Effect of Financial Innovative Payment Systems on Commercial Banks' Returns on Assets and Equity in Nigeria: An Application of Multi-Criteria Decision Making Methods

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Abstract

Innovation has been a key element of the Nigerian financial system based on the report of the Central Bank of Nigeria Technical Committee on E-Banking in 2003 which provided a platform for addressing its impact on the economy. This paper examined the effects of financial innovation on commercial banks' returns on assets and equity in Nigeria when different periods of analysis were considered. Data were obtained from the publications of the Central Bank of Nigeria on e-payment channels from 2009 to 2018. A decision making approach based on Multi-Criteria Decision Making (entropy and range of value) methods was employed for the determination of the innovative payment systems that enhance the performance of the banks. The entropy method determines the weights of banks' returns on assets and equity, whereas the range of value method ranks the innovative payment systems. Vector Autoregression (VAR) estimation technique was utilised to compute the decision matrix for the medium and long terms. Findings indicated that return on assets, with higher entropy weights (0.5733 in the medium years and 0.6058 in the long years respectively, as against weights of 0.4267 and 0.3942 for return on equity in the medium and long run respectively), was a better criterion for assessing commercial banks' returns on assets and equity. The paper concluded that commercial banks would enhance their medium and long terms' performance by employing the Multi-Criteria Decision Making (entropy and range of value) methods to make the best decisions on the relative importance of their financial innovative payment systems.

Keywords: Payment Systems, Returns on Assets and Equity, Multi-Criteria Decision Making, Automatic Teller Machines, Mobile Money Banking

JEL Classification: G21, G28

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1. Introduction

The banking system in Nigeria, over the years, has been under serious criticism in relation to the long queues and congestions in the banking halls, inefficient and sluggish services, long distance covered by customers to transact banking business, delays in processing customers' instructions, and delay in settlement of payments, among others. Unfortunately, the financial system in Nigeria is dominated by the banking sector, especially the commercial banks, which accounts for about 90% of the total assets in the system (Mamman & Hashim, 2014). The situation was made worse by the concentration of banks mainly in the state capitals, leaving most towns without banks. The attempt by the government in 1977 to encourage the establishment of banks in the rural areas of the country, though successful, was discontinued thereafter. With 4.4 numbers of branches per 100,000 adults (World Bank Report, 2017), the Nigerian banking system was considered to be grossly inadequate for any economic development. The implications of the inadequate banking facilities were that customers were frustrated and banking habit was adversely affected with the majority of the people excluded from the financial system.

In line with the best global practices, the banking system in Nigeria adopted innovative payment systems, with the aim of enhancing financial inclusion, making financial services readily and cheaply available to the majority of the people, and to contribute to the efficiency of the financial system. Some of the innovative payment systems include: Automatic Teller Machines (ATMs), National Electronic Fund Transfer (NEFT), Point of Sale (POS), internet (Web) banking, Mobile Money payment (MMO), NIBSS Instant Payments (NIP) and Real-Time Gross Settlement (RTGS). The new initiative for transacting banking businesses in Nigeria started in 1990, by the Societe Generale Bank (SGBN) with the launching of the Automated Teller Machine (ATM). Since then, the need to electronically settle transactions with the use of innovative payment systems such as ATM, NEFT, POS, Web, MMO, NIP and RTGS has become popular in the Nigerian banking industry. Most of these payment systems are products of recent developments in the Nigerian financial systems and therefore are regarded as innovative payment system, because many of them were introduced in the early 2000s. Prior to this period, the Nigerian economy has been predominantly cash-based.

The payment systems were introduced to efficiently and effectively improve resource mobilisation, utilisation and allocation in the economy to boost economic growth. In specific terms, the payment systems perform complementary functions to ensure that the financial system plays the critical role of enhancing financial inclusion and boosting the economy. The Automatic Teller Machines (ATMs), first introduced in Nigeria in 1989, is an electronic banking machine that people use to transact banking transactions by offering convenience, speedy and round the clock services, without the assistance of a bank officer. The National Electronic Fund Transfer (NEFT) is a method of transferring money to another bank account, especially when dealing with a large amount of money. The Point of Sales (POS) business gained widespread acceptance in Nigeria from 2013, after the introduction of the agent banking system by the Central Bank of Nigeria (CBN). The POS allows an

agent to offer customers a variety of transactions to choose from, such as withdrawal, transfer, bill payment, or even opening a personal bank account with the customer's debit card. The internet (Web) banking was adopted in Nigeria in the early 2000s to reduce the quantum of cash transactions by allowing the transfer of funds, payment of bills and taxes, customers' access to account balances, and checking of account activity/statement. Prior to the adoption, the Nigerian economy operated almost entirely on cash-based transactions, with large volume of money outside the banking system making the Central Bank of Nigeria (CBN) to have minimal control of the economy. The "NIBSS Instant Payments (NIP) is an account-number-based, online real-time Inter-Bank payment solution developed in the year 2011 by NIBSS. The acronym 'NIBSS' stands for Nigeria Inter-Bank Settlement System Plc. NIP is the Nigerian financial industry's preferred funds transfer platform that guarantees instant value to the beneficiary. The NIP service commenced with only two (2) commercial banks as participants. However, today, the number of participants has grown to include all commercial banks, Micro-Finance banks (MFBs), and Mobile Money Operators (MMOs)." The platform enables financial institutions to provide online real-time funds transfer services to their customers through all available electronic channels such ATM, internet banking, POS, bank branch, Kiosks, mobile apps and Unstructured Supplementary Service Data (USSD). The Real-Time Gross Settlement (RTGS), introduced in 2004, is an on-line Payment System that allows the processing and settlement of funds to take place continuously in real time to handle large value and time-critical payments.

