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Technological innovations, bank liquidity and performance in Nigeria

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Abstract
The Diffusion of Innovative theory by Rogers (1962) is adopted to examine the relationship that exist between technological innovations, bank liquidity and performance in Nigeria from 2009Q1 – 2020Q4. Secondary data on bank liquidity, bank performance, mobile pay, web pay; instant payments, automated teller machines, and point of sale were secured from the Central Bank of Nigeria statistical database. Robust estimation methods that include VAR and VECM models are used to determine how bank liquidity affect technological innovations and their overall performance. Findings show that though banks' digital innovations are accepted by customers, it is not frequently used. Also, the unavailability of funds in the short term hinders technological innovations. Overall, mobile pay, web pay, point of sale and instant payment significantly promote bank performance. The study thus recommends that in order to address illiquidity, banks should support customers with new customized products to help mobilize deposits and also explore long term financing for their technological innovations so as to remain competitive. They should also review their credit policies from time to time to make for on-time and flexible repayment of loans and advances. To ensure universal use of these digital platforms, banks should engage in more awareness programs, and maintain constant communication on ways to help in the use of these platforms. Furthermore, is the safety of their digital platforms by maintaining high safety standards in their security infrastructure; identify and manage 'Single Points of Failures' as well as give up-to-date information to their customers on how to remain safe.

Keywords: Liquidity, performance, DOI, innovations, VAR, VECM

1. Introduction

The interface Nigeria has with the global market has triggered her employment of technological innovations for efficient delivery of services and also to remain competitive. In addition, disruptions like the Covid-19 pandemic have led banks to seek for simpler and better ways of conducting business as regards delivery of financial services using technological innovations; at a lower cost to their customers. Likewise, the CBN's policy of promoting financial innovation is propelled by the objective of easing banking industry charges by about 30 per cent and curb violations in cyber-security (CBN, 2020). Thus, banks have relied on technological innovations to properly manage their operations, secure public confidence as well as add more value to their inter-bank communications (Kumar, 2009). Technology, in present times, is the avenue through which markets experience growth by means of new-market discovery (Gilbert, 2003). Rao, Angelov, and Nov (2006) posit that innovation alters the technological learning curve, and redefine performance metrics.

Innovation is key to competitive advantage because it triggers market dynamism (Thomond & Lettice, 2002). With it, new creations are carried out by firms for economic benefits. Innovations are either a product or a process. Product innovations

are products and services while process innovations are technological and organizational (Edquist, 2001). This study centres its research on technological innovation which is process in nature; and concerns how goods and services are produced for economic growth and employment.

Udin, Bujang and Beli (2019) argue that banks should maintain liquidity through technological innovations if they are to remain competitive. Its use has strengthened the liquidity profile of banks; such that they can be easily and conveniently reached by their customers to make payments and do withdrawals in real time (Foster & Pryor, 1986; Christensen & Rosenbloom, 1995). Besides, the adaptation of banks to new innovation improves efficiency and make them more susceptible to change. Simon (2016) maintain that banks should be friendly with new innovation to meet up with the 'efficiency and customer satisfaction' principle of the firm as well as secure a long-lasting relationship with their customers. Bhardwaj and Kaushik (2018) also emphasize that liquidity boost financial sector innovation which in turn leads to improved technological expertise and changes in customer expectations. It is therefore pertinent for banks to continuously revise their technological prowess especially in these periods of disruptions.

A firm's liquidity is its ability to meet up with short term liabilities and this is key if it has to function properly. Bank's liquidity can be strengthened when they invest more in technology. Ahlstrom (2010) argue that the main target of business is to advance innovations that generate economic growth and other general benefits. A technology-driven firm makes her products and services readily visible and accessible to clients and investors which results to more demand for its services. In a study on the impact of the twin shocks in the banking sector, KPMG (2020) assert that customer interaction with digital platforms increased during the Covid-19 period which led to tremendous pressure on technological resources and innovations. Similarly, Valchev (2021) opine that the Covid-19 crisis made consumers to be more confident in utilizing digital banking networks, and most of these customers may not be returning to branch banking. Though, adapting to new technological innovations is fraught with challenges like security infrastructure to secure operations and the identification of single points of failure, response to customers as well as availability of digital channels, cybercrimes, new regulatory measure and compliance, and cloud strategy (Deloitte, 2021); its benefits have far-reaching effects.

