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Box-Jenkins Modelling of Nigerian Maximum Lending Rates

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ABSTRACT

The Nigerian Maximum Lending Rate (NMLR) has been increasing continually for some decades now. This calls for concern and immediate attention of Nigerians and the Government as increasing NMLR is an indication of increasing lending rate of commercial banks in Nigeria. The NMLR has been surging higher and higher year by year without any intervention on its path, be it economical, financial, or even governmental. If this factor remains unchecked, the investors would find it difficult to borrow which would consequently lead to low investment, low production, and increase in the cost of living. The study aimed at modeling NMLR, and using the model to make a 12-month forecast. The methodology adopted was the Box-Jenkins ARIMA. Four models- ARIMA(5 1 0), ARIMA(0 1 6), ARIMA(2 1 1), and ARIMA(1 1 2) were proposed; after diagnosis, ARIMA(1 1 2) emerged as the best of them all. The data analysis and the forecast were carried out with the aid of two computer software packages (Eviews and Minitab). Based on the continual increase in NMLR and its 12-month out of sample forecast, it was recommended that cash reserve of the commercial banks be reduced, and were also urged to reduce their cost of operation to the possible minimum. Finally, the Federal Government should intervene by initiating and employing policies that would bring NMLR down.

INTRODUCTION

The greatest aim or objective of every business establishment, of which banking is not in exclusion is profit making. In Nigeria, commercial banks stand as a financial intermediation between one group, the possessors of surplus funds which may be individuals, government, government parastatals, etc and another group who are deficit in funds. The commercial banks intermediate between the groups in the sense that they position themselves in order to be seen as a safe-keeping house for money, and further attract the group that has excess or surplus fund for the moment to come and keep them in their custody. This, they do by attaching a percentage to be paid to the depositors on any amount deposited. This amount that will be paid to the depositor by virtue of the fund saved in the bank is called interest rate.

How then do commercial banks raise fund to pay interest to the depositors? This is very simple. The commercial banks use the fund mainly in business of lending to the group that have deficit of fund (that is in need of fund) in their financial endeavours. As this group (borrowers) borrows these funds from the commercial banks, they in turn will be required by the commercial banks to pay a certain percentage of the amount borrowed. That is, they pay interest to the commercial banks. The rate of the interest they pay to the bank is called lending rate. Thus, it is the interest paid by the borrowers that the banks use in paying interest to the depositors. So, lending rate is also an interest rate depending on the context. Interest rates can be defined as the rental payment for the use of credit by borrowers and returns for parting with liquidity by lenders, (Ibimodo, 2005).

Loans and advances giving out by the banks account for the highest percentage of the total assets of the banks. Based on this, the banks exercise precautions in their lending activities. Since the banks are seen as the professional institution in management of money, there will be no doubt that they will consider many factors before lending any money out. A layman can even attest to the fact that making deposit with the banks does not require many protocols compare to withdrawal of that same money, talk less of when that same money is to be lent to another person who is not the owner of it. Lending is influenced by good number of factors. These factors include: lending rate, volume of deposit, to mention but a few.

Having profit making as the key reason for establishing and running any business venture at the back of our mind, it will be reasonable to say that the banks will be always willing to lend as long as the lending rate is high. So, based on this the need comes for regulation of the lending rate.

Maximum Lending Rate and Prime Lending Rate

Lending rate is the interest paid to the banks for the fund borrowed from the bank. This rate may vary from bank to bank depending on the duration the fund will be used before paying it back; generally in lending, risks are involved; cost of funding etc. popularly, we have terms of loan (short, medium, and long), but the duration for each of them also varies from bank to bank. For long term loans, among other things that will be considered by the banks is ones creditworthiness. Before proceeding, it will be of utmost importance to distinguish between the two lending rates, viz: Maximum Lending Rate and Prime Lending Rate.

As the name implies, the Maximum Lending Rate is the highest interest rate a bank charges to the borrower. In charging interest rate to the borrowers, banks use a measure as a yardstick. This rate is the preferential rate they charge their most creditworthy, largest, and most secured borrowers. This rate is termed Prime Lending Rate. Thus it is not unusual to see always that the Prime Lending Rate is lower than Maximum Lending Rate.

Owing to the fact that lending rate services amongst others, the interest rate the bank pays to the depositors, it would be expected that the higher the interest rate, the higher the lending rate, and vice versa. In other words, we can say that lending rate is directly proportional to interest rate.

