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Time Series Analysis of Sectoral Distribution of Commercial Banks' Loans and Advances in Nigeria: An ARMA Approach

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Abstract
This paper model the sectoral distribution of commercial banks' loans and advances in Nigeria using Autoregressive moving average (ARMA) and Autoregressive integrated moving average (ARIMA). The study covered the period from 2018 – 2022 (5 years) on quarterly basis. The data for the study is sourced from central bank of Nigeria (CBN) annual statistical bulletin. The study revealed that Agriculture had the highest average (3829.83 billion Naira) and Education sector had the lowest average (74.40 billion Naira) of loans and advances. Agriculture sector had the highest coefficient of variation (42.0%) while Oil and Gas had the lowest coefficient of variation (11.0%) of loans and advances. The sectors had strong positive relationship with gross domestic product (GDP). ARMA and ARIMA revealed that AR (1) past values had no significant impact on the current value of the time series data (sectors loans and advances) and MA (1) had no significant relationship with past errors. ARIMA provides the best fit for the sectors loans and advances. The Augmented Dickey-Fuller unit test showed that the sectors loans and advances are non-stationary and contain a unit root at all levels. We conclude that Government and Oil and Gas sectors loans and advances from commercial banks appreciate (positive impact) the GDP. Construction and Education sector loans and advances from commercial banks depreciates (negative impact) the GDP while Agriculture sector loans and advances from commercial banks fluctuates the GDP. The software for estimation was STATA version 14.0 and the 95% (0.05) level of significance was used for the study.
Keyword: Sectoral, Commercial banks', Loans, Advances and ARMA

Introduction

The key role of financial institutions towards the growth and development of the economy cannot be over emphasized. Sustainable growth in any given economy, financial resources must be effectively and efficiently mobilized and assigned in such a way to harness the synergies between human, material and managerial resources for optimal economic output [1]. Within the theoretical literature, it generally accepted that intensification of financial instruments and institutions would tremendously decrease transaction and information costs in an economy which in turn influences savings rate, investment decision and technologically innovative ventures [2].

Loans and advances are borrowed funds with definite terms for repayment. Loans and advances are grouped into three, short, medium and long-term loans. While short terms loans are funds borrowed from bank for a short period of time usually in twelve calendar months, medium term loans (revolving loans) spans within one to five years where as long-term loans are loans whose maturity lasting for more than five years [3]. It is worthy of note that the duration of the loan determines the interest rate and consequently the revenue to be generated by the bank. However, the banks will prefer a short-term loan because of the uncertainty of the Nigeria business environment [4].

Total loans and advances made and held by a bank is a major balance sheet item which produces among the largest of the bank's revenue. The quality of outstanding loans and advances portfolio influences the viability and eventual financial results of banks; it has a direct bearing on bank profitability. Loans and advances are considered the most vital factor while forecasting NPAs. As the size of loans and advances increases, the proportion of NPA's increase due to increase in risk in that case [5].

When there are insufficient accumulated savings to finance a business and when the return on borrowed funds exceeds the interest rate charged on the loan, it makes sense to borrow rather than postpone the business activity until sufficient savings can be accumulated, assuming the capacity to service the debt exists [6]

[7] evaluated the nature of long-run relationship existing between bank credits to the private sector of Nigeria's economy and the nation's economic growth as well as the directions of prevailing causality between them from period 1981 and 2011. Applying Autoregressive Distributed Lag Bound (ARDL) and Granger Causality

techniques, the results indicate significant long-run relationship between the study variables but without significant causality in any direction.

[8] determined the effect of bank lending activities on economic development in Nigeria, covering the period, 1980-2013. Applying the test for stationarity with the Ordinary Least Square (OLS), and Co-integration procedures, the results revealed a significant relationship between bank lending activities and economic development in Nigeria. Credit to the general commerce and production sectors were statistically significant as well as met the a priori expectation.

