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The Disaggregated Impact of Financial Development on the Effectiveness of Monetary Policy in Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The fast development in the financial system has attracted researchers' interest in studying its implication on the economy, though empirical evidence is highly limited on disaggregated levels. This study is undertaken to examine the impact of disaggregated financial development on the effectiveness of monetary policy in Nigeria. The study used Autoregressive Distributed Lag Model to capture the data-generating process as well as both short-run and long-run relationships. The scope of analysis ranged from 2000 quarter 1 to 2021 quarter 4 to circumvent the effect of regime changes, as the chosen time horizon represents the period of the uninterrupted civilian regime in Nigeria. The data are sourced from the Central Bank of Nigeria's and the International Monetary Fund's statistical databases. Moreso, quarterly frequency data are used to reflect the short-run nature of the monetary policy. The finding reveals financial market development enhances the effectiveness of monetary policy in terms of achieving both its primary and secondary objectives while financial institutions development does not. Given the findings, it is recommended that the Government together with the Central Bank of Nigeria should design policies that would enhance

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the efficiency of the financial market, particularly markets infrastructure and technology-based products to reduce information asymmetry and transactional costs to ease the way of doing business.

Keywords: Monetary policy effectiveness; financial market development; financial institution development; ARLD.

JEL Classification: C15, E5, E44.

1. INTRODUCTION

Studies on financial development have gathered momentum in the last decade following rapid transformation happening in the financial system across the globe. Financial development can have a significant impact on the effectiveness of the actions taken by the central bank of a country in their effort to regulate the money supply, inflation, and interest rates, to achieve macroeconomic objectives. The effectiveness of monetary policy depends on the ability of changes in interest rates and other policy tools to influence economic activity. In a well-developed financial system, changes in policy rates can be transmitted more efficiently through the banking system to households and firms. The more developed the financial system, the more effective monetary policy can be in influencing economic outcomes [1]. A well-developed financial system can also enhance financial intermediation, which refers to the process of mobilizing savings and allocating them to productive investments. Financial intermediaries such as banks and other financial institutions play a critical role in channeling funds from savers to borrowers. A more efficient financial system can result in better allocation of resources and higher economic growth. Another way in which financial development can affect monetary policy is through inflation targeting. Inflation targeting is a policy framework that involves setting a specific inflation target and adjusting policy rates to achieve that target. In a well-developed financial system, inflation targeting can be more effective because the central bank can communicate its policy intentions more effectively, and the market can respond more quickly and accurately [2]. A more developed financial system can also impact exchange rate management. A well-developed financial system can attract more foreign investors, which can increase demand for the local currency and help stabilize the exchange rate. Additionally, a more efficient financial system can enable firms to better hedge against exchange rate risk, reducing volatility in the foreign exchange market [3].

Studies in the existing literature such as Odhiambo [4] and Olumuyiwa and Tolulope [5] had centred largely on the impact of aggregate financial development, neglecting the sub-components analysis which has full information to explain its dynamics on monetary policy. This is because developments in the financial system have many dimensions, with varying implications for monetary policy. The way financial institutions' development would impact monetary policy is different from how financial market developments will do. For this study, a broad-based disaggregated index of financial development (financial market index and financial institutions index) developed by the International Monetary Fund is employed Olumuyiwa & Tolulope, [5]). The index which is for 183 countries are sub-divided according to access, efficiency, and the depth dimensions of development of financial institutions and markets.

Following the introduction, section two (2) covers literature review. Section three (3) focused on the methodology of the study, while section four (4) presents results and discussions. Section five (5) covers the conclusion and policy recommendations.

2. LITERATURE REVIEW

2.1 Theoretical Framework

Theories explaining the relationship between financial development and monetary policy effectiveness are indirect [6]. Indirect in the sense that, most of the theories explained the relationship through the link giving much attention to reporting financial development and economic growth nexus but taking into consideration indirectly how financial development regulates monetary policy transmission effects on the output of a country. For this study, the Schumpeter theory of 1912 is adopted to guide the estimation. Schumpeter's [7] theory of development and the monetary transmission mechanism explain that the growth

of any economy is a function of when credit is allowed to flow freely. If it is allowed to be circulated to the extent that it reaches low-income earners, economic growth improves. The theory, on the other hand, opined that the most essential drivers for growth and innovation are services provided by financial intermediaries. The argument of the theory was supported and extended by Mckinnon [8] and Shaw [9] and later popularised by Fry [10] and Marco [11]. According to Mckinnon [8], operational restrictions of the financial system by the government such as direct credit programs, high reserve requirements, and interest rate ceilings may affect financial deepening which on the other hand, will affect investment qualitatively and quantitatively, consequently, economic growth will respond negatively. The Schumpeterian theory links financial development and economic growth and suggests that there exists a positive and strong correlation between economic growth and with positive relationship existing between them. Thus, the more developed the financial market and financial institutions are, the more developed the economy will be, and the less developed the financial market and financial institutions are the less developed will be the economy. This implies that financial development is an engine of growth. Economic growth, therefore, tends to retard due to a poor financial system.

