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Impact of Sub-Economic on Money Supply in Nigeria: An Autoregressive Distribution Lag (ARDL) Approach

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Abstract

The escalation in dollar rates and the price instability in the Nigerian economy went through some significant structural and institutional changes such as the liberalization of the external trade, the elimination of price and interest rate controls, and the adoption of a managed float exchange rate system as well as the changes in monetary policy including innovations in the banking sector. Hence, the study examines the impact of financial development on money demand in Nigeria by means of ARDL approach. It examined the quarterly returns of M2, exchange rate (EXR), inflation rate (IFR), currency in credits to private sector (CPS) and circulation (CIC). The data span from 1991 to 2018. The study utilizes regression model techniques where the regression model's residual is tested for Cointegration using Engle-Granger residual approach, the significances of the variable's co-movement are checked by pairwise Granger Causality tests and ARDL and VECM are estimated in order to account for the short run and long run relationship among the variables. From the empirical results, Engle-Granger residuals and pairwise Granger Causality tests confirm cointegration among variables. The ARDL and VECM confirm the long run relation between money demand (M2) and financial development variables: CPS and CIC. ARDL models (short run relationship) are estimated for exchange rate and inflation rate. Long run (VECM) analysis has confirmed significance of financial development variables (CPS and CIC) with positive sign; implies that money demand function is stable in long run. The VECM granger causality results reveal that bidirectional causality exists between currency in circulation and money demand in both short and long run. Unidirectional causal relationship exists between credits to private sector and money demand in both short and long run. Hence, government should pay more attention on financial development and ensure a coordination of both fiscal and monetary policy.

Keywords

Sub-Economy, Money Supply, ARDL, Cointegration, Error Correction Model

1. Introduction

The demand for money refers to the total amount of riches held by the households and companies; this is affected by several factors such as income levels, interest rates, price levels (inflation) and uncertainty. The impact of these factors on demand for money can be attributed to these three reasons: transaction, precautionary and speculative. The demand for money function creates a contextual to review the efficacy of monetary policies, as an imperative issue in terms of the overall macroeconomic stability. Money demand is an important indicator or pointer of growth for a particular economy. [1] affirmed that increment in money demand mostly indicates a country's improved economic situation, as against the falling demand which is normally a sign of abating economic climate. Monetarists accentuate the role of governments in controlling for the amount of money in circulation. Their assessment on monetary economics is that the variation on money supply has a major influence on national product in the short run and on price level in the long run. As well, they claim that the objectives of monetary policy are paramountly met by steering the increment rate of money supply.

Today's monetarism is allied with the work of Friedman, who was one among the generation of economists to agree to take Keynesian economics and then disparage it on its own terms. Friedman debated that inflation is at all times and universally a monetary phenomenon. Similarly, he backed that central bank policy aimed at keeping the supply and demand for money in equilibrium, as measured by growth in productivity and demand [2]. For instance, the European Central Bank formally bases its monetary policy on money supply goals. Adversaries of monetarism, including neo-Keynesians, debated that demand for money is central to supply of money and the money supply is controlled by its Central Bank, for example, Central Bank of Nigeria (CBN) while some conservative economists disputed that demand for money cannot be predicted.

Recently, the rise in Nigeria's exchange rates is being acknowledged as the most imperative threat to the country's economy. The exchange rates instability by the means of uncertainty generated, affects negatively economic decisions of investors, implementing of growth policy, the fight against unemployment and economic convergence [3]. [4] pointed out that the monetary policy has no short-term impact on the price changes. In other words, monetary and fiscal policy tools are less important to control the variations of general price level in Nigeria in the short term. On divergent, some authors remark that the short-run and long run effects of money supply are significant [5] [6] [7].

There are short-term and long-term aspects of money demand. The growing production relates to the long-term aspect of money demand or the need for money (transaction demand). This means that the increased issue of money which is consistent with price stability may solely be achieved in the long run if it follows the growth of output. [1] stated that the increased issue of money which is consistent with price stability may solely be achieved in the long run if it follows the growth of output. In the short term, a decreasing rate of money circulation may cause the money demand to rise irrespective of the movements in real production. However, the ongoing increase in money supply, regardless of the trends in production, leads to the stronger inflator pressures. Hence, this study set out to examine the relationship between money supply and other macroeconomic time series.

[8] studied the money demand functions for long run and short run for Nepal using the annual data set of 1975 to 2009. The ARDL modeling to cointegration had used to analysis cointegration. The bounds test shows the exists of long run cointegration relationship among demand for real money balances, real GDP and interest rate in case of both narrow and broad monetary aggregates. Furthermore, the CUSUM and CUSUM SQ test reveals that both the long run narrow and broad money demand functions are unchanging (stable).

[9] queried velocity of money demand function and its relationship with interest rate fluctuations of Pakistan data. The results established stable money demand function via velocity of money, real permanent income per capita, real interest rate, transitory income, and expected inflation. It revealed that money velocity is independent from interest rate. [10] revisited money demand function for Japanese economy. The results showed that instability in money demand due to many changes in monetary policy of Japan. [11] tested the stability of money demand function for Tonga using approaches of LSE Hendry's General to Specific (GETS) and Johansen's Maximum Likelihood (JML). The results projected that there is a stable long run cointegrated relationship that exists between real narrow money, real income and rate of interest.

[12] examined whether financial innovation makes money demands is stable or not in Kenya. They used quarterly data (1998Q4 to 2013Q3) and utilized ARDL bounds test. They found out that in the face of financial innovation, money demand in Kenya is stable. Similarly, an earlier study by [13] examined the effect of financial liberalization on money demand in Uganda based on data (1982Q4 to 1998Q4). He employed Johansen cointegration test and found that M2 and its determinants are cointegrated. Thereafter, he used Chow test to assess the stability of the money demand during the period when a financial reform was implemented in the study. The author found out that the introduction of financial liberalization does not make M2 unstable in Uganda.

[14] measured monetary aggregate using M2, and employed a Johansen test. The study's findings showed that M2 and its determinants are cointegrated. Based on the results from Hansen, CUSUM and CUSUMSQ tests, the author concluded that demand for M2 is stable in Nigeria. [15] used another cointegration technique called ARDL bounds test. The author used quarterly data over the

period of 1970Q1 to 2002Q4. The author measured monetary aggregate using M2 and found it to be cointegrated with its determinants. The study further tested for parameter consistency test using CUSUM and CUSUMSQ tests and the results obtained by [16] are mixed. The result from CUSUM showed that M2 is stable while the finding from CUSUMSQ showed that M2 is unstable.

[16] examined the stability of money demand function a case study of Turkey. Johansen cointegration confirmed the long run cointegration relationship among money demand, income and interest rate. Conflictingly, [17] reexamined the money demand function for Turkey and he found an asymmetric behavior and nonlinearity function. His results projected that the stability of money demand function is influenced by upon stability of inflation for monthly data from1990 to 2012.

[18] investigated the money demand function a case study of Nigeria over the period 1970 to 2010. They have established stability of M1 by using Chow breakpoint test, (CUSUM) and (CUSUMSQ) tests by incorporating real income, short term interest rate, real expected exchange rate, expected inflation rate and foreign real interest rate.

Meanwhile, this research feasibly will be of extraordinary importance not only to the scholar as regards the use of statistical tools in the analysis of money demand; drawing conclusion and decision making from available data. It could also contribute to the available proposed literature on the concept of money demand in the scientific communal used by experienced top practitioners all around the world.

2. Aim and Objectives

This study aims at providing a comprehensive analysis of money demand while the specific objectives are:

1) To estimate the effect of financial development on money demand.

2) To analyze the relationship between money demand and other macroeconomic variables in Nigeria.

