_6 = \gamma_7 = \gamma_8 = 0$), is tested against the alternative hypothesis, (H_1: $\gamma_1 \neq \gamma_2 \neq \gamma_3 \neq \gamma_4 \neq \gamma_5 \neq \gamma_6 \neq \gamma_7 \neq \gamma_8 \neq 0$) denoted by F(RGDP/MS, GOV, INFL, NEER, TBR, TOPN,FD). Similarly, in equations (2) - (8), where MS, GOV, INFL, NEER, TBR, TOPN and FD are dependent variables the null hypothesis are denoted; *F(MS/ RGDP, GOV, INFL, NEER, TBR, TOPN,FD), F(GOV/ MS, RGDP, INFL, NEER, TBR, TOPN,FD), F(INFL/ MS, GOV, RGDP, NEER, TBR, TOPN,FD), F(NEER/ MS, GOV, INFL, RGDP, TBR, TOPN,FD), F(TBR/ MS, GOV, INFL, NEER, RGDP, TOPN,FD), F(TOPN/ MS, GOV, INFL, NEER, TBR, RGDP,FD) and F(FD/ MS, GOV, INFL, NEER, TBR, TOPN,RGDP).* The terms ε_1 - ε_8 are mutually uncorrelated white noise error terms.

Two sets of critical values are reported in Pesaran and Pesaran (1997) as well as in Pesaran et al. (2001). The two sets of critical values provide critical value bounds for all classifications of the regressors into purely I(1), purely I(0) or mutually cointegrated. However, these critical values of Pesaran et al (2001) are generated on sample sizes of 500 and 1000 observations and 20 000 and 40 000 replications, respectively. Narayan (2004a & 2004b) and Narayan (2005) argue that such critical values cannot be used for small sample sizes like the one in this study. Given the relatively small sample size of 42 observations in the present study, we extract the appropriate critical values from Narayan (2005) which were generated for small sample sizes of between 30 and 80 observations. One set assumes that all variables are *I*(0) and the other set assumes they are all *I*(1). If the computed F-statistic exceeds the upper critical bounds value, then the H0 is rejected. If the F-statistic falls into the bounds then the test becomes inconclusive. Lastly, if the F-statistic is below the lower critical bounds value, it implies no cointegration.

Granger (1988) demonstrates that causal relations among variables can be examined within the framework of ECM, with cointegrated variables. While the short run dynamics are captured by the individual coefficients of the lagged terms, the error correction term (ECT) contains the information of long run causality. Significance of lagged explanatory variable depicts short run causality while a negative and statistical significant ECT is assumed to signify long run causality. The short-run causality is thus determined from the following ARDL model, for case where RGDP is the explained variable:

$$\Delta RGDP_t = \gamma_0 + \sum_{i=1}^{n} \xi_{i1}\Delta RGDP_{t-i} + \sum_{i=0}^{n} \xi_{i2}\Delta MS_{t-i} + \sum_{i=0}^{n} \xi_{i3}\Delta GOV_{t-i} + \sum_{i=0}^{n} \xi_{i4}\Delta INFL_{t-i} + \sum_{i=0}^{n} \xi_{i5}\Delta NEER_{t-i} + \sum_{i=0}^{n} \xi_{i6}\Delta TBR_{t-i} + \sum_{i=0}^{n} \xi_{i7}\Delta TOPN_{t-i} + \sum_{i=0}^{n} \xi_{i8}\Delta FD_{t-i} + \eta ECM_{t-1} + \varepsilon_t \quad (9)$$

where, Δ is the difference operator, ECM representing the error -correction term derived from the long-run cointegrating relation from the above specified ARDL model 1. In each equation, η_i should exhibit a negative and significant sign for causality to exist in the long run.

Following Narayan and Smyth (2005), we used Pesaran and Pesaran (1997) to test for parameter stability. Once the error correction models have been estimated, Pesaran and Pesaran (1997) suggest applying the cumulative sum of recursive residuals (CUSUM) and the CUSUM of square (CUSUMSQ) tests to assess the parameter constancy.

3. Empirical Results and Discussion

Unit Root Test

In order to examine the integrating level of variables, standard tests like DF-GLS, and Ng-Perron are employed. Mostly in the literature to find out the order of integration ADF (Dicky & Fuller, 1979) and PP (Philip & Perron,

1988) tests have been used extensively. Due to their poor size and power properties, both tests are not reliable for small sample data set (Dejong et al, 1992 and Harris, 2003). These tests seem to over-reject the null hypotheses when it is true and accept it when it is false. While newly proposed tests such as Dicky-Fuller generalized least square (DF-GLS) de-trending test developed by Elliot et al. (1996) and Ng-Perron test following Ng-Perron (2001) seem to solve this arising problem.

