Digitalisation and Financial System Stability: What Role for Macroprudential Policies?

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Abstract

The recent spate of financial digitalisation have been revolutionary, leading to significant changes in the structure of the financial system, its operational paradigm, **users' perception and experiences, and the regulatory landscape.** *These developments have been driven by explosive growth of technological advancements in fintech such as big data analytics, distributed ledger technology, and artificial intelligence, among others. Digitalisation of the financial system not only offers numerous benefits but also poses significant risks to the financial system, its stakeholders, and financial stability. This paper documents these issues and, in addition provides conceptual clarifications on financial digitalisation, and highlights relevant macroprudential policy regulations aimed at managing the phenomenon and minimising risks to financial stability. The paper equally provides policy recommendations targeted at enhancing surveillance and supervision that will optimise the process to the benefit of all stakeholders.*

I.   Introduction

The evolution of financial systems has been an age-long phenomenon, while the on-going transformation of the financial sector has ushered in paradigm shift in conceptualisation, production and consumption of financial services in recent times. This contemporary revolution has been driven by modern advances in computing that began in the 1950s, and their applications for further innovations, especially to the financial services sector. In contrast to the brick and mortar banking system that, a few decades ago, was characterised by geographical and temporal barriers to service delivery and consumption, the financial system today is digitalised. Thus, virtually every consumer has in his/her palm a digital electronic gadget to initiate, and complete at least a payment transaction.

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Hitherto, an evolutionary process that leveraged on a combination of technological advancements in computing as well as information and communication science, financial digitalisation has assumed a revolutionary dimension with the advent of the internet, big data analytics, artificial intelligence (AI), and distributed ledger technology (DLT), among others. This ever-expanding financial phenomenon continues to offer numerous benefits to financial sector stakeholders, with positive implications for financial system stability in particular, and stable macroeconomic development, in general.

In Nigeria, financial digitalisation has provided the populace with a diverse array of financial products that were hitherto unavailable, giving millions of consumers choice, speed, convenience, and ability to save time and money while carrying out their financial transactions. With the advent of digitalisation, the financial industry in Nigeria has become more competitive, with over 85 fintech startups offering various digital financial product ranging from digital payments and remittances, lending, savings, and investment, to digital insurance, e-commerce, and other digital financial services platforms, among others (Cambridge Centre for Alternative Finance, 2021).

In addition to several hundred of the jobs that contribute to a reduction in unemployment, digital finance has attracted large amount of foreign capital into the country in the form of seed capital. More importantly, the financial system has benefited immensely from digitalisation: the efficiency of the financial industry has improved due to decentralisation, diversification and induced competition which forced the operators to step up their games. These developments have also engendered greater transparency and deeper financial inclusion.

These immense benefits notwithstanding, financial digitalisation poses several risks and challenges to financial system stability. Some of these risks are financial, and they include contagion, excess volatility, maturity and liquidity mismatches, as well as procyclicality risks. Nonfinancial risks are mostly operational risks posed to financial stability and they include: concentration and business risks of critical financial market infrastructure, governance and regulatory control risks, data privacy, and consumer protection risks, among others.

Regulatory and supervisory authorities, globally and in Nigeria, are cognizant of these risks, and have been putting in place policies to optimise financial digitalisation by maximising its benefits and reducing the potential risks. The authorities aim to manage digital finance as a means of realising the

objective of macro-prudential policy – preventing and reducing systemic risk through limiting the disruption in the provision of key financial services, promoting efficient functioning of financial market with a view to maintaining, and enhancing stability of the financial system (Warjiyo & Juhro, 2019; Abubakar & Setiawan, 2021).

In Nigeria, a number of such regulations and frameworks have been issued by relevant authorities to manage the financial digitalisation process and ensure that it does not undermine the stability of the financial system. Some of these include the Central Bank of Nigeria (CBN) Open Banking Framework, 2021; the Security and Exchange Commission (SEC) Crowdfunding Rules, 2021; the CBN Framework for Regulatory Sandbox Operations, 2020; the CBN Guidelines for Licensing and Regulation of Payment Service Banks in Nigeria, 2018; CBN Risk-Based Cyber-Security Framework and Guidelines for Deposit Money Banks and Payment Service Providers, 2018; and Nigeria Deposit Insurance Corporation (NDIC) Framework for the Establishment of Pass-through Deposit Insurance for Subscribers of Mobile Money Operators in Nigeria, 2015.

