Modeling the Effect of Monetary Policy on Commercial Bank's Lending Operation in Nigeria using Vector Error Correction Model (1991- 2020)

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Abstract

The study examines the effect of monetary policy on commercial bank's lending operation in Nigeria between February, 1991 to October, 2020 using the macroeconomic time series variables of exchange rate, interest rate, maximum lending rate and prime lending rate. The vector error correction model was employed to analyze these interactions as well as the effect and pattern of causality among the variables under investigation. Monthly data spanning from February, 1991 to October, 2020 which covered a period of 29 years and 7 months (357 observations) were sourced from the Statistical Bulletin of the Central Bank of Nigeria (CBN). Preliminary statistical approach such as descriptive statistics and time plot were carried out to test if the data set obey the normality assumption and to verify if there is trend on the series. Pre-estimation diagnosis such as unit root test, lag order selection criteria and co-integration test were carried out and the results shows that at level, all variables had unit root, then, at first difference all variables were stationary. The lag order selection criteria chose lag 3 (14.7844) of Akaike information criteria, but the vector error correction model (VECM) was done at lag 2 indicating losing a lag. The co-integration test shows the presence of long run relationship among the variables. The vector error correction model (VECM) estimated from the results obtained shows that all the variables had positive effect on commercial bank's lending operation. The post estimation test on vector error correction model such as normality of the residuals, serial correlation and heteroscedasticity shows that the VEC model was multivariate normal, no serial correlation and homoscedastic. The inverse root of AR characteristic polynomial shows that the estimated VECM satisfy the stability condition of the diagnostic test. The variance decomposition test shows that the variables have a very weak influence in predicting one another. Recommendations were made based on the result of findings in the study.*

Keywords: *Monetary, Policy, Lending, and Operation*

1.1 Background to the study

Monetary policy, as one of the most important tools of economic performance, is said to resolve economic shocks more quickly. Basically, monetary policy is concerned with addressing a number of monetary objectives such as price stability, economic growth, preventing financial crisis, stabilizing long-term interest rate, exchange rate and ensuring low inflation. Yet, the effect on the system and its response to several shocks have not been captured.

Moreover, Government adopted their moribund monetary policies under the supervision of major financial institutions like the World Bank and other International Monetary Fund (IMF) without considering its consequences and impact on the lending operation of commercial bank.

Soludo[1] reported a decline of more than 373.1 billion naira outside the banking system due to the failure of banks to mobilize savings by offering acceptable interest rates to small depositors, which caused distress (worry) from the sector because confidence in the banking sector was partially declining. All these, together with an increase in informal sector that undermined the monetary policy on the system, brought about reduction of out-flow of liquid capital from commercial bank and further weakend the effect of monetary policy on commercial bank's lending operation. Therefore, in order to achieve economic performance, these problems need to be addressed comprehensively and as well identifying some of the obstacles that hinder the implementation of monetary policy on commercial bank's lending operation. Hence, the study focused on determining the effect of the monetary policy on commercial bank lending operation in Nigeria. The aim of the study is to model the effect of monetary policy on commercial bank's lending operation in Nigeria between 1991 to 2020 using the VEC model. Specifically, the objectives of the study include to; determine the impact of Interest Rate on Commercial Bank Lending Operation in Nigeria; ascertain the impact of Exchange Rate on Commercial Bank's Lending Operation in Nigeria. determine the impact of Maximum Lending Rate on Commercial Bank's Lending Operation in Nigeria and determine the impact of the Prime Lending Rate on Commercial Bank's Lending Operation in Nigeria.

The outcome of this study will be helpful to government in the area of management of the economy and policy makers in the area of policy formulations. It will also serve as a useful guide to the banking sector and other financial institutions. The findings of this study will significantly add to the body of knowledge regulating finance decisions in the country. Researchers and the students will also find this study as useful and additional literature on Vector Error Correction (VEC) model and as well Vector Autoregressive (VAR) model.

In an attempt to examine the effect of monetary policy on commercial bank's lending operation in Nigeria using Vector Error Correction model several studies were reviewed and among some of the studies reviewed are Felix et al[2] studied on interest rate and commercial banks' lending operations in Nigeria: a structural break analysis using chow test. The variables used in the study were interest rate, fixed exchange rate, bank loan and advance. Also, Yakubu et al,[3] examine determinants of Bank Lending Behaviour in Nigeria: An Empirical Investigation. This was done using prime lending rate, liquidity ratio, number of bank branches, interbank rate, real gross domestic product, inflation rate and Treasury bills rate. Similarly, this study also reviews a study carried out by Uloma[4], on monetary policy instruments and their effects on turnover ratio of commercial banks in Nigeria using the following variables; money supply, liquidity ratio, monetary policy rate, and cash reserve ratio- on commercial banks turnover ratio and Osakwe et al,[5]studied on the effect of monetary policy instruments on banking sector credits in Nigeria using monetary policy instruments and banking sector credits in Nigeria. From all the studies reviewed so far none of them focused on modelling the effect of monetary policy on commercial bank's lending operation in Nigeria using vector error correction model and the variables to be used in the study include, exchange rate, interest rate and commercial lending operation include maximum and prime lending rate. However, since these variables have not been used in previous studies this implies that much work had not been done in this area and this shows that there exist gaps between this study and other related studies. Therefore, this study is aimed at filling the gap

METHODOLOGY

3.1 Model Specification

In line with the objective of this study, the model adopted for the study is vector error correction model (VECM).