LITERATURE REVIEW

In reality, people are pushed to consume little or even forego consumption totally when interest rate is high, but do otherwise when the interest rate is low. This situation will also influence the lending rate high and low respectively, since there is a directly proportional relationship between the two rates. The idea is supported by renowned economists like Marshall (1923), Pigou (1917), etc in their classical theory of interest rate. They said that under perfect competition, interest rate can be determined by savings and investment as a result of the existence of inverse relationship between interest rate and demand for capital. According to Hansen (1951), the rate cannot be determined if the income is not foreknown

Keynes criticized the classical theory of interest in his Liquidity Preference Theory of interest (Keynes 1936). It states that interest rate can be calculated in terms of money, and can be determined by its demand and its supply; it says that the interest rate can be controlled by altering the supply of money. So, the theory made lending rate a phenomenon that can be absolutely determined by money only. The theory can be seen as a theory of the demand for money that depends mostly on the lending rate. The postulator argued that the classical theory of interest rate ought not to have extended their theory to investment and savings, since it will be impracticable for all the money that are deposited as savings to be channelled into investment.

The Post Keynesian economics disagree in totality with many other thoughts about lending or interest rate determination. The group was of the opinion that it is the responsibility of all the Central Banks to determine the interest rate instead of leaving it in the control of forces like demand and supply.

The Neoclassical or Loanable Funds Theory of Interest is a flow theory that determines the lending rate by relating the demand and the supply of loanable funds or credit. The theory was initiated by a Swedish economist Wicksell (1936), and gained support by many other economists like Robertson (1934). The theory estimated the lending rate by analyzing the supply of funds to be loaned out and the rate at which the funds are demanded to be borrowed. It was postulated based on the choice of the individuals regarding their consumption and their savings attitude. Since all the money earned are basically or invariably for the purpose of consumption; therefore when someone saves, the idea is that the savings of now will be consumed tomorrow. So, it means that whosoever saves now must have decided not to forego consumption at some times in the future, rather forego consumption in the present. The theory is seen as the most appropriate for determining long term lending rate.

According to Alao (2010), in his re-examination of Nigeria financial sector on the assumption that interest rate is determined by a combination of domestic rate in close economy and the uncovered interest parity in a wholly open economy. In his econometric analysis, he employed error correction approach using Engle Granger methodology. He found out that returns on foreign assets will play an important role in determining interest rate both for long run and short run as Nigeria financial sector incorporate itself more into the global market.

Uzeru (2012) made a study on the factors affecting lending rate using twenty eight commercial banks of Ghana. In that study a short period of six years (2005 – 2010) were used while causative correlation and multiple regression analysis were applied. It was found that lending rate increases with increasing interest paid out to the depositors for bank specific factors; decreases with increasing Treasury Bill rates for industry specific factors; increases with increasing inflation and gross domestic product for macroeconomic factors.

Onanuga and Shittu (2010) investigated the determinants of interest rate in Nigeria using Vector Error Correction Model (VECM) on quarterly data between first quarter of 2000 and last quarter of 2008. In summary, it was found that rising domestic outputs and past quarters' Treasury Bill Rate led to significant increase in current Treasury Bill Rate, while increase in past quarters' Real Money Supply cause current Treasury Bill Rate to decline. In all, real Gross Domestic Product accounts for as much as 37.4% of the variation in Treasury Bill Rate after 5 quarters (15 months), while Real Money Supply and Expected Foreign Returns accounted for 8.41% and 4.48% of variation in Treasury Bill Rate in the same period.

Were and Wambua (2013) employed both descriptive and regression analysis in studying the determinants of interest rate spreads in Kenya's banking sector. The regression analysis that was done on yearly panel data of commercial banks for the years (2002 – 2011) showed that bank specific factors (bank size based on assets, liquidity risk, non-performing loans to total loans ratio, operating cost, return on average assets) are significant in determining the interest rate spread while macroeconomic factors (real economic growth, inflation) were found to be insignificant. The study further noted that big banks have higher spreads than small banks.

Rhyne (2002), defined intermediation cost (that is information cost, transaction cost, administration cost, default cost, and operational cost) as the difference that exists between the gross cost of borrowing and the net return on lending. He further stated that the lending rate the commercial banks charge on assets depends on the level of risks the banks are ready to bear.

It has been a popular norm cutting across all the banks that bank specific factors, Industry/market specific factors and macroeconomic variables have been identified as factors contributing to high lending rate. Demirguc-Kunt and Huizinga (1998), Moore and Craigwell (2000), as well as Sologoub (2006) are of the opinion that the major drivers of commercial banks lending rate are the bank specific factors such as; the bank size, bank ownership, the loan portfolio, capital adequacy, overhead and operating cost, and shares of liquid and fixed assets. Beck and Hesse (2006) agreed with them, and stressed further that lending rate are mainly driven by the bank size, as well as overhead costs and sectoral compositions of loans in his study where Ugandan commercial banks were used as a case study.