3) To brings to light the short and long run impacts of money demand on inflation and other macroeconomic variables in Nigeria.

3. Research Methodology

3.1. Source of Data

The nature of this study required the usage of secondary data. Data utilized are quarterly time series and covers a period of 1991 to 2018; they are sourced from Central Bank of Nigeria database. The analyses are carried out using the EViews 9.0 package.

3.2. Research Methodology

3.2.1. Regression Model (Ordinary Least Square Method)

A priori Expectation: $C > 0$, $\beta_1 > 0$, $\beta_2 > 0$.

The ordinary Least Square (OLS) technique will be employed in obtaining the numerical estimates of the coefficients of the equation. The OLS method is chosen because it possesses some optimal properties; its computational procedure is fairly simple and it is also an essential component of most other estimation techniques. The regression model is given as

$$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i,\ i = 1, 2, \cdots, n \tag{3.1}$$

where Y_i and X_i are the dependent and independent in the *i*th observations respectively. β_0 and β_1 are unknown and are usually obtained by method of Least Square, and ε_i is the error term. The least square estimates in this case are given by simple formulas.

$$\hat{\beta}_1 = \frac{\sum x_i y_i - \frac{1}{n}\sum x_i \sum y_i}{\sum x_i^2 - \frac{1}{n}\left(\sum x_i\right)^2} \tag{3.2}$$

$$\hat{\beta}_0 = \overline{y} - \hat{\beta}\overline{x} \tag{3.3}$$

3.2.2. Auto-Regressive Distributed Lagged (ARDL) Model

The autoregressive distributed lag (ARDL) models are the standard ordinary least squares regressions, which include the lags of both the dependent variable and independent variables as regressors (Erdoğdu H. and Çiçek H., 2017). The basic form of an ARDL (*p*, *q*) regression model is given as:

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \cdots + \beta_p Y_{t-p} + \alpha_0 X_t + \alpha_1 X_{t-1} + \cdots + \alpha_q X_{t-q} + \varepsilon_t$$

$$Y_t = \beta_0 + \sum_{i=1}^{p} \beta_i Y_{t-i} + \sum_{i=0}^{q} \alpha_i X_{t-i} + \varepsilon_t \tag{3.4}$$

where ε_t is a disturbance term, the dependent variable is a function of its lagged values, the current and lagged values of other exogenous variables in the model; *p* lags are used for dependent variable while *q* lags are for exogenous variables. The bounds testing procedure, developed by [16], requires the estimation of the following equation, which derives the relationship between money supply (M2) and its determinants, exchange rates (EXR), inflation rate (IFR), credit to private sector (CPS) and currency in circulation (CIC) as a conditional autoregressive distributed lag (ARDL):

$$\begin{aligned}\Delta \text{LM2}_t = {} & \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta \text{LM2}_{t-i} + \sum_{i=1}^{q_1} \alpha_{2i} \Delta \text{EXR}_{t-i} + \sum_{i=1}^{q} \alpha_{3i} \Delta \text{IFR}_{t-i} \\ & + \sum_{i=1}^{q_3} \alpha_{4i} \Delta \text{CPS}_{t-i} + \sum_{i=1}^{q_4} \alpha_{5i} \Delta \text{CIC}_{t-i} + \beta_1 \text{LM2}_{t-1} \\ & + \beta_2 \text{EXR}_{t-1} + \beta_3 \text{IFR}_{t-1} + \beta_4 \text{CPS}_{t-1} + \beta_5 \text{CIC}_{t-1} + \varepsilon_t \end{aligned} \tag{3.5}$$

where LM2 is the natural log of money supply, Δ is the first difference operator p, q_1, q_2, q_3 and q_4 are the lag lengths. The null hypothesis in the long-run is $H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ which implies no cointegration. The computed F-statistic is compared with critical values or *p*-values. If the F-test statistic falls less than the lower bound signifies is no cointegration. If the F-test statistic is greater than the upper bound, it signifies cointegration. Conversely, if the F-statistic lies between both critical values, it signifies inconclusive.

If a long-run relationship among the variables is established (cointegration presence), then the long-run model(s) is/are estimated using Error Correction Term (ECM) while for short-run relationship (no cointegration) ARDL model(s) is/are estimated. The long-run relationship model is specified in the Equation (3.4):

$$\begin{aligned}\Delta \text{LM2}_t &= \alpha_0 + \sum\nolimits_{i=1}^{q} \alpha_i \Delta \text{LM2}_{t-i} + \sum\nolimits_{i=1}^{p_1} \alpha_{2i} \Delta \text{EXR}_{t-i} + \sum\nolimits_{i=1}^{p_2} \alpha_{3i} \Delta \text{IFR}_{t-i} \\ &\quad + \sum\nolimits_{i=1}^{p_3} \alpha_{4i} \Delta \text{CPS}_{t-i} + \sum\nolimits_{i=1}^{p_4} \alpha_{5i} \Delta \text{CIC}_{t-i} + \lambda_6 \text{ECT}_{t-1} + \varepsilon_t\end{aligned} \quad (3.6)$$

where λ_6 is the coefficient of the error (or equilibrium) correction term (ECT). A negative and statistically significant error correction term ensures convergence of the dynamics to the long-run equilibrium. The significance of the error correction model provides further confirmation to the co-integration evidence, giving the impression of a long run movement between economic growth and the explanatory variables. Implying that in the incidence of the presence of external shock resulting to disequilibrium of the system, the model can still converge with time to its normal state with a relatively average speed of adjustment of $\lambda_6\%$ percent per time.

Conversely, for the short-run relationship model; $\text{ARDL}(p, q_1, q_2, q_3, q_4)$ is stated in Equation (3.5).

$$\begin{aligned}\Delta \text{LM2}_t &= \alpha_0 + \sum\nolimits_{i=1}^{q} \alpha_i \Delta \text{LM2}_{t-i} + \sum\nolimits_{i=1}^{p_1} \alpha_{2i} \Delta \text{EXR}_{t-i} + \sum\nolimits_{i=1}^{p_2} \alpha_{3i} \Delta \text{IFR}_{t-i} \\ &\quad + \sum\nolimits_{i=1}^{p_3} \alpha_{4i} \Delta \text{CPS}_{t-i} + \sum\nolimits_{i=1}^{p_4} \alpha_{5i} \Delta \text{CIC}_{t-i} + \varepsilon_t\end{aligned} . \quad (3.7)$$

4. Presentation and Analysis of Data

Presentation of Data

The data are quarter and generally covers the period from 1991 to 2018. E-Views 9.0 analysis package is utilized to carry out all the analysis in this study. Table 1 presents the variables descriptions of the time series data considered in this study.

Table 2 displays the descriptive statistics for the data. As observed, M2 has mean, median, maximum and minimum of 7184.08, 2415.83, 27,068.58 and 71.03 respectively for the time period examined. M2 has standard deviation and Jarque-Bera statistic value of 8150.99 and 16.70 respectively with p-value of 0.0002. EXC has mean, median, maximum and minimum of 119.92, 127.99, 306.21 and 9.52 respectively for the time period examined. EXR also, has standard deviation and Jarque-Bera statistic value of 81.78 and 6.90 respectively with p-value of 0.0318. IFR has mean, median, maximum and minimum of 19.15, 12.20, 78.50 and 2.30 respectively for the time period examined. And has standard deviation and Jarque-Bera statistic value of 17.31 and 93.17 respectively with p-value of 0.0000.

Furthermore, CPS has mean, median, maximum and minimum of 7191.80, 2067.16, 22,967.44 and 79.96 respectively for the time period examined. And has standard deviation and Jarque-Bera statistic value of 8110.20 and 14.63 respectively

Table 1. Variables description.

