



**DIGITAL BANKING AND FINANCIAL DEEPENING IN NIGERIA**

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**KEY WORDS**

*Digital Banking, Financial Deepening, ATM, POS, Mobile banking, Internet Banking.*

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**A B S T R A C T**

*This study examined the effect of digital banking on financial deepening in Nigeria for the period 2009-2024. Digital banking was considered from the prism of POS banking, ATM banking, mobile and internet banking; while broad money supply (M3) to GDP ratio was adopted as a measure of financial deepening. Data from Central Bank of Nigeria (CBN) statistical bulletin were utilized for the study. These data were subjected to descriptive analysis, ADF unit root test, granger causality test and ECM estimation. Results demonstrated that the most popular digital banking channel is internet banking, followed by mobile banking, POS banking and ATM banking. Also, causality runs from POS banking, ATM banking and mobile banking to M3-GDP ratio respectively. Only POS banking was statistically significant while POS and internet banking have positive effects on M3-GDP ratio. The study submitted that digital banking has mixed, causal, and insignificant effects on financial deepening in Nigeria. This led to the suggestions that there is need for more POS terminals in the hinter lands as this will go a long way in enhancing POS operations; more ATM machines should be mounted in the rural areas and bank customers should be allowed to make use of these machines at all times; there is also the need for improved power supply to aid digital banking; and telecommunication network providers on their part should brace up by improving in their services to Nigerians.*

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**Introduction**

The banking industry is a very competitive industry. Players in the industry are always innovating to meet the ever-changing demands of customers but in a typically developing country like Nigeria, the demands of customers, mainly those in the rural areas, are limited due to series of factors. In this line, there have been concerted efforts on the part of industry regulators to make financial services readily available to Nigerian. Put differently, the drive for financial deepening and inclusion by the Central Bank of Nigeria (CBN) has remained a constant as enhancing the depth

and access to financial services leaves in its wake increased aggregate investment, financial stability and economic growth. Thus, Shan and Liu (2023) averred that “financial deepening aims to expand various products and services in the financial market and system, enhance inclusiveness in the financial system, and provide more comprehensive and diversified financial services and support for economic development”.

The approach to financial deepening and inclusion keeps changing. The way it was during the days of traditional banking is not the same today. Technological advancement has changed the narrative and the trend today is digital banking. This is a type of banking that promotes the use of digital channels to carry out banking transactions like cash withdrawal, cash deposits, investment and others. Ubah, Adigwe, Okaro and Okoye (2023) added that “Digital banking services have diversified from basic money transfer and bill payments to credit, cross-border remittances, savings, bulk disbursements and other value-added services like pay-as-you-go utility bills, and so on.” Online banking, mobile banking, and digital wallets are popular channels of digital banking. These make it easier for point of sales (POS), automated teller machine (ATM), mobile phone and internet banking transactions. Thus, digital banking provides customers with convenient access to financial services which reduces the need to visit the branch of a bank; it also enables customers to carryout financial transactions quickly and efficiently from the comfort of their homes; and it reduces associated costs that characterize traditional banking.

Buttressing the causality effects of financial deepening, the International Monetary Fund in recent times projected that “...improving Nigeria’s financial system would increase growth by 0.8% per annum, which, at current rates, would accelerate economic growth beyond population growth” (IMF, 2022). Accordingly, the CBN has adopted measures like the “Maya declaration to reduce Nigeria’s adult financial exclusion rate from 46.3% to 20% by 2020”. These measures have been yielding results as “Financial inclusion in Nigeria increased from 47% in 2008 to 64% in 2020; and about half of Nigerian adults (53.6 million) now use formal financial services, up from 48.4 million in 2018.

However, Nigeria still lags significantly behind its peers in Sub-Saharan Africa as a quarter of Nigerians still rely on informal institutions only, and it has a high proportion of financially excluded adults at 36% (38 million)” (EFInA, 2021). To have more insight, there is a dearth of empirical studies on digital banking and financial deepening in Nigeria as majority of reviewed studies either focused on financial inclusion or were done in other countries (Liang, Wei & Duan; 2025; Mundia & Makori, 2024; Ongaga, 2022; Nkechika, 2022; Eromosele, 2021). Hence, this study provides answer to the question: to what extent has digital banking drive financial deepening in Nigeria?