Performance is enhanced in the presence of liquidity and technological innovations. Adopting several digital platforms has significant impact on financial performance; though faced with cyber threat and increased fraud due to relaxed internal control systems (KPMG, 2020). Ferrouhi (2014); and Charmler, Musah, Akomeah, and Gakpetor, (2018); found that liquidity is positively associated with return on assets. Aghion and Howitt (2007) recognized the significance of technological innovation as the key driver of economic growth and firm performance. According to Schumpeter (1943), tech-innovation accelerates 'creative destruction' when digitization overrides prevailing market conditions. Thus, firms will increase their profitability by gradually accumulating 'monopolistic rents' through introducing new services, products, and organizational procedures that help gain market share at the expense of non-innovating players (Savona, Cainelli Evangelista, 2006). Thus, this study is very significant in this era of the covid-19 pandemic because it will make

managers take more-informed decisions especially in the delivery of services to their customers; and secure significant profits.

Numerous inconclusive studies exist on the relationship between technological innovations, bank liquidity and performance in Nigeria. In this study, we complement quantitative analysis with an up-to-date study to include NIBSS instant payment as a proxy for technological innovations. In furtherance, Abubakar, Shagari, and Olusegun (2015); Ugoani and Ugoani (2017); and Nkwodimmah and Ochei (2019); centered their research on how financial technology affects liquidity. This study add to current literature as it empirically evaluates how bank liquidity affects their technological innovations and leads to performance. This is attributed to the fact that only liquid DMBs can be able to compete favourably in terms of adoption and adaptation to newly improved technological innovations in the banking industry due to its capital-intensive nature. KPMG (2020) report that the high demand for digital assets is a challenge for banks, only more mature banks may have advantage.

The remainder of this study is as follow: section 2 expounds on both theoretical and empirical literature; section 3 develops the methodology; section 4 discusses the results and section 5 concludes.

2. Technological innovations, Bank liquidity and Performance.

The theoretical literature upon which this study is built is the **Diffusion of Innovation theory** (DOI) propounded by Rogers (1962). It is a model that explains technological innovations among adopters; and the significance of communication and networking within the process of adoption which ranges from Innovations (technology enthusiasts) » Early adopters (visionaries) » Early majority (pragmatists) » Late majority (conservatives) » Laggards (skeptics) (Kaminski, 2011). Applying it to the banking institution, it is the process whereby a technological innovation is communicated virtually to all banking customers who accepts it by using it for their financial transactions. Rogers (1962) views its acceptability by customers as dependent on its relative advantage (its superiority), observability (its visibility to potential adopters), compatibility (its consistency with present needs), trialability (its nature of experience) and complexity (its simplicity).

Bharadwaj (2018) put forward a concise insight of technological innovations associated with the banking sector are:

i. ***Application Programming Interface (API)*** platforms are range of protocols that enables third parties to have access to banks services. Thus, allowing them to be able to provide augmented special services individually to customers' e.g. customer mobile wallets, payment switches, 3rd-party financial service providers, internet banking, use of tablets, gaming console & card systems etc.
ii. ***Artificial Intelligence*** creates room for better decision making as large spectrum of historical data can be collected and gathered at ease using algorithm. Thus, customers can be sure of tailor- made products instead of voluminous product for large market. This will invariably lead to customers' loyalty and at the same time reduce the switch cost of retaining customers as banks provide good retention benefits.
iii. ***Augmented Reality*** enhances customers' experiences through the adoption of virtual, augmented, and mixed reality of modernized technologies. It is based on giving

customers total autonomy as to transactions they can execute at home. Example is using phone cameras to make face identification before transactions are initiated.

iv. ***Block chain*** is a distributed ledger technology with no form of involvement of database administrator. Through this, banks can be able to save a huge sum by turning their 'Know Your Customer' operations from cost-centers into profit-centers based on shared activities. Block chain can be very effective in the areas of trade finance, syndicated loans, and payments.

v. ***Hybrid Cloud*** enables banks to respond swiftly in providing timely resources to address key issues like governance, data security, compliance, and large data mobilization.

vi. ***Instant Payment*** is built on the need to meet customers' expectation on instantaneous and convenient payment through a cashless mechanism; to ensure continuous patronage and customer loyalty e.g. bills payment, money transfer, online shopping, ticket sales

vii. ***Prescriptive Security*** is the deployment of Advanced Analytic, Artificial Intelligence, and Real-time monitoring to make cyber threats more visible; and thus stop the disruption of the system.

viii. ***Quantum Computing*** uses exponential computing power, that is quantum bits that have three states – 0 or 1 or both, to solve complex banking data operations.

ix. ***Robotic Process Automation*** are automated payment systems that use suitable technologies like chatbots, machine learning, intelligent analytics, processing of natural language; that performs human actions and decisions at much higher quality, scale, and speed, to ensure customer have better experiences while banking e.g POS and ATM

x. **Smart Machines** like ERICA and LEO (put into operation by UBA), act as virtual assistant for the banks and customers.