Tennant (2006) showed that macro-policy variables, such as public sector domestic borrowing, discount rates and Treasury Bill Rates, are commonly perceived to impact on commercial bank lending rate. Additional macroeconomic policy variables included by Crowley (2007) in his own study for determination of lending rate of commercial banks in English-speaking African countries are broad money growth, and the fiscal balance. The macroeconomic variables which have been empirically shown to increase spread in lending rate include: high and variable inflation and real interest rates (Demirguc-Kunt and Huizinga, 1998); lending rate uncertainty - proxied by inter-bank lending rate volatility (Brock and Franken, 2002); broad money growth (Crowley, 2007); increased fiscal deficits (Crowley, 2007); and a high share of commercial bank public sector loans (Randall, 1998).

Akinlo and Owoyemi (2012) investigated the determinants of interest rates spread in Nigeria using panel data for the period 1986 – 2007, for 12 commercial banks. In summary, their results suggested that a reduction in cash reserve ratio, as well as a reduction in bank overhead costs amongst others will help to reduce the lending rate of Nigerian banks to a moderate level. In other words, these factors proportionally vary to the lending rate.

MATERIALS AND METHOD

ARIMA Methodology

There are two widely used linear time series model, viz: Autoregressive (AR) and Moving Average (MA). These two models give the model ARMA when they are combined, and then ARIMA after undergoing manipulation of Differencing or Integration.

Autoregressive of order p, AR(p) model, assumes that the future value of a variable is a linear combination of 'p' past observations and a random shock or error term with a constant term. This can be stated mathematically as

$$Y_t = C + \theta_1 Y_{t-1} + \theta_2 Y_{t-2} + \theta_3 Y_{t-3} + - - - - + \theta_p Y_{t-p} + \varepsilon_t$$

$$Y_t = C + \sum_{i=1}\theta_i Y_{t-i} + \varepsilon_t$$

Where Y_t and ε_t are the actual values and the random shock respectively at time t, θ_i (i=1, 2, 3,- - -, p) are the parameters of the model and C is a constant.

Similarly, for a Moving Average of order q, MA (q), the model is given as

$$Y_t = C + \beta_1\varepsilon_{t-1} + \beta_2\varepsilon_{t-2} + \beta_3\varepsilon_{t-3} + - - - - + \beta_q\varepsilon_{t-q} + \varepsilon_t$$

$$Y_t = C + \sum_{j=1}\beta_j\varepsilon_{t-j} + \varepsilon_t$$

Where C is the mean of the series, β_j (j=1,2, - - -,q) are the model parameters, and ε_t the random shock which is assumed to be a White Noise process.

Closer look at the model shows that MA is a linear regression of current observation of the series against the random shocks of at least one prior observation. It is of simple type if the predictor or exogenous variable is the random shock of one prior observation, but becomes multiple type if the exogenous variables comprises random shocks of at least two prior observations.

As mentioned previously, the effective merger of AR(p) and MA(q) gives another class of time series known as Autoregressive Moving Average of order (p,q) written as ARMA(p,q) which has a mathematical model of

$$Y_t = \mu + \varepsilon_t + \sum_{i=1}\theta_i Y_{t-i} + \sum_{j=1}\beta_j\varepsilon_{t-j}$$

The Concept of Stationarity

Stationarity is a fundamental property in modelling of every time series. What actually does this property entails in a time series? A stationary time series is one whose statistical properties such as mean, variance, autocorrelation, partial autocorrelation remain unchanged over some given period of time. It can be said to be 'weakly' or 'strictly' depending on the properties it exhibits. 'Strictly stationarity' among others requires that the joint distribution of the series $\{Y_1, Y_2, \ldots, Y_n\}$ be the same to the joint distribution of $\{Y_{1+k}, Y_{2+k}, \ldots, Y_{3+k}\}$. However, in practice it is always difficult to fulfil the above condition. The difficulty makes 'strictly stationarity' to be spoken of in theory or in abstract sense. That means that whenever stationarity is spoken of in time series analysis like in this piece of work, it is 'weakly stationarity' that is meant. Just as 'strictly stationarity' requires some conditions to be met, 'weakly stationarity' requires its own as well. The conditions are as follows:

1. $E(Y_t) = \mu_y$. This means that at every period the mean of the series remains at the same level. Based on this, mean stationary can also be regarded as level stationary.
2. $Var(Y_t) = E[Y_t - \mu_y]^2 = \sigma^2$ constant variance.
3. $Cov(Y_t \; Y_{t-k}) = \gamma_k$. Constant autocovariance with respect to a particular lag.