$$\left.\begin{aligned}
\Delta ECR_{it} &= \sigma + \sum_{j=i}^{k-1}\beta i\Delta ECR_{it-1} + \sum_{s=i}^{k-1}\phi_j\Delta InINR_{t-j} + \sum_{m=i}^{k-1}\partial_m\Delta InMLR_{t-m} + \sum_{l=i}^{k-1}\gamma_{li}\Delta InPLR_{t-j} + \lambda_1 ECT_{t-1} + \mu_{1t}\\
\Delta INR_{it} &= \sigma + \sum_{j=i}^{k-1}\beta i\Delta InECR_{it-1} + \sum_{s=i}^{k-1}\phi_j\Delta InINR_{t-j} + \sum_{m=i}^{k-1}\partial_m\Delta InMLR_{t-m} + \sum_{l=i}^{k-1}\gamma_{li}\Delta InPLR_{t-j} + \lambda_2 ECT_{t-1} + \mu_{2t}\\
\Delta MLR_{it} &= \sigma + \sum_{j=i}^{k-1}\beta i\Delta InECR_{it-1} + \sum_{s=i}^{k-1}\phi_j\Delta InINR_{t-j} + \sum_{m=i}^{k-1}\partial_m\Delta InMLR_{t-m} + \sum_{l=i}^{k-1}\gamma_{li}\Delta InPLR_{t-j} + \lambda_3 ECT_{t-1} + \mu_{3t}\\
\Delta PLR_{it} &= \sigma + \sum_{j=i}^{k-1}\beta i\Delta InECR_{it-1} + \sum_{s=i}^{k-1}\phi_j\Delta InINR_{t-j} + \sum_{m=i}^{k-1}\partial_m\Delta InMLR_{t-m} + \sum_{l=i}^{k-1}\gamma_{li}\Delta InPLR_{t-j} + \lambda_4 ECT_{t-1} + \mu_{4t}
\end{aligned}\right\} \quad 3.4$$

Where;k-1 = lag length reduced by 1, $\sigma, \beta_{i,} \phi_j, \partial_{m,} \gamma$ = short-run dynamic coefficients of the model's adjustment long-run equilibrium. λ = Speed of adjustment parameter with negative sign, μ = Stochastic error term often referred to as shock, Δ = Change in variables

3.2 Source of Data for this Study

The data for this study is sourced from Central Bank of Nigeria (CBN) statistical bulletin spanning from February, 1991 - October, 2020.

3.3 Method of Estimation Procedure

The estimation procedure employed in this study are in sequence as specified in econometric analyses. These include examining time series properties such as time plot of the original series, descriptive statistics and unit root test. Also, the priori behavior of the variables will be examining lag length order and co-integration properties of the used data in the estimation. Thirdly, the econometric criteria by estimating Vector Error Correction Model and Variance decomposition of the Variables.

3.3.1 Time Plot

A time plot or time series graph is a graphical representation of the raw series against the time. It helps us to know how data changes over time..

3.3.2 Descriptive Statistics

Descriptive statistic is used to test for normality of a variable (raw data) and this is done using joint test of both skewness and kurtosis. The test statistic is defined by equation 3.1

$$X^2 = N/6\left[S^2 + \frac{(K-3)^2}{4}\right] \qquad 3.1$$

Where: S = skew statistic, K = kurtosis, N = Size of the variables. The hypotheses for this descriptive statistics are as follows: Ho: Not normally distributed against Ha: Normally distributed.

3.5.3 Unit Root Test

The unit root test is another type of stationarity test conducted to determine if the series have zero mean and constant variance. A series is said to have unit root when there is trend in the variable. In order to remove the trend, the variable have to be de-trended (differenced) and this is done using the Augmented Dickey Fuller Test (ADFT) and Philips – Perron Test (PPT). Dickey Fuller Test (ADFT): $\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta Y_{t-i} + e_t$

3.2

Where Y_t is a series to be tested for presence of unit root, t is time or trend variable $\Delta Y_t = Y_t - Y_{t-1}$, e_t is a white noise process. Philip – Perron Test (PPT): $y_t = C + \delta_t + \alpha y_t - 1 + e_{(t)}$ 3.3

The hypothesis to be tested to confirmed whether there is unit root is given as thus:
Null hypothesis (Ho): $P > 0.05$ (There is unit root) against alternative hypothesis (H_A): $P < 0.05$ (No unit root). Accepting the null hypothesis reveals that the series have unit root. In this case, we difference the variables to remove the unit root.

3.3.4 Lag Length Order

A critical element in the specification of VAR model is the determination of the lag length order. The general specification is to fit VAR models with order L = 0,1,2, … L where by models with too few lag could lead to systematic variation in the residuals whereas, too many lags come with the penalty of loss of degrees of freedom.

3.3.5 Co-integration Test

Co-integration test is used to determine the existence of long-run relationship between two or more variables, where the time-series data are often not stationary. According to Sayed (2008), the idea of co-integration between variables was developed by Engle and Granger in 1987.The test hypotheses are: Ho: No co-integration, against Ha: Co-integration

3.3.6 Post Estimation Test

This is the set of procedures available to assess the validity of a model in any number of different ways. It is use to perform various tests for heteroscedasticity, normality of the residuals, serial correlation etc, for model fit. In this case, when the test statistics is greater than the probability value (p-value), the null hypothesis cannot be rejected, but when the test statistics is less than the probability value (p-value), the null hypothesis is rejected respectively.

3.3.7 Variance Decomposition

A variance decomposition or forecast error variance decomposition (FEVD) is used to aid in the interpretation of a vector auto-regression (VAR) model once it has been fitted. The variance decomposition indicates the amount of information each variable contributes to other variables in the auto-regression. It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables.