This study is presented in five sections. Section II presents the conceptual framework on pertinent issues in digitalisation, financial stability and macroprudential policy. Section III discusses the benefits of financial digitalisation and the risks it poses to financial stability. The role of macroprudential policies and other relevant regulations in managing these risks are discussed in section IV while section V presents the conclusions and recommendations.

II. Conceptual Framework

This section presents a brief discussion of issues pertinent to financial digitalisation.

II.1 Digitisation, Digitalisation and Digital Transformation

Digitisation is the process of converting raw data, structured and unstructured - such as images, behavioral patterns like consumption, payment, movements - into forms that can be understood and processed by a computer system.

Digitalisation: is the innovative use of digitised data to generate ideas, create applications, provide solutions, and support further innovations in a spiral of technological revolutions. According to Mosteanu and Fathi (2020) and Solis, et al. (2014), digitalisation involves realignment or new investment in

advanced (digital) technologies and business models to effectively engage customers and enhance their experience. It is simply the use of digital technologies to change a business model, or the process of migrating to a digital business.

Digital transformation: leverages on digital technologies to make dramatic changes in the society in general, and business in particular (Majchrzak et al., 2016) with the purpose of achieving economic improvements through promoting business efficiencies, creating new business models and enhancing customer experience (Piccinini, et al., 2015; Fitzgerald, et al., 2014).

II.2   Digital Technologies and Digitalised Financial Sector Products and Services

Finance as an integral part of human activities that provides support to other activities, is not excluded from the wave of digital revolution. Digitalisation has transformed the models of modern finance, with the traditional methodology replaced by digital processes. Some of the technologies underlying financial digitalisation include the internet of things, cloud computing, Distributed Ledger Technology (DLT), artificial intelligence/machine learning (AI/ML), among others.

i.   Internet of Things: consists of the network of connected devices that compile data about direct and indirect users, as well as those who come in contact with the operations of the devices (Patel & Patel, 2016; OECD, 2018).

ii.   Advancement in ICT technologies has made it possible for firms/users to share computing services from a remote infrastructure for many benefits including cost-sharing and cost reduction. This arrangement, and the underlying technology, has been termed '**cloud computing**'.

iii.   Cloud computing simply refers to delivery (and access to) of a range of computing services – servers, storage, databases, networking, software, analytics, and even the internet (often termed as the cloud) from a remote station to (by) one or numerous firms. Firms may choose from different cloud deployment models: the private cloud (solely for a single firm), the public cloud (most common, this cloud is jointly used by several firms), the hybrid cloud (a firm may use a private cloud for some purposes and a public cloud for others), and the multi-cloud

where a firm subscribes to many clouds to achieve different objectives (Parne, 2021; European Banking Forum, 2020; Yan, 2017).

iv. Distributed Ledger Technology (DLT): permits recording and sharing of data across multiple data stores (ledgers) which are collectively maintained and controlled by a distributed network of computer servers called nodes, each of which has the same data records. DLT is a protocol that is used to build a ledger system that stores records which are not centrally controlled by a single party, or intermediary, but instead shared by participants who partake in the ownership, transactions or contract agreements within the system (OECD, 2018).

v. Artificial Intelligence (AI): has been conceptualised as 'human intelligence exhibited by machines' (Financial Stability Board, 2017). It refers to a suite of technologies, enabled by adaptive predictive power and exhibiting some degree of autonomous learning, that have made dramatic advances in our ability to use machines to automate and enhance... 'pattern recognition, foresight, customisation, decision-making and interaction' (WEF, 2018; Deloitte, 2018).