Although, the introduction of these financial innovative payment systems was expected to increase bank efficiency and customers' satisfaction, and culminate in better performance for commercial banks, opinions differ on the possible effects of the various innovative payment systems on the performance of commercial banks in the country. For instance, the report of the Central Bank of Nigeria (CBN) Technical Committee on E-Banking in 2003 addressed issues relating to the impact of financial innovation on customers and the need to meet international best practice. Elumaro and Obamuyi (2018) observed that fraudsters are taking advantage of innovative payment systems to defraud unsuspecting customers, resulting in loss of confidence with adverse implications for bank performance. Innovative payment systems by banks in Nigeria were also found to follow similar patterns, with banks competing among themselves, with little or no differentiation in their product lines. The forgoing implied that the benefit of the various financial innovative payment systems, if not properly evaluated, may be eroded by fraudulent practices, cost elements and other restrictions (such as regulations and entry barriers), and hence produce a cyclical effect of increasing cost and lowering performance.

Based on the foregoing, it is apposite to ask the following pertinent questions: (i) what are the essential financial innovative payment systems that enhance the banks' performance? (ii) what would be the benefit of employing the Multi-Criteria Decision Making (entropy and range of value) methods in the determination of the relationship between banks' returns on assets and equity and financial innovative payment systems under different time horizons? In order to provide answers to the

questions, the study aimed to: (i) identify the essential financial payment systems in Nigeria; (ii) determine the relative importance of each of the criteria for assessing banks' returns on assets and equity; and (iii) rank the innovative payment systems according to their contributions to banks' returns on assets and equity. Therefore, the motivation for the study was to employ the multi-criteria decision making methods to determine the criterion for measuring banks' returns on asset and equity and rank the innovative payment systems according to their relative contributions to banks' returns on asset and equity in Nigeria. Hence, this study empirically determines how commercial banks use innovation to gain competitive advantage in the specific context of Nigeria's financial system when different periods of analysis are considered.

2. Literature Review

2.1. Theoretical Issues

The emergence of financial innovation in Nigeria is connected with the constraint-induced financial innovation theory and the transaction cost innovation theory. The constraint-induced financial innovation theory pioneered by Silber (1983) postulated that financial institutions innovate for the purpose of profit maximisation. In the process of innovation, several restrictions (such as regulations and entry barriers) are imposed on the banks. The attempt to overcome the restrictions leads the banks to innovate and ultimately boosts their performance. On the other hand, the transaction cost innovation theory (Hicks & Niehans, 1983) argued that the dominant factor of financial innovation is the reduction of transaction cost, and that innovation is the response of the advance in technology which caused the transaction cost to reduce. Consequently, the reduction of transaction cost stimulates financial innovation and improvement in financial services. Thus, the theory advocated for financial innovation to reduce cost and positively influence the performance of commercial banks. Based on the constraint-induced financial innovation theory and the transaction cost innovation theory, financial innovative payment systems that play significant improvement in the banks' returns on assets and equity are considered key elements for lowering the cost of transactions and enhancing efficiency in the Nigerian financial system.

2.2. Empirical Review

Many empirical studies have examined the relationship between financial innovation and performance of commercial banks. For instance, Nyathira (2012) examined the effect of financial innovation on the performance of commercial banks in Kenya. The measures of innovativeness used were the value of Real-Time Gross Settlement (RTGS) and the value of automated clearing transactions. The study found that financial innovation was positively correlated to the profitability of the commercial banks. Muia (2013) studied the relationship between financial innovation and growth in profitability of Islamic banking in Kenya, using the regression model. The study measured innovativeness with the contribution of agent banking, internet banking and mobile banking. The results concluded that increasing the number of innovations enhances the relationship between

profitability (ROA) and financial innovations. The study found that a 1% increase in financial innovation increased ROA by 0.48%.

Similarly, Cherotich, Sang, Shisia and Mutung'u (2015) studied the effect of financial innovations and the performance of commercial banks in Kenya, using a multiple regression model. The measures of innovativeness for the study were value of RTGS transfers, value of National Electronic Fund Transfer (NEFT) cleared and the value of cheques cleared. The study found that financial innovation has a positive and significant influence on the financial performance of commercial banks in Kenya, which has also influenced their competitive advantage. Akhisar, Tunay and Tunay (2015) studied the effects of innovations on bank performance in 23 developed and developing countries, using dynamic panel data. The study adopted the measures of innovativeness as credit cards, point of sales, automatic teller machines and internet banking. The results showed that bank profitability in developed and developing countries was significantly affected by the ratio of the number of branches to the number of Automatic Teller Machines (ATMs) and electronic banking services.

Bara and Mudzingiri (2016) analysed the effect of financial innovation on the growth of the financial sector of Zimbabwe, using the ARDL and Granger causality test. They found that financial innovation has a relationship with the growth in the financial sector that varies depending on the variable used to measure financial innovation. Usman (2016) in a study of bank performance, risk and economic growth in Pakistan, employed aggregated log sum of the number of online branches, the number of ATMs and number of credit cards. The results of the ordinary least square (OLS) showed that there was a positive and statistically significant relationship between financial innovation and bank return on assets (ROA) in Pakistan. Gündogu and Taskin (2017) examined the relationship between financial innovation and the performance of the Turkish banking system. The study employed ordinary least square regression, with measures of innovativeness being internet banking, ATMs, credit cards, size of bank loans and non-performing loans. They found that only credit card usage significantly influenced the performance of banks in Turkey. The study revealed that a 1% increase in credit usage increased ROA by 0.66%.