2.2 Empirical Review

Several studies have been undertaken in the area of components of financial development and the effectiveness of monetary policy. Wiafe, Quaidoo, and Sekyi [12] using Ghana data and SVAR as a technique of analysis discovered that as mobile money grows, monetary policy becomes less effective. The study also showed that, albeit in a limited way, policy rates in Ghana react to the expansion of mobile money. In Nigeria, Olajide and Temidayo's [3] study uses quarterly data to examine the effects of several components of financial development on the monetary transmission mechanism in Nigeria from 1986 to 2017. The findings revealed that financial development indicators and their interactions with the policy rate had various degrees of impact on each channel of monetary policy. Oyadeyi and Akinbobola (2020) examined the impacts of the different aspects of financial development on monetary transmission mechanisms using the ARDL technique and found that financial development indicators and their interactions with the policy rate influenced each channel of monetary policy to different degrees. This implies that different channels of transmission mechanism impact variables differently. Samba and Mbassi [13] investigated the extent to which financial development has contributed to the efficiency of macroeconomic policy represented by monetary policy, in the Central African Economic and Monetary Community (CEMAC) area in the period spanning from 1986 to 2009. The study reveals that among the three financial development indicators used, only the measure of financial development is positively related to monetary policy efficiency.

Obafemi and Ifere [2] used quarterly data from 1970 to 2013 to examine the strongest and most prominent monetary transmission channels in Nigeria. For a better and clearer examination of the transmission mechanism, it compared the results of the Factor Augmented Vector Autoregression (FAVAR) model with the classic Vector Autoregression (VAR) model. To determine the exact channel of transmission in Nigeria, the FAVAR combined a huge data of 53 macroeconomic indicators with a standard VAR model that predicted six variables. The results of both models revealed that the major and strongest channels of monetary policy transmission in Nigeria are interest rates and credit channels.

For stability, Barnea, Landskroner, and Sokoler [14] using Overlapping-Generation Model (OGM) found Policy tradeoffs in trying to accomplish both monetary and financial stability targets. Also, “the monetary policy transmission mechanism depends on financial stability tools”. Zehao [15] examined how financial intermediary leverage affects monetary policy transmission using the vector autoregressive model and found that monetary policy shock has larger magnitudes when financial intermediaries have lower leverage. The study also opined that the financial intermediary leveraging is counter-cyclical, justifying why monetary policy is not efficient in recessions.

Edgar and Robert [16] developed a monetary growth production model with heterogeneous agents to ascertain how the optimal monetary policy differs across countries with varying levels of financial development and the extent to which the redistributive impact of inflation depends on the magnitude of financial development among others. The findings of the panel revealed that nations at the peak stages of financial development (i.e., “economies in which money,

bonds, and claims to capital are traded) had the highest levels of capital formation and social welfare if inflation is low". Inflation has redistributive effects regardless of the level of financial growth. The model also predicts that economies with small stock markets will have the greatest income disparity. The model's predictions are backed up by empirical studies on the function of money growth and the effects of financial development in various nations.

Studies on the components of financial development have also produced mixed outcomes just as the ones on the aggregate. Nyangosi and Aora [17] examined the impact of information technology and banking performance in Kenya. The study discovered that using ATMs and mobile banking resulted in better service and consequently enhanced financial institution performance. Information technology is also a major trend in the banking sector, according to the study. While this study shows that using financial innovations improves consumer satisfaction, it does not show whether they lead to improved performance.

Using a sample of 37 nations affected by severe pandemics, Wei and Han [18] employed an event-study methodology to assess how the COVID-19 epidemic has affected the communication of monetary policy to the financial markets. Markets for government bonds, stocks, currencies, and credit default swaps are examples of financial markets. The findings imply that the pandemic's emergence significantly hampered the transmission of monetary policy to financial markets. Following the pandemic outbreak, neither conventional nor unconventional monetary policies significantly affect all four financial markets over our sample period.