RESULTS

This chapter is based on the presentation of results of the test carried out in this research work.

4.1 Descriptive Statistics of the Study Variables

Table 4.1 is the result for the descriptive test for normality and this test statistic provides basic information about the variables and highlights potential relationship between variables.

Table 4.1: Descriptive Statistics of the Study Variables

	INR	MLR	PLR	EXR
Mean	5.752297	24.42465	19.02661	160.8667
Median	4.070000	23.20000	17.95000	139.1700
Maximum	19.38000	45.30000	37.80000	494.7000
Minimum	1.330000	17.17000	11.31000	11.86000
Std. Dev.	4.364702	4.578381	3.802009	107.9320
Skewness	1.454380	0.816820	1.815899	1.248017
Kurtosis	3.842507	3.707841	7.939082	3.854811
Jarque-Bera	136.4142	47.15103	559.0694	103.5433
Probability	0.000000	0.000000	0.000000	0.000000

Note: INR: Interest Rate, MLR: Maximum Leading Rate, PLR: Prime Lending Rate EXR: Exchange Rate

4.2 Time Plot

Figure 4.1, 4.2, 4.3 and 4.4 is the time plot for exchange rate, interest rate, maximum lending rate and prime lending rate respectively. This is to verify if there exist trend in the movement of the variables.

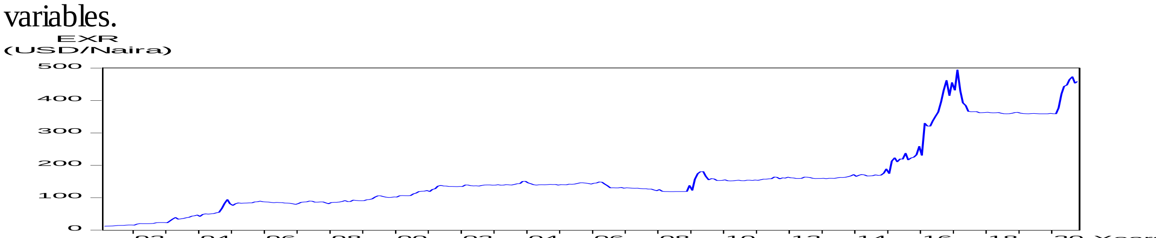

Figure 4.1: Time Plot of the Raw Data of Monthly Exchange Rate (Naira/ US Dollar)

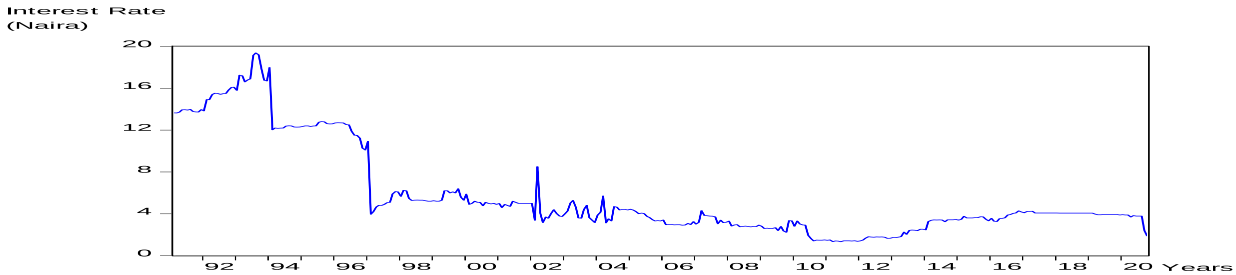

Figure 4.2: The Time Plot of the Raw Data of Monthly Interest Rate (Naira)

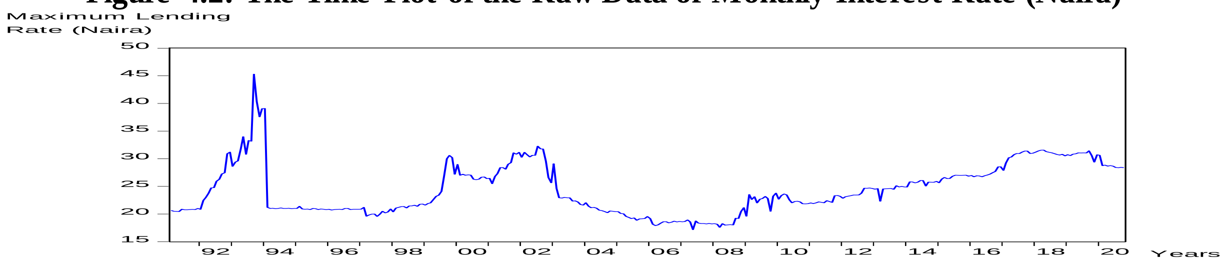

Figure 4.3: Time Plot of the Raw Data of Monthly Maximum Lending Rate (Naira)