Okon and Amaegberi (2018), using panel unit root and SURE model to analyse the effect of mobile banking transactions on bank profitability in Nigeria, found that ATM, Point of Sale (POS), Mobile Money banking (MMO) and bank size significantly impact on the performance of commercial banks in Nigeria.

Although, the empirical review confirmed the relationship between innovation and the performance of commercial banks, none of the studies analysed the effects with respect to different periods of analysis, either in the medium or long term. This study is also unique because it used multi-criteria decision making methods to determine the appropriate criteria for measuring banks' returns on assets and equity and the importance of the financial payment systems as determinants of banks'

returns on assets and equity in Nigeria. This study fills the gap in the literature and showed how commercial banks use innovation in order to gain competitive advantage in the specific context of the Nigerian financial system. The regulators and the banks would be guided during policy formulation on different effects of financial innovation on banks' returns on assets and equity, when different periods of analysis are considered.

3. Methodology

3.1. Theoretical Framework

The theoretical framework underpinning this work was based on the transaction cost innovation theory (Hicks & Niehans, 1983). The expectation was that the adoption of various innovative payment systems would reduce transaction costs, and ultimately enhance the performance of the banks, with respect to different periods of analysis.

3.2 Sources of Data Collection

The study obtained secondary data from the publications of the Central Bank of Nigeria on e-payment channels from 2009 to 2018, the period that witnessed aggressive innovation in the financial sector of the country. In addition, there was the problem of getting up-to-date and complete data beyond 2018 for all the variables at the time of preparing the research. Data for financial innovative payment systems, used as the independent variables, were captured by the values of cheque transactions (CHEQ); values of NEFTs cleared (NEFT); the values of ATM transactions (ATM); the values of PoS transactions (POS); the values of internet web transactions (WEB); the values of NIP transactions (NIP); the values of mobile money transactions (MMO). The two main criteria for measuring bank performance (return on assets and return on equity) used in the study were obtained from the sampled banks' annual reports.

3.3. Model Specification

The Augmented Dickey-Fuller unit root test was employed on the time series data from 2009 to 2018 to determine the stationarity of the variables. The null hypothesis of this stationarity test is that variable has unit root. A statistical significance of the ADF statistics implies a rejection of the null hypothesis of unit root and an acceptance of the alternative hypothesis that the variable is stationary. The Vector Autoregression (VAR) estimation technique, developed by Sims (1980), was utilised to compute the data for decision matrix for the variables of banks' returns on assets and equity and innovative payment systems.

The study adapted the work of Isik and Adali (2017), who combined the entropy and range of value methods of the Multi-Criteria Decision Making (MCDM) for the apple selection problem. The entropy method was used to determine which of the performance criteria better reflect the contributions of the various innovations in the banking sector. As Wu, et al. (2011) argued, entropy is a very good scale when it is applied to different cases of assessment or evaluation in different decision making process. The entropy weights described the importance of the performance variables.

On the other hand, the Range of Values (ROV) method was used to rank the contributions of the seven financial innovative payment systems to banks' returns on asset and equity. Thereafter, the ROV method is used to calculate the best and worst contribution of each of the innovative payment systems. The models for the determination of the entropy weights and range of values are specified in sections 3.3.1 and 3.3.2.

3.3.1. Determination of Entropy Weights

The entropy method involved presenting and normalising the decision matrix, determining the entropy values and calculating the entropy weights (Hu, et al., 2015; Li, et al., 2011, and Işık & Adalı, 2017; Dehdasht, et al., 2020). The decision matrix showed the status of the performance variables with respect to innovative payment systems. Thereafter, the decision matrix was normalised, and all the entries of the decision matrix were used to determine the entropy values and weights. The entropy method is based on the assumption that there are m financial innovative payment systems and n evaluation criteria to calculate the decision matrix (see Işık & Adalı, 2017).

Step 1

Assuming there are m financial innovative payment systems and n evaluation criteria, the decision matrix is calculated as follows

$$D = \begin{pmatrix} X_{11} & X_{12} \ldots . & X_{1n} \\ X_{21} & X_{22} \ldots . & X_{2n} \\ \vdots & & \\ X_{m1} & X_{m2} \ldots . & X_{mn} \end{pmatrix} \quad \cdots\cdots(1)$$

Step 2

To normalize the entries in the decision matrix, make comparisons between the different performance measures, using the beneficial (maximization) and non-beneficial (minimization) criteria, as shown in Eq. (II) and Eq. (II):

$$D_{ij} = \frac{X_{ij} - \min(X_{ij})}{Max_{ij} - Min(X_{ij})} \quad \text{(Beneficial Criterion)} \cdots\cdots(2)$$

$$D_{ij} = \frac{Max(X_{ij}) - X_{ij}}{Max(X_{ij} - Min(X_{ij})} \quad \text{(Non – Beneficial Criterion)} \cdots\cdots(3)$$

Step 3

Next, the entropy values (ej) is determined as follows:

$$\text{ej} = \frac{\sum_{-i-1}^{m} f_{ij} Inf_{ij}}{Inm}, \quad \text{where } f_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}} \quad \cdots\cdots(4)$$

Step 4: the entity weights (w_{ij}) are calculated

$$w_{ij} = \frac{1- e_j}{n- \sum_{i-1}^{m}} e_j, \quad \text{where } \sum_{i=1}^{n} w_j = 1 \quad \cdots\cdots(5)$$

By normalizing 1-e_j which represent the intensity of each criteria, the final weights of each criterion is obtained (Wu, et al., 2011; Isik & Adali, 2017; Dehdasht, et al., 2020).