## **LITERATURE REVIEW**

### **Conceptual Review**

#### **Digital banking**

Digital banking is a term that is mistaken to mean the same thing as internet and electronic banking. While they are similar, there is still a slight different between them. E-banking, digital banking and electronic banking all involve manipulation or transfer of money in the form of digits; they however differ on the platforms providing such services. While e-banking and internet banking platforms basically involves connection to internet before movement of digits, digital banking in addition to e-banking and internet banking also encompass all other methods of movement of digits for banking transactions such as the unstructured supplementary service data (Liang, Wei & Duan, 2025). Thus, IBM Global Services (2015) sees digital banking as “a set of alternative delivery channels for banking services.

It has to do with conducting financial transactions through various electronic means, without physically interacting with the bank.” Digital banking may include e-banking, electronic banking, online banking, virtual banking, direct banking and high tech-banking (Ubah, Adigwe, Okaro and Okoye (2023). In Nigeria, the popular digital banking channels are: Automatic Teller Machine (ATM), Point of Sale Terminals (POS), Mobile Money Transfer (MMT), and Online Money Payment (WEB).

#### **Financial Deepening**

Financial deepening is one concept that has been variously defined. It is used interchangeably with financial development and financial inclusion, though financial development is a precursor for financial inclusion. Ndebbio (2014) sees financial deepening as “an increase in the stock of assets of financial markets, institutions and organizations in a country.” Ohwafasa and Aiyedogbon (2023) defined it as “a process which involves specialization in financial functions and institutions through which organized domestic institution and markets relate to foreign markets.” They stressed that an increase in the real size of the monetary system will generate opportunity for the profitable operation of other institutions as well via bill dealers to industrial banks and insurance companies. Aigbovo and Orebator (2022) added that “financial deepening is the ability of financial institutions in an economy to effectively mobilize savings for investment purposes.”

According to Nnanna and Dogo (2018), comprehensive indicators of financial development/deepening are access, depth and efficiency; but specific indicators implies relating monetary and financial aggregates such as M1, M2 and M3 to Gross Domestic Product (GDP); or relating credit to private sector to GDP. However, Friends (2018) opined that “since financial deepening means an increase in the supply of financial assets in the economy, it is important to develop some measures of the widest range of financial assets, including money. This range of financial assets includes but not limited to: broad money (M2), liabilities of bank and non-bank financial institutions, treasury bills, value of shares and money market fund. The sum

Chukwunyeaka L. Okafor (Ph.D),  
Christian M. Odumeh, Chidozirim S. Anukam (Ph.D)

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of these financial assets can thus approximate the widest measures of financial deepening.”

### **Theoretical Framework**

Related theories include technology acceptance model, innovation diffusion theory, bank-focused theory, bank-led theory and nonbank-led theory. However, the study was anchored on Innovation Diffusion Theory (IDT), propounded by Everett M. Rogers in 1962. According to Adamgbo and Dibiah (2025), the theory explains and describes the mechanism of utilization and success of new inventions. “An innovation is any idea, object or practice that is perceived to be new while diffusion of innovation is the process through which the innovation is communicated using various channels over a period of time” (Gichuki & Jagongo, 2017). They added that “...not every innovation is utilized even if it is good and sometimes, it may take a long time for an innovation to be utilized...” Thus, Rogers (1995) identified five attributes that affect the rate of utilization which include relative advantage, compatibility, complexity, triability and observability.

The suitability of this theory stems from the fact that the non-use of some of the digital banking channels like mobile phones may not be as a result of unavailability of such devices or unawareness but rather the nature of some people who adopt the “wait and see” attitude before adopting a new idea. Thus, the low rate of financial deepening via digital banking channels, in a country like Nigeria, is far from unawareness as the penetration level of mobile phones is very high. Again, the structural problems of the country in terms of power supply in rural areas may be a serious factor. Hence, it may take longer time for e-banking channels to be fully accepted because “not every innovation is utilized even if it is good.”

### **Empirical Literature**

Adamgbo and Dibiah (2025) examined the effects of digital financial innovations on financial deepening and real growth in Nigeria between 2009 and 2022 by adopting the Autoregression Distributed Lag (ARDL) models and findings suggested that digital financial innovations affect financial deepening and real growth in Nigeria in the short and long runs with varying degree of impacts as ATM and POS transactions showed more positive and significant impacts.

Mundia and Makori (2024) examined the effects of digital financial innovations on financial deepening in Kenya using descriptive and explanatory research design approaches. Adopting multiple regression analytical technique, results showed that mobile phone banking, ATM banking, online banking, and agency have positive significant effects on financial deepening in Kenya.