II.3   Historical Evolution of Digitalisation

Historically, the modern digital world enjoyed today may be conceived to have began in the 1950s when computers were invented (Tarpey, 2022). There are evidence that there were early efforts at inventing the digital world. Gottfried Wilhelm Leibniz in 1679 developed the first-ever binary system, while George Boole in 1847, developed the Boolean algebra that was used in the mathematical analysis of logic that aided the universal spread and adoption of computation. Building on research on the binary language and how to digitise it, Alec Reeves discovered in 1938 the Pulse Code Modulation technology used in developing voice calls in the telecommunication industry. Also, the digital voice transmission technology known as the SIGSALY was first discovered and used in the early 1940s.

Ever since the advent of computer operations in the 1950s, digitisation, and hence the process of digitalisation, has been evolving exponentially. The application of digital technologies in the financial sectors immediately trails the development of these technologies. Digitalisation of banking operations, however, started with the advent of Automated Teller Machines (ATMs) and cards in the 1960s (Financial Stability Board, 2017). The process was

accelerated with the emergence of internet and e-commerce during 1980s, and by 1990s, digital banking (online banking) started becoming fashionable in the financial industry (Financial Stability Board, 2017).

The proliferation of smart mobile devices in 2000s has ever since been **expanding, following consumers' preference for performing banking** transactions with convenience. This development has continued to support the growth in digital banking in leaps and bounds in recent times, with revenues expected to exceed US$10.00 trillion by 2027 (GMI, 2021).
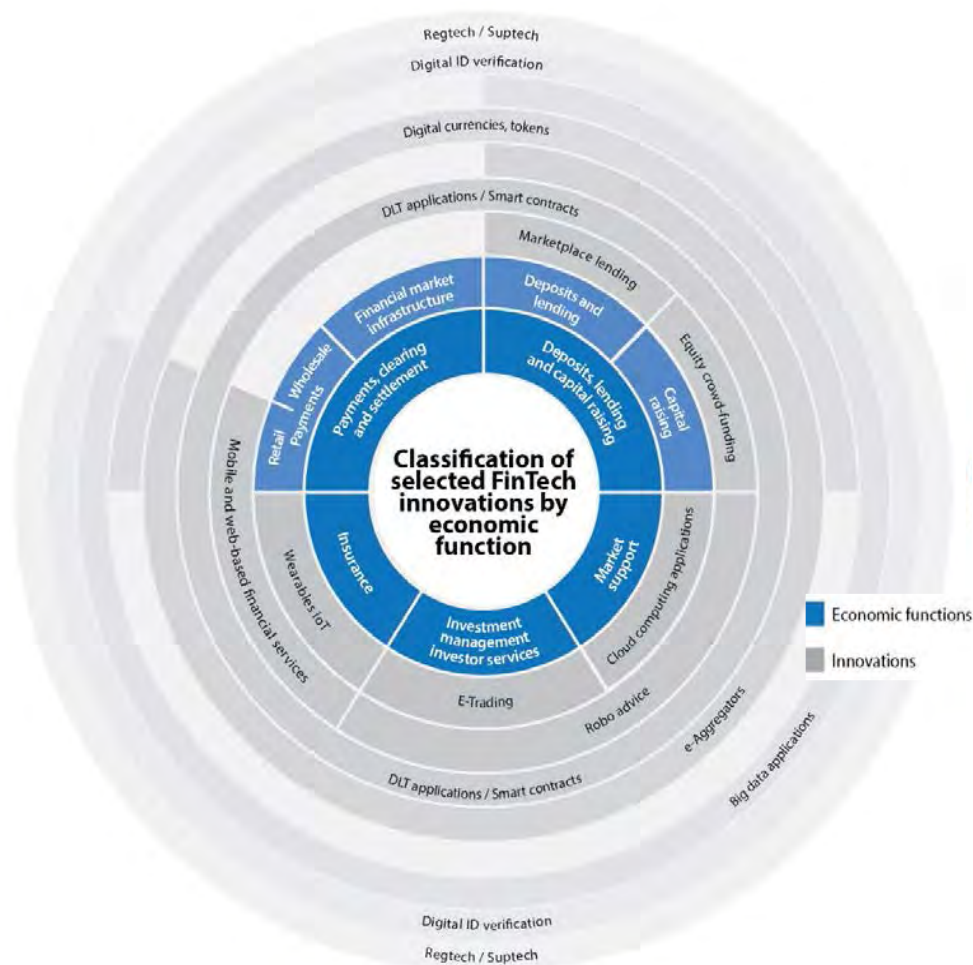
II.4   Institutional Drivers of Financial Sector Digitalisation

Though the digitalisation of the financial sector has been on-going since 1950s, recent revolution in the sector has been propelled by development of private institutions that invest and attract investments into the development of financial digitalisation for profits, amidst other corporate objectives. These institutions are FinTechs, and more recently, BigTechs.