3.3.2. Determination of Range of Values

For the ROV, the steps involved obtaining a decision matrix and normalising the entries. From the normalized results of the beneficial and non-beneficial criteria, the best and worst performance for each of the financial innovative payment systems are determined (Isik & Adali, 2017).

$$\text{Maximize: } \cup_i^+ = \sum_{j=1}^{n} r_{ij} w_j \quad \cdots\cdots(6)$$

$$\text{Minimize: } \cup_i^- = \sum_{j=1}^{n} r_{ij} w_j \quad \cdots\cdots(7)$$

Where wj (j = 1,…,n) are criteria weights which satisfy

$$\sum_{j=1}^{n} w_j = 1 \text{ and } w_j \geq 0 \quad \cdots\cdots(8)$$

Then, the scoring is derived from the mid-point of $\cup_i^+ and\ U_i^-$ as follows;

$$\cup_i = \frac{\cup_i^+ + U_i^-}{2} \quad \cdots\cdots(9)$$

Based on the result, the financial innovative payment system with the highest ROV is regarded as the most relevant to banks' performance, while the one with the lowest ROV is the least relevant to banks' returns on assets and equity. As reported by Işık and Adalı (2017), the entropy and range of value methods provided some advantages to the decision makers in evaluating the best financial innovative payment systems that most contributed to banks' performance in the country.

4. Results and Discussions

The results of the Multi-Criteria Decision Making (MCDM) were used to determine a better criterion (return on assets or return on equity) for assessing the performance of the commercial banks and to rank the financial innovative payment systems with reference to the performance criteria. First, the unit root test of the ADF was used to test the stationarity of the data. Second, the Vector Autoregression (VAR) estimation technique, developed by Sims (1980), was utilised to compute the data for the decision matrix for the variables of banks' performance and innovative payment systems. The choice of variables in the VAR model reflects the relationship between the indicators of financial innovative payment systems and commercial banks' returns on assets and equity. The analysis was done based on short term (one year), medium term (five years) and long run (ten years) of financial innovations in the sector.

4.1. Results of the Unit Roots, Vector Autoregression and Variance Decomposition

The Augmented Dickey-Fuller unit root test for the variables employed in this study is reported in Table 1. All the variables are tested at levels and first difference. Evidence from the result obtained shows that ROA and ROE are stationary at level. Other variables namely, ATM, CHEQUES, MMO, NEFT, NIP and POS are stationary in their first difference. However, WEB is not stationary at the conventional levels, it only attains stationarity at the second difference.

Following the Vector Autoregression result, variance decomposition (VDC) and impulse response function were derived. At this junction, the results of this regressions are bifurcated into two based on the measures of banks' returns on assets and equity used in the study. First, is the relationship between financial innovation variables and return on assets (Table 2). The second estimate shows the interaction of financial innovation variables and return on equity (Table 3). The discussions of the variance decomposition are presented in 3 horizons. First, is the short term (horizon 1), second is the medium term (horizon 5) and long-run (horizon 10).

Table 1. Unit Root Test of the Variables

S/N	Variables	ADF test at level	Critical Value at 5%	ADF test at FD	Critical value at 5%	Order of Integration
1	ROA	-4.581456	-2.935001	-4.194997	-2.933158	I(0)
2	ROE	-4.337735	-2.935001	-4.133373	-2.933158	I(0)
3	ATM	-2.609818	-2.933158	-4.137643	-2.933158	I(1)
4	CHEQUES	-1.541999	-2.933158	-3.538016	-2.933158	I(1)
5	MMO	-1.958556	-2.933158	-3.261697	-2.933158	I(1)
6	NEFT	-2.251754	-2.933158	-3.620479	-2,933158	I(1)
7	NIP	-0.004754	-2.933158	-3.780197	-2.933158	I(1)
8	POS	-0.197743	-2.933158	-3.160179	-2.933158	I(1)
9	WEB	0.219465	-2.933158	-2.518942	-2.933158	I(2)

4.1.1. Variance Decompositions (VDCs) of ROA and Financial Innovation Variables

Table 2 shows the estimates of the VDCs using ROA as a measure of banks' returns on assets and equity. The VDCs account for the relative proportion of the individual shocks to all variables within the VAR estimates. As expected, own shocks to ROA explained 100% of the variation in itself in the first period, this proportion declined to 72.9% in the 10th period. The response of shocks to ROA explained by innovations in ATM is negligible through the horizons. The innovation of CHEQUES and NEFT explained a significant proportion of shocks to ROA, especially in the medium term and long run.

The second row presents the shocks to ATM explained by changes in the variables of interest. A significant proportion of the variation in ATM is explained by ROA of commercial banks during the period of investigation. Other financial innovation variables do not explain a significant

proportion of variation in ATM. Similarly, shocks to CHEQUES explained by changes in ROA are significant in the periods. The significance of these shocks is larger in the short run than in the long run. In the short run, about 75.6% is recorded and declined to 56.9% in the long run.