Kimingi [19] established the role of technological innovations in the performance of commercial banks. The study used a descriptive research design, analyzing both primary and secondary data, and discovered that banks had incorporated a variety of innovations, including mobile banking and Internet banking. Marwa [20] used a time series analysis to investigate the drivers of financial market development in Egypt. Financial development is influenced by economic growth, trade openness, investment, human capital, and per capita GDP, according to the empirical findings from the ARDL and the Johansen test for Cointegration, whereas inflation hurts financial development in Egypt. Allen and Gale [21] further asserted that liberalising the financial system improves the resilience of the economy to real shocks because reforms strengthen the link between the real and financial sectors. Chinn and Ito [22] examined the relationship between capital account liberalization and financial development using panel data analysis for the 1977–1997 timeframe. The study reveals that when institutional quality (legal and property rights) is established, there is a substantial positive association between financial development (as measured by private credit and stock market turnover) and capital controls. Studies by Bekaert, Harvey, and Lundblad [23], and Tressel and Detragiache [24], found that financial sector deepens through financial liberalisation. This is premised on the belief that financial reforms promote financial intermediation by enhancing risk management and allowing more efficient foreign banks to enter the market, as well as increasing the availability of new financial instruments and services.

Acemoglu and Zilibotti [25] opined that financial deepening could promote economic diversification, which in turn may help reduce cyclical risk, and thus dampen cyclical fluctuations. Greenwald and Stiglitz [26] held that efficiency in the financial market mitigates information asymmetries, and as such enables economic agents to process information more effectively that in turn lowers growth volatility. In addition, Aghion, Banerjee, and Piketty's [27] study established the link between financial sector development and growth volatility, especially for developing countries. Bekaert, Harvey, and Lundblad (2001a) concluded that equity market liberalisation increased real economic growth by 1 percent on average using four (4) different sample sizes (28, 50, 75, and 95) from 1980 to 1997.

Berube and Cote [28] found that the coefficient for financial liberalisation had a positive and substantial effect on the Canadian long-run savings function, implying that financial reforms have had a beneficial effect on resource and savings mobilization. Burkett and Dutt [29] found evidence that financial reform leads, on average, to more output volatility, and subsequently to macro-financial instability. Obadan [30] showed how a country can be very vulnerable to a financial crisis if its financial institutions are weak or not well-regulated. Soyibo [31] found that financial depth, as measured by M2/GDP, declined in Nigeria shortly following financial deregulation, particularly in 1987-1989, but rose in 1990 and 1991.

3. METHODOLOGY

3.1 Data

The study employed quarterly data from 2000Q1 to 2021Q4 on the real gross domestic product (RGDP), gross fixed capital formation, the interaction of financial market index, the interaction of financial institutions index, and Broad money supply in addressing the objective of the paper. The data were sourced from the Central Bank of Nigeria's and the International Monetary Fund Databases in the case of financial development indexes. Real GDP, which is the dependent variable, measures the economic activities in the country and represents the secondary objective of monetary policy. Credit to the private sector was used as one of the control variables to capture the level of financial development in the country, while the Financial Institutions Index and Financial Markets Index, representing the two major components of financial development are the key independent variables of the study.

3.2 Model Specification - Linear Autoregressive Distributed Lag Model (ARDL)

The ARDL model specified is presented in the equation below.

$$\Delta y_t = \delta_0 + \delta_1 y_{t-1} + \delta_1 FMI * M3_{t-1} + \delta_2 FII * M3_{t-1} + \delta_3 GCF_{t-1} + \delta_4 CPS_{t-1} + \sum_{i=1}^{l} \tau_{1i} \Delta y_{t-i} + \sum_{i=0}^{m} \tau_{2i} \Delta FMI * M3t-1 + i=0nτ3i\Delta FII*M3t-1 + i=0qτ4i\Delta GCFt-1 + i=0pτ5i\Delta CPSt-1 + \varepsilon t \quad (1)$$

According to Pesaran et al. [32], long-run relationship is determined by a test of joint significance on the coefficients of the lagged levels of all the variables presented on the right side of the equation. The test is based on the Wald test restriction with the null hypothesis that $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$

The error correction component of the ARDL is similar to that of the NARDL, the difference is that the ARDL has only the positive component. Thus, the general specification is given as:

$$\Delta Y_t = \rho \varepsilon'_{t-1} + \sum_{j=1}^{p-1} \omega_j \Delta Y_{t-j} + \sum_{j=0}^{q-1} \pi_j^{+} \Delta X_{t-j}^{+} + + e_t \quad (2)$$