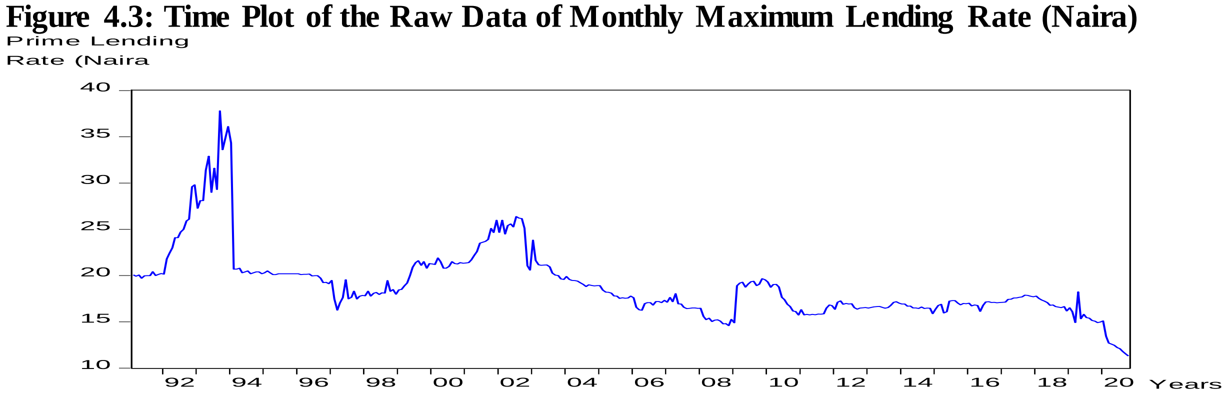

Figure 4.4: Time Plot of the Raw Data of Monthly Prime Lending Rate (Naira)

4.3 Unit Root Test

Table 4.2 shows the result for unit root test. The Augmented Dickey-Fuller and Phillips-Perron unit test were utilized to ascertain the presence of unit root in the study variables.

Table 4.2: Unit Root Test Results

Variable	ADF Level	Prob.	Phillips-Perron Levels	Prob.	ADF 1st Diff	Prob.	Phillips-Perron 1st Diff	Prob.	Order of integration
EXR	-0.4219	0.9837	0.4691	0.9855	-4.8534***	0.000	-22.2599***	0.000	I(1)
INR	-1.7105	0.4251	-1.7443	0.4080	-16.3595***	0.000	-24.6117***	0.000	I(1)
MLR	-2.7672	0.0641	-2.8678	0.0502	-8.2730***	0.000	-21.0274***	0.000	I(1)

PLR	-2.2487	0.2946	-2.2487	0.1896	-8.7894***	0.000	-22.2982***	0.000	I(1)

Note: * = significant at 10%, ** = significant at 5%, and *** = significant at 1%. EXR = Exchange Rate, INR = Interest Rate, MLR = Maximum Lending Rate, PLR = Prime Lending Rate, ADF = Augmented Dickey-Fuller.

Table 4.2 contains the result for the unit root test. Most time series are inherently non-stationary and may cause spurious or biased estimation. The results obtained showed that at level, all the variables had unit root (Non-stationary) as the probability value (p-value) is greater than 5% level of significance. At first difference, all the variables had no unit root (stationary) as the probability value (p-value) is less than 5% level of significance.

4.3.1 Time Plot for the Differenced Series

Figure 4.5, figure 4.6, figure 4.7 and figure 4.8 is the time plot for the differenced data for exchange rate, interest rate, maximum lending rate and prime lending rate respectively, to ascertain the stationarity condition.