An extensive number of reports have explored on the relationship between technological innovations and bank liquidity; with inconclusive findings. Recent studies like Sunday and Chime (2020) examined the link between e-banking and commercial banks performance in Nigeria using quarterly time series from 2009Q1-2018Q4. Employing Granger Causality, Johansen co-integration, and Vector Error Correction techniques at the 5% level, the study found evidence of positive and significant relationship between web pay and mobile pay. Nkwodimmah and Ochei (2019) investigated the relationship between financial technology and the Nigerian banks' liquidity from 2009Q1-2017Q4. The ARDL framework employed suggest that fin-tech impact positively on the liquidity of Nigerian banks'; as such, it can bring about the desired financial development in Nigeria. Udin, Bujang, and Beli (2019) analyzed the relationship between technology and banks' liquidity from 2012-2017 in Asian countries. Utilizing the fixed and random effect models; the findings show that mobile cellular and ATM are significant with bank liquidity ratio. Spatareanu, Manole, and Kabiri (2019) explored the significance of innovative activity for UK firms as it relates to bank-based financing. The study adopts the regression analysis and found that banks that do not specialize in financing innovation may encounter distress when faced with stern

competition. El-Chaarani and El-Abiad (2018) studied the impact of innovation on Lebanese banks during the period 2010-2017. Applying the multiple regression method, they gave evidence that internet banking and ATM are positive to bank performance. However, investment in computer software and mobile banking are shown to be insignificant. Mustapha (2018) evaluated the impact of e-banking and the performance of banks in an emerging country like Nigeria; covering the period 2012-2017. Exploiting the panel OLS method, the study found that the adoption of electronic banking promotes performance of banks in Nigeria. Chipeta and Muthinja (2018) examined innovation and the performance of Kenya banks from 2009-2013. Adopting the dynamic GMM, financial innovation promotes financial performance significantly. Phan, Narayan, Rahman, and Hutabarat (2020) evaluated 41 banks in the Indonesian FinTech market and found negative connection between growth and bank performance. Scott, Van and Zachariadis (2017) assessed the impact of SWIFT adoption and bank performance in 29 European-American countries, using the panel OLS technique. The study found support for SWIFT adoption as it strongly has some bearing on the profitability of small banks. Kamau and Oluoch (2016) researched on innovation and banks performance in Kenya from 2012-2015. Applying the regression model, ATM, use of cards (debit and credit), internet and agency banking have positive and significant influence on banks performance. However, ATM has the utmost impact. A contrary report was established by Abubakar, Lekaz, and Shagari (2015) that, from 2006-2014, technological innovations like point of sale and mobile banking are not significantly related with liquidity.

To further ascertain the relationship between bank liquidity and performance, Charmler, Musah, Akomeah, and Gakpetor (2018) examined the liquidity and profitability of banks' in Ghana from the period 2007-2016 and found liquidity to be positive and significant with ROA. This means that liquidity promotes the profitability of banks. Moussa (2015) found a contrary opinion among Tunisian banks that liquidity is insignificant in measuring performance. In the case of South Africa, Marozva (2015) asserted that performance is negatively related to liquidity by way of the ARDL approach. Ferrouhi (2014) analyzed the nexus between liquidity risk and financial performance of Moroccan banks covering 13 years. Applying the OLS method, the study reveals that the core elements of bank performance are banks size, liquidity ratio, share capital, external funding to total liabilities, foreign direct investments, realization of financial crisis variable, and unemployment rate.

Generally, previous literatures have looked into the impact of technology on bank liquidity or on economic growth. This study examined how bank liquidity affect their innovativeness/technology and also leads to overall performance. This is the gap in literature.

3.Methodology

The ex-post facto research design that examines how data from already concluded events perform prior to a study, was adopted in this study. Quarterly data was sourced from the Central Bank of Nigeria statistical database, over periods 2009Q1 to 2020Q4. For a broader and more detailed analysis, robust estimation methods that includes VAR and VECM model were employed to determine how bank liquidity impact on technological innovations and their overall performance; at the 5% level. Unlike previous studies, this study adopted three proxies of technological innovations such as *API platforms e.g. Mobile pay and Web pay*; *Instant Payments* e.g. *NIBSS*; and the

Robotic Process Automation e.g. *Automated Teller Machines and the Point Of Sale*; as well as two proxies of liquidity such as the *current asset to current liabilities ratio*, and *loans to total assets ratio*. Many studies used *Return on Equity* as a proxy for financial performance to know how firm's managers are efficient at generating income and growth from shareholders' equity; in line with the principle of shareholders' wealth maximization. The digital banking model adopted by Mustapha (2018), Nkwodimmah and Ochei (2019), and Sunday and Chime (2020) is extended further to include NIBSS instant payment. The logarithm of technological innovations was taken to bring the variables on the same scale of measurement and make for better generalizations. The study assumes that it is banks' liquidity that triggers their quest for technological innovations; since only liquid DMBs can be able to compete favourably in terms of adoption and adaptation to newly improved innovations in the banking industry due to its capital-intensive nature (KPMG (2020).