Ubah, Adigwe, Okaro and Okoye (2023) examined the effect of digital banking on financial inclusion in Nigeria using relevant data covering 2010 to 2021. These were analysed using Ordinary Least Square multiple regression analytical techniques and results showed that POS and USSD banking have significant effects on financial inclusion while web banking has no significant influence on financial inclusion.

Misati, Osoro, Odongo and Abdul (2022) examined the effect of digital financial innovation on financial depth and economic growth in Kenya using the ARDL technique of analysis. The main outcome of the study is that there is evidence of a positive relationship between digital financial innovation and financial depth with the strongest impact emanating from internet usage and mobile financial services; and the lowest impact from bank branches. Also, there was also the outcome that financial depth has a significant positive impact on economic growth consistent with the supply-leading finance theory.

Adejoh, Ameji and Olorunfemi (2021) examine the causal relationship between digital banking and financial deepening in Nigeria using quarterly data between 2009Q1 and 2019Q4. Accordingly, the Toda-Yamamoto (Y-T) estimation technique was adopted and results revealed that there is no causal relationship between digital banking and financial deepening in Nigeria which implies that digital banking does not spur financial deepening in the country.

Nwude, Igweoji and Udeh (2020) assessed the role of e-banking in stimulating financial inclusion in Nigeria between 2007 and 2017. They used multiple regression analysis in their empirical analysis. Findings from the study revealed the existence of a positive and significant relationship between e-banking platforms and financial inclusion with the exception of internet banking which has a negative and insignificant relationship.

Ene, Abba and Fatokun (2019) examined the impact of electronic banking on financial inclusion in Nigeria using the proportion of banked adult population to total bankable adult population as a proxy for financial inclusion. Pearson correlation technique was used for data analysis. They reported that automated teller machines do not significantly impact financial inclusion while point-of-sale devices significantly impact financial inclusion in Nigeria.

Edoka and Anyanwaokoro (2019) evaluated the impact of electronic payment system on financial deepening indicators in Nigeria by using quarterly time series data for a 6-year period (2009 - 2017). Granger causality tests and correlation analyses were the statistical tools used. Their study revealed that there exist a bi-directional relationship between automated teller machine transaction and private sector credit in Nigeria. Also, a unidirectional relationship exists between automated teller machine transaction and broad money supply in Nigeria.

Mwai, Memba and Njeru (2019) used descriptive cross-sectional design to examine the relationship between mobile phone banking and financial deepening of commercial banks in Kenya. Their target population was all the 41 commercial banks operating in Kenya. Secondary data was collected from the commercial banks financial innovations reports and primary data was collected using semi-structured questionnaire. The data obtained were analyzed using descriptive statistics, regression analysis and Pearson's product moment correlation analysis. The study established that there is a statistically significant relationship between financial innovations adoption and financial deepening of commercial banks in Kenya.

Kabakova & Plaksenkov (2018) looked at digital platforms and the ecosystems of financial inclusion in Russia. Internet banking, mobile banking and card banking were used as variables for the study. Data was analysed using ordinary least square regression. Result showed that digital platforms have greatly aided the financial inclusion ecosystem in Russia.

In Pakistan, Kemal (2016) assessed the association between mobile banking and financial inclusion. The study covered the beneficiaries of the Benazir Income Support Programme (BISP) of Pakistan in 2016. The study used 33 semi-structured interviews conducted on BISP managers, women beneficiaries, mobile operator, bankers, and international agency staff. Subsequently, two focus groups were organized with women beneficiaries. Adopting descriptive analytical tools, the study revealed that mobile banking was socially constructed to meet managerial objectives, enable managers achieves transparency, visibility, security and efficiency in delivering payments. For the women beneficiaries, it provided flexibility and convenience to receive payments.

In Ethiopia, Asfaw (2015) examined the challenges and prospects of financial inclusion in Ethiopia by considering six commercial banks that commenced mobile banking service and three commercial banks that did not launch mobile banking service in the country in 2015. Adopting an exploratory research design, the study relied on questionnaires and data so generated were analyzed using descriptive analytical tools. The study observed that lack of timely approval of new products by regulatory body, lack of interagency cooperation and lack of aggregators between service provider and retail agents were major problems affecting financial inclusion. Conversely, high mobile phone penetration rate was observed to be the most important potential.