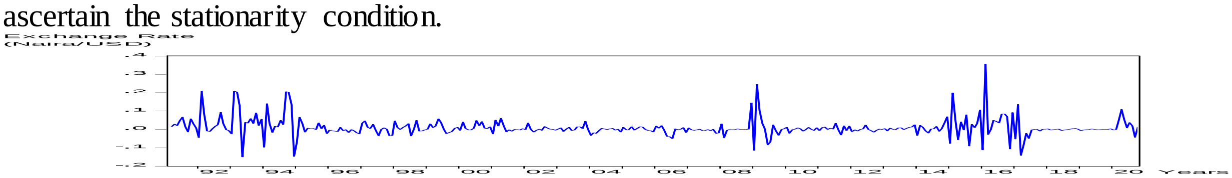

Figure 4.5: Time Plot of the Exchange Rate at First Difference

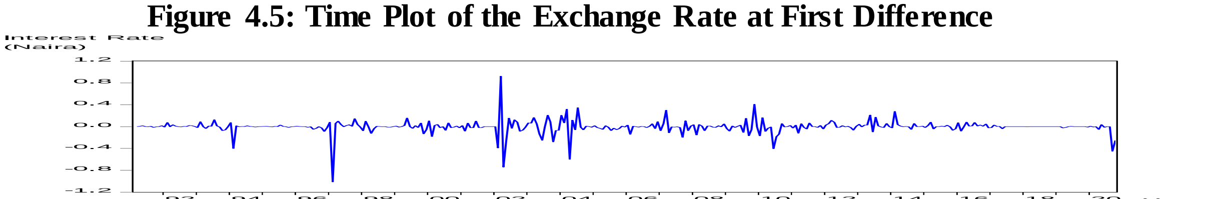

Figure 4.6: Time Plot of the Interest Rate at First Difference

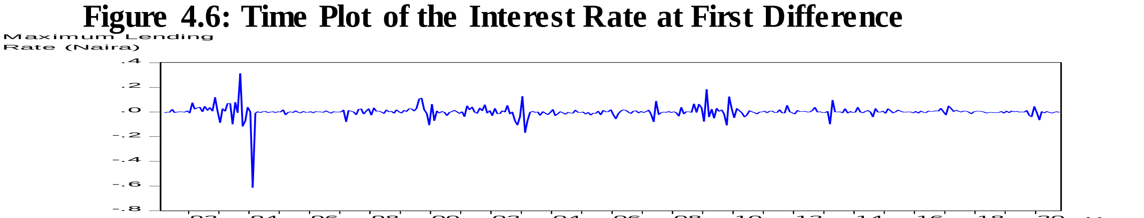

Figure 4.7: Time Plot of the Maximum Lending Rate at First Difference

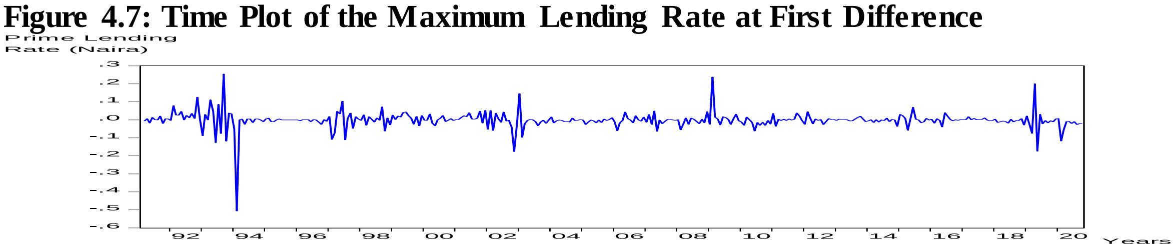

Figure 4.8: Time Plot of the Prime Lending Rate at First Difference

Figure 4.1 shows the time plot of exchange rate which has series of fluctuation (rise and fall) over the period under investigation. However, in 2017 there was a clear evidence of a spontaneous rise in exchange rate at which was the highest recorded within the period. In figure 4.2, the time plot for the interest rate shows the highest rate in 1993 and then began to fluctuate within the period. Figure 4.3 shows the time plot for the maximum lending rate with the highest lending rate in 1993 and then fluctuates to the least rate in 2017. The time plot for prime lending rate as shown in figure 4.4 indicates that prime lending rate went at its peak in 1993 and then continued to rise and fall until it attain its least value in 2020. Therefore, figure 4.1, figure 4.2, figure 4.3 and figure 4.4 did not follow a steady pattern in the movement of the series. Hence, they are time variant (non-stationary).

Figure 4.5, figure 4.6, figure 4.7 and figure 4.8 shows the time plot for the differenced variables which clearly shows that all the series were de-trended. The variables vary within the zero (O) mean, showing that it is stationary with the evidence of clustering volatility at constant variance.

4.4 VAR Lag Order Selection

Table 4.3 is the result for the lag order selection to ascertain the VAR lag length before estimation

Table 4.3: VAR Lag Order Selection

Lag	Log L	LR	FPE	AIC	SC	HQ
0	-2408.234	NA	36.05059	14.93643	14.98321	14.95511*
1	-2380.500	54.60889	33.52456	14.86378	15.09769	14.95715
2	-2361.149	37.62355	32.83770	14.84303	15.26407	15.01110
3	-2335.694	48.86138	30.97397*	14.78448*	15.39265*	15.02725
4	-2319.855	30.01028*	31.01159	14.78548	15.58078	15.10295

Note "*" indicates lag order selected by the criterion, LR = Likelihood Ratio
FPE = Final prediction Error, AIC=Akaike information criterion, SC= Swartz Criteria

Table 4.3 contains the VAR Lag Order Selection Criteria for the model. The lag order is selected using statistical information criteria. The result obtained in Table 4.3 of VAR lag order selection are as follows. Final Prediction Error 30.97397*, Akaike Information Criteria 14.78448*, Schwartz Information Criteria 15.39265*, respectively selected in lag 3. Others are Likelihood Ratio 30.01028* of lag 4, Hanna Quinn 14.95715* of lag 1. However, 14.7844* of lag 3 was selected because it has the smallest AIC among others. Hence, the vector error correction model (VECM) is a VAR model in first difference indicating loss a lag. Consequently, the VECM analysis is done at lag 2.

4.5 Co-integration Test

Table 4.4 is the Johansen co-integration test result to determine the presence of long-run relationship among the study variables

Table 4.4: Johansen Co-Integration Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.172549	87.92473	47.85613	0.0000	66.48147	27.58434	0.0000
At most 1	0.040404	21.44326	29.79707	0.3306	14.47626	21.13162	0.3273
At most 2	0.016397	6.967000	15.49471	0.5815	5.802906	14.26460	0.6387
At most 3	0.003311	1.164094	3.841466	0.2806	1.164094	3.841466	0.2806

Note: "*" Indicates rejection of the hypothesis.

Table 4.4 from the trace statistic indicates that the null hypothesis of no co-integrating relationship was rejected and the alternative hypothesis of co-integration accepted. This is so as the value of the trace statistic 87.92 is greater than the critical value of 47.85 and the probability value (0.000) is less than the significant level of 5%). More so, from the Maximum Eigen statistic, the null hypothesis of no co-integrating relationship was rejected in favour of the alternative hypothesis of co-integrating relationship because, Max-Eigen statistic 66.48 is greater than the critical value of 27.58 and the probability value 0.000 is less than 5% level of significance. Therefore, there is a co-integrating (long-run) relationship between exchange rate, interest rate, maximum and prime lending rates in Nigeria.

The normalized co-integrating equation is:

INR = -0.495MLR + 0.417PLR + 379.5EXR

(0.2347) (0.2928) (42.6259)

In the above normalized co-integrating equation, interest rate is positioned as the dependent variable. In the interpretation, the co-efficient of the variables are reversed. This simply means that in the long-run, maximum lending rate has negative impact on interest rate while prime lending rate and exchange rate had positive impact ceteris paribus. The co-efficient of prime lending rate is statistically significant at the 5% level. Given the existence of co-integrating equations, the estimation of the vector error correction model was necessary.