The first model states that a bank is liquid if it employs technological innovations:

$$TINO_{it} = \alpha + \beta_1 LIR1_{it} + \beta_2 LIR2_{it} + \varepsilon_{it} \quad 1$$

Apriori, β_1 and $\beta_2 > 0$

Second, technological innovations and banks' liquidity affects overall performance:

$$ROE_{it} = \alpha + \sigma_1 LIR1_{it} + \sigma_2 LIR2_{it} + \sigma_3 ATM_{it} + \sigma_4 POS_{it} + \sigma_5 MOPA_{it} + \sigma_6 WEPA_{it} + \sigma_7 NIP_{it} + \varepsilon_{it} \quad 2$$

Apriori, α_1 and $\alpha_2 < 0$, α_3, α_4, α_5, α_6, and $\alpha_7 > 0$

Where, TINO = Technological innovations, LIR1 = current assets to current liabilities ratio; LIR2 = loans to total assets ratio, ROE = Return on equity, ATM = value of automated teller machine, POS = value of point of sale, MOPA = value of mobile pay, WEPA = value of web pay, NIP = Nigeria Inter-Bank Settlement System, α_0 = Intercept; β_1, β_2, σ_1, σ_2, σ_3, σ_4 σ_5, σ_6, and σ_7 = Constant parameters, ε_t = stochastic term

4.Results and Discussions

Table 4.1: Summary of Descriptive Statistics

	ROE	LIR2	LIR1	ATM	MOPA	POS	WEPA	NIP
Mean	28225.82	9.70	1.19	2800.34	682.59	559.32	101.96	22040.37
Std. Dev.	8906.07	11.57	0.08	1829.17	894.50	552.19	69.91	19385.32
Skewness	0.21	1.38	-0.04	0.69	1.92	0.99	1.55	0.80
Kurtosis	1.96	2.64	2.52	2.34	6.42	3.27	5.50	3.15
Jarque-Bera	2.53	3.04	0.47	4.68	53.05	7.99	31.68	5.22
Probability	0.28	0.08	0.79	0.09	0.00	0.01	0.00	0.07

Source: E-view 10.0

Table 4.1 reveals that return on equity and variables of technological innovations deviate significantly from their mean. This is in response to the compatibility and assessment of new technology in the market place (Rogers, 1962). Skewness describes the symmetry of the distribution. The outcome establishes that all the variables are skewed to the right except current ratio (LIR1) which is skewed to the left. Kurtosis describes the level of peakedness of the distribution. Value of ATM, and ROE are leptokurtic given that they are less than 3; LIR1, LIR2, POS, and NIP are mesokurtic since their values are approximately 3; and MOPA and WEPA are platykurtic given their values to be less than 3. The Jarque-Bera test establishes the normality of the distribution, and from the analysis, ROE, LIR1, LIR2, ATM, and NIP are normally distributed whereas MOPA, POS and WEPA are not normally distributed.

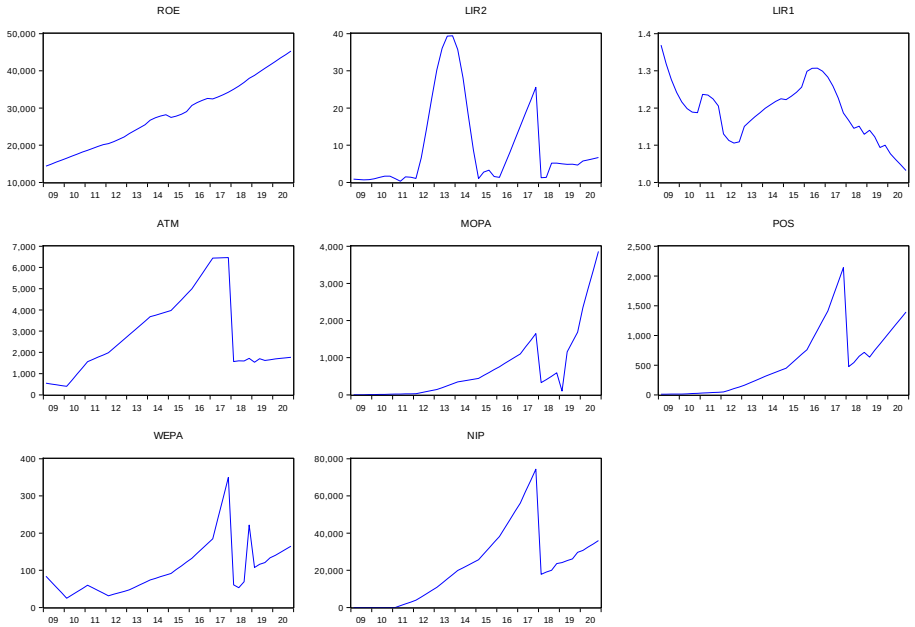

Fig 4.1 Graphical evaluation of the variables in the Covid era.
Source: E-view 10.0