Variables	Code	LogCode
1) M2	M2	LM2
2) Exchange Rate	EXR	
3) Inflation Rate	IFR	
4) Credit to Private Sector	CPS	LCPS
5) Currency in Circulation	CIC	LCIC

Note: L denotes natural logarithm. Variables are in local currency (Naira).

Table 2. Descriptive statistics.

	M2	LM2	EXR	IFR	CPS	LCPS	CIC	LCIC
Mean	7184.076	7.761371	119.9235	19.15309	7191.795	7.725483	2691.252	6.742552
Median	2415.827	7.787807	127.9915	12.20000	2067.156	7.633511	987.7407	6.894110
Maximum	27,068.58	10.20613	306.2095	78.50000	22967.44	10.04183	9839.582	9.194169
Minimum	71.02860	4.263083	9.452100	2.700000	79.95892	4.381513	25.12970	3.224050
Std. Dev.	8150.988	1.801879	81.78081	17.30694	8110.204	1.814827	3004.080	1.868675
Skewness	0.896601	−0.272455	0.604130	1.889521	0.763109	−0.166562	0.883879	−0.316737
Kurtosis	2.397231	1.740348	3.133710	5.496694	2.007925	1.570417	2.492814	1.695253
Jarque-Bera	16.70156	8.790370	6.896261	93.17067	14.63488	9.516501	15.78363	9.817049
Probability	0.000236	0.012337	0.031805	0.000000	0.000664	0.008581	0.000374	0.007383
Observations	112	112	112	109	112	112	112	112

with p-value of 0.0006. Also, CIC has mean, median, maximum and minimum of 2691.25, 987.74, 9839.58 and 25.13 respectively for the time period examined. Its standard deviation and Jarque-Bera statistic value are 0.8839 and 15.73 respectively with p-value of 0.0004. However, M2, CPS and CIC data are converted into natural logarithm in order to stabilize the variance.

From the descriptive statistics results and considering the p-values of the variables, this can be deduced; the p-values confirm abnormality for all the variables at 1% level of significance. Figure 1 and Figure 2 present the time series plots of the series.

In Figure 1, it shows that LM2 has been gradually increasing over the years. EXR was relatively constant from 1991 to 1998 but rose abruptly in 1999 and maintained a steady increment from 2000 to 2014 and skyrocketed in 2015 and 2016. IFR also increased gradually over the years; 1991 to 1996 but declined abruptly in 1997 and oscillated over the period 1998 to 2016. LCPS and LCIC have been on gradual increment over the years (see Figure 1).

The plots also show that all the series exhibit non-stationary behaviour. The augmented Dickey Fuller test is used to formally test for stationarity in the time-series.

1) Test for Stationarity

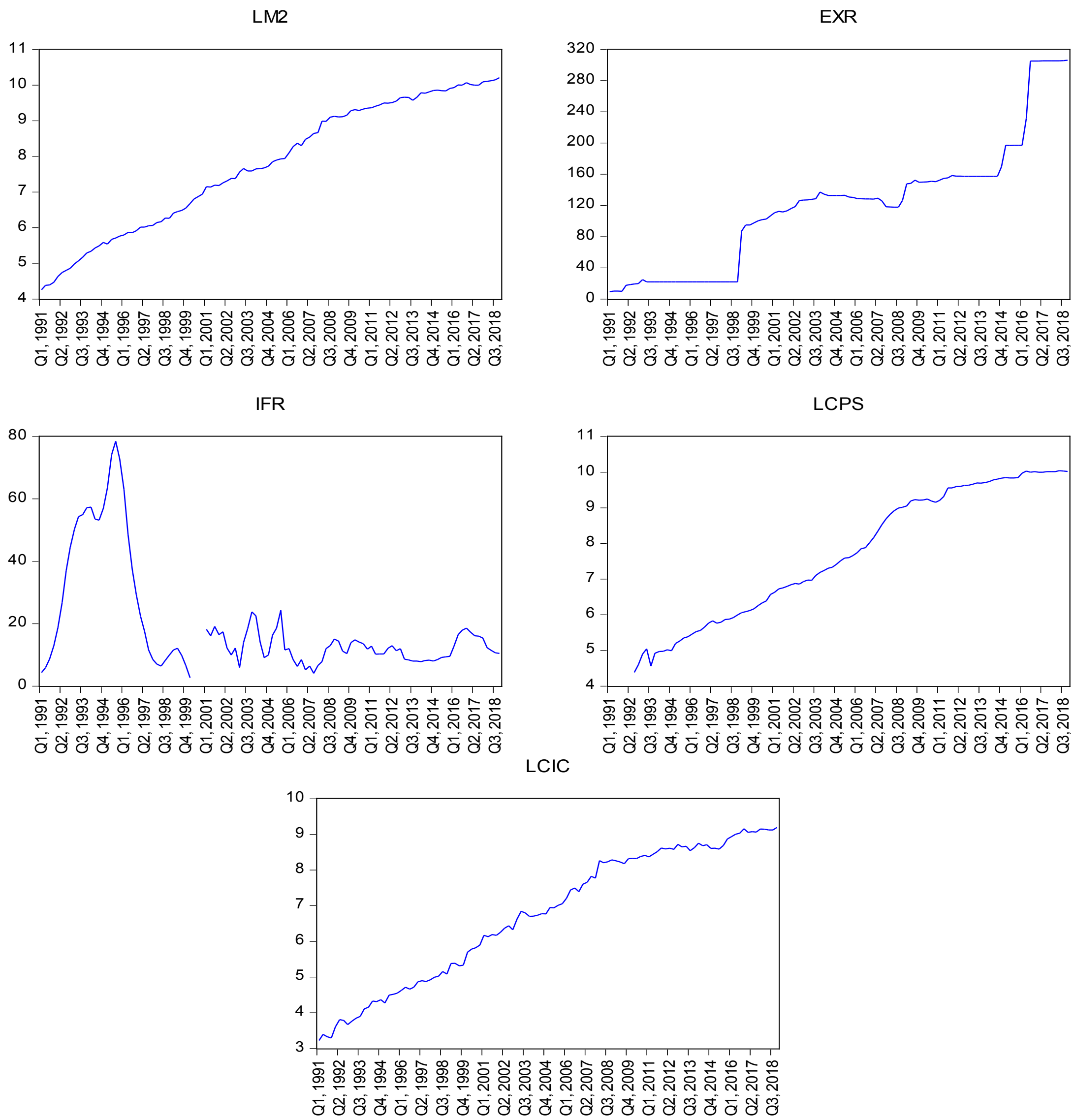

Figure 1. Time series plots.

The results from the ADF test with a linear time trend are reported in **Table 3**. Using the ADF test, the unit root cannot be rejected for all the four variables at 5% level of significance which conforms to the time series plots earlier presented. The ADF test with trend is further used at the 1st difference, the unit root can be rejected for all the five (5) variables at 5% level of significance. **Figure 2** presents the stationary series of the variable at first difference. Also, it can be deduced and established that ARDL model is appropriate since data are stationary purely at first difference.