Mago and Chitokwindo (2014) examined the impact of electronic banking on financial inclusion in Zimbabwe, with a focus on mobile banking in the Masvingo province. Questionnaire was also used for data collection; and 2SLS regression technique was employed for data analysis and results revealed that electronic banking significantly impacts financial inclusion in Zimbabwe. Results showed that low income people are willing to adopt mobile banking, thereby enhancing financial inclusion.

### **Literature Gap**

Prior to this time, studies have been undertaken in the areas of digital banking, financial technology and financial inclusion but not financial deepening. Given that financial inclusion is a segment of financial deepening, it became imperative to consider financial deepening as a stand-alone. Again, emphasis has always been on electronic and internet banking with few studies on digital banking. The foregoing are the points of departure which makes this study unique.

## Methodology

This study adopted the quasi-experimental research design as the topic did not allow for full scale experiment. Again, emphasis was on establishing the cause-effect relationship between digital banking channels and financial deepening in Nigeria. The data used for the study were yearly time series data on M3-GDP ratio, and value of POS, ATM, mobile and internet banking transactions in Nigeria between 2009 and 2023. These data were sourced from Central Bank of Nigeria (CBN) statistical bulletin, 2023 edition.

Following preliminary ADF (Augmented Dickey Fuller) unit root test, the study adopted Johansen cointegration technique for data analysis. According to Emanakuku (2020), “this technique is used to find a possible correlation between time series processes in the long term.” In other words, the choice of this technique for co-integration analysis is because it allows for more than one co-integrating relationship and it is subject to asymptotic properties. This technique utilizes two test statistics to determine the number of co-integrating vectors. These are trace and maximum eigenvalue test statistics. Thus, to test for co-integration, we compare the value of likelihood ratio to the critical value at 5 percent.

Hence, “if the likelihood ratio test’s value is greater than the critical value at 5%, the null hypothesis ( $H_1$ ) is accepted and the conclusion is that there is co-integration among the variables and vice versa” (Maddala, 2022). In addition, descriptive analysis, granger causality test and diagnostic tests were also carried out. The diagnostic tests checked for the presence of serial correlation, heteroscedasticity, and the suitability of the errors of the model (Normality test). All test and analyses were enabled by the E-Views 10 software.

For the purpose of this study, the relationship between digital banking and financial deepening can be specified using a multiple regression model. This model is functionally given as:

$$\text{BMS/GDP} = f(\text{POSB}, \text{ATMB}, \text{MOBB}, \text{INTB}) \quad \dots\dots\dots (1)$$

$$\text{BMS/GDP} = \beta_0 + \beta_1\text{POSB} + \beta_2\text{ATMB} + \beta_3\text{MOBB} + \beta_4\text{INTB} + \mu_t \quad \dots\dots\dots (2)$$

Where:

|           |   |                                                    |
|-----------|---|----------------------------------------------------|
| BMS/GDP   | = | Broad Money Supply to Gross Domestic Product Ratio |
| POSB      | = | Point of Sales Banking                             |
| ATMB      | = | Automated Teller Machine Banking                   |
| MOBB      | = | Mobile Banking                                     |
| INTB      | = | Internet Banking                                   |
| $\beta_0$ | = | Intercept/Constant Term                            |
| $\beta_i$ | = | Slopes of the model                                |
| $\mu_t$   | = | Error Term                                         |
| f         | = | Functional relation                                |

**A Priori Expectation:**  $\beta_1, \beta_2, \beta_3, \beta_4 > 0$ . This implies that the study expected ATM, POS, mobile and internet banking to have positive effects on broad money supply (M3)-GDP ratio. Thus;