In the third row, the shocks to MMO explained by innovations in the variable of interest are explained. A large proportion of the shocks to MMO are explained by innovations in values of cheque transactions (CHEQUE). For instance, in the short run and long run CHEQUES explained 67.8% and 41.0%, respectively of the variation in MMO. Similarly, ROA and ATM explained a significant magnitude of the variation in MMO during the period of study.

Table 2. Variance Decomposition of ROA and Financial Innovation Variables

Horizon (Years)	ROA	ATM	CHEQUES	MMO	NEFT	LNIP	LPOS	LWEB
Shocks to ROA explained by innovations in:								
1	100.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	83.944	0.0687	12.417	0.260	2.694	0.387	0.166	0.065
10	72.861	0.988	15.102	0.407	3.609	2.180	4.128	0.726
Shocks to ATM explained by innovations in:								
1	96.218	3.782	0.000	0.000	0.000	0.000	0.000	0.000
5	80.100	3.358	13.835	0.683	1.566	0.399	0.021	0.037
10	74.119	3.010	17.906	1.070	2.509	0.760	0.540	0.086
Shocks to CHEQUES explained by innovations in:								
1	75.580	4.499	19.920	0.000	0.000	0.000	0.0000	0.000
5	63.180	3.333	33.019	0.123	0.120	0.115	0.036	0.072
10	56.947	2.812	33.265	1.777	2.475	2.356	0.272	0.097
Shocks to MMO explained by innovations in:								
1	15.524	2.756	67.777	13.942	0.000	0.000	0.000	0.000
5	16.363	13.238	47.098	21.529	0.975	0.409	0.366	0.019
10	17.089	15.835	41.007	19.097	2.349	0.551	4.030	0.041
Shocks to NEFT explained by innovations in:								
1	66.078	0.006	21.399	0.081	12.436	0.000	0.000	0.000
5	50.335	5.708	17.353	1.054	14.183	3.963	5.984	1.420
10	36.230	12.518	16.076	1.289	10.071	8.024	12.180	3.613
Shocks to NIP explained by innovations in:								
1	76.205	0.878	13.532	0.332	5.769	3.284	0.000	0.000
5	66.161	3.621	17.718	2.105	7.093	3.023	0.261	0.018
10	58.348	6.539	21.488	2.157	7.340	2.496	1.076	0.555
Shocks to POS explained by innovations in:								
1	74.238	0.637	7.078	7.669	4.666	3.551	2.160	0.000
5	49.278	10.420	10.210	13.152	5.615	3.332	7.030	0.964
10	33.200	21.734	7.437	10.690	4.554	6.653	11.112	4.620
Shocks to WEB explained by innovations in:								
1	15.041	3.421	39.689	4.840	13.941	8.991	13.798	0.279
5	13.705	2.480	20.819	1.942	11.318	21.917	26.050	1.768
10	9.180	6.736	28.141	3.223	6.2488	24.234	19.902	2.337

The fourth row shows the shocks to NEFT explained by innovations in the ROA and other financial innovation variables. ROA accounts for a significant proportion of the variation in NEFT in all the horizons. For instance, in the short run and long run 66.1% and 36.2% of the variation in NEFT are explained by ROA. Similarly, shocks to NEFT explained by innovations in values of cheques transactions are 21.4% and 16.0% in the short run and long run. Other financial innovation variables that explained a significant variation in NEFT, especially in the medium term and long run are ATM and POS.

Further, the fifth row depicts the shocks to NIP explained by innovation in ROA and financial innovation variables. Expectedly, shocks to NIP explained by innovation in ROA are significant in the period. Similarly, CHEQUES and NIP account for a significant variation in NIP during the horizons. For example, in the long run, shocks to NIP explained by innovation in CHEQUES and NEFT are 21.5% and 7.3% respectively.

In the 6th row, shocks to POS explained by innovations in variables of interest are reported. Accordingly, ROA explained a significant proportion of the variation in POS with a high percentage of 74.2% in the short run (1st horizon). Other variables of interest namely, ATM, CHEQUES, MMO, NEFT, NIP and WEB explained different levels of variation in POS. For instance, ATM and MMO explained 21.7% and 10.7% of the variation in POS.

The last row in this segment refers to the shocks to WEB explained by innovations in ROA and financial inclusion variables. Interestingly, ROA and financial innovation variables explained a significant quantum of the variations in WEB in all the horizons. CHEQUES, ROA and NEFT explained a significant proportion of the variation in WEB in the short run (see the 7th row of Table 2) while NIP accounts for a large variation in WEB in the long run.

Figure 1 displays the full set of impulse responses derived from the VAR system. Our major interest here is the response of ROA to financial innovation variables. Evidence from row 1 of the impulse response matrix indicates that CHEQUES and NEFT resulted in positive increase in ROA in the period of study. The response of ATM to return on assets (ROA) is positive in the short run and becomes negative in the long run. On average, the response of ATM to CHEQUES is positive in the period of study. The response of ATM to other financial innovation variables is not significant during the studied period.

In row 3 of the impulse response matrix, CHEQUES responded positively to ROA in the short run, negative in the medium term and positive over the long run. Further, the response of other financial innovation variables is insignificant. The response of MMO to ROA and other financial innovation variables is depicted in row 4. Response of MMO to ROA is negative in the initial period and becomes positive in the long run. Also, MMO and ATM share a positive relationship during the period. The response of MMO to CHEQUE is negative in the short run and becomes negative over the long run.