2) Regression Model (Ordinary Least Square Method)

We made use of the econometric procedure to estimate the relationship between the variables. The ordinary Least Square (OLS) technique is employed to obtain the numerical estimates of the coefficients of the equation. The OLS method is chosen because it possesses some optimal properties; its computational

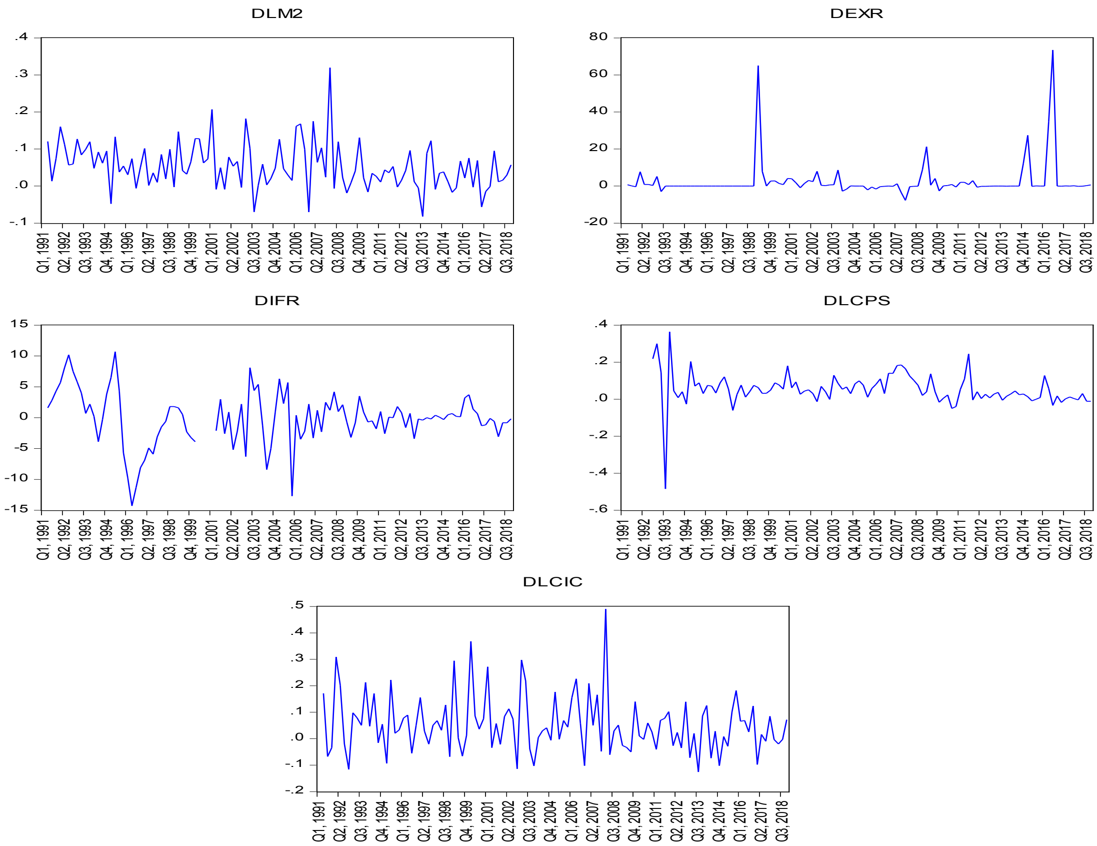

Figure 2. Plots of the differenced time series.

Table 3. Unit root test (ADF test).

Variables	k	Integration Order (*I*)	Test Stat	*P*-Value
LM2	3	1	−4.2519	0.0000
EXR	0	1	−3.5434	0.0455
IFR	4	1	−3.5434	0.0455
LCPS	1	1	−8.5813	0.0000
LCIC	3	1	−5.0763	0.0003

Note: $\hat{k}$ is the AIC lag term is used to select the optimal lag, to make the residuals white noise.

procedure is fairly simple and it is also an essential component of most other estimation techniques.

$$\text{LM2} = 0.0005\text{EXR} + 0.0001\text{IFR} + 0.3997\text{LCPS} + 0.5219\text{LCIC} + 1.1732 \quad (4.1)$$

The regression estimation results (Table 4) show that the relationship between the dependent LM2 and independent variable EXR, LCPS, LCIC and intercept C, are the significant relationships except for IFR. However, the regression model (4.1) is spurious model since the R-squared is GREATER than the Durbin-Waston statistics (*i.e.* 0.9987 > 0.6476). Therefore, the regression model's residual is tested for Cointegration using Engle-Granger residual approach (see Table 5).

Table 4. Regression model estimation.

Dependent Variable: LM2				
Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
EXR	0.000530	0.000160	3.303156	0.0013
IFR	0.000105	0.000478	0.220573	0.8259
LCPS	0.399658	0.029601	13.50133	0.0000
LCIC	0.521931	0.033425	15.61503	0.0000
C	1.173199	0.048804	24.03905	0.0000
R-squared	0.998743	Mean dependent var		7.978278
Adjusted R-squared	0.998692	S.D. dependent var		1.681740
S.E. of regression	0.060826	Akaike info criterion		−2.714265
Sum squared resid	0.362584	Schwarz criterion		−2.586365
Log likelihood	144.7846	Hannan-Quinn criter.		−2.662461
F-statistic	19468.38	Durbin-Watson stat		0.647611
Prob (F-statistic)	0.000000			

Table 5. Engle granger residual cointegration test.

Null hypothesis: Series are not cointegrated

Automatic lags specification based on Akaike criterion (maxlag = 12)

Dependent	tau-statistic	Prob.*	*z*-statistic	Prob.*
LM2	−4.820635	0.0589	−43.46458	0.0178
EXR	−4.935277	0.0453	−47.48814	0.0075
IFR	−5.590841	0.0103	19.36761	1.0000
LCPS	−3.552120	0.4853	−43.38370	0.0167
LCIC	−4.902115	0.0490	−47.82295	0.0070

3) Cointegration Test

Table 5 presents the Cointegration test results of the regression model (4.1) residual. The results show that series; LM2, EXR, LCPS and LCIC *p*-values are significant (less than 1%), therefore we can reject the H_0 in favor of cointegration for all the series except IFR with *p*-value of 1.0000. Hence, the results affirm the presence of Cointegration (variables co-move) among the variables; LM2, EXR, LCPS and LCIC.

Moreover, as results of the presence of Cointegration among the variables (see Table 5), it is crucial to know the nature or significance of the variables' co-movement. The pairwise Granger Causality tests were carried out; Table 6 presents the tests' results. Table 6 depicts that the pairwise Granger Causality test is significant for four pairs of the variables considered. As observed, LCPS does granger cause LM2, LM2 does granger cause LCPS, LCIC does granger cause LCPS and LCPS does granger cause LCIC significant at 1%, 10%, 10% and

Table 6. Pairwise granger causality tests.

Null Hypothesis:	Obs	F-Statistic	Prob.
DEXR does not Granger Cause DLM2	104	0.73932	0.6392
DLM2 does not Granger Cause DEXR		0.74356	0.6357
DIFR does not Granger Cause DLM2	93	0.34742	0.9293
DLM2 does not Granger Cause DIFR		0.53150	0.8081
DLCPS does not Granger Cause DLM2	98	3.39285	0.0031***
DLM2 does not Granger Cause DLCPS		2.01479	0.0627*
DLCIC does not Granger Cause DLM2	104	0.64457	0.7179
DLM2 does not Granger Cause DLCIC		0.74048	0.6383
DIFR does not Granger Cause DEXR	93	0.58817	0.7636
DEXR does not Granger Cause DIFR		0.23828	0.9745
DLCPS does not Granger Cause DEXR	98	0.49339	0.8369
DEXR does not Granger Cause DLCPS		1.02445	0.4204
DLCIC does not Granger Cause DEXR	104	1.25640	0.2812
DEXR does not Granger Cause DLCIC		0.61696	0.7406
DLCPS does not Granger Cause DIFR	87	0.16236	0.9917
DIFR does not Granger Cause DLCPS		0.30927	0.9476
DLCIC does not Granger Cause DIFR	93	0.86412	0.5386
DIFR does not Granger Cause DLCIC		0.10017	0.9982
DLCIC does not Granger Cause DLCPS	98	1.92986	0.0750*
DLCPS does not Granger Cause DLCIC		2.34580	0.0309**

Note: *, ** and *** denote significant at 10%, 5% and 1% respectively.

respectively. However, EXR and IFR show no significant granger causes for any variables. Thus, subsequent analysis depicts the cointegration models (ARDL and VECM) of the variables.