[9] investigated the effect of bank lending and economic growth on the manufacturing output in Nigeria. Times series data covering a period of 36 years (1973-2009) were employed and tested with the co-integration and vector error correction model (VECM) techniques. The findings of the study show that manufacturing capacity utilization and bank lending rates significantly affect manufacturing output in Nigeria. The relationship between manufacturing output and economic growth could not be established in the country.

[10] ascertained relationship between banking sector credit and economic growth in Nigeria over the period 1970-2008. The causal links between the pairs of variables of interest were established using Granger causality test while a Two-Stage Least Squares (TSLS) estimation technique was used for the regression models. The results of Granger causality test show evidence of unidirectional causal relationship from GDP to private sector credit (PSC) and from industrial production index (IND) to GDP. Estimated regression models indicate that private sector credit impacts positively on economic growth over the period of coverage in this study. However, lending (interest) rate impedes economic growth.

[11] determined the effect of bank lending on growth in Nigeria using a sample of data from 1989 to 2012. With quantile regression estimation method, it was found that commercial bank lending was having a negative effect on growth while institutions were not sufficiently protecting customers from the negative effect that often arise when banks liquidate. Central bank policies were found to be minimizing bank losses and helping to drive economic growth in general.

[12] examined the impact of commercial bank credit to the private sector on the economic growth in Nepal from supply side perspectives. The study has applied Johansen co-integration approach and Error Correction Model (ECM) using the time series data for the period of 1975-2013. The empirical results show that bank credit to the private sector has positive effects on the economic growth in Nepal only in the long run. Nevertheless, in the short run, it has been observed a feedback effect from economic growth to private sector credit.

[13] investigated the impact of bank credit on economic growth in Nigeria applying the reduced form of vector autoregressive (VAR) technique using time series data from 1960 to 2011. Current gross domestic product (GDP) is the dependent variable and proxy for economic growth while bank credit to the private sector (CPS) to GDP ratio and broad money (M2) to GDP ratio were proxies for financial indicator and financial depth respectively. A major finding was that there is a significant positive relationship between bank credit to the private sector, broad money and economic growth [14].

The aim of this paper is to model and forecast time series data (Banks' loans and advances) by capturing patterns such as trends, seasonality and autocorrelations using autoregressive moving average (ARMA) and autoregressive integrated moving average (ARIMA) because of its effectiveness in analyzing time-dependent data. The remaining part of the paper are arranged as follows: ARMA/ARIMA model are specified in section 2, section 3 presents the result obtained from the utilization of the stated model in section 2 on sectoral distribution of commercial banks' loans and advances in Nigeria. Discussions of results are done in section 4 and concluding remarks are in section 5.

Methods

Autoregressive (AR) Component

An Autoregressive model is a time series model that expresses the current value of a variable as a linear combination of its past values and a random error term. The mathematical formulation of AR(*p*) model where *p* is the order of auto-regression is defined (1).

$$y_t = c + \sum_{i=1}^{p} \phi_i Y_{t-i} + \epsilon_t \quad (1)$$

where, y_t = time series at time t, c = constant (optional) in the model, ϕ_i = autoregressive coefficients and ϵ_t = white noise error term.

Moving Average (MA) Component

A moving average model is a time series model that expresses the current value as a linear combination of past error terms (shock/noise). Unlike an AR model which uses past values of the series, an MA model relies on the past forecast errors. The mathematical function of an MA(q) model where q is the order moving average defined in (2).

$$y_t = c + \epsilon_t + \sum_{i=1}^{q} \theta_j \epsilon_{t-j} \quad (2)$$

where, θ_j = moving average coefficients, y_t = time series at time t, c = constant (optional) in the model and ϵ_t = white noise error term or random shocks. Combining (1) and (2) give rise to rise to the autoregressive moving average (ARMA). The ARMA (p, q) model is presented in (3).

$$y_t = c + \sum_{i=1}^{p} \phi_i Y_{t-i} + \sum_{i=1}^{q} \theta_j \epsilon_{t-j} + \epsilon_t \quad (3)$$

where, y_t = time series at time t, c = constant (optional) in the model, ϕ_i = autoregressive coefficients, θ_j = moving average coefficients and ϵ_t = white noise error term.