The fifth row depicts the response of NEFT to ROA and other financial inclusion variables. ROA, CHEQUES and NIP responded negatively to the variation in NEFT, especially in the medium term of the analysis. However, ATM and POS show positive response to NEFT. The response of NIP to ROA and CHEQUES is negative in the short run, but shows a positive effect in the case of ATM and NEFT. The response of POS to ROA is negative in the short run and becomes positive in the medium term. Similarly, the response of POS to ATM and MMO show a positive relationship in the period. As expected, WEB responded negatively to ROA in the initial period, but positively in the

medium term. In the last row of the impulse response matrix, CHEQUES and NIP have positive response to WEB, especially in the long run.

Figure 1. Impulse Response Function of ROA and Financial Innovation Variables

4.1.2. Variance Decomposition of ROE and Financial Innovation Variables

Table 3 depicts the VDCs of the interactions between financial innovation variables and return on equity (ROE). Accordingly, the first, fifth and tenth horizons are reported here for preciseness and clarity. These periods can be described as the short, medium and long terms relationship among the variables. Of prime interest is the shock to ROE explained by financial innovation variables, namely, ATM, Cheques, MMO, NEFT, NIP, POS and WEB. Expectedly, in the first horizon, ROE explained 100% of the variation in itself, however, the effects of financial innovation variables in this period are nil. By the fifth period, the value of cheques transaction and POS explained 11.9% and 5.2%, respectively of the variation in ROE.

The second row in Table 3 shows the shocks to ATM explained by the variables of interest. Own shocks accounted for 92.4% and 71.7% in the first and tenth horizons. Notably is the effect of the value of cheques transaction on ATM transactions; about 17.5% of the changes in ATM transactions can be attributed to changes in cheque transactions. Other financial innovation variables do not exert significant changes in the value of ATM transactions.

Similarly, the value of ATM transactions explained a sizeable variation in the shocks to cheques. For instance, in the first and fifth horizon 8.9% and 6.5% of the variation in cheques are explained by innovation in the value of ATM transactions. Other variables such as MMO and NIP explained 2.7% and 2.4% of the variation in the value of cheque transactions. The effect of the values of POS and WEB transactions is negligible.

The fourth row depicts the shocks to MMO explained by changes in ROE and other financial innovation variables. A larger proportion of the variation in MMO explained by ROE was recorded in the first horizon. In the fifth and tenth periods, 15.4% and 18.1% of the shocks to MMO are explained by innovations in ATM. In all the horizons, a highly significant variation in MMO is explained by the value of cheques transaction. First, fifth and tenth horizons recorded 68.7%, 47.9% and 40.3%, respectively. Additionally, POS explained a significant proportion of the variation in MMO in the tenth period.

The fifth row depicts the shocks to NEFT explained by innovations in ROE and financial innovation variables. Evidence from the variance decomposition result indicates that a significant proportion of the shocks to NEFT are explained by innovation in ROE, especially during the first horizon. ATM innovation explained about 6.9% and 14.6% of the variation in NEFT in the fifth and tenth horizons, respectively. Other financial innovation variables accounted for various degrees of innovation in NEFT. For instance, cheque resulted in 16.2%, NIP caused 9.6% and POS led to 9.6% of the average variation in NEFT in the tenth horizon.

Next, is the shock to NIP explained by innovation in ROE and financial innovation variables. Accordingly, ROE explained a significant proportion of the variation in NIP in all the horizons. ATM innovation and the value of cheques transaction accounted for a large proportion of the variation in

NIP, especially in the tenth period. These two variables accounted for 10.5% and 22.4% in the reference period. Innovation in NEFT accounted for a marginal variation in NIP in all the horizons considered.

Further, row 7 shows the shocks to POS explained by financial innovation variables. Evidences from the VDCs shows that ATM innovation explained 14.9% and 28.5% of the average shock to POS in the fifth and tenth periods. Similarly, the value of cheque transactions, MMO and NIP exert significant variation in the value of POS transactions. In the tenth horizon, MMO, NIP and WEB accounted for 5.7%, 7.4% and 4.3% of the variation in POS, respectively.

Table 3. Variance Decomposition of ROE and Financial Innovation Variables

Horizon (Years)	ROE	ATM	CHEQUES	MMO	NEFT	LNIP	LPOS	LWEB
Shocks to ROE explained by innovations in:								
1	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	84.189	0.974	9.951	0.417	2.140	1.158	0.843	0.328
10	72.091	2.464	11.999	0.539	3.075	3.455	5.237	1.1384
Shocks to ATM explained by innovations in:								
1	92.397	7.603	0.000	0.000	0.000	0.000	0.000	0.000
5	77.264	6.506	13.554	1.024	1.204	0.363	0.042	0.042
10	71.651	5.811	17.529	1.570	1.917	0.758	0.653	0.118
Shocks to CHEQUES explained by innovations in:								
1	71.353	8.871	19.776	0.000	0.000	0.000	0.000	0.000
5	60.223	6.508	32.774	0.135	0.118	0.143	0.022	0.078
10	54.259	5.586	32.950	2.691	1.757	2.394	0.267	0.094
Shocks to MMO explained by innovations in:								
1	16.135	1.343	68.692	13.830	0.000	0.000	0.000	0.000
5	14.676	15.376	47.889	20.555	0.404	0.180	0.7857	0.135
10	14.363	18.117	40.329	18.037	0.808	0.965	7.040	0.341
Shocks to NEFT explained by innovations in:								
1	68.599	0.000	20.57	0.061	10.767	0.000	0.000	0.000
5	53.259	6.867	16.817	0.505	10.813	4.722	5.475	1.542
10	38.15	14.635	16.241	0.518	7.759	9.582	9.551	3.562
Shocks to NIP explained by innovations in:								
1	76.155	1.784	14.050	0.015	4.687	3.310	0.000	0.000
5	65.798	6.061	18.840	0.729	5.096	3.181	0.273	0.020
10	57.132	10.496	22.377	1.380	4.699	2.625	0.745	0.546
Shocks to POS explained by innovations in:								
1	76.181	0.729	7.655	4.123	4.202	3.840	3.270	0.000
5	49.824	14.919	11.551	7.087	4.066	3.628	7.997	0.928
10	33.275	28.517	8.383	5.683	2.734	7.444	9.666	4.297
Shocks to WEB explained by innovations in:								
1	15.536	1.556	40.332	4.614	9.734	8.153	19.781	0.294
5	13.343	1.227	20.372	1.644	7.377	24.104	29.678	2.253
10	8.628	6.404	28.125	3.609	4.072	26.869	19.913	2.381