Where $\pi_j^{+} \neq \alpha_j^{+}$, and $e_t \neq \varepsilon_t$; $e_t \sim$ iid $(0, \sigma_e^2)$

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics

According to Hejase and Hejase (2013), "descriptive statistics deals with describing a collection of data by condensing the amounts of data into simple representative numerical quantities or plots that can provide a better understanding of the collected data" (p. 272). Therefore, this study used means, medians, maximum, and minimum values. Results show that the average values of logarithm of real GDP (RGDP), Interaction of FMI and M3 (FMI*M3), Interaction of FII and M3 (FII*M3), and Credit to the Core Private Sector (CPS) for the period 2000Q1 to 2021Q4 was 16.33, 14.46, 14.40, and 15.72, respectively. Mostly, the kurtosis of the data set is close to that of standard normal distribution, however, the values of the skewness suggest left skewness. Moreso, the tails of most of the variables reveals the absence of outliers also given the mean, median, as well as the maximum and minimum values of each of the variables. The Jarque-Bera statistic confirms non-normality for all the variables.

4.2 Unit Root Test

The unit root tests conducted indicated that none of the variable is integrated up to order 2. This means that the prerequisite of modelling the non-linear ARDL is met. The unit root tests were carried out based on the inclusion of a constant term as well intercept and trend. The results across all the three method of unit root test (Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) or Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test statistics) indicated that none of the variables is integrated of order 2 (Table 2).

4.3 Co-Integration Test

The test of long run relationship between the variables was based on the ARDL bound test. The test has advantage over the Engle and Granger (1987) and Johansen and Juselius (1990) approach as a stationarity test is not necessarily required. However, the test breaks down where there is a I (2) series. The advantage of the bound test over the Engle and Granger (1987) and Johansen and Juselius (1990) dwells on the flexibility of its method as it could be deployed irrespective of the integration order; I (0), I(1), or fractionally integrated. The test of unit root above as earlier stated is to ensure than none of the variables is I (2) so that the cointegration test does not break down.

The bound test null hypothesis is no levels relationship meaning that, there is no correlation between the variables of interest. The null hypothesis is rejected if the calculated F-statistics is above the upper bound value at 5 percent level of significance. Where the F-statistics is below the lower bound value, we may not reject the null hypothesis. The test is inconclusive when the calculated F-statistics lies between the lower bound and upper bound value. From Table 3, it shows that the calculated F-statistics of 39.72 is greater than the upper bound value across all the levels of significance. This suggests the variables have cointegrating relationship. Put differently, real GDP, interaction of financial market index and broad money supply, credit to core private sector, and the interaction of financial institutions index and broad money supply have long-run relationship.

4.4 Discussion of Results

Table 4 presents the long- and short-run ARDL results. Following the establishment of a long-run relationship between the variables in the model, the study advanced the estimation to examine the long-run and short-run impact of the variables in the model. The outcome of the result shows that components of financial development enhance the effectiveness of monetary policy differently in Nigeria. This is because the financial market index and the financial institutions index affect monetary policy differently. The coefficient of the financial markets interaction with the intermediate target of monetary policy is positive indicating that there is a direct and significant relationship between the financial markets development and monetary policy in the long run [33-35]. Specifically, a percentage change in the financial markets interaction with the intermediate target of monetary policy increase in output by 0.09 percent, ceteris paribus. The result is statistically significant at 1 percent level of significance, thus positive development in financial markets in Nigeria makes monetary policy to be effective.

Table 1. Descriptive statistics

Descriptive Statistics				
	LRGDP	**LFMI_M3**	**LFII_M3**	**LCPS**
Mean	16.33	14.46	14.40	15.72
Median	16.44	14.85	14.64	16.18
Maximum	16.83	16.03	16.17	17.38
Minimum	15.52	11.87	11.75	13.08
Std. Dev.	0.36	1.24	1.36	1.32
Skewness	-0.63	-0.64	-0.49	-0.58
Kurtosis	2.17	2.00	1.83	1.85
Jarque-Bera	8.31	9.56	8.56	9.76
Probability	0.02	0.01	0.01	0.01
Sum	1436.82	1272.20	1266.87	1383.22
Sum Sq. Dev.	11.56	133.04	161.08	151.80
Observations	88	88	88	88