4) Autoregressive Distribution Lags Estimation

Table 7 presents the Bound test results of the ARDL models. The results show that EXR and IFR as dependent variable do not exhibit long-run relationship (no Cointegration) with their corresponding exogenous variables. Thus, the null hypothesis for the long-run relationship can be rejected for only the number 1, 4 and 5 ARDL models (LM2, LCPS and LCIC as dependent variable). The ARDL models (short-run relationship) for EXR and IFR are specified (see model 4.2, and 4.3).

$$\begin{aligned}\Delta\text{DEXR} =\ & 1.2206\Delta\text{EXR}(-1) - 0.2631\Delta\text{EXR}(-2) + 14.6556\Delta\text{LM2} \\ & - 0.0026\Delta\text{IFR} - 4.3769\Delta\text{LCPS} - 7.3744\Delta\text{LCIC} - 24.2920\end{aligned} \tag{4.2}$$

$$\begin{aligned}\Delta\text{IFR} =\ & 1.4176\Delta\text{IFR}(-1) - 0.1883\Delta\text{IFR}(-2) - 0.5156\Delta\text{IFR}(-3) \\ & + 0.2216\Delta\text{IFR}(-4) - 0.5504\Delta\text{LM2} + 0.0021\Delta\text{EXR} \\ & + 0.6262\Delta\text{LCPS} - 0.5629\Delta\text{LCIC} + 4.2937\end{aligned} \tag{4.3}$$

Table 7. ARDL bound test.

S/N	Dependent Variable	Model Selection	F-Statistic	Cointegration	Decision
1	LM2	ARDL (1, 0, 0, 1, 2)	6.7031*	Yes	Estimate ECM (long-run model)
2	EXR	ARDL (2, 0, 0, 0, 0)	0.9120	No	Estimate ARDL (short-run model)
3	IFR	ARDL (4, 0, 0, 0, 0)	0.8086	No	Estimate ARDL (short-run model)
4	LCPS	ARDL (3, 0, 0, 0, 0)	5.0812*	Yes	Estimate ECM (long-run model)
5	LCIC	ARDL (1, 1, 0, 0, 1)	4.8416*	Yes	Estimate ECM (long-run model)

Note: * indicates significant at 0.05 level (*i.e.* F-Stat > 4.01 critical value).

The long-run relationships exhibited by LM2, LCPS and LCIC and exogenous variables are estimated by means of vector error correction model (VECM).

5) Vector Error Correction Model Estimation

The existence of cointegration between LM2, EXR, IFR, LCPS and LCIC and as the results of the ARDL bound test, they lead us to apply Granger causality test to perform clear picture of causality relationship among these variables. Table 8 presents the cointegration equation and depicts the long run relationship between LM2, EXR, IFR, LCPS and LCIC. The results explain that LCPS and LCIC. Have positively significant impact on LM2. However, EXR and IFR have an insignificant impact on LM2. It means that 1% increase in LCPS and LCIC will lead to increase in LM2 by 31.15% and 62.18% respectively.

The cointegrating equation and long-run model is given by model 4.4 and 4.5:

$$\begin{aligned} \mathrm{ECT}_{t-1} = {} & \mathrm{LM2}_{t-1} - 0.0001\mathrm{EXR}_{t-1} - 0.0011\mathrm{IFR}_{t-1} \\ & - 0.3115\mathrm{LCPS}_{t-1} - 0.6218\mathrm{LCIC}_{t-1} - 1.1965 \end{aligned} \tag{4.4}$$

$$\begin{aligned} \mathrm{LM2}_{t-1} = {} & 0.0001\mathrm{EXR}_{t-1} + 0.0011\mathrm{IFR}_{t-1} + 0.3115\mathrm{LCPS}_{t-1} \\ & + 0.6218\mathrm{LCIC}_{t-1} + 1.197 \end{aligned} \tag{4.5}$$

The results of VECM granger causality has reported in Table 9. The path of causality can be divided into short run and long run causality. The results show that LM2 causes LCIC (a financial development variable) in short-run only but LCIC causes LM2 both in short- and long-run. Thus, we can approximately say that bidirectional causality exists between "currency in circulation" and money demand (LM2). Also, LM2 causes LCPS (a financial development variable) both in short and long run while LCPS does not cause LM2 both in short and long run. So, unidirectional causality exists between money demand and "credits to private sectors". Lastly, LCIC cause itself only in both short.

The VECM residual diagnostic test was also applied to the empirical model to measure the adequacy of the specification of the model. As displayed in Table 10, the computed Residual Serial Lagrange multiplier (LM) test for AR[4] = 31.41 is statistically insignificant at conventional significance levels, which suggests that the disturbances are serially uncorrelated.

6) Variance Decomposition Approach

Variance Decomposition Approach is an improved approach to Granger causality. It signposts the magnitude of projected error variance for a series accounted

Table 8. Long run analysis.

Cointegrating Eq:	ECT(−1)
LM2(−1)	1.000000
EXR(−1)	−0.000113
	(0.00034)
	[−0.32737]
IFR(−1)	−0.001102
	(0.00100)
	[−1.10643]
LCPS(−1)	−0.311468
	(0.06352)
	[−4.90327][a]
LCIC(−1)	−0.621778
	(0.07217)
	[−8.61579][a]
C	−1.196502

Note: Standard errors in ( ) & *t*-statistics in [], [a]significant at 1%.

Table 9. VECM granger causality analysis.

Dependent Variable	Short-Run						Long-Run
	C	DLCIC(−1)	DLCPS(−1)	DIFR(−1)	DEXR(−1)	DLM2(−1)	ECT(−1)
DLM2	0.043803 (0.00896) [4.8860][a]	−0.3212 (0.1109) [−2.8973][b]	0.101315 (0.07416) [1.36613]	−0.000698 (0.00144) [−0.48351]	−9.71E−05 (0.00054) [−0.1784]	0.308855 (0.18265) [1.69093]	−0.2173 (0.09862) [−2.2035][b]
DLCPS	0.042472 (0.01371) [3.0982][a]	−0.198273 (0.16952) [−1.16961]	−0.090789 (0.11340) [−0.80058]	0.000757 (0.00221) [0.34278]	−0.00039 (0.00083) [−0.4672]	0.473076 (0.17930) [2.6385][b]	−0.03296 (0.0080) [−4.1200][a]
DLCIC	0.043393 (0.01606) [2.7023][a]	−0.416171 (0.19857) [−2.0958][b]	0.165318 (0.13284) [1.24450]	−0.000895 (0.00259) [−0.34617]	−0.00026 (0.00097) [−0.2631]	0.388552 (0.1717) [2.2630][b]	0.097993 (0.17664) [0.55475]

Source: Authors computation. Note: ( ) Standard errors, [] *t*-statistics, [a] and [b] significant at 1% & respectively.

Table 10. VEC residual serial correlation LM tests.

Null Hypothesis: no serial correlation at lag order h

Sample: 1 112

Included observations: 99

Lags	LM-Stat	Prob
1	26.37222	0.3880
2	25.29744	0.4458
3	21.20947	0.6809
4	31.41266	0.1757

Probs from chi-square with 25 df.

for by innovations from the independent variables over different time-horizons. Table 11 has incorporated results of Variance Decomposition Approach (VDA). It presents the forecast error variance in LM2, LCPS and LCIC. The period (1) signifies the short run while down to period (10) it signifies long-run.

Table 11. Variance decomposition approach.