II.4.1 FinTechs

FinTechs are firms that invest and attract investment into the development of technology-enabled innovations in financial services with the corporate goal of creating new business models, applications, processes or products. According to Pazarbasioglu et al. (2020), FinTechs are new entrant firms that specialise in providing financial services which leverage on digital technologies for their delivery and use by consumers. Functionally, Fintech has been conceptualised as digital technologies that have the potential to transform the provision of financial services spurring the development of new – or modify existing – business models, applications, processes, and products with an associated material effect on financial markets and institutions and the provision of financial services (Financial Stability Board, 2017; Basel Committee on Banking Supervision, **2018). FinTech's** innovations that digitalise financial services delivery, and the economic function performed were documented by Financial Stability Board (2017) and summarised in Figure 1.

Figure 1: FinTech' Digitalisation of Financial Sector and Economic Roles

Regtech / Suptech

Digital ID verification

Digital currencies, tokens

DLT applications / Smart contracts

Marketplace lending

Deposits and lending

Financial market infrastructure

Deposits, lending and capital raising

Equity crowd-funding

Retail | Wholesale Payments

Payments, clearing and settlement

Capital raising

Mobile and web-based financial services

Classification of selected FinTech innovations by economic function

Wearables IoT

Insurance

Market support

Cloud computing applications

Investment management investor services

E-Trading

Robo advice

e-Aggregators

DLT applications / Smart contracts

Big data applications

Digital ID verification

Regtech / Suptech

■ Economic functions
■ Innovations

Source: Financial Stability Board (FSB), (2017).

II.4.2   BigTech

BigTech refers to large globally active technology firms with a relative advantage in digital technology which usually provide web services (search engines, social networks, e-commerce, etc.) to end users over the internet and/or IT platforms or they maintain infrastructure (data storage and processing capabilities) on which other companies can provide products or services (Basel Committee on Banking Supervision, 2018). They leverage on these assets and inherent economies of scale to offer digital financial services (DFS) to the market (Pazarbasioglu et. al., 2020; Andrian, 2021). They are large

companies with an initial primary focus on providing digital services, rather than financial services (Frost et al., 2019).

These firms did not, however, start as financial services companies, but took advantage of their vast assets to enter the financial services business (Genberg, 2020). While they start with payment transaction on entry into the financial sector, BigTech later migrated to delivery of other financial services such as provision of credit, insurance, and savings and investment products, either directly or in cooperation with financial institution partners (Frost et al., 2019; Crisanto & Ehrentraud, 2021).

These firms leverage on their DNA (Data analytics, a technological capability shared with FinTech; Network of customer base, a capability feature shared with traditional (incumbent) banks, and Activities in financial services delivery) to enter the financial industry (Beck & Serrano, 2022; Carstens, 2022; Andrian, 2021; Frost et al., 2019) with a potential to dominate the market. Carstens (2022) report that BigTech account for 94.0 per cent of mobile payment in China while their global credit transaction grew by 40.0 per cent to over US$700.00 billion in 2020.

II.5   Financial System Stability

The Financial system is an arrangement comprising financial institutions, instruments, markets, and market infrastructures that facilitates flow of funds and ease the exchange of goods and services globally and/or within an economy. This system contributes to economic growth and development of any nation through providing essential services including mobilisation of savings, efficient storage of wealth, maturity transformation of financial assets and liabilities, allocation of resources, facilitating exchange of goods and services, cross-border currency exchange and managing financial risks (Organisation for Economic Co-operation and Development, 2018). In addition, the financial system serves as the pricing mechanism and governance medium for determination of crucial macro-financial prices like interest rates, exchange rates, risk premia that index nominal real value of money, and by extension, values of other commodities (Heckel & Waldenberger, 2022).