Source: Computed by the authors

Table 2. Unit root test results

ADF Test					
First Difference		**LRGDP**	**LFMI*M3**	**LFII*M3**	**LCPS**
	Intercept	-2.038	-8.698*	-9.013*	-6.013*
	Intercept & Trend	-3.688*	-9.012*	-9.412*	-6.387*
PP Test					
First Difference		**LRGDP**	**LFMI*M3**	**LFII*M3**	**LCPS**
	Intercept	-11.506*	-8.701*	-9.031*	-6.148*
	Intercept & Trend	-13.666*	-9.012*	-9.412*	-6.509*
KPSS Test					
First Difference		**LRGDP**	**LFMI*M3**	**LFII*M3**	**LCPS**
	Intercept	0.293^	0.443^	0.516^	0.443^
	Intercept & Trend	0.068^	0.054	0.064^	0.064^

Source: Computed by the authors

Table 3. Bound test of cointegration

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	**Value**	**Signif.**	**I (0)**	**I (1)**
			Asymptotic: n=1000	
F-statistic	39.72421	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
Actual Sample Size	84		**Finite Sample: n=80**	
		10%	2.474	3.312
		5%	2.92	3.838
		1%	3.908	5.044

Source: Computed by the authors

Table 4. ARDL long and short run results

Selected Model: ARDL (4, 0, 0, 3)				
Long run coefficients				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	1.51	0.64	2.35	0.0214
LRGDP (-1)	-0.11	0.05	-2.08	0.0414
LFMI_M3	0.09	0.03	2.81	0.0064
LFII_M3	-0.11	0.03	-3.43	0.001
LCPS (-1)	0.04	0.02	1.81	0.0744
Short run coefficients				
D (RGDP (-1))	-0.76	0.07	-10.69	0.0000
D(RGDP (-2))	-0.90	0.04	-20.65	0.0000
D(RGDP(-3))	-0.84	0.06	-13.37	0.0000
D(LCPS)	-0.04	0.05	-0.79	0.4297
D(LCPS(-1))	-0.05	0.05	-1.12	0.2658
D(LCPS(-2))	-0.07	0.05	-1.40	0.1653
ECM (-1)	-0.10	0.0073	-14.47	0.000
R-Square= 0.9130 Adjusted R-Square= 0.9063				
F-Stat. =1727.015 Prob. =0.000				

Source: Computed by the authors

Table 5. Diagnostic tests

Test	**F-Statistic**	**P-Value**	**Conclusion**
Breusch-Pagan Godfrey	2.017	0.0635	Homoscedasticity
Breusch-Godfrey LM Test	26.91	0.00	There is Serial Correlation
Jacque-Bera	408.53	0.09	Normally Distributed Residuals
Adjusted R Square	0.99		
Cusum			Stable
Cusum sq			Stable

Source: Computed by the authors

On the other hand, the coefficient of the financial institutions index interaction with the intermediate target of monetary policy is negative indicating that there is an indirect and significant relationship between the financial institutions development and monetary policy in the long run. Specifically, a percentage change the financial institutions interaction with the intermediate target of monetary policy decrease output by 0.11 percent, ceteris paribus. The result is statistically significant at 1 percent level of significance, therefore, an increase in the number of financial institutions in Nigeria tends to make monetary policy ineffective. The finding implies that increasing the number of financial institutions in Nigeria to enhance the effectiveness of monetary policy might not work in Nigeria's current level of financial development

[36]. However, deepening the financial market could induce output and consequently enhances the effectiveness of monetary policy in Nigeria. From this, it is therefore, recommended that the monetary authority should deepen its financial market to enhance the effectiveness of monetary policy.

The R-square value of 0.9130 (91.30%) implies that 91.30% of total variation in real output was explained by financial development and financial institution indices, as well as credit to private sector in Nigeria. Coincidently, the adjusted R-square value of 0.9063 (90.63%) was found to be high after adjusting for the degree of freedom, implying that the model of this study is fit. The f-statistics value of 1727.015 with the corresponding probability value of 0.0000 indicates that the variables understudied significantly influenced real output.

The error correction mechanism behaved according to a priori as the coefficient was -0.10 showing the expected negative sign as well as the requirement of less than one. The coefficient is also statistically significant at 1 percent level. Thus, a 10 percent disequilibrium from the steady state of the relationship can be corrected within a quarter [37-40].