Variance Decomposition of LM2:						
Period	S.E.	LM2	EXR	IFR	LCPS	LCIC
1	0.057725	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.076813	95.24680	0.150191	0.009477	2.549037	2.044492
3	0.093464	93.73310	0.171608	0.011206	4.588927	1.495162
4	0.108785	91.40150	0.177070	0.026711	7.256403	1.138318
5	0.123587	88.82029	0.176112	0.060434	9.801132	1.142034
6	0.137957	86.18641	0.173334	0.109258	12.13253	1.398474
7	0.151926	83.68921	0.169827	0.166690	14.17727	1.797011
8	0.165480	81.40647	0.166217	0.227174	15.94317	2.256973
9	0.178606	79.36427	0.162763	0.286880	17.45635	2.729733
10	0.191299	77.55782	0.159579	0.343568	18.75106	3.187971
Variance Decomposition of LCPS:						
Period	S.E.	LM2	EXR	IFR	LCPS	LCIC
1	0.088269	1.309463	0.504234	0.685781	97.50052	0.000000
2	0.121403	3.129396	1.042118	1.159614	94.11820	0.550675
3	0.149967	3.339975	1.251581	1.365604	93.45045	0.592389
4	0.175195	3.546756	1.330117	1.495353	93.15496	0.472818
5	0.198460	3.669680	1.360759	1.596008	93.00275	0.370803
6	0.220154	3.763920	1.370092	1.680355	92.88191	0.303719
7	0.240577	3.835827	1.369374	1.752676	92.77548	0.266645
8	0.259914	3.893242	1.363873	1.815263	92.67623	0.251392
9	0.278301	3.939925	1.356235	1.869660	92.58336	0.250816
10	0.295846	3.978573	1.347823	1.917093	92.49689	0.259622
Variance Decomposition of LCIC:						
Period	S.E.	LM2	EXR	IFR	LCPS	LCIC
1	0.103397	75.03825	0.244132	0.445003	0.253103	24.01951
2	0.131948	79.20227	0.157836	0.499701	1.357845	18.78235
3	0.156708	80.99061	0.117007	0.610578	1.535111	16.74670
4	0.178068	81.59022	0.094788	0.699348	1.778569	15.83707
5	0.197492	81.79768	0.080296	0.757616	1.974621	15.38979
6	0.215367	81.82338	0.070282	0.793404	2.153615	15.15932
7	0.232040	81.76580	0.062935	0.814407	2.312333	15.04452
8	0.247718	81.66879	0.057333	0.826065	2.454067	14.99374
9	0.262560	81.55517	0.052927	0.831894	2.580370	14.97964
10	0.276681	81.43680	0.049376	0.834116	2.693024	14.98668

Cholesky Ordering: LM2 EXR IFR LCPS LCIC.

According to the VDA results, 77.56% of LM2 is explaining by itself, 0.16% of LM2 is explaining by EXR, 0.34% of LM2 is explained by IFR, 18.75% of LM2 is explained by LCPS and 3.19% of LM2 is explained by LCIC. The major portion in explaining LM2 has LCPS. The ratio of LM2, EXR, IFR and LCIC to LCPS is 3.98%, 1.35%, 1.92% and 0.26% respectively. 92.50% of LCPS is explained by itself. Similarly, 81.44% of LCIC is explained by LM2, 0.05% of LCIC is explained by EXR, 0.83% of LCIC is explained by IFR, 2.69% of LCIC is explained by LCPS and 14.99% of LCIC is explained by itself.

5. Summary

This research work examined the impact of financial development on money demand in Nigeria by means of ARDL approach. It examined the quarterly returns of M2, exchange rate (EXR), inflation rate (IFR), currency in credits to private sector (CPS) and circulation (CIC). The data span from 1991 to 2018.

In the preliminary analysis, the descriptive statistics and distribution of all the series revealed conventional facts. Also, the time series plots and augmented dickey-fuller tests of the original series indicate non-stationarity thus necessitating appropriate transformation to achieve stationarity.

In successive analysis, the study further employed regression model. The regression model's residual is tested for Cointegration using Engle-Granger residual approach, the significances of the variable's co-movement are checked by pairwise Granger Causality tests and ARDL and VECM are estimated in order to account for the short run and long run relationship among the variables.

5.1. Conclusions

The objectives of the study have been basically accomplished. Engle-Granger residuals test and pairwise Granger Causality test have been applied to check cointegration among variables. Both tests have confirmed cointegration among variables. The ARDL and VECM confirm the long-run relation between money demand (M2) and financial development variables; credits to private sector and currency in circulation. ARDL models (short-run relationship) are estimated for exchange rate and inflation rate. Long-run (VECM) analysis has confirmed significance of financial development variables (CPS and CIC) with positive sign (see model 4.5). It means that money demand function is stable in long-run.

VECM Granger causality was applied to check causality in short- and long-run. Results revealed that bidirectional causality exists between currency in circulation and money demand in both short and long run. Unidirectional causal relationship exists between credits to private sector and money demand in both short- and long-run.

5.2. Recommendations

From the aforesaid,

1) Government should pay more attention on financial development *i.e.* cre-

dits to private sector and currency in circulation, in both short and long run to control money demand since it has statistically significant impact on money demand in both short-run and long-run.

2) We suggest a coordination of both fiscal and monetary policy.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Maravić, J. and Mirjana, P. (2010) Econometric Analysis of Money.

[2] Friedman, M. (1970) A Theoretical Framework for Monetary Analysis. *Journal of Political Economy*, **78**, 193-238. https://doi.org/10.1086/259623

[3] Drama, B.G. and Yao, K.A. (2018) Oil Price, Budget Deficit, Money Supply and Inflation in WAEMU Countries. *Asian Journal of Economic Modeling*, **6**, 317-326.

[4] Keho, Y. (2016) Budget Deficits, Money Supply and Price Level in West Africa. *Journal of Economic and Financial Studies*, **4**, 1-8. https://doi.org/10.18533/jefs.v4i05.209

[5] Doe, L. and Diarisso, S. (1998) The Monetary Origin of Inflation in the WAEMU Countries. Information Notes and Statistics, BCEAO.

[6] Nubukpo, K.K. (2003) The Effectiveness of the Monetary Policy of the Central Bank of West African States Since the Liberalization of 1989. Center for International Cooperation for Agronomic Research and Development (CIRAD), 1-42.

[7] Dembo Toe, M. (2010) Forecast of Inflation in the WAEMU Zone: A Component Approach. BCEAO, Study and Research Paper, No. DER 11/02.

[8] Bhatta, R.S. (2011) Stability of Demand for Money Function in Nepal: A Cointegration and Error Correction Modeling Approach, MPRA Paper No. 41404, University Library of Munich, Munich.

[9] Omer, M. (2010) Stability of Money Demand Function in Pakistan. SPB Working Paper Series.

[10] Tang, C.F. (2007) The Stability of Money Demand Function in Japan: Evidence from Rolling Cointegration Approach. MPRA paper 19807, University Library of Munich, Germany.

[11] Kumar, S. and Manoka, B. (2008) Testing the Stability of Demand for Money in Tonga. MPRA Paper 19300, University Library of Munich, Germany.

[12] Ndirangu, L. and Nyamongo, E.M. (2015) Financial Innovations and Their Implications for Monetary Policy in Kenya. *Journal of African Economics*, **24**, i48-i71. https://doi.org/10.1093/jae/eju029

[13] Nachega, J.-C. (2001) Financial Liberalization, Money Demand and Inflation in Uganda. IMP Working Paper 01/118. https://doi.org/10.5089/9781451854084.001

[14] Anoruo, E. (2002) Stability of the Nigerian M2 Money Demand Function in the SAP Period. *Economics Bulletin*, **14**, 1-9.