Autoregressive Integrated Moving Average (ARIMA) Model

The ARIMA model is a powerful statistical model for time series forecasting that combines three components: AR component, MA component and Integrated (I) components for differencing to make the series stationary. The mathematical function of ARIMA (p, d, q) is presented in (4).

$$\Delta^d Y_t = c + \sum_{i=1}^{p} \phi_i Y_{t-i} + \sum_{i=1}^{q} \theta_j \epsilon_{t-j} + \epsilon_t \qquad (4)$$

where, $p =$ number of lagged observations (AR components), $d =$ number of times the series is differenced to make it stationary, $q =$ number of lagged forecast errors (MA component), $\epsilon_t =$ white noise error term or random shocks and $\Delta^d Y_t =$ differenced time series (to remove trends).

Data: The sectoral distribution of commercial banks' loans and advances data is secondary. The data was sourced from Central Bank of Nigeria (CBN) from 2018 to 2022 on quarterly basis (60 months/5 years) and STATA version 14.0 is used for analysis. The sectors loans and advances are the explanatory variables and GDP is the dependent variable.

Results and Discussion

The trend analysis of Agric and Oil and Gas sector (Figure 1) and Government and Education sector (Figure 2) revealed that the loans and advances for the sectors rises and fall and displayed random behavior (stochastic). The loans and advances for Figure 1 and 2 also revealed a tie indicating that the loans and advances for the sectors are equal at a point in time within the studied period. In Figure 3, GDP revealed continuous growth despite its rise and fall within the studied period. The Construction sector loans and advances remain constant and do not go above or fall below zero. This implies that more loans and advances are taken from commercial banks for Agriculture, Oil and Gas, Government and Education use while no loans and advances are taken for Construction purpose in the Nigeria.