Table 2. DF-GLS & Ng-Perron Unit Root Test				
Variables	DF-GLS at level		DF-GLS at first difference	
RGDP	-0.234997		-6.098889[a]	
MS	0.185335		-3.617825[a]	
GOV	1.269989		-7.549572[a]	
INFL	-3.940680[a]		-	
NEER	-1.542314		-6.056837[a]	
TBR	-1.308860		-6.986005[a]	
TOPN	-0.18519		-6.260638[a]	
FD	-0.875320		-5.503878[a]	
Ng-Perron at level				
	MZa	MZt	MSB	MPT
RGDP	0.37870	0.31650	0.83575	44.6801
MS	0.38735	0.21539	0.55606	23.6257
GOV	1.45987	2.00951	1.376650	137.505
INFL	-16.7457[a]	-2.89172	0.17268	1.47000
NEER	-4.29394	-1.45564	0.33900	5.72052
TBR	-3.25025	-1.17326	0.36098	7.43071
TOPN	0.09432	0.05735	0.60805	25.4304
FD	-2.15737	-0.68962	8.82966	
Ng-Perron at first difference				
	MZa	MZt	MSB	MPT
RGDP	-20.4732[a]	-3.19861	0.15623	1.19973
MS	-14.9435[a]	-2.73124	0.18277	1.64792
GOV	-19.8249[a]	-3.13378	0.15807	1.28770
INFL	-	-	-	-
NEER	-20.4617[a]	-3.19855	0.15632	1.19744
TBR	-20.2826[a]	-3.17508	0.15654	1.24131
TOPN	-20.4746[a]	-3.19095	0.15585	1.22696
FD	-20.0654*	-3.16138	0.15755	1.24246

Note: *Ng-Perron (2001, Table 1) &*Mackinnon (1996); a(1%), b(5%) and c(10%)

ARDL Bounds Test for Cointegration

The unit root results reported in Table-2 shows that all the series, except inflation, are non-stationary at level but become stationary after taking their first difference i.e. I(1). Thus we apply ARDL bounds testing approach to cointegration to test long run relationship between the variables. The appropriate lag order of variables should be determined before proceeding to the ARDL bounds testing approach to cointegration (Pesaran et al. 2001). The results reported in Table 3 imply that lag order is 1 based on the minimum value of SBC. The appropriateness of lag order avoids the spuriousness of ARDL bounds testing approach to cointegration results.

Table 3: Lag Length Selection					
Lag	LR	FPE	AIC	SC	HQ
0	NA	0.000131	13.76047	14.09825	13.88260
1	388.4267*	1.23e-08*	4.430576	7.470559*	5.529737*
2	82.65054	1.24e-08	4.037074	9.779264	6.113268
3	65.14219	1.41e-08	2.894261*	11.33866	5.947489

The results of the ARDL bounds testing approach are also shown in Table 4.

Table 4. ARDL Bounds Test for Cointegration

Model Number	Variables	F – Statistics	Cointegration
1	F(RGDP/MS, GOV, INFL, NEER, TBR, TOPN,FD)	1.273229	No Cointegration
2	F(MS/ RGDP, GOV, INFL, NEER, TBR, TOPN,FD)	1.453089	No Cointegration
3	F(GOV/ MS, RGDP, INFL, NEER, TBR, TOPN,FD)	1.881414	No Cointegration
4	F(INFL/ MS, GOV, RGDP, NEER, TBR, TOPN,FD)	4.85500**	Cointegration
5	F(NEER/ MS, GOV, INFL, RGDP, TBR, TOPN,FD)	1.307811	No Cointegration
6	F(TBR/ MS, GOV, INFL, NEER, RGDP, TOPN,FD)	1.69044	No Cointegration
7	F(TOPN/ MS, GOV, INFL, NEER, TBR, RGDP,FD)	0.946159	No Cointegration
8	F(FD/ MS, GOV, INFL, NEER, TBR, TOPN,RGDP)	3.154190	Inconclusive*
	Critical value	Lower Bound	Upper Bound
	1%	3.644	5.464
	5%	2.676	4.130
	10%	2.260	3.534

Notes: *** Statistical significance at 1% level; ** Statistical significance at 5% level; * Statistical significance at 10% level. The lag length k=1 was selected based on the Schwarz criterion (SC). Critical values are obtained from Narayan (2005) case III for 40 observations. The number of regressors is 7.