4.6 Results for the Vector Error Correction Model Estimation

5.3.1 Effect of Interest Rate on Maximum Lending Rate, Prime Lending Rate and Exchange Rate

Long-run**:**D(LNINR) = 14.5647*$LNMLR_{-1}$ + 0.9698*$LNPLR_{-1}$ - 4.8101*$LNEXR_{-1}$ **+ 0.0003**

Short-run:
D(LNINR) = **- 0.1380*ECT$_{-1}$** - 1.0224*D(LNINR)$_{-1}$ - 0.5265*D(LNINR)$_{-2}$ + 1.2669*D(LNMLR)$_{-1}$ + 0.4001*D(LNMLR)$_{-2}$ + 0.3247*D(LNPLR)$_{-1}$ + 0.1995*D(LNPLR)$_{-2}$ - 0.5265*D(LNEXR) $_{-1}$ - 0.2966*D(LNEXR) $_{-2}$ - 0.0088.

The result in Table 4.5 shows a coefficient of determination (R^2) of 0.687. This implied that 68.7% variation in interest rate is explained by variations in maximum lending rate, Prime lending rate and exchange rate. The remaining 31.3% are variations expounded by other variables not included in the model.
In the long-run, maximum lending rate and exchange rate had a significant impact on interest rate; the sign of exchange rate was however negative indicating decrease in interest rate as exchange rate increases. On the other hand, the positive sign of maximum lending rate indicates increase in interest rate as maximum lending rate increases *ceteris paribus*.

The error correction term shows the speed with which the model returns to equilibrium following an external shock. In table 4.5, the results obtained shows a negative coefficient (-0.1380ECT) of error correction term. The negative sign however indicates a backward movement towards equilibrium. 0.1380 ECT shows the correction of the previous period's deviation from the long-run equilibrium in the subsequent period at an adjustment speed of 13.8%. This is statistically significant at 5% level of significance (at an absolute value of t-stat = |-4.999| > t-crit. = 1.96) The error correction term was significant at 5% level of significance (as the absolute value of t_{-cal} = |-4.999| > t_{-crit} =1.96). The short-run result in Table 4.5 also shows that, interest rate lag 1 and lag 2; (t = |-21.2965| > 1.96, and t = | -11.7449| > 1.96 respectively), exchange rate lag 1 and lag 2; (t = |-3.2551| > 1.96, and t = -2.2978 > 1.96 respectively), and maximum lending rate lag 1 (t= 3.6191 > 1.96) had significant effect on interest rate at 0.05 level of significance.

5.3.2 Effect of Maximum Lending Rate on Interest Rate, Prime Lending Rate and Exchange Rate

Long-run: D(LNMLR) = - 14.5647*LNINR$_{-1}$ + 0.9698*LNPLR$_{-1}$ - 4.8101*LNEXR $_{-1}$ - 0.0003
Short-run:D(LNMLR) = - 0.1678*ECT$_{-1}$ + 0.1309*D(LNINR)$_{-1}$ + 0.0577*D(LNINR)$_{-2}$ + 0.6256*D(LNMLR) $_{-1}$ + 0.1442*D(LNMLR)$_{-2}$ + 0.1944*D(LNPLR) $_{-1}$ + 0.1380*D(LNPLR)-$_{2}$ - 0.5856*D(LNEXR) $_{-1}$ - 0.2678*D(LNEXR) $_{-2}$ – 0.0038.

The above result as presented in Table 4.6 shows that the coefficient of determination (R^2) is 0.821. This shows that 82.1% variation in maximum lending rate is explained by variations in prime lending rate, interest rate and exchange rate. The remaining 31.9% are variations resulting from other variables not included in the model.

The above model shows that in the long run, interest rate and exchange rate had a significant impact on maximum lending rate. Also, the negative sign of the error correction term shows the correction of the previous error in the current term and at an adjustment speed of 16.78%. It was also statistically significant at 5% level of significance (as the absolute value of t_{-cal} = |-20.40| > t_{-crit} =1.96). The short-run result in Table 4.6 also shows that all variables at lag 1 and lag 2 had significant effect on maximum lending rate (t-calculated > t-tabulated).

5.3.3 Effect of Prime Lending Rate on Interest Rate, Maximum Lending Rate, and Exchange Rate

Long-run:D(LNPLR) = - 14.5647*$LNINR_{-1}$ + 0.9698*$LNMLR_{-1}$ - 4.8101*$LNEXR_{-1}$ - 0.0003
Short-run: D(LNPLR) = - 0.1271ECT_{-1} + 0.0976*$D(LNINR)_{-1}$ + 0.0473*$D(LNINR)_{-2}$ + 1.3112*$D(LNMLR)_{-1}$+ 0.4934*$D(LNMLR)_{-2}$ - 1.0192*$D(LNPLR)_{-1}$ - 0.4364*$D(LNPLR)_{-2}$ - 0.3985*$D(LNEXR)_{-1}$ - 0.1702*$D(LNEXR)_{-2}$ – 0.0011.

The result presented in Table 4.7 on the effect of prime lending rate on interest rate, maximum lending rate and exchange rate shows that the coefficient of determination (R^2) is 0.763. This shows that 76.3% variation in prime lending rate is explained by variations in maximum lending rate, interest rate and exchange rate. The remaining 23.7% is caused by variations in other variables not included in the model.

The long-run result shows that interest rate and exchange rate had a significant impact on prime lending rate. The negative sign on interest rate and exchange rate indicates that as interest rate and exchange increases, prime lending rate decreases.

The negative sign of the error correction term indicates the correction of the previous error in the current term and at an adjustment speed of 12.71%. It was also statistically significant at 5% level of significance (as the absolute value of t_{cal} = | -13.31| > t_{crit} =1.96). The short-run result also shows that all variables at lag 1 and lag 2 were significant in affecting prime lending rate (t-calculated > t-tabulated).