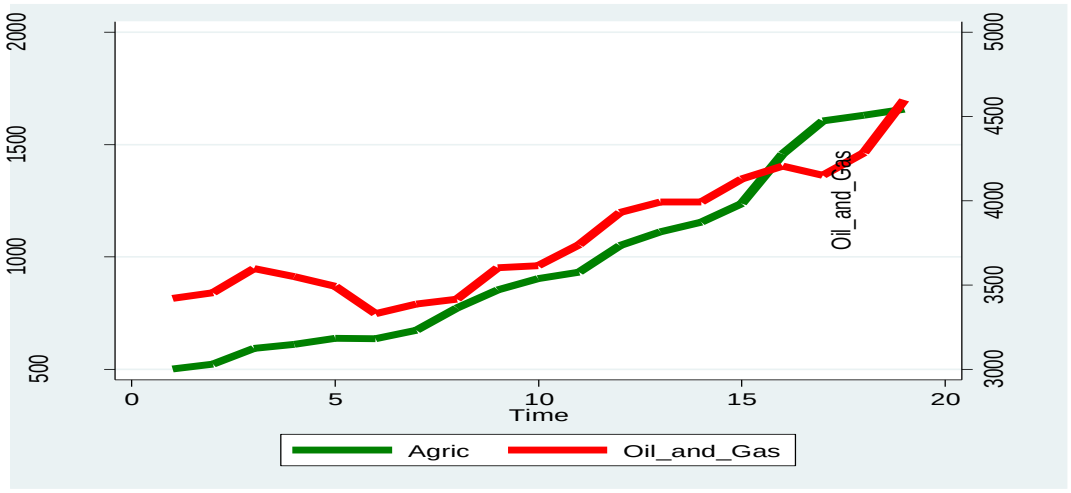

Fig. 1: Line Plot of Agric and Oil and Gas

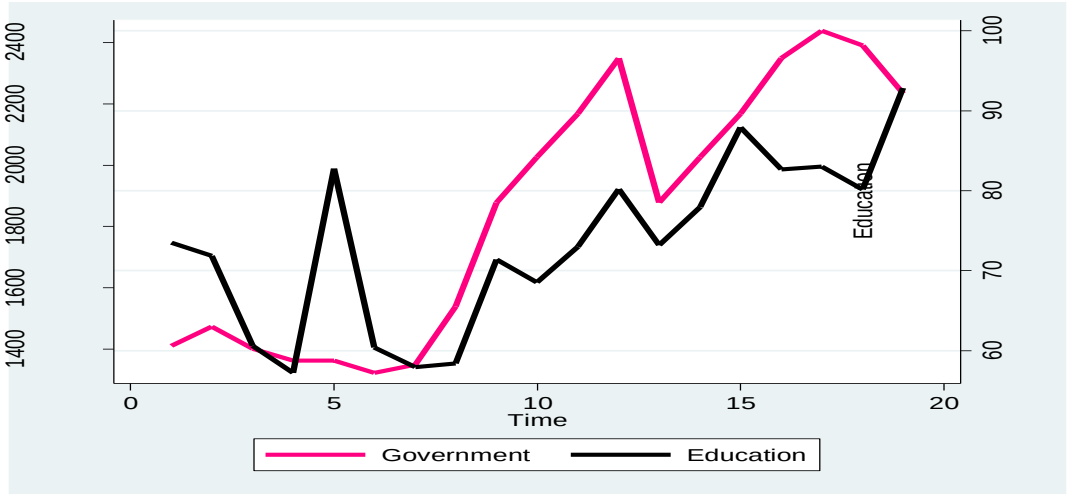

Fig. 2: Line Plot of Government and Education

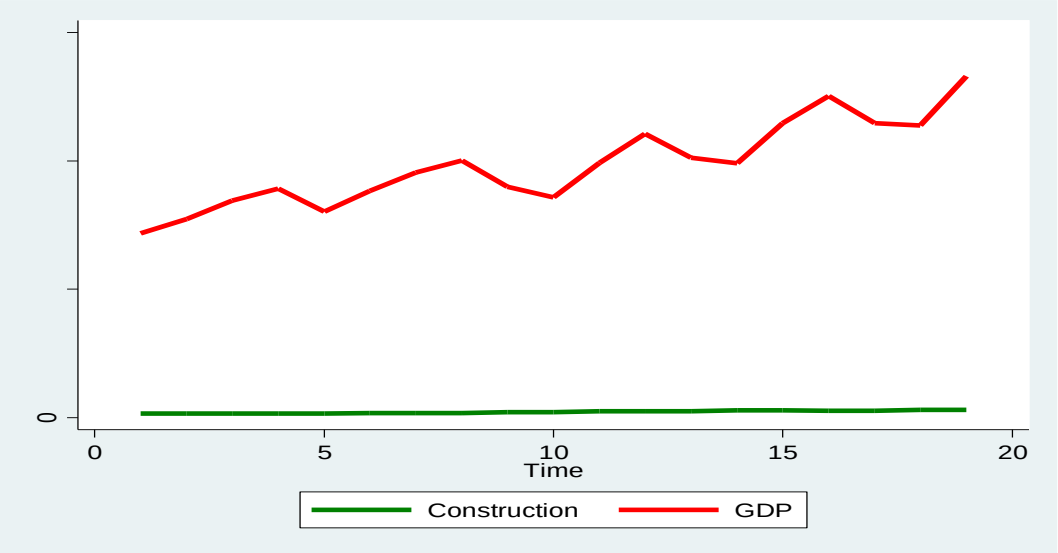

Fig. 3: Line Plot of Construction and GDP

The Oil and Gas sector had the highest average (3829.83 billion Naira) loans and advances followed by Government sector (1871.79 billion Naira), Agricultural sector (1017.66 billion Naira) and Construction sector (880.83 billion Naira). The Education sector had the lowest average (74.40 billion Naira) for loans and advances from commercial banks in Nigeria within the studied period. Agric (0.51) and Oil and Gas (0.65) sectors are positively skewed to the right and leptokurtic (less flat top) in nature. Government (-0.10), Education (-0.01) and Construction (-0.01) sector are negatively skewed and leptokurtic. Agric sector had the highest CV (42.0%) while Oil and Gas had the lowest CV (11.0%).