ARDL cointegration test reported in Table 4 shows that when inflation (model 4) is the dependent variable, the calculated F-statistics is found to be higher at 95% level of significance than the upper critical bound values of Narayan (2005). This suggests that there exists a long-run cointegration relation between real output, money supply, government expenditure, exchange rate, interest rate, trade openness and financial deepening when the price variable is the dependent variable. Similarly, when financial deepening (model 8) is the dependent variable, the calculated F-statistics is falls between the lower and upper bounds of the critical values at 90% level of significance. Thus we cannot make decision on whether to reject or not to reject the null hypothesis of no cointegration. As evidenced from Table 4, other models (1, 2, 3, 5, 6, 7), when real output, money supply, government expenditure, exchange rate, interest rate and trade openness are dependent variable, there is no evidence of existence of cointegration relationships between the macroeconomic variable.

Based on the existence of cointegration relationship for model 4 (possibly model 8), we therefore estimate the long-run relationships using the Stock-Watson's dynamic ordinary least squares (DOLS) model. The presence of leads and lags for different variables eliminates the bias of simultaneity within a sample and DOLS estimates and provide better approach to normal distribution. DOLS model with dependent variable y_t and independent variable x_t is specified as below:

$$y_t = \phi_0 + \phi_1 x_t + \sum_{j=-m}^{n} d\Delta x_{t-j} + \varepsilon_t$$

Where n and m show lag and lead length, and ϕ indicates the long run effect of a change in x on y. The reason why lag and lead terms are included in DOLS model is that they have the role to make its stochastic error term independent of all past innovations in stochastic repressors (Baba et al, 2013). The DOLS estimator corrects standard OLS for bias induced by endogeneity and serial correlation. The DOLS estimator is preferred to the non-parametric FMOLS estimator because of its better performance. According to Wagner and Hlouskova (2010), the DOLS estimator outperforms all other studied estimators, both single equation estimators and system estimators, even for large samples. Moreso, Harris and Sollis (2003) suggest that non-parametric approaches such as FMOLS are less robust if the data have significant outliers and also have problems in cases where the residuals have large negative moving average components, which is a fairly common occurrence in macroeconomic time series data.

Table 5. Long-Run Coefficients Estimates of Models 4 and 8

Regressors/Dependent Variable	Inflation (INFL) equation	Financial Deepening (FD) Variable
RGDP	2.961957 (0.1789)	-0.620617 (0.3381)
MS	-5.534009* (0.0937)	1.219615* (0.0077)
GOV	2.762028 (0.3528)	-0.640099 (0.1842)
INFL	-	-0.053585 (0.7195)
NEER	0.285147 (0.1750)	-0.089909* (0.0673)
TBR	-0.353346 (0.6392)	0.043554 (0.8340)
TOPN	2.220035 (0.1831)	-0.466963 (0.3324)
FD	4.198792 (0.2016)	-

Notes: **, * denote significance level at 95%, 90% respectively. Figures in parentheses are the estimated P-value.

We present in Table 5 the precise nature of the long-run relationship when inflation is the dependent variable (column 1), the following inferences can be drawn: first, the coefficient of real output in the inflation equation is found to be positive but statistically insignificant, indicating any increases in real output in the long-run raises rate of inflation in Nigeria during the study period. Second, the long-run coefficient of money supply is negative and significant at 10 percent level; suggesting that any rise in the money supply would lead to long-run fall in inflation. However, these findings does not support the quantity theory of money postulation, which holds that in the long run the price level moves in proportion with changes in the money supply (Friedman, 1956). Third, the estimated long-run coefficient of interest rate (measured by treasure bill rate) is negative but insignificant indicating that a rise in the interest rate in the economy will lead to fall in the price level. Since interest rate is the opportunity cost of holding wealth in the form of money rather than an interest-bearing asset, a rise in the interest rate reduces the quantity of money that an economic agent plan to hold. Therefore, the reduced quantity of money does not assert inflationary pressure in the economy. Lastly, the estimated long-run coefficient of government spending, exchange rate, trade openness and financial deepening in inflation equation are found to be positive and statistically insignificant.

When financial deepening is the dependent variable (column 2), the following inferences is rawn: money supply and exchange rate are found to significant determinant of financial deepening whereas other variable of interest are found to be insignificant in Nigeria. It can be observed that the value of money supply coefficient is relatively high (1.219) indicating its greater role in influencing financial deepening in Nigeria.