The financial system is open to many shocks that may originate internally or externally, with the effects felt by all economic agents. Therefore, a stable financial system is preferred as it minimises the negative effects that arise from shocks. Financial stability is the ability of the financial system to withstand

severe shocks without systemic disruptions to the delivery of financial services (European Central Bank, 2019, 2020, 2021).

II.6 Macroprudential Policies and Tools (MPT)

Financial stability is crucial for the economic system as an unstable financial system would be incapable of delivering support for economic growth and development. It is thus a focal point for government authorities in promoting economic objective. Financial authorities often put in place several measures and policies to engender financial system stability, including the macroprudential policies.

Macroprudential policies are sets of financial policies designed to preserve financial stability by limiting the buildup of exposures that are capable of causing systemic disruptions in credit and other essential financial services that are supportive of stable economic growth. These policy tools assess the connectedness of a financial institution with the other part of the financial system and real economy.

According to the European Central Bank (ECB), macroprudential policies/tools are broadly classified into capital-based measures; liquidity-based measures; borrower-based measures, instrument-based measures and activity-based measures (European Central Bank, 2020; Galati & Moessner, 2011; Lorencic & Festic, 2021; Kahou & Lehar, 2017).

Capital-based measures encompass a set of capital requirements which are designed to increase the loss absorption capacity of banks, fostering financial sector resilience. In addition, by altering banks' cost of capital, higher capital requirements should affect the price and volume of credit. This helps tame the financial cycle by limiting credit excesses. The capital framework for banks is enshrined in the Basel III agreements, Basel Committee on Banking Supervision (2018). It comprises instruments such as, capital buffers for global systemically important institutions and other systemically important institutions; countercyclical capital buffers to prevent the cyclical build-up of systemic risks; systemic risk buffers; and leverage restrictions, requirement to hold liquid assets to cope with market panics, and to make the financial system less complex (Bouchetara et al., 2020). After successfully implementing Basel II, the Nigerian banking sector commenced the adoption of Basel III from November 2021, based on CBN's guidelines.

On the capital adequacy-based indicators, commonly known as capital adequacy ratio (ratio of regulatory capital to risk-weighted assets), the international convention is that regulatory capital should not be less than 8.0 **per cent of banks' risk weighted a**ssets, while the required minimum ratio in Nigeria is 10.0 per cent for Regional and National banks and 15.0 per cent for International banks. An additional 1.0 per cent is required as the counter cyclical buffer for all banks while domestic systemically important banks are further required to set aside Higher Loss Absorbency (HLA) or additional capital surcharge of 1.0 per cent to their respective minimum required CAR.

Liquidity-based measures are, for instance, liquidity coverage ratio, net stable funding ratio; and time-varying systemic liquidity surcharges (European Central Bank, 2020). They are designed to provide an indication of the liquidity available to meet expected and unexpected demands for cash.

Borrower-based measures directly impose limits on the terms and conditions of lending related to the riskiness of loans. These instruments encompass limits on the size of the loan in relation to either the value of the underlying collateral, instrument-based measures and activity-based measures which restrict lending are, for instance, mortgage limits at the level of an individual borrower; limits on large exposures; time varying caps on debt-to-income ratio (DTI); loan-to-income ratio (LTI), loan-to-deposit ratio (LTD), loan-to-value ratio (LTV); limits on lending to sectors; time-varying limits on credit growth; and restrictions on asset composition and activities (Kahou & Lehar, 2017; Galati & Moessner, 2011).

On the one hand, borrower-based instruments make debt more sustainable, thereby reducing the probability of default of individual borrowers and limiting amplification effects on consumption and investment in the event of negative shocks. On the other hand, **they improve the quality of banks' mortgage loan** portfolios through more prudent lending standards, which gradually render loan portfolios less risky (European Central Bank, 2021). The loan to deposit ratio (LDR) as prudential measure has been 80.0 per cent maximum in Nigeria. However, as part of regulatory measures to increase lending to the real sector of the Nigerian economy, all Deposit Money Banks (DMBs) were required to maintain a minimum of 60.0 percent LDR effective September 30, 2019. Subsequently, the minimum was further raised to 65.0 per cent and all banks were required to meet this threshold by December 31, 2019.