To better capture technological innovations, liquidity and performance in the pandemic era, the above graphical analysis explains the covid-19 period from late 2019 – 2020. Figure 4.1 shows that the ROE of DMBs in the Covid-era from 2019, has continued to increase with a rise in technological innovations acceptability by bank customers and the charges on customers while using these digital platforms. Current ratio, LR1, seems to be declining indicating that loans and advances by banks may result into short term illiquidity issues; while non-current ratio, LR2, has an upward trend signifying an inefficient employment of short term financing facilities and a sign of difficulty in managing working capital. In furtherance, all technological innovations experienced a sharp upward trend from mid-2018 to present times. This is attributed to the fact that these innovations fulfill its basic principles of relative advantage, visibility, compatibility, customer assessment/trialability and simplicity (Rogers, 1962); leading to better banking experiences, persistent loyalty and patronage on the part of customers.

Table 4.2: Stationarity Test

Variables	Level			First differenced			Conclusion
Variables	**ADF Test Statistics**	**T-Critical at 5%**	**P-value**	**ADF Test Statistics**	**T-Critical at 5%**	**P-value**	**Conclusion**
ROE	1.935352	-2.933158	0.9998	-5.104781	-2.931404	0.0001	I(1)
TINO	-1.681563	-2.925169	0.4338	-6.939300	-2.926622	0.0000	I(1)
LIR2	-2.468095	-2.926622	0.1297	-4.499750	-2.926622	0.0007	I(1)
LIR1	-0.734586	-2.933158	0.8268	-4.036258	-2.926622	0.0028	I(1)
ATM	-1.621082	-2.925169	0.4641	-6.363367	-2.926622	0.0001	I(1)
MOPA	1.766041	-2.925169	0.9996	-5.987264	-2.926622	0.0006	I(1)
POS	-1.442404	-2.925169	0.5539	-7.073064	-2.926622	0.0000	I(1)
WEPA	-2.687749	-2.925169	0.0839	-7.347016	-2.929734	0.0000	I(1)
NIP	-1.676873	-2.925169	0.4362	-6.959690	-2.926622	0.0000	I(1)

Source: E-view 10.0

The outcome of table 4.2 reveals that all the variables were stationary at 5%; consequently, we reject the null hypothesis that there exist unit roots among the variables.

Table 4.3.1: Co-integration Test: Technological Innovations and Liquidity

Series	Trace statistic	0.05 critical value	P-value	Max-Eigen Statistic	0.05 Critical Value	P-value
TINO	25.43194	29.79707	0.1466	13.12619	21.13162	0.4407
LR1	12.30575	15.49471	0.1429	10.49153	14.26460	0.1816
LR2	1.814218	3.841466	0.1780	1.814218	3.841466	0.1780

Source: E-view 10.0

The Johansen co-integration test was utilized to validate the occurrence of long-run connection. The decision criterion is that the p-value of the Trace and Max-Eigen test must be less than 5% for the existence of long-run relationship. The outcome of table 4.3.1 reveals that there are no co-integrating equations for Trace and Max-Eigen test respectively given their p-values which are greater than 5 per cent level; accordingly, the absence of long-run association between liquidity and technological innovations in Nigeria.

Table 4.3.2: Co-integration Test: Technological Innovations, Liquidity, and Performance

Series	Trace statistic	0.05 critical value	P-value	Max-Eigen Statistic	0.05 Critical Value	P-value
ROE	298.66	159.53	0.00	106.44	52.36	0.00
LR2	192.22	125.62	0.00	66.726	46.23	0.00
LR1	125.49	95.75	0.00	41.93	40.08	0.03
ATM	83.56	69.82	0.00	32.30	33.88	0.08
MOPA	51.26	47.86	0.02	19.38	27.58	0.39
POS	31.88	29.79	0.02	16.06	21.13	0.22
WEPA	15.82	15.49	0.04	14.53	14.26	0.04
NIP	1.29	3.84	0.25	1.29	3.84	0.26

Source: E-view 10.0

The outcome of table 4.3.2 reveals that there are seven (7) and three (3) co-integrating equations for Trace and Max-Eigen test respectively given that their p-values are less than 5 per cent; thus, the existence of long-run association amongst technological innovations, liquidity, and bank performance in Nigeria .