The last row of the VDCs depicts the shocks to WEB explained by changes in ROE and financial variables. The result shows that the value of cheques transaction explained the highest degree of variation in WEB. Also, the values of NIP and POS transaction accounted for a significant proportion of the variation in WEB. For example, in the tenth horizon, the values of cheques, NIP and POS transactions accounted for 28.1%, 26.9% and 19.9% of the rate of variation in WEB. A relatively low shock on WEB could be attributed to MMO and NEFT.

Figure 2 depicts the impulse response function derived from the VAR estimate. The impulse response functions provide the dynamic consequences of shocks on the future behaviour of the series of interest. It shows the systemic response of one standard deviation innovation in one variable relative to the other. Our prime interest is the first row that shows the response of return on equity (ROE) to financial innovation variables. The response of ROE to ATM is insignificant in the initial period but became positive and significant in the long-run. On average, the response of ROE to value of cheque transactions was positive and significant during the period of investigation. Similarly, the response of return on equity to the value of POS transaction is only positive in the long run. The response of ROE to other variables, namely, MMO, NEFT and WEB is not significant in the reference period.

Additionally, in order to determine the response of financial innovation variables to return on equity, the first column of Figure 2 would be appraised. The response of ATM to ROE was positive in the initial period but became negative in the medium and long-run. Similarly, the response of the value of cheques transaction to return on equity was positive in the short-run but became negative in the medium and long-run. However, the response of MMO to return on equity was negative in the initial period, positive in the medium term and negative in the long-run. The response of NEFT to ROE was negative in the short run and was near zero afterwards. Consequently, the response of NIP to ROE was negative in the short-run, positive in the mid horizon and returned to negative in the long run. The response of the value of POS transactions and WEB to ROE showed similar trends. The two financial innovation variables showed a negative response in the short run, positive in the medium term and negative in the later period. The impulse response functions provide the dynamic consequences of shocks on the future behaviour of the series of interest.

Figure 2. Impulse Response Function of ROE and Financial Innovation Variables

4.2. Multi-Criteria Decision Making (Entropy and Range of Value) Methods

4.2.1. Results of the Entropy Method

Table 4 showed the decision matrix, computed through variance decomposition analysis, which indicated the contributions of different financial innovative payment systems with regard to the two criteria of banks' ROA and ROE for the medium term (5 years) and long term (10 years).

Table 4. Decision Matrix for 5 and 10 years (medium and long term)

Innovations/Alternatives	Criteria (j): 5 years		Criteria (j): 10 years	
(i)	ROA	ROE	ROA	ROE
ATM	0.0687	0.9740	0.9880	2.4640
CHEQ	12.4170	9.9510	15.1020	11.9990
MMO	0.2600	0.4170	0.4070	0.5390
NEFT	2.6940	2.1400	3.6090	3.0750
LNIP	0.3870	1.1580	2.1800	3.4555
LPOS	0.1660	0.8430	4.1280	5.2370
LWEB	0.0650	0.3280	0.7260	1.1384

The decision matrix in Table 4 was normalised for the medium and long run, as shown in Table 5. According to Işık and Adalı (2017), all the entries of the decision matrix were normalised to have the performance measures comparable and dimensionless.

Table 5. Normalised Decision Matrix for 5 and 10 years (Medium)

Innovations/Alternatives	Criteria (j): 5 years		Criteria (j): 10 years	
(i)	ROA	ROE	ROA	ROE
ATM	0.0003	0.0671	0.0395	0.1680
CHEQ	1.000	1.000	1.0000	1.0000
MMO	0.0158	0.0092	0.0000	0.0000
NEFT	0.2128	0.1883	0.2179	0.2213
LNIP	0.0261	0.0863	0.1207	0.2545
LPOS	0.0082	0.0535	0.2532	0.4099
LWEB	0.0000	0.0000	0.0217	0.0523

Based on the results from Table 5, entropy values and weights were then calculated as shown in Table 6. The smaller the value of the entropy, the larger the entropy-based weights, and that the specific criterion provides more information and becomes more important than the other criterion in the decision making process (Wu, et al., (2011); Işık & Adalı, 2017).

Table 6. Entropy values and entropy weights for 5 and 10 years

	Criteria (j): 5 years		Criteria (j): 10 years	
	ROA	ROE	ROA	ROE
Entropy values	0.3367	0.5064	0.6145	0.7491
Entropy weights	0.5733	0.4267	0.6058	0.3942

From Table 6, using the entropy approach reflected more on ROA (which has entropy weights of 0.5733 in the medium years and 0.6058 in the long years respectively) as against weights of 0.4267 and 0.3942 on ROE in the medium and long run respectively. This means ROA, with higher entropy

weights, is a better criterion for assessing the contribution of the financial innovative payment systems over the period of study.