5.3.4 Effects of Exchange Rate on Interest Rate, Maximum Lending Rate, and Prime Lending Rate

Long-run:D(LNEXR) = - 14.5647*$LNINR_{-1}$ + 0.9698*$LNMLR_{-1}$ - 4.8101*$LNPLR_{-1}$ - 0.0003
Short-run: D(LNEXR) = - 0.0505ECT_{-1} - 0.031*$D(LNINR)_{-1}$ - 0.0075*$D(LNINR)_{-2}$ - 0.5922*$D(LNMLR)_{-1}$ - 0.3198*$D(LNMLR)_{-2}$ + 0.0051*$D(LNPLR)_{-1}$ + 0.0218*$D(LNPLR)_{-2}$ - 0.8406*$D(LNEXR)_{-1}$- 0.3698*$D(LNEXR)_{-2}$ - 0.0012.

The result presented in Table 4.8 on the effect of exchange rate on interest rate, maximum lending rate, and prime lending rate shows that the coefficient of determination (R^2) of 0.624. This implied that 62.4% variation in exchange rate is explained by variations in maximum lending rate, prime lending rate and interest rate. The remaining 37.6% are variations explained by other variables not included in the model.

The long-run result shows that interest rate and prime lending rate had significant impact on exchange rate. The negative sign on interest rate and prime lending rate indicates that as interest rate and prime lending rate increases, exchange rate decreases.
The negative sign on the error correction term depicts a backward movement towards

equilibrium, the result shows a speed of adjustment of 5.05% and statistically significant at 5% level of significance (as the absolute value of t_{cal} = |-4.3671| > t_{crit} =1.96). Table 4.8 also shows that maximum lending rate lag 1 and lag 2; (t = |-4.2982| > 1.96 and t = |-3.738| > 1.96 respectively) and exchange rate lag 1 and lag 2; (t = |-13.256| > 1.96 and t = |-7.27709| > 1.96) respectively had significant effect on exchange rate at 0.05 level of significance.

4.7 Post Estimation Test on the Vector Error Correction Model

Post estimation test particularly serial correlation, normality of the residuals and heteroscedasticity were conducted on the Vector Error Correction Model and the results summarized in Table 4.9 as shown below

Table 4.9: Summary of Post Estimation Test Result on the Vector Error Correction Model

S/n	Type of Test Conducted	Null Hypothesis.	Test Statistics	Prob. Value	Decision	Conclusion
1	Residual serial correlation LM test	No serial correlation at lag 1	Rao F-stat (0.8033)	0.6830	Cannot Reject	No serial correlation at lag 1
2	Residual serial correlation LM test	No serial correlation at lag 2	Rao F-stat (1.6238)	0.0566	Cannot Reject	No serial correlation at lag 2
3	Jarque-Bera residual Normality test on INR component	Residual is multivariate normal	Jarque-Bera (0.64853)	0.6167	Cannot Reject	Multivariate normal
4	Jarque-Bera residual Normality test on MLR component	Residual is multivariate normal	Jarque-Bera (0.12968)	0.7087	Cannot Reject	Multivariate normal
5	Jarque-Bera residual Normality test on PLR component	Residual is multivariate normal	Jarque-Bera (0.15213)	0.4792	Reject	Residual is Multivariate normal
6	Jarque-Bera residual Normality test on EXR component	Residuals are multivariate normal	Jarque-Bera (0.29359)	0.8671	Cannot Reject	Residual is Multivariate normal
7	Residual Heteroskedasticity test	Residual is Heteroskedastic	Chi-Sq (0.2869)	0.1136	Reject	Residual is Homoscedastic

table 4.9 shows the post estimation test conducted on the vector error correction model as summarized which includes the test for serial correlation, normality of the residuals and heteroscedasticity. From the result obtained, the model had no serial correlation at lag 1 and lag 2. This is because at lag 1, Rao F-stat equal to 0.8033 and the probability value of 0.683 is greater than the 5% level of significance. Also at lag 2, Rao F-stat equal to 1.6239 and the p-value of 0.0566 is greater than 5% level of significance.

The result also shows that the residuals were multivariate normal on the interest rate, maximum lending rate, prime lending rate and exchange rate components. The post estimation test carried out on heteroscedasticity revealed that the value of chi-square (0.2869) is greater than 5%. This point to the fact that there is absence of heteroscedasticity in the residuals, hence, residual is homoscedastic. The stability test was also conducted and the result was presented in Figure 4.9. The graph shows that all roots lie inside the unit root circle and the detailed result shows that all modulus were less than one. The Inverse roots of a characteristic polynomial satisfy the stability condition (of the diagnostic test) since no root lied outside the unit root circle. Therefore, the estimated VECM is stable.

4.8 Model Stability Test

Figure 4.9 is the graph of inverse roots of the characteristic AR polynomial. It satisfies the stability condition of the diagnostic test

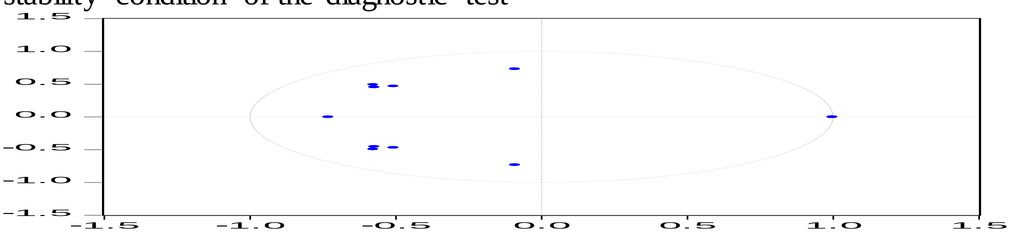

Figure 4.9: Inverse Root of a Characteristics Polynomial

4.9 Variance Decomposition

Table 4.10 is the variance decomposition test. It splits the variation in an exogenous variable into the component shocks to the VAR