Table 4.4: VAR Model: Liquidity and Technological Innovations

Dependent Variable: TINO			
Regressor	**Coefficient**	**Std. Error**	**t-Statistic**
C	1.266747	0.67835	1.86740
LIR1(-1)	-4.693322	1.62281	-2.89210
LIR2(-1)	0.002830	0.00916	0.30902
R-squared	0.977785	**F-statistic**	286.1006
Adjusted R-squared	0.974368		

Source: E-view 10.0

The absence of a long run co-integrating relationship between liquidity and technological innovations in Nigeria has necessitated the use of the VAR model to estimate short run dynamics among the variables. Table 4.4 reveal a negative but significant short run relationship between current ratio and technological innovations while non-current ratio has a positive but insignificant relationship with technological innovations. As a result, liquidity can be explained by technological innovations, meaning there exist significant influence of technological innovations on the variations in liquidity. Moreover, the adjusted R-square of 97 per cent show that the model has a good fit; and the F-stat of 286.1006 establish that all of the lags of each of the individual variable is jointly significant.

Table 4.5: VECM Model: Technological Innovations, Liquidity, and Performance

	Dependent Variable: ROE		
Regressor	**Coefficient**	**Std. Error**	**t-Statistic**
C	388.20	154.620	2.51
LIR1(-1)	2.99	0.58402	5.13
LIR2(-1)	-54.92	22.4027	-2.45
ATM(-1)	2.76	0.87450	3.16
MOPA(-1)	0.17	1.74929	0.09
POS(-1)	16.75	10.2180	1.64
WEPA(-1)	-164.17	38.3499	-4.28
NIP(-1)	-0.89	0.20719	-4.28
ECM(-1)	-0.61	0.27457	-2.24
R-squared	0.65		
Adjusted R-squared			
F-statistic			

Source: E-view 10.0

The VECM was applied to examine the long-run relationship between the dependent and independent variables as well as their speed of adjustment. Table 4.5 reveals that ATM and LIR1 are positive and significant to ROE given their t-statistic of 3.15 and 5.12. Mobile pay and POS are positive but not significant to ROE given their t-statistics of 0.09 and 1.63. However, web pay, LIR2 and NIP are negative but significant to ROE with t-statistic values of -4.28, -2.45, and -4.28. The Error Correction Model reveals a 61.5% speed of adjustment of previous disequilibrium with its expected negative sign which indicates that the ECM (-1) is statistically significant at the 5% level (t = -2.23). Adjusted R-square of 56 per cent shows that the model is of good fit; while the F-statistics of 3.636982 indicates that the model is significant.

Table 4.6: VAR Causality/Block Exogenity Wald Test – Technological Innovations and Liquidity

Dependent variable: TINO			
Excluded	Chi-sq	df	Prob.
LIR1	8.652017	2	0.0132
LIR2	2.835779	2	0.2422
All	**10.34491**	**4**	**0.0350**

Source: E-view 10.0

The causality/block exogenity wald test was used to determine the individual and joint influence of bank liquidity on technological innovations and on overall performance. The result of table 4.6 shows that only current asset to current liabilities (LIR1) influences technological innovations given its p-value as 0.0132; whereas, loans to total assets (LIR2) does not support technological innovations given its p-value as 0.2422. Jointly, liquidity promotes the use of technological innovations among DMBs in Nigeria.

Table 4.7: VEC Block Exogeneity Wald – Technological Innovations, Liquidity, and Performance

Dependent variable: D(ROE)			
Excluded	**Chi-sq**	**Df**	**Prob.**
D(LIR1)	3.081768	2	0.2142
D(LIR2)	2.083512	2	0.3528
D(ATM)	1.428608	2	0.4895
D(MOPA)	6.021500	2	0.0493
D(WEPA)	9.411345	2	0.0090
D(POS)	15.88573	2	0.0004
D(NIP)	6.782163	2	0.0337
All	**27.08814**	**14**	**0.0188**

Source: E-view 10.0

The result of table 4.7 shows that specifically mobile pay, web pay, point of sale and instant payment significantly promote bank performance. Overall, all the variables jointly influence banks' return on equity in Nigeria.

4.8 Forecast Error of Volatility

Variance decomposition method (VDM) and impulse response function (IRF) were employed to assess the shock and response of each predictor variable to performance respectively.