[15] Akinlo, E.A. (2006) The Stability of Money Demand in Nigeria: An Autoregressive Distributed Lag Approach. *Journal of Policy Modelling*, **28**, 445-452. https://doi.org/10.1016/j.jpolmod.2005.09.001

[16] Dogru, B. and Recepoglu, M. (2013) Dynamic Analysis Money Demand Function in

Turkey. *International Journal of Economics and Finance*, **5**, 20.
https://doi.org/10.5539/ijef.v5n9p20

[17] Afsin, S. (2013) Estimating Money Demand Function by a Smooth Transition Regression Model: An Evidence for Turkey. Working Papers 791, Economic Research Forum.

[18] Iyoboyi, M. and Pedro, L.M. (2013) The Demand for Money in Nigeria: Evidence from Bounds Testing Approach. *Business and Economics Journal*, **2013**, BEJ-76.

Appendix

Null Hypothesis: LM2 has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 4 (Automatic—based on AIC, maxlag = 4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−0.647617	0.9738
Test critical values:	1% level	−4.046072	
	5% level	−3.452358	
	10% level	−3.151673	

*MacKinnon (1996) one-sided *p*-values.

Null Hypothesis: D (LM2) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 3 (Automatic—based on AIC, maxlag = 4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−4.251920	0.0053
Test critical values:	1% level	−4.046072	
	5% level	−3.452358	
	10% level	−3.151673	

*MacKinnon (1996) one-sided *p*-values.

Null Hypothesis: EXR has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 1 (Automatic—based on AIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−1.963052	0.6145
Test critical values:	1% level	−4.043609	
	5% level	−3.451184	
	10% level	−3.150986	

Null Hypothesis: D(EXR) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic—based on AIC, maxlag = 4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−8.180842	0.0000
Test critical values:	1% level	−4.043609	
	5% level	−3.451184	
	10% level	−3.150986	

Null Hypothesis: IFR has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic—based on AIC, maxlag = 4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−2.533017	0.3119
Test critical values:	1% level	−4.051450	
	5% level	−3.454919	
	10% level	−3.153171	

Null Hypothesis: D (IFR) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic—based on AIC, maxlag = 4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−3.543375	0.0455
Test critical values:	1% level	−4.055416	
	5% level	−3.456805	
	10% level	−3.154273	

Null Hypothesis: LCPS has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic—based on AIC, maxlag = 4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−0.520437	0.9811
Test critical values:	1% level	−4.051450	
	5% level	−3.454919	
	10% level	−3.153171	

Null Hypothesis: D(LCPS) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic—based on AIC, maxlag = 4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−8.581258	0.0000
Test critical values:	1% level	−4.049586	
	5% level	−3.454032	
	10% level	−3.152652	

Null Hypothesis: LCIC has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic—based on AIC, maxlag = 4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−0.530218	0.9807
Test critical values:	1% level	−4.046072	
	5% level	−3.452358	
	10% level	−3.151673	

Null Hypothesis: D (LCIC) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 3 (Automatic—based on AIC, maxlag = 4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−5.076255	0.0003
Test critical values:	1% level	−4.046072	
	5% level	−3.452358	
	10% level	−3.151673	

VEC Lag Order Selection Criteria

Endogenous variables: DLM2 DEXR DIFR DLCPS DLCIC

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−204.4334	NA	9.50e−05	4.927846	5.071531*	4.985640*
1	−168.1493	67.44584*	7.29e−05*	**4.662336***	5.524448	5.009102
2	−158.7894	16.29716	0.000106	5.030340	6.610879	5.666077
3	−136.6108	36.00767	0.000115	5.096725	7.395691	6.021433
4	−120.7281	23.91741	0.000147	5.311250	8.328643	6.524930
5	−106.6086	19.60127	0.000199	5.567261	9.303080	7.069912
6	−84.39132	28.22900	0.000229	5.632737	10.08698	7.424359
7	−69.83063	16.78761	0.000327	5.878368	11.05104	7.958962
8	−60.02281	10.15398	0.000544	6.235831	12.12693	8.605396

*Indicates lag order selected by the criterion, LR: sequential modified LR test statistic, FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion (each test at 5% level).

ARDL Bounds Test

Sample: 8 112

Included observations: 102

Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	6.703127	4
	Critical Value Bounds	
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Dependent Variable: LM2

Method: ARDL

Sample (adjusted): 8 112

Included observations: 102 after adjustments

Maximum dependent lags: 4 (Automatic selection)

Model selection method: Akaike info criterion (AIC)

Continued

Dynamic regressors (4 lags, automatic): EXR IFR LCPS LCIC

Fixed regressors: C

Number of models evalulated: 2500

Selected Model: ARDL (1, 0, 0, 1, 2)

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.*
LM2(−1)	0.747570	0.050388	14.83633	0.0000
EXR	2.15E−05	8.48E−05	0.253197	0.8007
IFR	7.72E−05	0.000234	0.329780	0.7423
LCPS	0.014123	0.037342	0.378192	0.7062
LCPS(−1)	0.072220	0.037998	1.900637	0.0604
LCIC	0.486424	0.029393	16.54884	0.0000
LCIC(−1)	−0.396912	0.044121	−8.995953	0.0000
LCIC(−2)	0.058052	0.031707	1.830917	0.0703
C	0.339475	0.063813	5.319871	0.0000
R-squared	0.999706	Mean dependent var		8.009428
Adjusted R-squared	0.999681	S.D. dependent var		1.659916
S.E. of regression	0.029649	Akaike info criterion		−4.114668
Sum squared resid	0.081754	Schwarz criterion		−3.883053
Log likelihood	218.8481	Hannan-Quinn criter.		−4.020879
F-statistic	39559.51	Durbin-Watson stat		1.668496
Prob (F-statistic)	0.000000			

ARDL Bounds Test

Sample: 7 112

Included observations: 102

Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	0.912015	4
	Critical Value Bounds	
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Dependent Variable: EXR

Method: ARDL

Sample (adjusted): 7 112

Included observations: 103 after adjustments

Maximum dependent lags: 4 (Automatic selection)

Continued

Model selection method: Akaike info criterion (AIC)

Dynamic regressors (4 lags, automatic): LM2 IFR LCPS LCIC

Fixed regressors: C

Number of models evaluated: 2500

Selected Model: ARDL (2, 0, 0, 0, 0)

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.*
EXR(−1)	1.220624	0.098674	12.37024	0.0000
EXR(−2)	−0.263069	0.101764	−2.585102	0.0112
LM2	14.65564	17.65140	0.830282	0.4084
IFR	−0.002648	0.084270	−0.031419	0.9750
LCPS	−4.376877	8.822736	−0.496091	0.6210
LCIC	−7.374413	10.94607	−0.673704	0.5021
C	−24.29200	22.45592	−1.081764	0.2821
R-squared	0.983669	Mean dependent var		126.6453
Adjusted R-squared	0.982649	S.D. dependent var		80.91200
S.E. of regression	10.65809	Akaike info criterion		7.636057
Sum squared resid	10905.10	Schwarz criterion		7.815116
Log likelihood	−386.2569	Hannan-Quinn criter.		7.708582
F-statistic	963.7522	Durbin-Watson stat		1.977128
Prob (F-statistic)	0.000000			

ARDL Bounds Test

Sample: 7 112

Included observations: 98

Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	0.808640	4
	Critical Value Bounds	
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Dependent Variable: IFR

Method: ARDL

Sample (adjusted): 7 112

Continued

Included observations: 99 after adjustments

Maximum dependent lags: 4 (Automatic selection)

Model selection method: Akaike info criterion (AIC)

Dynamic regressors (4 lags, automatic): LM2 EXR LCPS LCIC

Fixed regressors: C

Number of models evaluated: 2500

Selected Model: ARDL (4, 0, 0, 0, 0)