Table 1: Summary Statistics and Effective Sizes of the Sectors Loans and Advances

Variables	Mean	Skewness	Kurtosis	CV	E-Size	
Agric	1017.66	0.51	1.93	0.42	0.92	
Oil & Gas	3829.83	0.65	2.33	0.11	0.91	
Government	1871.79	-0.10	1.36	0.22	0.78	
Education	74.40	-0.01	2.05	0.15	0.68	
Construction	880.83	-0.01	1.42	0.25	0.85	

CV = Coefficient of Variation and E-Size = Effective Size

The effective sizes of all the sectors showed strong positive/significant relationship between the sectors loans and advances from commercial banks and GDP in Nigeria. The Agric sector had the highest variation (42%) from the mean followed by Construction, Government and Education with a variation of 25%, 22% and 15% respectively from the mean and Oil and Gas had the lowest variation (11%) from the mean (Table 1). The sectors distributions of commercial banks' loans and advances within the studied period are non-stationary and contain a unit root. This is because the absolute values of the test statistics are less than the absolute value of the critical values at 1%, 5% and 10% level of significance (Table 2).

Table 2: Augmented Dickey-Fuller Unit Root Test for Sectors Loans and Advances

Variables	Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value	
Agric	1.259	-3.750	-3.000	-2.630	
Oil and Gas	1.180	-3.750	-3.000	-2.630	
Government	-0.933	-3.750	-3.000	-2.630	
Education	-1.862	-3.750	-3.000	-2.630	
Construction	0.216	-3.750	-3.000	-2.630	
GDP	-0.871	-3.750	-3.000	-2.630	

GDP = Gross Domestic Product

The ARMA model for the sectoral distribution of commercial banks' loans and advances revealed that Agric, Oil and Gas, Government and Construction coefficients are non-significant at 95% because their probability values (P) are greater than the pre-specified level of significance (alpha) and their confidence intervals contain zero. Only Education sector coefficient (-193.26) is significant at the pre-specified level of significance (0.05) and the confidence interval (-380.56, -5.96) do not contain a zero. This implies that the loans and advances

from commercial banks for Education and Construction depreciate the Nigerian gross domestic product (GDP) while Agric, Oil and Gas and Government appreciate GDP. The AR (1) coefficient (-0.05) is not significant because the probability value (0.916) is greater than 0.05 level of significance and the confidence interval (-1.01, 0.91) contain a zero. This implies that past values had no significant impact on the current value of the time series (sectors loans and advances).

Table 3: ARMA for Sectoral Distribution of Commercial Banks' Loans and Advances

GDP	Coefficient	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Agric	11.72	7.12	1.64	0.100	-2.25	25.68
Oil and Gas	12.28	7.54	1.63	0.103	-2.49	27.05
Government	1.91	3.83	0.50	0.619	-5.60	9.41
Education	-193.26	95.56	-2.02	0.043*	-380.56	-5.96
Construction	-8.53	10.77	-0.79	0.428	-29.63	12.57
Constant	-359.08	21376.64	-0.02	0.987	-42256.52	41538.37
		ARMA				
AR (1)	-0.05	0.49	-0.11	0.916	-1.01	0.91
MA (1)	1.00	183.67	0.01	0.996	-358.99	360.99
Sigma	1973.61	181441.86	0.01	0.496	0.00	357593.12

Wald chi-square (7) = 53.01, Log likelihood = -172.5837 and P. > chi-square = 0.0000, AR(1) = First Auto Regression, MA (1) = First Moving Average, Std. Err. = Standard Error, P = Probability, Conf. = Confidence and GDP = Gross Domestic Product

$$Y_t = -359.08 - 0.05Y_{t-i} + 1.00\epsilon_{t-i} + \epsilon_t \quad (5)$$

The MA (1) coefficient (1.00) is not significant (no significant relationship with past errors) because the probability value (0.996) is greater than 0.05 level of significance and the confidence interval (-358.99, 360.99) contains a zero. This implies that past random shocks (residuals) had no notable influence on the current value of the time series (sectors loans and advances). The ARMA regression provides a best fit to the data points since the log-likelihood (-172.58) is low compared to that of ARIMA regression. The ARMA regression is significant because the P. > chi-square (0.00) is less than 0.05 level of significance. The Wald chi-square (53.01) is not significant because it is greater than the Wald chi-square critical value (30.14). This implies that the predictor variables (sectors) do not influence the outcome variable (GDP). The white noise (sigma) (1973.61) is not significant because the probability value (0.496) is greater than 0.05 and the confidence interval contain a zero (Table 3).