Table 4.8: VDM: Technological innovations and Liquidity

Variance Decomposition of TINO:				
Period	**S.E.**	**TINO**	**LIR1**	**LIR2**
1	1989.772	100.0000	0.000000	0.000000
2	2639.109	96.24394	3.727425	0.028635
3	3071.243	92.29361	7.489361	0.217027
4	3372.371	89.05344	10.28459	0.661968
5	3589.660	86.49182	12.14660	1.361582
6	3752.522	84.44939	13.32891	2.221695
7	3878.679	82.82756	14.07061	3.101829
8	3978.265	81.58178	14.54712	3.871101
9	4057.127	80.68179	14.87103	4.447187
10	4119.052	80.08582	15.10608	4.808107

Source: E-view 10.0

Table 4.8 illustrates technological innovations were solely explained by its own volatility in period one. In period two, variations to technological innovations were described by 96%, 3.73%, and 0.027% of its own that shocks to sensitivity, current ratio, and non-current respectively. Consequently, in exception to itself, current ratio explains more of the variations to technological innovations.

Table 4.9: VDM: Technological Innovations, Liquidity, and Performance

Variance Decomposition of ROE:									
Period	**S.E.**	**ROE**	**LIR1**	**LIR2**	**ATM**	**MOPA**	**WEPA**	**POS**	**NIP**
1	322.7218	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	460.2909	98.91613	0.399311	0.221672	0.082781	0.146316	0.021276	0.066884	0.145627
3	573.7110	96.64366	1.144835	0.919818	0.112622	0.470045	0.167313	0.195569	0.346140
4	678.0449	93.60225	1.950523	2.179383	0.126090	0.933057	0.298181	0.422946	0.487568
5	778.7768	90.12129	2.644391	3.961138	0.132121	1.489468	0.342740	0.767409	0.541441
6	878.5230	86.42336	3.148255	6.136960	0.132811	2.094151	0.314682	1.226068	0.523711
7	978.6070	82.67737	3.445828	8.536837	0.128994	2.708502	0.258696	1.779148	0.464625
8	1079.593	79.02006	3.557196	10.99100	0.121564	3.303729	0.216643	2.397159	0.392641
9	1181.548	75.55861	3.519901	13.35801	0.111648	3.861649	0.214199	3.047999	0.327978
10	1284.218	72.36913	3.376041	15.53702	0.100448	4.373552	0.259873	3.702167	0.281767

Source: E-view 10.0

Table 4.9 depicts that shocks to ROE was solely explained by its own shock in period one. In period two, shocks to ROE was described by 98.9%, 0.39%, 0.22%, 0.08%, 0.15%, 0.02%, 0.07%, and 0.15% of its own shock, current ratio, non-current ratio, ATM, mobile pay, web pay, POS, and NIP individually. Consequently, in exception to itself, non-current ratio explains more of the shocks to ROE.

Table 4.10: IRF: Technological innovations and Liquidity

Response of TINO:			
Period	**TINO**	**LIR1**	**LIR2**
1	1989.772	0.000000	0.000000
2	1656.532	509.5207	-44.65842
3	1415.038	668.4498	-135.9292
4	1192.612	680.6014	-234.1233
5	1008.509	628.8990	-316.4870
6	864.0809	558.3291	-370.6716
7	754.3399	489.8005	-392.1703
8	671.4996	430.7075	-382.1250
9	607.3138	381.4431	-345.4793
10	554.4252	339.3732	-289.4006

Source: E-view 10.0

Table 10 shows that impulsiveness to technological innovations was wholly accounted for by its own shock in period one. From period two, it was determined by its own positive shock and that of current ratio; whereas, periods 2-10 reveal negative shock of non-current ratio. Thus, the response of technological innovations to its own sensitivity and current ratio increases technological innovations but the response of non-current ratio retard growth in technological innovations among DMBs in Nigeria.

Table 4.11: IRF: Technological Innovations, Liquidity, and Performance

Response of ROE:								
Period	ROE	LIR1	LIR2	ATM	MOPA	WEPA	POS	NIP
1	322.7218	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	324.6875	-29.08628	21.67143	-13.24335	-17.60670	6.714014	11.90399	17.56519
3	329.4325	-54.05689	50.57545	-13.97510	-35.17288	22.48606	22.40533	28.82300
4	335.0141	-72.10598	83.61862	-14.45692	-52.36941	28.63861	36.06620	33.20044
5	340.9517	-84.08700	118.3403	-14.88673	-68.87554	26.60502	52.05583	32.28361
6	347.0421	-90.88599	152.7782	-14.95767	-84.43454	18.70895	69.34365	27.53570
7	353.2137	-93.28129	185.4445	-14.50157	-98.87289	6.980834	87.03775	20.18832
8	359.4691	-91.97913	215.2850	-13.47304	-112.1031	-6.896782	104.4079	11.25742
9	365.8476	-87.63501	241.6253	-11.90870	-124.1173	-21.57118	120.8816	1.562117
10	372.4014	-80.86052	264.1093	-9.895898	-134.9760	-35.99347	136.0329	-8.257607

Source: E-view 10.0

Table 4.11 shows that the response to ROE was entirely explained by its own shock in period one. From period two, POS, NIP, and WEPA mostly generated positive shocks thereby increasing the investment in technological innovations that leads to growth. Whereas ATM and MOPA had negative responses which means inhibiting growth in technological innovations among DMBs in Nigeria.