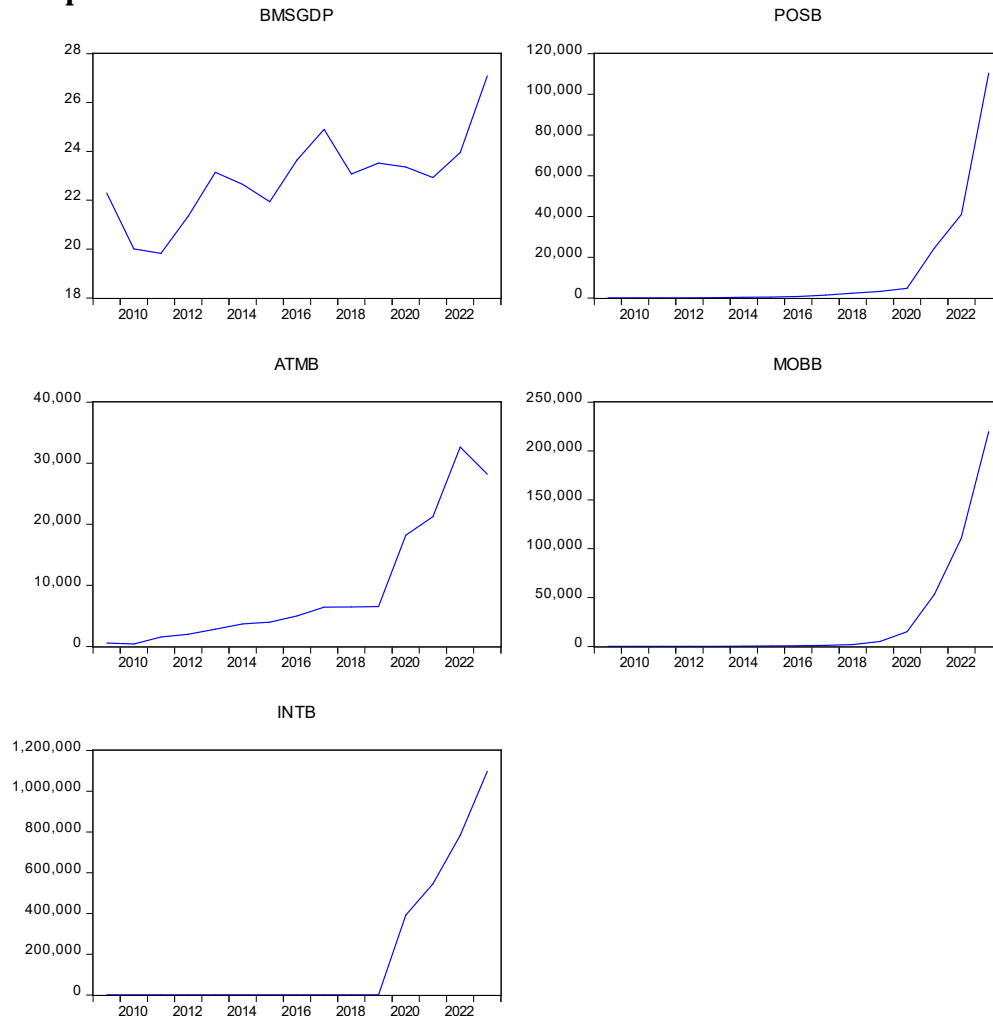
**Table 1:** Table of a priori expectations

| Variables | Definitions                                        | Expectation         |
|-----------|----------------------------------------------------|---------------------|
| BMS/GDP   | Broad Money Supply to Gross Domestic Product Ratio | Endogenous Variable |
| POSB      | Point of Sales Banking                             | +                   |
| ATMB      | Automated Teller Machine Banking                   | +                   |
| MOBB      | Mobile Banking                                     | +                   |
| INTB      | Internet Banking                                   | +                   |

**Source:** Researcher's Computation

## Data and Interpretation of Results

### Graphical Presentation of Data



**Source:** E-views 10 Output

The figures above are graphical representation of the data used for the study. It shows movements in the values of the above variables. The graphs shows that the variable MSS/GDP is the most volatile with steady up and down movements between 2009

Chukwunyeaka L. Okafor (Ph.D),  
Christian M. Odumeh, Chidozirim S. Anukam (Ph.D)  
& Wisdom E. Nwaguru (Ph.D) *International Journal of Accountancy, Finance and Taxation*  
and 2024; while the other variables moved progressively from left to right, albeit with different magnitudes and shapes; thus mirroring a typical supply curve as the values of POSB, ATMB, mobile and internet banking transactions increased with respect to time.

### Descriptive Analysis

| Statistics   | BMS/GDP  | POSB     | ATMB     | MOBB     | INTB     |
|--------------|----------|----------|----------|----------|----------|
| Mean         | 22.91133 | 12623.10 | 9312.227 | 27268.16 | 188003.8 |
| Median       | 23.07000 | 759.0000 | 4988.130 | 756.9000 | 132.3600 |
| Maximum      | 27.09000 | 110347.1 | 32648.02 | 219800.1 | 1097133. |
| Minimum      | 19.82000 | 11.03000 | 399.7100 | 1.270000 | 25.05000 |
| Std. Dev.    | 1.802771 | 29410.32 | 10481.06 | 61292.33 | 352404.2 |
| Skewness     | 0.299581 | 2.728442 | 1.211201 | 2.420647 | 1.594618 |
| Kurtosis     | 3.560091 | 9.421142 | 3.002242 | 7.751116 | 4.171696 |
|              |          |          |          |          |          |
| Jarque-Bera  | 0.420435 | 44.38040 | 3.667524 | 28.75702 | 7.215058 |
| Probability  | 0.810408 | 0.000000 | 0.159811 | 0.000001 | 0.027119 |
|              |          |          |          |          |          |
| Sum          | 343.6700 | 189346.5 | 139683.4 | 409022.3 | 2820057. |
| Sum Sq. Dev. | 45.49977 | 1.21E+10 | 1.54E+09 | 5.26E+10 | 1.74E+12 |
|              |          |          |          |          |          |
| Observations | 16       | 16       | 16       | 16       | 16       |