4.5 Diagnostic Tests

The Breusch-Pagan Godfrey test for heteroscedasticity confirms that the residuals have constant variance over time, that is, they are homoscedastic while the Breusch Godfrey Langrage Multiplier test for serial correlation indicates the presence of autocorrelation in the residuals. Furthermore, the Jacque Bera test indicates that the sample data for this study have the kurtosis matching a normal distribution. The CUSUM and CUSUM of squares tests provides evidence of the stability of model coefficients (Appendix I).

4.6 Robustness Check

To also check the validity of the finding, a robustness check was performed by replacing the secondary objective of monetary policy with the primary objective which is inflation. After conducting cointegration test which confirms the existence of long-run relationship, another autoregressive Distributed Lag Mode with inflation as the dependent variable was estimated. The results corroborate the findings from the model with the secondary goal of monetary policy (real GDP). Specifically, an increase in financial market index interaction with the broad money supply reduces inflation by 0.43 percent, though statistically insignificant at the required level of significance. However, an increase in financial institutions index interaction with the intermediate target of monetary policy increase inflation by 0.21 percent. This implies that while financial markets development enhances the effectiveness of monetary policy in Nigeria, financial institutions development does not. This finding is consistent with the finding from the main regression i.e., RGDP Model.

In summary, the outcome of this study shows that while financial market development enhances the effectiveness of monetary policy, the financial institution development does not. This is consistent with both the secondary and primary objectives of monetary policy models. The finding implies that increasing the number of financial institutions in Nigeria to enhance the effectiveness of monetary policy might not work in Nigeria's current level of financial development. However, deepening the financial market could induce output and consequently enhances the effectiveness of monetary policy in Nigeria. From this, it is therefore, recommended that the monetary authority should deepen its financial market to enhance the effectiveness of the monetary policy [41-43].

5. CONCLUSION

The growing interest in modelling the relationship between monetary policy and financial development in African nations appears not to cover the disaggregated approach. Also observed were the mixed findings which may not be unconnected with the choice of proxies, methodology, frequency, the scope of data, and jurisdictional biases**.** To investigate the disaggregated impact of financial development on the effectiveness of monetary policy in Nigeria, quarterly frequency data is used to reflect the short run nature of the monetary policy. The findings show that financial market development is the most effective component of financial development in enhancing the outcome of monetary policy and is consistent in terms of meeting the primary and secondary targets of monetary policy.

Given the finding that financial development enhances the effectiveness of monetary policy in Nigeria, it is recommended that the government together with the Central Bank of Nigeria should design policies that could enhance the financial

market such as promoting technology, fintechs, and neobanks to reduce information asymmetry and transactional costs to ease the way of doing business. This may imply that government should not bother much in the development of more financial institutions as its non-sensitivity to monetary policy may imply its adequacy in present Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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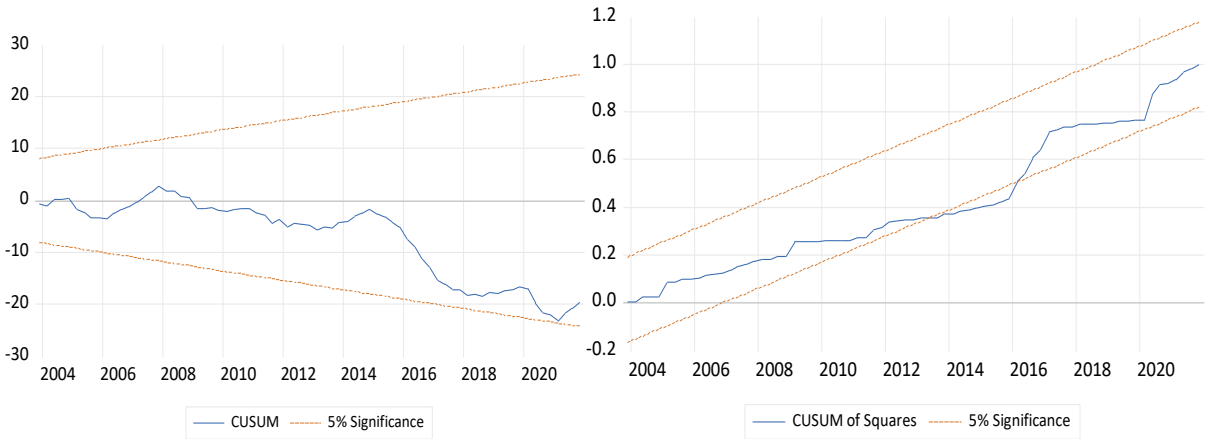
APPENDIX I

CUSUM and CUSUM of squares graphs



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