4.12 Discussion of Findings

Findings from the VAR analysis reveal that LIR1 is negative but statistically significant while LIR2 is positive but insignificant. This means that in the short term, banks cannot drive technological innovations due to low level of deposits from customers or their inability to mobilize new deposits, increase in loans and advances especially in periods of disruptions, and the low level of capital base which makes it difficult for banks to compete favourably (KPMG, 2020).

The positive and significant nature of ATM and LIR1 on Return on Equity indicates that the ATM digital channel is more frequently used and generally acceptable by bank customers due to its simplicity and compatibility; in support with previous findings by Sunday and Chime (2020); El-Chaarani and El-Abiad (2018); and Chipeta and Muthinja (2018). Likewise, the banks are able to meet up with short term liabilities with revenues gotten from the use of ATM by bank customers.

Mobile pay and POS are also positive but insignificant to Return on Equity. This is in disagreement with Abubakar, Lekaz, and Shagari (2015) that point of sale is not a significant contributor of bank performance. Web pay, Instant Payment and LIR2 is also negative but significant to Return on Equity. This points out that though these platforms are necessary for easier banking transactions, however, it may not be universally available for use or customers do not seem to utilize them more frequently; maybe due to higher bank charges, network challenges and the risk of internet fraud. Finally, the illiquidity of banks show their inability to employ short term measures in terms of launching new digital products and services. This is in support of the findings by Aghion and Howitt (1998) that innovations and technological changes are

for long term economic growth and development.

4.13Limitations of the Study

This study is limited as not all of the dimensions of technological innovations are included in the analysis due to the unavailability of adequate statistical data e.g. for variables like NEFT, Remita, M-cash etc. Additionally, the use of liquidity ratio posit another limitation since it is historic in nature and as such do not completely give the current state of affairs of banks in Nigeria.

5. Conclusion and Recommendations

The influx of global disruptions in the Nigerian economy and especially in the banking sector necessitated huge investments in technological innovations. For banks to carry out innovations, they are expected to be liquid (KPMG, 2020). Liquidity drives investments in technology that leads to growth (Ahlstrom, 2010). Thus, it is a key driver of economic performance (Aghion & Howitt. 2007).

In present times, almost all aspects of banking transactions are conducted virtually. This means that virtual payment systems have been embraced by bank customers due to its flexibility (Merton, 1990). However, virtual systems are faced with the risk of fraud, cyber threat and anti-money laundering (Deloitte, 2021). These fraudsters are becoming more technologically inclined to take advantage of these digital channels (KPMG, 2020).

The overall objective of this study is to empirically examine the nature of relationship between liquidity, technological innovations and performance of deposit money banks in Nigeria from 2009Q1 to 2020Q4; adopting the Diffusion of Innovation Theory of Rogers (1962). The analysis makes use of liquidity ratios (current and non-current ratios), technological innovations (automated teller machine, mobile pay, point of sale, web pay, and NIBSS instant pay), and return on equity. For elaborateness of analysis, the study asserts that only liquid DMBs can acquire newly improved technological innovations in the banking industry due to its capital-intensive nature.

The study found that technological innovations are generally accepted and utilized by bank customers. Its employment was at its apex during the Covid-19 disruption period. Also, liquidity is significant in explaining innovations, however, short term liquidity cannot drive technological innovations. Overall, these digital channels can drive the performance of banks in the long term.

In line with the findings, the study recommends that: due to the illiquid nature of banks in the short term, they should explore long term financing for their technological innovations and also support customers with new customized products in order to mobilize deposits and remain more competitive. Similarly, they should conduct a review of their liquidity regulatory indicators to ensure cash inflows; reevaluate their working capital management strategy and seek for other ways to attract more deposits; as well as the review of their credit policies to make for on-time and flexible repayment of loans and advances. Furthermore, they should engage in more awareness programs on their various digital platforms for easier banking transactions for customers. These digital platforms should be readily available at lower cost so that businesses can also buy into them; likewise, maintain constant communication on ways to help in the use of these platforms. They should also ensure the safety of their digital platforms

by maintaining high safety standards in their security infrastructure; identify and manage 'Single Points of Failures' and also give up-to-date information to their customers on how to remain safe.

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