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.*
IFR(−1)	1.417559	0.102720	13.80028	0.0000
IFR(−2)	−0.188279	0.169971	−1.107712	0.2709
IFR(−3)	−0.515586	0.169031	−3.050238	0.0030
IFR(−4)	0.221568	0.101433	2.184387	0.0315
LM2	−0.550366	5.975196	−0.092108	0.9268
EXR	0.002088	0.009850	0.211978	0.8326
LCPS	0.626236	2.952164	0.212128	0.8325
LCIC	−0.562863	3.688142	−0.152614	0.8790
C	4.293728	7.388747	0.581117	0.5626
R-squared	0.965487	Mean dependent var		19.59987
Adjusted R-squared	0.962419	S.D. dependent var		17.98814
S.E. of regression	3.487157	Akaike info criterion		5.422559
Sum squared resid	1094.424	Schwarz criterion		5.658479
Log likelihood	−259.4167	Hannan-Quinn criter.		5.518012
F-statistic	314.7109	Durbin-Watson stat		2.045246
Prob (F-statistic)	0.000000			

ARDL Bounds Test

Sample: 10 112

Included observations: 100

Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	5.081240	4
	Critical Value Bounds	
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Dependent Variable: LCPS

Method: ARDL

Sample (adjusted): 10 112

Included observations: 100 after adjustments

Maximum dependent lags: 4 (Automatic selection)

Model selection method: Akaike info criterion (AIC)

Dynamic regressors (4 lags, automatic): LM2 EXR IFR LCIC

Fixed regressors: C

Number of models evalulated: 2500

Selected Model: ARDL (3, 0, 0, 0, 0)

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.*
LCPS(−1)	0.643464	0.097837	6.576930	0.0000
LCPS(−2)	0.047433	0.116717	0.406393	0.6854
LCPS(−3)	0.089251	0.091219	0.978422	0.3304
LM2	0.157173	0.158909	0.989073	0.3252
EXR	−0.000616	0.000206	−2.989560	0.0036
IFR	0.000534	0.000586	0.910665	0.3649
LCIC	0.103236	0.094456	1.092955	0.2773
C	−0.150412	0.205849	−0.730689	0.4668
R-squared	0.998352	Mean dependent var		7.857243
Adjusted R-squared	0.998227	S.D. dependent var		1.769851
S.E. of regression	0.074527	Akaike info criterion		−2.278681
Sum squared resid	0.510999	Schwarz criterion		−2.070268
Log likelihood	121.9341	Hannan-Quinn criter.		−2.194333
F-statistic	7962.741	Durbin-Watson stat		2.225183
Prob (F-statistic)	0.000000			

ARDL Bounds Test

Sample: 8 112

Included observations: 102

Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	4.841586	4
	Critical Value Bounds	
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Dependent Variable: LCIC

Method: ARDL

Sample (adjusted): 8 112

Included observations: 102 after adjustments

Maximum dependent lags: 4 (Automatic selection)

Model selection method: Akaike info criterion (AIC)

Dynamic regressors (4 lags, automatic): LM2 EXR IFR LCPS

Fixed regressors: C

Number of models evalulated: 2500

Selected Model: ARDL (1, 1, 0, 0, 1)

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.*
LCIC(−1)	0.747832	0.054474	13.72824	0.0000
LM2	1.517195	0.090371	16.78844	0.0000
LM2(−1)	−1.117179	0.113923	−9.806461	0.0000
EXR	1.15E−06	0.000149	0.007692	0.9939
IFR	−0.000441	0.000412	−1.072427	0.2863
LCPS	0.014290	0.066018	0.216457	0.8291
LCPS(−1)	−0.139491	0.067168	−2.076745	0.0406
C	−0.481515	0.118018	−4.080021	0.0001
R-squared	0.999146	Mean dependent var		6.992431
Adjusted R-squared	0.999082	S.D. dependent var		1.736022
S.E. of regression	0.052592	Akaike info criterion		−2.977324
Sum squared resid	0.259995	Schwarz criterion		−2.771444
Log likelihood	159.8435	Hannan-Quinn criter.		−2.893956
F-statistic	15708.14	Durbin-Watson stat		1.697695
Prob (F-statistic)	0.000000			

Vector Error Correction Estimates

Sample (adjusted): 9 112

Included observations: 99 after adjustments

Standard errors in ( ) & *t*-statistics in []

Cointegrating Eq:	CointEq1
LM2(−1)	1.000000
EXR(−1)	−0.000113
	(0.00034)
	[−0.32737]
IFR(−1)	−0.001102
	(0.00100)
	[−1.10643]

Continued

LCPS(−1)	−0.311468				
	(0.06352)				
	[−4.90327]				
LCIC(−1)	−0.621778				
	(0.07217)				
	[−8.61579]				
C	−1.196502				
Error Correction:	D(LM2)	D(EXR)	D(IFR)	D(LCPS)	D(LCIC)
CointEq1	−0.168001	29.26148	7.004815	−0.032957	0.097993
	(0.09862)	(18.3111)	(6.25559)	(0.15080)	(0.17664)
	[−1.70354]	[1.59802]	[1.11977]	[−0.21855]	[0.55475]
D(LM2(−1))	0.308855	16.46215	7.030901	0.473076	0.388552
	(0.18265)	(33.9143)	(11.5861)	(0.27930)	(0.32717)
	[1.69093]	[0.48540]	[0.60684]	[1.69380]	[1.18762]
D(EXR(−1))	−9.71E−05	0.235130	−0.000295	−0.000389	−0.000256
	(0.00054)	(0.10104)	(0.03452)	(0.00083)	(0.00097)
	[−0.17841]	[2.32717]	[−0.00853]	[−0.46719]	[−0.26308]
D(IFR(−1))	−0.000698	0.300454	0.455950	0.000757	−0.000895
	(0.00144)	(0.26801)	(0.09156)	(0.00221)	(0.00259)
	[−0.48351]	[1.12105]	[4.97976]	[0.34278]	[−0.34617]
D(LCPS(−1))	0.101315	14.36538	2.788954	−0.090789	0.165318
	(0.07416)	(13.7701)	(4.70428)	(0.11340)	(0.13284)
	[1.36613]	[1.04323]	[0.59285]	[−0.80058]	[1.24450]
D(LCIC(−1))	−0.321199	−17.22164	1.222886	−0.198273	−0.416171
	(0.11086)	(20.5843)	(7.03219)	(0.16952)	(0.19857)
	[−2.89729]	[−0.83664]	[0.17390]	[−1.16961]	[-2.09579]
C	0.043803	1.479145	−0.842567	0.042472	0.043393
	(0.00896)	(1.66457)	(0.56867)	(0.01371)	(0.01606)
	[4.88597]	[0.88861]	[−1.48166]	[3.09821]	[2.70230]
R-squared	0.158969	0.113110	0.244882	0.043725	0.078389
Adj. R-squared	0.104119	0.055269	0.195635	−0.018641	0.018284
Sum sq. resids	0.306563	10568.86	1233.496	0.716807	0.983565
S.E. equation	0.057725	10.71816	3.661634	0.088269	0.103397
F-statistic	2.898262	1.955539	4.972549	0.701098	1.304199
Log likelihood	145.5089	−371.6670	−265.3381	103.4645	87.80379
Akaike AIC	−2.798159	7.649839	5.501779	−1.948777	-1.632400
Schwarz SC	−2.614666	7.833332	5.685272	−1.765284	-1.448906
Mean dependent	0.049326	2.772241	−0.479259	0.050031	0.051413
S.D. dependent	0.060988	11.02722	4.082709	0.087457	0.104355

Continued

Determinant resid covariance (dof adj.)	9.93E−05
Determinant resid covariance	6.88E−05
Log likelihood	−227.9596
Akaike information criterion	5.413326
Schwarz criterion	6.461859