4.2.2. Results of the Range of Value Method

The ROV method was used to rank the financial innovative payment systems for the medium and long run periods. The use of the range of value method is in line with the work of Işık and Adalı (2017), that it provided some advantages to the decision makers in evaluating the best financial innovative payment systems (over other methods of ranking) that most contributed to banks' performance in the country. Based on the decision matrix and the normalised values in Tables 4 and 5 respectively, the contribution of the best (U+) and least (U-) financial innovative payment system to banks' returns on assets and equity was determined. For the purpose of this study, the ranking of the best and least payment systems was done by dividing their scores by two {U+ + U- / 2}. As Hu, et al. (2015) observed, the financial innovative payment system with the biggest composite performance value is the best one.

Table 7. Ranking of alternatives using ROV method for 5 years

Innovations/Alternatives (i)	U^+	U^-	$\frac{U^+ + U^-}{2}$	Rank
ATM	0.042842	0.982305	0.512574	1st
LNIP	0.051787	0.958224	0.505006	2nd
LPOS	0.027529	0.980004	0.503767	3rd
CHEQ	1.000000	0.000000	0.500000	4th
LWEB	0.000000	1.000000	0.500000	4th
MMO	0.012984	0.985919	0.499452	6th
NEFT	0.202346	0.793580	0.497963	7th

Table 7 contained the results of the ROV method used for the ranking of the contributions of the financial innovative payment systems in the medium term. The results indicated that the best contribution to banks' performance was given by ATM, with the highest value, followed by LNIP and LPOS in the second and third positions respectively.

Table 8. Ranking of alternatives using ROV method for 10 years

Innovations/Alternatives (i)	U^+	U^-	$\frac{U^+ + U^-}{2}$	Rank
MMO	0.000000	1.000000	0.500000	1st
CHEQ	1.000000	0.000000	0.500000	1st
NEFT	0.219240	0.779945	0.499590	3rd
ATM	0.090155	0.879082	0.484600	4th
LNIP	0.173444	0.794525	0.483980	5th
LPOS	0.314972	0.647515	0.481243	6th
LWEB	0.033763	0.418815	0.226289	7th

However, Table 8 showed that, in the long run, both the MMO and CHEQ have the highest contributions to banks' performance, while NEFT was next in terms of contribution.

Overall, the ranking indicated that the contribution of ATM to banks' performance was highest in the medium term, but could not be sustained in the long run, with MMO and CHEQ making the best contribution. This implied that many people switched from ATMs to the use of MMO. The disparity in the importance of ATMs in the long run could be linked to the prevalence of card fraud in ATM transactions in Nigeria. This was consistent with Elumaro and Obamuyi (2018), who found that card fraud in ATMs, among others, has a negative effect on the volume of transactions in Nigerian banks. The other problems associated with the usage of ATMs such as the issue of network and cost of maintenance and servicing could be responsible for the observed disparity. The result indicated the need for government to re-examine the country's financial policy in line with best global practices.

5. Conclusion and Implications

The focus of this empirical enquiry was to determine how commercial banks use different financial innovative payment systems to gain a competitive advantage in the specific context of the Nigerian financial system. Thus, in line with the constraint-induced financial innovation theory and the transaction cost innovation theory, the introduction of financial innovative payment systems by banks must be informed by the goal of lowering the cost of transactions and enhancing efficiency in the Nigerian financial system with significant improvement in the banks' returns on asset and equity.

Specifically, this paper examined the nature of the relationship between financial innovation and commercial banks' performance at different time horizons (medium and long terms). The study found that specific financial innovative services such as Automatic Teller Machines (ATMs), Point of Sale (POS), National Electronic Fund Transfer (NEFT), Mobile Money payment (MMO), values of cheques transactions (CHEQUES) and internet (Web) banking have significantly affected the performance of commercial banks in Nigeria at various degrees, depending on the periods under consideration. Amongst the innovative payment systems, the Automatic Teller Machines was found to be the key determinant of bank performance in the medium term, whereas mobile money banking was found to play important role in the determination of bank performance in the long run.

The study concluded that banks should re-examine the policy on the use of ATMs and POS, and ensure that both the banks and customers derive maximum benefits, in terms of cost, convenience and safety, for the purpose of enhancing their impact on banks' performance in the long run. The banking sector will in turn experience better performance which will improve the economy of the country. Finally, the paper concluded that commercial banks would enhance their medium and long terms' performance by employing the Multi-Criteria Decision Making (entropy and range of value) methods to make the best decisions on the relative importance of their financial innovative payment systems.

This study has both theoretical and methodological implications for the financial systems in Nigeria. First, on theoretical ground, financial innovation would only be meaningful, if it boosts bank performance, especially in the medium and long terms, based on the increased or expanded volume of transactions on the innovative payment platforms, while providing better returns for the shareholders, and minimising cost for the customers. This implied that commercial banks need to be more focused through continuous innovation in services such as the CHEQUE, NEFT and POS, and be more concerned about their ultimate performance, especially in the long run. In addition, the government needs to strengthen the cash-less policy, through improved awareness and renewed support to commercial banks. This will increase the confidence of the populace and encourage more usage/patronage of these services. Second, on the methodological grounds, policy makers and banks will be able to determine the extent of banks' performance and rank the innovative payment systems in order of their economic desirability.

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