The Dynamics of Short-Run Causality

We estimated model (9) to determine the nature and direction of short-run dynamics of the selected macroeconomic variables. Table 6 presents the estimated results as follows:

Table 6. Granger Causality Test using VECM

	Dependent Variable							
Regressors/	Model 1 ΔRGDP	Model 2 ΔMS	Model 3 ΔGOV	Model 4 ΔINFL	Model 5 ΔNEER	Model 6 ΔTBR	Model 7 ΔTOPN	Model 8 ΔFD
Constant	0.1558 (0.1668)	0.1010 (0.1201)	-0.0791 (0.4248)	-0.9151** (0.0331)	0.0991 (0.8523)	0.2199 (0.7142)	0.1210 (0.3130)	-0.0447 (0.5740)
ΔRGDP	-	0.1116 (0.3646)	0.2038 (0.1837)	0.9733 (0.2455)	0.5638 (0.5130)	-0.0053 (0.9832)	-0.9192*** (0.0000)	-0.3616*** (0.0034)
ΔRGDP(-1)	-0.0724 (0.7145)	-0.0159 (0.8988)	-0.0678 (0.6528)	-0.3809 (0.6537)	-0.2126 (0.8127)	0.0787 (0.7655)	0.0584 (0.7972)	0.2016 (0.1428)
ΔMS	0.3370 (0.3444)	-	0.7778*** (0.0047)	1.0566 (0.4411)	0.6440 (0.6865)	-0.2544 (0.6090)	0.4395 (0.2344)	0.0421 (0.8606)
ΔMS(-1)	-0.0492 (0.9050)	0.1167 (0.6359)	0.2939 (0.38310	3.3516** (0.0368)	1.9456 (0.3042)	-0.7890 (0.1532)	-0.2564 (0.5692)	0.0735 (0.8037)
ΔGOV	0.0172 (0.9340)	0.2176* (0.0564)	-	-0.5619 (0.4724)	-1.7660* (0.0824)	0.3945 (0.1698)	0.3644* (0.0887)	0.2360* (0.0837)
ΔGOV(-1)	0.1451 (0.4774)	0.1787 (0.1359)	0.0394 (0.8383)	-0.7171 (0.3722)	-2.0543** (0.0265)	-0.1667 (0.5627)	-0.0558 (0.8012)	0.1034 (0.4735)
ΔINFL	0.0563 (0.2780)	0.0249 (0.4097)	-0.0390 (0.3641)	-	0.1614 (0.5042)	0.0562 (0.4329)	0.0243 (0.6594)	-0.0093 (0.7978)
ΔINFL(-1)	0.0267 (0.6250)	-0.0002 (0.9929)	0.0501 (0.2647)	-0.1540 (0.4732)	0.2059 (0.4223)	0.0088 (0.9124)	-0.0242 (0.6823)	-0.0572 (0.1280)
ΔNEER	-0.0253 (0.5947)	0.0155 (0.5425)	-0.0317 (0.3747)	0.1247 (0.4645)	-	-0.0117 (0.8456)	0.0076 (0.8692)	0.0524* (0.0769)
ΔNEER(-1)	-0.0252 (0.5168)	0.0084 (0.7023)	0.0191 (0.5484)	-0.0854 (0.5682)	0.1953 (0.2764)	0.0889 (0.1077)	-0.0580 (0.1433)	-0.0527* (0.0516)
ΔTBR	0.0209 (0.8808)	-0.1050 (0.1957)	0.1627 (0.1637)	0.3614 (0.5229)	-0.1959 (0.7646)	-	0.0483 (0.7463)	0.1417 (0.1656)
ΔTBR(-1)	-0.0876 (0.5526)	0.0222 (0.7969)	-0.0375 (0.7628)	0.4762 (0.4077)	-0.7741 (0.2647)	-0.1414 (0.4904)	-0.0569 (0.7180)	0.2605** (0.0160)
ΔTOPN	-0.7201*** (0.0000)	0.1400 (0.2122)	0.2513* (0.0628)	0.5643 (0.4661)	0.6661 (0.4084)	-0.0834 (0.7141)	-	-0.4244*** (0.0001)
ΔTOPN(-1)	-0.1427 (0.3366)	-0.0356 (0.7163)	-0.0984 (0.4324)	-0.0310 (0.9625)	-0.0251 (0.9744)	0.0563 (0.7978)	0.0657 (0.7215)	0.1395 (0.2202)
ΔFD	-0.4966** (0.0214)	0.0240 (0.8592)	0.2005 (0.2870)	-0.2447 (0.7962)	2.1841* (0.0514)	0.1160 (0.7142)	-0.8045*** (0.0004)	-
ΔFD(-1)	-0.2885 (0.2137)	0.0212 (0.8791)	-0.1802 (0.3666)	0.2235 (0.8184)	-1.7420 (0.1453)	-0.1471 (0.6522)	0.0725 (0.7849)	0.5241*** (0.0092)
ecm(-1)	1.03E+12** (0.0179)	7.35E+11 (0.1880)	-0.8732*** (0.0014)	-4.33E+12 (0.3232)	1.10E+13 (0.3323)	-1.19E+13* (0.1000)	-0.7939*** (0.0023)	-0.7660*** (0.0005)