The ARIMA model for sectoral distribution of commercial banks' loans and advances showed that the coefficients of all the first differenced (D1) sectors are significant at the pre-specified level of significance (0.05) because their probability values are less than 0.05. However, the confidence intervals are significant because the intervals do not contain zero at 95% (0.05). The model revealed that Agric, Education and Construction loans and advances depreciate GDP while Oil and Gas and Government loans and advances appreciate GDP.

Table 4: ARIMA for Sectoral Distribution of Commercial Banks' Loans and Advances

D. GDP	Coefficient	Std. Err.	z	P>|z|	[95% Conf. Interval]	
D1. Agric	-47.45	23.33	-2.03	0.042	-93.17	-1.74
D1. Oil and Gas	20.53	7.02	2.93	0.003	6.78	34.28
D1. Government	12.31	3.79	3.25	0.001	4.88	19.74
D1. Education	-225.63	59.62	-3.78	0.000	-342.49	-108.78
D1. Construction	-51.31	14.86	-3.45	0.001	-80.44	-22.18
Constant	4316.70	1441.19	3.00	0.003	1492.03	7141.38
			ARMA			
AR (1)	0.12	0.49	0.24	0.814	-0.85	1.08
MA (1)	1.00	0.56	1.80	0.072	-0.09	2.09
Sigma	1859.31					

D. GDP = Differenced gross domestic product, D1 = First differenced, P = Probability, AR (1) = First Auto Regressive, MA (1) = First Moving Average, Std. Err. = Standard Error and Conf. = Confidence, Wald chi-square (7) = 69.80, Log likelihood = -162.63 and P. > chi-square = 0.0000

$$Y_t = 4316.70 + 0.12Y_{t-i} + 1.00\epsilon_{t-i} + \epsilon_t \quad (6)$$

The AR (1) coefficient (0.12) is not significant because the probability value (0.814) is greater than 0.05 level of significance and the confidence interval (-0.85, 1.08) contain a zero. This implies that past values do not

significantly impact the current value. The MA (1) coefficient (1.00) is not significant (no significant relationship with past errors) because the probability value (0.072) is greater than 0.05 level of significance and the confidence interval (-0.09, 2.09) contain zero. This implies that past random shocks (residuals) had no notable influence on the current value of the time series (sectors loans and advances). The ARIMA (1, 1, 1) regression provides a poor fit to the data points since the log-likelihood (--162.63) is high compared to that of ARMA (1, 1) regression. The ARIMA (1, 1, 1) regression is significant since the P > chi-square (0.00) is less than 0.05 level of significance (alpha). The Wald chi-square (69.80) is not significant because it is greater than the Wald chi-square critical value (30.14). This indicates that the predictor variables influence the outcome variable (Table 4).

Conclusion

This paper demonstrated the use of time series technique to model sectoral distribution of commercial banks' loans and advances using Autoregressive Moving Average (ARMA) and Autoregressive Integrated Moving Average (ARIMA). Government and Oil and Gas sectors appreciate (positive impact) the GDP. Construction and Education sector depreciates (negative impact) the GDP while Agriculture sector loans and advances fluctuates the GDP. The effective size of the sectors had strong positive relationship with GDP and non-stationary and had a unit root. The Wald Chi-square test revealed that the predictor variables (sectors loans and advances) had influence on the outcome variable (GDP). ARIMA (1, 1, 1) had poor fit for the sectors loans and advances from commercial banks in Nigeria and the predictor variables influence the outcome variable.

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