**Source:** E-views 10 Output

The descriptive statistics in the above table shows that money supply-GDP ratio (MSS/GDP) has a mean value of 22.91% with minimum and maximum values of 19.82% and 27.09% respectively, and a standard deviation of 1.80%. Similarly, the mean values of POSB, ATMB, MOBB and INTB are ₦12623.10 billion, ₦9312.227 billion, ₦27268.16 billion and ₦188003.8 billion respectively. The table also puts the skewness value of MSS/GDP, POSB, ATMB, MOBB and INTB at 0.299581, 2.728442, 1.211201, 2.420647, and 1.594618; which implies that all the variables are positively skewed to the right. Given the p-values of Jarque-Bera statistic, only the variables MSS/GDP and ATMB are normally distributed with probability values greater than 5% (0.05).

However, the curves of the variables are positively peaked at leptokurtic level, suggesting that it is moving above normal distribution. This is because the Kurtosis of these variables (3.560091, 9.421142, 3.002242, 7.751116 and 4.171696) fall within the benchmark of 3 for standard normal distribution; thus, the lower the value, the flatter the peak.

### Unit Root Test

| Variables | ADF Statistic | Critical Value (5%) | Prob. Value | Remark |
|-----------|---------------|---------------------|-------------|--------|
| BMS/GDP   | -4.054782     | -3.144920           | 0.0112      | I(1)   |
| POSB      | -4.588803     | -3.119910           | 0.0041      | I(1)   |

Chukwunyeaka L. Okafor (Ph.D),

Christian M. Odumeh, Chidozirim S. Anukam (Ph.D)

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*International Journal of Accountancy, Finance and Taxation*

|      |           |           |        |      |
|------|-----------|-----------|--------|------|
| ATMB | -5.555189 | -3.119910 | 0.0008 | I(1) |
| MOBB | -4.409925 | -3.212696 | 0.0085 | I(1) |
| INTB | -4.254141 | -3.119910 | 0.0072 | I(1) |

**Source:** Extract from E-views 10 Output

Unit root test result using the Augmented Dickey Fuller (ADF) approach showed that all the variables were stationary at first difference as the probability values of the variables (0.0112, 0.0041, 0.0008, 0.0085 and 0.0072) were all less than 5% (0.05).

### Granger Causality Test

| Null Hypothesis                            | Obs | F-Statistic | Prob.  |
|--------------------------------------------|-----|-------------|--------|
| LOG_POSB does not Granger Cause LOG_BMSGDP | 14  | 7.45396     | 0.0149 |
| LOG_BMSGDP does not Granger Cause LOG_POSB |     | 0.89825     | 0.4447 |
| LOG_ATMB does not Granger Cause LOG_BMSGDP | 14  | 7.47041     | 0.0148 |
| LOG_BMSGDP does not Granger Cause LOG_ATMB |     | 0.48406     | 0.6332 |
| LOG_MOBB does not Granger Cause LOG_BMSGDP | 14  | 10.3916     | 0.0060 |
| LOG_BMSGDP does not Granger Cause LOG_MOBB |     | 0.08818     | 0.9165 |
| LOG_INTB does not Granger Cause LOG_BMSGDP | 14  | 2.93904     | 0.1104 |
| LOG_BMSGDP does not Granger Cause LOG_INTB |     | 0.52097     | 0.6128 |
| LOG_ATMB does not Granger Cause LOG_POSB   | 14  | 1.70128     | 0.2423 |
| LOG_POSB does not Granger Cause LOG_ATMB   |     | 1.84218     | 0.2198 |
| LOG_MOBB does not Granger Cause LOG_POSB   | 14  | 3.33459     | 0.0885 |
| LOG_POSB does not Granger Cause LOG_MOBB   |     | 0.64956     | 0.5478 |
| LOG_INTB does not Granger Cause LOG_POSB   | 14  | 7.08786     | 0.0169 |
| LOG_POSB does not Granger Cause LOG_INTB   |     | 1.42410     | 0.2958 |
| LOG_MOBB does not Granger Cause LOG_ATMB   | 14  | 7.18134     | 0.0164 |
| LOG_ATMB does not Granger Cause LOG_MOBB   |     | 0.13051     | 0.8795 |
| LOG_INTB does not Granger Cause LOG_ATMB   | 14  | 2.00093     | 0.1974 |
| LOG_ATMB does not Granger Cause LOG_INTB   |     | 0.46840     | 0.6421 |
| LOG_INTB does not Granger Cause LOG_MOBB   | 14  | 0.41208     | 0.6756 |
| LOG_MOBB does not Granger Cause LOG_INTB   |     | 2.10280     | 0.1846 |