It is of utmost importance to make a nonstationary series stationary. This is because non-stationarity in a series makes it difficult in modeling the underlying ARMA process, in the sense that it dominates the patterns of ACF and PACF which happen to be important tools in model identification, and to that effect, affect the authenticity of the result gotten from the analysis; thus giving misleading results. For the purpose of brevity, henceforward 'weakly stationarity' will be regarded as stationarity.

White Noise Series and Random Walk Series

White Noise series satisfies the three conditions listed above for stationarity. Therefore it is stationary. Random walk on the other hand is non stationary.

For stochastic non-stationary series, stationarity is achieved by subtracting the lag of the series from the series itself. This is called 'differencing'.

DISCUSSION

Nigerian Maximum Lending Rate Status (Stationary or Non-Stationary?)

The first tool employed in this test is examination of its Time plot which happens to be the first step in any time series investigation.

From Figure 4.1, it is clearly seen that Nigeria Maximum Lending Rate has a highly pronounced trend. The gradient of the line of best fit to the plot would be of positive nature against the value of zero that is expected of every stationary series. So at this point, it will not be wrong to say that Nigeria Maximum Lending Rate is non–stationary.

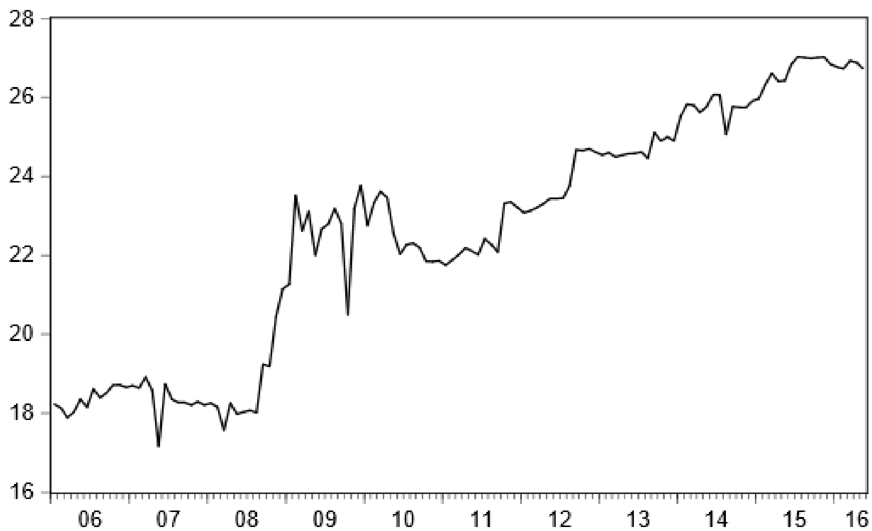

Figure 4.1: Time Plot of Nigeria Maximum Lending Rate

The second tool employed for this test is the correlogram of the realisations. The correlogram is shown in Table 4.1.

The slow decline in the values of the Autocorrelation is an indication of correlation among the values. Also Partial Autocorrelation at lag 1 is highly significant. These properties are exhibited by non–stationary series, thus affirming the result (that is the non–stationarity status) of the first tool employed.

Table 4.1: Correlogram of Nigerian Maximum Lending Rate.

Sample: 2006M01 2016M05
Included observations: 125

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.967	0.967	119.61	0.000
		2	0.942	0.115	234.10	0.000
		3	0.918	0.012	343.67	0.000
		4	0.890	-0.053	447.71	0.000
		5	0.864	-0.020	546.40	0.000
		6	0.829	-0.138	638.09	0.000
		7	0.804	0.096	724.97	0.000
		8	0.774	-0.053	806.24	0.000
		9	0.748	0.045	882.81	0.000
		10	0.720	-0.045	954.38	0.000
		11	0.690	-0.036	1020.7	0.000
		12	0.667	0.047	1083.1	0.000
		13	0.639	-0.042	1141.0	0.000
		14	0.612	-0.021	1194.6	0.000
		15	0.584	-0.033	1243.8	0.000
		16	0.554	-0.056	1288.5	0.000
		17	0.523	-0.050	1328.8	0.000
		18	0.497	0.068	1365.4	0.000
		19	0.474	0.035	1398.9	0.000
		20	0.449	0.004	1429.4	0.000
		21	0.421	-0.084	1456.8	0.000
		22	0.404	0.118	1481.7	0.000
		23	0.380	-0.091	1504.1	0.000
		24	0.356	-0.032	1524.1	0.000
		25	0.334	-0.003	1541.7	0.000
		26	0.313	0.031	1557.4	0.000
		27	0.287	-0.126	1570.8	0.000
		28	0.264	0.044	1582.1	0.000
		29	0.243	0.011	1591.9	0.000
		30	0.218	-0.057	1599.9	0.000
		31	0.194	-0.038	1606.2	0.000
		32	0.173	0.041	1611.3	0.000
		33	0.151	-0.011	1615.3	0.000
		34	0.130	-0.047	1618.2	0.000
		35	0.112	0.059	1620.4	0.000
		36	0.098	0.060	1622.1	0.000