Table 4.10: Variance Decomposition

Variance Decomposition of D(LNINR):					
Period	S.E.	D(LNINR)	D(LNMLR)	D(LNPLR)	D(LNEXR)
1	0.196191	100.0000	0.000000	0.000000	0.000000
2	0.201823	96.98286	2.467956	0.282593	0.266591
3	0.229603	96.73690	2.616656	0.383255	0.263184
:	:	:	:	:	:
:	:	:	:	:	:
10	0.300250	95.72225	3.206338	0.412605	0.658811

Variance Decomposition of D(LNMLR):					
Period	S.E.	D(LNINR)	D(LNMLR)	D(LNPLR)	D(LNEXR)
1	0.054954	0.000729	99.99927	0.000000	0.000000
2	0.071213	1.129049	93.05459	0.241401	5.574957
3	0.072955	1.895764	90.83779	0.405148	6.861302
:	:	:	:	:	:
:	:	:	:	:	:
10	0.080744	3.815103	79.43957	0.883291	15.86204

Variance Decomposition of D(LNPLR):					
Period	S.E.	D(LNINR)	D(LNMLR)	D(LNPLR)	D(LNEXR)
1	0.063801	0.011751	38.65011	61.33814	0.000000
2	0.074014	0.651791	48.49932	46.08592	4.762965
3	0.080790	0.777227	42.41142	52.53134	4.280014
:	:	:	:	:	:
:	:	:	:	:	:
10	0.097902	1.639488	30.44799	60.40924	7.503275

Variance Decomposition of D(LNEXR):					
Period	S.E.	D(LNINR)	D(LNMLR)	D(LNPLR)	D(LNEXR)
1	0.077220	0.010292	2.133490	1.258314	96.59790
2	0.078126	0.254853	3.426584	1.293394	95.02517
3	0.088629	0.245258	4.467275	1.345290	93.94218
:	:	:	:	:	:
:	:	:	:	:	:
10	0.119210	0.280699	8.401041	1.753562	89.56470

Table 4.10 shows the result of variance decomposition test for interest rate, maximum lending rate, prime lending rate and exchange rate. The percentage of the forecast error variance as shown in Table 4.10 shows that in the short run, 100% forecast variance in interest rate is self-explained. Maximum lending rate, prime lending rate and exchange rate however, shows very weak influence in predicting interest rate, therefore they are strongly exogenous. As we move into the future interest rate decreases while maximum lending rate, prime lending rate and exchange rate increases but were not strongly exogenous as the percentage forecast variance of

interest rate was 95.7% in the long run while the percentage forecast variance of maximum lending rate, prime lending rate and exchange rate were 3.21%, 0.41% and 0.66% respectively. Similarly, the percentage of the forecast error variance as shown in Table 4.10 shows that in the short run, 99.9% forecast variance in maximum lending rate is self-explained. Interest rate, prime lending rate, and exchange rate, shows very weak influence in predicting maximum lending rate and were strongly exogenous. Maximum lending rate decreases while interest rate, prime lending rate and exchange rate increases as we move into the future but were not strongly exogenous as the percentage forecast variance of maximum lending rate was 79.44% in the long run while the percentage forecast variance of interest rate, prime lending rate and exchange rate were 3.82%, 0.88% and 15.86% respectively. Also, the percentage of the forecast error variance presented in Table 4.10 shows that in the short run, 69.4% forecast variance in prime lending rate is self-explained. Interest rate, maximum lending rate and exchange rate, shows very weak influence in predicting prime lending rate and were strongly exogenous. Prime lending rate decreases while interest rate, maximum lending rate and exchange rate increases as we move into the future but were however not strongly exogenous as the percentage forecast variance of prime lending rate in the long run was 60.4% while the percentage forecast variance of interest rate, maximum lending rate and exchange rate were 1.64%, 30.4% and 7.5% respectively. In another development, the percentage of the forecast error variance as shown in Table 4.10 revealed that in the short run, 96.59% forecast variance in the exchange rate was self-explained. Interest rate, maximum lending rate and prime lending rate shows very weak influence on exchange rate and were strongly exogenous. Exchange rate decreases while interest rate, maximum lending rate and prime lending rate increases as we move into the future but were however not strongly exogenous because the percentage forecast variance of exchange rate in the long run was 89.56% while the percentage forecast variance of interest rate, maximum lending rate and prime lending rate were 0.28%, 8.40% and 1.75% respectively.

6.1 Conclusion

It could be concluded that maximum lending rate and exchange rate had a significant impact on interest rate. Also, interest rate and exchange rate have a significant impact on maximum lending rate. Interest rate and exchange rate, also have significant effect on prime lending rate and interest rate and prime lending rate have significant impact on exchange rate. Therefore, from the results obtained, monetary policy has a positive effect on commercial bank's lending operation in Nigeria within the period under investigation. However, model diagnostic check was done to determine the robustness of the model. This shows that the estimated models were robust and adequate.

6.2 Recommendations

The following recommendations were made based on the results obtained in the study and they include:

1. In modeling the Effect of Monetary policy on Commercial Bank's Lending Operation in Nigeria, there is need for the inclusion of the lags of the response variable among the determinants (interest rate and exchange rate), particularly for multivariate models.
2. There is also the need for policies, which will stabilize exchange rate and interest rate so that their response to shock will significantly improve commercial bank's lending operation

in Nigeria.

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