**Source:** E-views 10 Output

Result of pairwise granger causality test revealed that there is no bidirectional relationship between the variables. Rather, there is unidirectional relationship between:

1. Point of Sales (POS) banking and broad money supply (M3) - GDP ratio;
2. Automated Teller Machine (ATM) banking and broad money supply (M3) - GDP ratio;
3. Mobile banking and broad money supply (M3) - GDP ratio;
4. Internet banking and Point of Sales (POS) banking; and
5. Mobile banking and Automated Teller Machine (ATM) banking.

### ECM Estimation

| Variables   | Coefficients | Std. Error | t-statistic | Prob. Value | Decision      |
|-------------|--------------|------------|-------------|-------------|---------------|
| C           | -0.014943    | 0.032082   | -0.465774   | 0.6538      | -             |
| D(LOG_POSB) | 0.104288     | 0.033179   | 3.143217    | 0.0137      | Significant   |
| D(LOG_ATMB) | -0.015296    | 0.035126   | -0.435469   | 0.6747      | Insignificant |
| D(LOG_MOBB) | -0.049769    | 0.029789   | -1.670727   | 0.1333      | Insignificant |
| D(LOG_INTB) | 0.004029     | 0.008324   | 0.484031    | 0.6413      | Insignificant |
| ECM(-1)     | -1.349999    | 0.357482   | -3.776412   | 0.0054      | Significant   |

**Source:** Extract from E-views 10 Output

From the above table, POS and internet banking transactions have positive effects on M3/GDP ratio while ATM and mobile banking transactions have negative effects on money supply-GDP ratio. Also, the table indicated that only POS banking has a significant influence on M3/GDP ratio (financial deepening); thus the effects of ATM, mobile and internet banking are insignificant. ECM(-1) equation has the desired negative and significant signs which implies that in an event of any distortion to the equilibrium relationship between digital banking and financial deepening, the speed of re-convergence to equilibrium, which is initiated by digital banking, is about 135% per annum.

### Diagnostics Tests

| Test               | Approach              | Test Statistic | P-value  | Remark  |
|--------------------|-----------------------|----------------|----------|---------|
| Normality          | Jarque-Bera           | 1.065600       | 0.586959 | Present |
| Heteroscedasticity | Breusch-Pagan-Godfrey | 0.642561       | 0.6444   | Absent  |
| Autocorrelation    | Q-Stat.               | >3             | ≥0.05    | Absent  |

**Source:** Computation from E-views Output

Diagnostic test results revealed that errors of the model are normally distributed and there is absence of heteroscedasticity and autocorrelation is the model. This further implies that the results of the analysis are valid and reliable.

## **Discussion of Findings**

### **POS Banking and MSS/GDP Ratio**

Results revealed that point of sales (POS) banking has a direct cum positive association with financial deepening as represented by M3/GDP ratio. In other words, as the former increases, the latter increases too. Similarly, Mamudu and Gayovwi (2019), and Ene, Abba and Fatokun (2019) reported that POS transactions have positive impacts on financial inclusion. Student t-test at 5% level of significance revealed that the association between both variables is a significant one which may be as a result of the preponderance of POS terminals in all the nooks and crannies of Nigeria (Babarinde, 2023). Nevertheless, it was observed also that there is a unidirectional causal association between POS banking and financial deepening, with causality running from the former to the latter (Adejoh, Ameji & Olorunfemi, 2021).