Thirdly, the test of a Unit Root was carried out using Augmented Dickey–Fuller (ADF) Test. The result of the test is shown on Table 4.2. The ADF test statistic recorded a value (–0.845210) greater than all the three test critical values. Thus based on Table 4.2, at 99% confidence, Nigerian Maximum Lending Rate has at least one unit root. This third test confirmed the nonstationarity status of Nigerian Maximum Lending Rate. That led to differencing the data

Table 4.2: ADF Unit Root Test on Nigerian Maximum Lending Rate

Null Hypothesis: NMLR has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.845210	0.8022
Test critical values:	1% level	-3.484198	
	5% level	-2.885051	
	10% level	-2.579386	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(NMLR)
Method: Least Squares
Date: 06/26/17 Time: 16:39
Sample (adjusted): 2006M03 2016M05
Included observations: 123 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
NMLR(-1)	-0.013935	0.016487	-0.845210	0.3997
D(NMLR(-1))	-0.286747	0.087426	-3.279892	0.0014
C	0.404461	0.374735	1.079326	0.2826

R-squared	0.091669	Mean dependent var	0.069837
Adjusted R-squared	0.076531	S.D. dependent var	0.566007
S.E. of regression	0.543918	Akaike info criterion	1.644050
Sum squared resid	35.50155	Schwarz criterion	1.712639
Log likelihood	-98.10905	Hannan-Quinn criter.	1.671911
F-statistic	6.055251	Durbin-Watson stat	2.090888
Prob(F-statistic)	0.003123		

Differencing

The plot of the first differences is shown in Figure - - -above. As mentioned before, if a line of best fit is to be fitted to the first differenced data $Z_t = Y_t - Y_{t-1}$, it will appear to be parallel to the x-axis, that is it will be a horizontal line. The equivalence of saying that the gradient or the slope of the line will be zero, which is a property exhibits by a level stationary (constant mean over time) series.

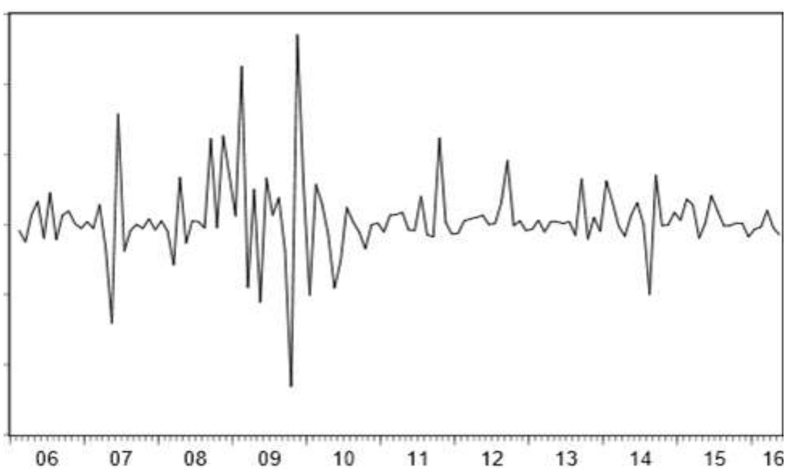

Figure 4.2: Time Plot of First Differenced on Nigerian Maximum Lending Rate.

Sample: 2006M01 2016M05
Included observations: 124

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.293	-0.293	10.936	0.001
		2	-0.064	-0.164	11.462	0.003
		3	0.106	0.040	12.907	0.005
		4	0.007	0.050	12.913	0.012
		5	0.184	0.248	17.341	0.004
		6	-0.253	-0.140	25.796	0.000
		7	0.084	-0.014	26.732	0.000
		8	-0.107	-0.207	28.270	0.000
		9	0.060	0.004	28.766	0.001
		10	0.042	0.030	29.012	0.001
		11	-0.195	-0.064	34.266	0.000
		12	0.168	0.074	38.194	0.000
		13	-0.064	0.011	38.780	0.000
		14	0.050	0.023	39.139	0.000
		15	0.031	0.056	39.272	0.001
		16	-0.127	-0.090	41.603	0.000
		17	0.052	-0.102	41.998	0.001
		18	-0.136	-0.161	44.734	0.000
		19	0.009	-0.148	44.746	0.001
		20	0.077	0.108	45.629	0.001
		21	-0.231	-0.134	53.726	0.000
		22	0.048	-0.045	54.073	0.000
		23	-0.006	-0.016	54.079	0.000
		24	-0.026	-0.109	54.183	0.000
		25	-0.055	-0.125	54.667	0.001
		26	0.022	0.020	54.746	0.001
		27	0.006	-0.118	54.752	0.001
		28	-0.099	-0.102	56.351	0.001
		29	0.189	0.082	62.228	0.000
		30	-0.050	0.070	62.642	0.000
		31	-0.099	-0.050	64.291	0.000
		32	0.099	-0.034	65.955	0.000
		33	0.057	0.077	66.521	0.000
		34	0.011	-0.029	66.542	0.001
		35	-0.041	-0.021	66.832	0.001
		36	-0.037	-0.090	67.075	0.001