Notes: ***, **, * denote significance level at 99%, 95%, 90% respectively.
Figures in parentheses are the estimated P-value.

As ARDL bounds test showed that there exists no cointegrating relationship for real output (model 1) on other macroeconomic variables and they are thus neutral to real output in the long-run. However, in the short-run, the real output equation suggests that only trade openness and financial deepening are non-neutral to real output and cause the changes in real output. The ECM term included in the real output equation is statistically significant at 5% level but it has wrong sign of negative.

Similarly, the ARDL bounds test showed that there exists no cointegrating relationship for money supply (Model 2) and exchange rate (Model 5) equations. Whereas short run dynamics of model 2 reveals that government spending has significant effect on money supply and for model 5, current and first lag government spending will affect exchange rate. The ECM term included in models 2 and 5 are positive and not statistically significant, thus confirm lack of evidence of long run causality between respective explanatory variable and its regressors.

The result of ARDL bounds test of cointegration showed that there is evidence of cointegrating relationship for inflation rate, model (4), therefore suggesting long run causality between inflation and the selected macroeconomic variables. Nonetheless, in the short-run, it is only the first lag of money supply that has effect on the inflation rate. This finding suggests that inflation is a monetary phenomenon in Nigeria. The lagged ECM term included in the inflation rate equation is negative but statistically not significant. In case of model 6, this study does not find support for causality between interest rate variable and other selected macroeconomic variables, both in the short run and in the long run.

The result of short run dynamics further showed that in model 3 the government spending is caused by money supply and trade openness only while in model 7 real output, government spending and financial deepening have effect on trade openness. The negative sign and significant of lagged ECM terms in the two models (3 & 7) suggest that there exist a long run causality between the variables in the equations. This finding is contrary to the earlier result of ARDL bounds test of cointegration which showed no evidence of such cointegrating relationship.

Finally, in the short run dynamics of model 8, real output, government spending, current and first lagged exchange rate, first lagged treasure bill rate, trade openness and first lagged financial deepening have effect on financial deepening. Moreover, the coefficient of ECM is negative and statistically significant confirming the results obtained under the ARDL bounds test of cointegration that there exists a long run relationship for financial deepening model.

4. Conclusions and Policy Implications

The present paper attempted to examine the long-run cointegration between real output, money supply, government expenditure, inflation, exchange rate, interest rate, trade openness and financial deepening in Nigeria for the period 1970 – 2013. To investigate the long-run cointegration between the selected macroeconomic variables, ARDL bounds test for cointegration was employed and thereafter estimated the long run relationship using the Stock-Watson's dynamic OLS. We further estimated the dynamics of short-run causality between the selected variables to determine the nature and direction of causality between these selected variables.

The bounds test revealed the existence of a long-run relation between macroeconomic variables when inflation rate and financial deepening were the dependent variables. However, reverse cointegration relationships is not found when the real output, money supply, government expenditure, exchange rate, interest rate and trade openness were the dependent variables.

This study finds feedback effect from the short run dynamics between government spending and money supply, trade openness and government spending, trade openness and real output, trade openness and financial deepening, real output and financial deepening, and finally financial deepening and nominal effective exchange rate. Furthermore, the short run dynamics revealed a unidirectional causality from money supply to inflation, from government spending to exchange rate and to financial deepening, and from interest rate to financial deepening.

The policy implication that can be deduced from the above findings are: Interest rate will not serve as an efficient intermediate target for the monetary policy; policy should be geared towards promotion of international trade and financial development; government spending should be checked especially extra budgetary spending in order to reduce money in circulation and subsequently control inflationary tendency in the economy.

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