### **ATM Banking and MSS/GDP Ratio**

On the relationship between automated teller machine (ATM) banking and financial deepening (MSS/GDP) in Nigeria, it was revealed that the former has a negative relationship with the latter to the tune of -0.015296, which subsequently implies that in an event where the monetary value of ATM banking (transactions) increases by ₦1, money supply (M3)-GDP ratio will decrease by about 0.02% and vice versa. This outcome, which aligns with those put forward by the likes of Nwude, Igweoji and Udeh (2020) and Ene, Abba and Fatokun (2019) was not expected because the more the value of ATM transactions, the more the depth of financial services all things being equal.

Nevertheless, t-test results showed that ATM banking has an insignificant relationship with broad money supply to GDP ratio which was also reported by Babarinde (2023). This may be as a result of the insufficient number of functional ATM terminals in the country today. Further analysis, nonetheless, revealed that ATM operations has a unidirectional relationship with MSS/GDP; which implies that a one-way causality runs from ATM banking to financial deepening in Nigeria, though Edoka and Anyanwaokoro (2019) reported a bi-directional relationship.

### **Mobile Banking and MSS/GDP Ratio**

Mobile banking operations was observed to have a negative insignificant nexus with financial deepening. The regression coefficient of this relationship is -0.049769, which connotes that a unit increase in the value of mobile banking operations has a tendency to decrease financial deepening (MSS/GDP) by about 0.02 percent. The study nonetheless, expected a positive relationship but the negative outcome of the relationship may be a result of poor services from telecommunication companies in Nigeria. The usual practice is that in majority of the very remote areas of the country, telecommunication services seem to be unstable and in extreme cases, they are not even available. This makes the use of mobile banking channels like the USSD very difficult, thereby affecting financial deepening adversely (Torki, Rezaei & Razmi, 2020).

Subsequently, granger causality test revealed a unidirectional relationship between mobile banking operations and financial deepening in Nigeria.

### **Internet Banking and MSS/GDP Ratio**

Internet banking, which is also known as online banking, showed a positive insignificant relationship with financial deepening in Nigeria; even as reported by Edoka and Anyanwaokoro (2019). This outcome (positive relationship) was expected because an increase in the number and value of internet banking transactions signifies more acceptances by the people, which ordinarily should enhance the index of financial deepening not minding the negatives of internet frauds. However, pairwise granger causality test showed absence of any form of causality between internet banking operations and financial deepening.

### **Conclusion and Recommendations**

The concern of this work was to determine the extent to which digital banking affects financial deepening in Nigeria. Accordingly, results suggest that digital banking has mixed, causal and insignificant effects on financial deepening in Nigeria. On this backdrop, it was recommended that:

1. There is need for more POS terminals in the hinter lands as this will go a long way in enhancing POS operations and as well contribute favorably to financial deepening in the country. Also, the Central Bank of Nigeria (CBN) should seriously regulate the way some of the POS merchants operate in remote areas to avoid over charging Nigerians who live in such areas.
2. More ATM machines should be mounted in the rural areas and bank customers should be allowed to make use of these machines at all times. The practice where a bank branch will have as much as 5 ATM machines and only one will be functional is affecting ATM banking in Nigeria and by extension digital banking in the country.
3. The need for improved power supply cannot be over stated as constant power supply holds the key to a seamless digital banking operation mainly for those who engage in internet and online banking.
4. Telecommunication network providers on their part have a big role to play in enhancing financial deepening in a country like Nigeria. This is because the use of USSD (Unstructured Supplementary Service Data) is sometimes impeded by poor network supply, mainly in the rural areas. This ultimately affects smooth operation of those who patronize digital banking channels.

### **Limitations of the Study**

The major limitation of this study was data availability on digital banking channels in Nigeria. According to the Central Bank of Nigeria, there are so many payment channels in the country like cheque, ATM, POS, Web Pay, Mobile Pay, NIP (NIBSS Instant Payment), NEFT (NIBSS - Nigeria Inter-Bank Settlement System - Electronic Fund Transfer), m-Cash, E-Bills Pay, Remita, NAPS (NIBSS Automated Payment Services) and Central Pay; but the CBN only started capturing data on these

Chukwunyeaka L. Okafor (Ph.D),  
Christian M. Odumeh, Chidozirim S. Anukam (Ph.D)

& Wisdom E. Nwaguru (Ph.D) *International Journal of Accountancy, Finance and Taxation*  
payment options from 2009. Nevertheless, most of the data on digital banking options are incomplete as those with complete records are ATM, POS, Web pay and Mobile pay banking. These limited the time scope of the study to just 16 years (2009-2024). In the future, related studies should go beyond 2024.

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