Table 4.3: Correlogram of First Differences on Nigerian Maximum Lending Rate.

After the first differences, the values of the Autocorrelation cannot said to be correlated, as they appeared not to have any pattern. It was also worthy of note that the highly significant value of Partial Autocorrelation at lag 1 became reduced. All these are the evidences of stationarity in the differenced data.

Table 4.4: ADF Unit Root Test on First Differences on Nigerian Maximum Lending Rate

Null Hypothesis: DNMLR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-14.88397	0.0000
Test critical values:	1% level	-3.484198	
	5% level	-2.885051	
	10% level	-2.579386	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DNMLR)
Method: Least Squares
Date: 06/21/17 Time: 20:14
Sample (adjusted): 2006M03 2016M05
Included observations: 123 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DNMLR(-1)	-1.293790	0.086925	-14.88397	0.0000
C	0.090498	0.049365	1.833231	0.0692

R-squared	0.646749	Mean dependent var	-0.000488
Adjusted R-squared	0.643829	S.D. dependent var	0.910313
S.E. of regression	0.543275	Akaike info criterion	1.633725
Sum squared resid	35.71290	Schwarz criterion	1.679451
Log likelihood	-98.47408	Hannan-Quinn criter.	1.652299
F-statistic	221.5326	Durbin-Watson stat	2.094525
Prob(F-statistic)	0.000000		

From Table 4.4, the ADF test value of –14.88397, been more negative than the test critical values even at 1% showed that there is absence of a Unit Root at 99% confidence. Therefore, it was confirmed that the First Differences on Nigerian Maximum Lending Rate is stationary.

Box-Jenkins ARIMA approach of times series analysis involves four distinct phases or steps. Although the fourth cut across virtually many empirical researches. They are as follows:

1. **Model Identification**

With the help of correlogram of Table 4.3, four models ARIMA(5 1 0), ARIMA(0 1 6), ARIMA(2 1 1), and ARIMA(1 1 2) were selected as competitors. Among them all ARIMA(1 1 2) shown in Table 4.5 emerged as the best owing to the fact that it recorded the least Information criterion, Akaike Information Criterion (AIC) of 1.611052.

Table 4.5: ARIMA(1 1 2)

Dependent Variable: DNMLR
Method: Least Squares
Date: 06/21/17 Time: 20:46
Sample (adjusted): 2006M03 2016M05
Included observations: 123 after adjustments
Convergence achieved after 17 iterations
MA Backcast: 2006M01 2006M02

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.065952	0.031870	2.069394	0.0407
AR(1)	-0.906840	0.029846	-30.38375	0.0000
MA(1)	0.633860	0.086919	7.292499	0.0000
MA(2)	-0.366054	0.089005	-4.112743	0.0001

R-squared	0.135327	Mean dependent var	0.069837
Adjusted R-squared	0.113529	S.D. dependent var	0.566007
S.E. of regression	0.532910	Akaike info criterion	1.611052
Sum squared resid	33.79521	Schwarz criterion	1.702506
Log likelihood	-95.07972	Hannan-Quinn criter.	1.648200
F-statistic	6.208114	Durbin-Watson stat	2.048745
Prob(F-statistic)	0.000592		

Inverted AR Roots	-.91	
Inverted MA Roots	.37	-1.00

2. **Estimation of Parameters**

All the parameters of the model are significant greater than zero as they all have absolute values of t–statistic greater than 2, and confirmed with p–values lower than 5%. The equation for the model is thus derived as follows

$Z_t = Y_t - Y_{t-1} = C + \theta_1 Y_{t-1} + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} + \varepsilon_t$

$Y_t = C + (1 + \theta_1)Y_{t-1} + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} + \varepsilon_t$

$Y_t = 0.065952 + (1 - 0.96840)Y_{t-1} + 0.633860\varepsilon_{t-1} - 0.366054\varepsilon_{t-2} + \varepsilon_t$

$Y_t = 0.065952 + 0.09316Y_{t-1} + 0.633860\varepsilon_{t-1} - 0.366054\varepsilon_{t-2} + \varepsilon_t$

3. **Model Diagnosis**

In diagnosing the model, it is expected that the correlogram of the residuals be white noise. That is $\varepsilon_t \sim N[0, n^{-1}] = N[0, 125^{-1}]$, where 0 is the mean or expectation of the residual, n^{-1} the variance of ACF or PACF of the residuals, and n = 125, the number of realizations.

Thus the standard error of ACF or PACF of the residuals is given by $n^{-1/2} = 125^{-1/2} = 0.089443$.

: . 95% confidence band for the ACF or PACF of the residual is 1.96(0.089443) = 0.1753. This means that 95% of a sample of at least first 20 ACF or PACF of residuals must lie within the interval [–0.1753, 0.1753] or 5% lie outside the band as a result of chance. After some higher lag, the ACF and PACF of the residuals dwindle almost to the value of zero. In order to maintain the sensitivity of the band in determining whether the residuals are white noise, a sample of first 30 residuals was used, putting into consideration that the sample units should be at most n/4 = 125/4 = 31.25, that is approximately 31.

Table 4.6: Correlogram of The Residuals of ARIMA(1 1 2)

Date: 07/05/17 Time: 21:25
Sample: 2006M01 2016M05
Included observations: 123
Q-statistic probabilities adjusted for 3 ARMA terms

	AC	PAC	Q-Stat	Prob
1	-0.025	-0.025	0.0800	
2	0.037	0.037	0.2554	
3	0.084	0.086	1.1589	
4	0.124	0.128	3.1391	0.076
5	0.107	0.112	4.6321	0.099
6	-0.174	-0.187	8.5954	0.035
7	-0.040	-0.089	8.8027	0.066
8	-0.076	-0.111	9.5704	0.088
9	0.004	0.008	9.5727	0.144
10	0.017	0.083	9.6131	0.212
11	-0.164	-0.091	13.312	0.102
12	0.119	0.121	15.279	0.084
13	-0.023	-0.021	15.354	0.120
14	0.045	0.013	15.644	0.155
15	-0.017	-0.022	15.686	0.206
16	-0.114	-0.133	17.567	0.175
17	-0.058	-0.146	18.050	0.204
18	-0.148	-0.144	21.243	0.129
19	-0.060	-0.070	21.777	0.151
20	-0.014	0.099	21.805	0.192
21	-0.242	-0.162	30.605	0.032
22	-0.049	-0.060	30.971	0.041
23	-0.038	-0.017	31.195	0.053
24	-0.067	-0.156	31.884	0.060
25	-0.073	-0.077	32.720	0.066
26	-0.010	-0.003	32.737	0.086
27	-0.007	-0.096	32.745	0.110
28	-0.052	-0.066	33.177	0.127
29	0.166	0.155	37.664	0.065
30	-0.030	-0.014	37.809	0.081

Table 4.6 showed the correlogram of the residuals for ARIMA(1 1 2). The two vertical broken lines of Autocorrelation and Partial Correlation marked the confidence band with the value –0.1753 on the negative axis, and the value 0.1753 on the positive axis.

For sample of first 30 ACFs or PACFs, it is expected that $\frac{95}{100}$ x $\frac{30}{1}$ = 28.5 out of the 30 lie within the band. In approximation, it is expected that only 1 out the first 30 ACFs or PACFs of the residuals lies outside the band while the remaining 29 lie within the band. In Table 4.6, the Autocorrelation recorded $ACF_{(21)}$ value of –0.242, while the Partial Autocorrelation recorded $PACF_{(6)}$ value of –0.187. Only one value lied outside the band for Autocorrelation, and same for Partial Autocorrelation. Thus the correlogram of the residuals are white noise.

4. Application (Forecasting)

Table 4.7 showed 12-month period forecast with its 95% confidence band done, using ARIMA(1 1 2) model. From Table, it can be seen that the last two actual values fell outside the 95% confidence band. That is not unusual, because forecasting using ARIMA method is best for short term. It explained the reason the errors of Table 4.8 increased as the period increased.

Table 4.7: 12-Month Forecast Period from Period 125

Period	Forecast	95% Limits Lower	Upper
126	26.9043	25.8561	27.9525
127	26.9653	25.6684	28.2621
128	27.0424	25.5964	28.4884
129	27.1070	25.4844	28.7296
130	27.1814	25.4293	28.9334
131	27.2481	25.3541	29.1421
132	27.3208	25.3105	29.3311
133	27.3888	25.2570	29.5207
134	27.4605	25.2223	29.6987
135	27.5294	25.1833	29.8754
136	27.6004	25.1559	30.0448
137	27.6697	25.1271	30.2123

From sum of squared forecast error in table 4.8, two actual measures of realized forecast error: Forecast Mean Squared Error (FMSE) and Forecast Standard Error (FSE) were computed which gave the results 2.7429183 and 1.6561758 for FMSE and FSE respectively.

Table 4.8: Computation of Forecast Error

Period	Actual	Forecast	Error	$(\text{Error})^2$
T_{126}	26.93	26.9043	0.0257	0.00066049
T_{127}	27.06	26.9653	0.0947	0.00896809
T_{128}	27.21	27.0424	0.1676	0.02808976
T_{129}	27.49	27.1070	0.3830	0.14668900
T_{130}	27.69	27.1814	0.5086	0.25867396
T_{131}	28.53	27.2481	1.2819	1.64326761
T_{132}	28.55	27.3208	1.2292	1.51093264
T_{133}	28.88	27.3888	1.4912	2.22367744

T_{134}	29.26	27.4605	1.7995	3.23820025
T_{135}	30.18	27.5294	2.6506	7.02568036
T_{136}	30.31	27.6004	2.7096	7.34193216
T_{137}	30.75	27.6697	3.0803	9.48824809
				32.91501985

$FMSE = \frac{\Sigma[A-F]^2}{12} = \frac{\Sigma[Error]^2}{12}$ = 32.91501985/12 = 2.74291832083333
FSE = √FMSE = √2.74291832083333 = 1.6561758.
Where A and F represent actual and forecast values respectively.

CONCLUSION AND RECOMMENDATION

Conclusion

This research work focused on ARIMA modelling of Nigeria Maximum Lending Rate (NMLR) using monthly data of 125 points which ranged from January 2006 to May 2016. The plot of the realizations on NMLR in Figure 4.1 showed a positive slope which means that NMLR on the average increases year by year. Four models: ARIMA(5 1 0), ARIMA(0 1 6), ARIMA(2 1 1), and ARIMA(1 1 2) were selected and tried on the NMLR realizations during the period mentioned above. After diagnosing the models, ARIMA(1 1 2) emerged the best of the four. Thus, seen as the model behind the stochastic process that generated the realizations of NMLR during the period that the realizations covered. The model was then applied in forecasting NMLR for the succeeded 12 months ahead of the data.

The data was analyzed with the aid of computer software packages- Eviews and Minitab. The former was employed in all the analyses, except in the application (Forecasting) where the later was used.

RECOMMENDATION

Based on my findings in this piece of work, these recommendations are given

1. Commercial banks should run in such a way that their cost of funds and cost of operations would be low as NMLR is continually surging with period, bearing in mind of the proportional relationship between these costs and lending rate.
2. Reduction in cash reserve of the commercial banks, so that

they would have enough to run their lending business. When they have enough money and being willing to lend, the force of demand and supply would eventually reduce the lending rate.

3. Government intervention in monetary, financial, and economic policies that will force the lending rate to reduce, and still keep the commercial banks afloat in their businesses.

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APPENDIX

125 realisations of Nigerian Maximum Lending Rate

	YEAR										
MTH	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Jan	18.23	18.70	18.26	21.27	22.76	21.75	23.08	24.54	25.52	25.97	26.77
Feb	18.14	18.64	18.16	23.52	23.33	21.88	23.13	24.60	25.83	26.33	26.73
Mar	17.89	18.92	17.58	22.62	23.62	22.02	23.21	24.49	25.80	26.61	26.93
Apr	18.03	18.58	18.25	23.12	23.47	22.19	23.31	24.53	25.63	26.41	26.88
May	18.36	17.17	17.98	22.01	22.56	22.11	23.44	24.57	25.76	26.43	26.73
Jun	18.16	18.74	18.03	22.67	22.03	22.02	23.44	24.58	26.07	26.84	
Jul	18.61	18.36	18.07	22.80	22.27	22.42	23.45	24.62	26.07	27.03	
Aug	18.39	18.27	18.02	23.18	22.31	22.27	23.76	24.46	25.07	27.01	
Sep	18.52	18.27	19.24	22.81	22.20	22.09	24.67	25.11	25.77	26.99	
Oct	18.71	18.21	19.19	20.50	21.85	23.32	24.65	24.90	25.75	27.01	
Nov	18.72	18.29	20.45	23.20	21.84	23.35	24.70	25.00	25.74	27.02	
Dec	18.66	18.21	21.15	23.77	21.86	23.21	24.61	24.90	25.91	26.84	