In addition to Basel III tools, other MPT ratios used in Nigeria include Industry Capital Adequacy Ratio (CAR), credit-to-GDP Ratio, Industry Liquidity Ratio

(LR), Industry Loan-to-Deposit Ratio (LDR), and Industry Non-Performing-Loan ratio (NPL ratio).

III. Digitalisation of the Financial System - Implications for Financial System Stability

Virtually all aspects of financial system operations have been digitalised, in view of the benefits of digitalisation for all its stakeholders: the financial institutions, consumers, and even the governments. Digitalisation of the financial system, driven largely by FinTechs presents several benefits and also risks to financial stability, and hence economic growth and development.

III.1 Benefits of Financial Sector Digitalisation to Economic Agents

Some of these benefits include:

1) Speed and Convenience

Digitalisation of financial services has reduced time taken for the completion of a financial transaction. This speed benefit is more pronounced in payment services as a consumer initiating a payment transaction can expect the payee to receive value in matter of minutes, unlike the old days when such a transaction can take days. In addition, other financial services such as credit and lending have also been made faster and easier with fintech. Borrowers may get same-day funding from digital (fintech) lenders as the process of loan application, approval and disbursement takes place online.

2) Reduced Costs and Increased Financial Savings

Individual and business customers have benefited from low transaction costs on financial services offered by FinTech and BigTech, and therefore are able to make savings on their financial transaction on accumulated basis. According to Acquisition International (2020), a UK fintech firm Cashplus demonstrated a potential to save its customers up to 50.0 per cent of transaction costs, with the total savings reaching up to GBP500 million.

3) Improved Access to Financial Services

The business model of FinTech enables them to penetrate deep into remote areas (geographical) and market (functional) where sizable number of people (potential consumers) are not served by the traditional financial system. FinTech leverages technological advantage to offer various financial

services without a need for physical branches, thus providing access to these services to as many people as possible.

The improved access to financial services is promoted by mobile banking operations, supported by the ubiquity of mobile telephony. The mobile money operators (a segment of the Fintech industry) leverage on the use of mobile telephones by virtually everyone (even in remote areas) to deepen financial access by the people. With their continuing market efforts, the number of registered mobile money accountincreased, globally, by 12.7 per cent from 1.07 billion in 2019 to 1.21 billion accounts in 2020, and further to 1.35 billion in 2021, having grown by 18.0 per cent over the previous year (GSMA, 2021; 2022). Much of this growth (43.0 per cent of all new accounts) originated from sub-Saharan Africa (SSA), where a significant proportion of the population are financially underserved.

4)   Improved Security of Transactions

With the awareness of potential vulnerability to threats of cyberattacks, FinTech and BigTech have deployed digital technology to make financial transactions on their platforms more secure. FinTechs and BigTechs have used data encryption to protect digitally stored data, biometric technology to reduce the risk of stolen passwords and falsified transaction, and data analytics to identify irregular pattern and detect fraud (Organisation for Economic Co-operation and Development, 2018). Similarly, AI and Bigdata analytics have the potential for use in monitoring incidence of fraud and cyberattacks, as well as for anti-money laundering and other compliance checks (Beck & Serrano, 2022).

5)   Enhanced Transparency

The use of DLT in which parties may not be able to alter record of financial transaction is promoting the transparency of financial transactions and reliability of financial record. In conjunction with regulatory reporting requirements such as Know Your Customer (KYC) and improved communication with customers, this has made information available to relevant stakeholders, hence improved the transparency of digitalised finance.

III.2   Benefit of FinTechs to Financial Stability

Financial digitalisation promoted by FinTech offers numerous supports for financial system stability, including:

a) Decentralisation and Diversification

Entry of FinTech into the financial market space, and subsequent proliferation of these firms have led to unbundling of financial services, thus reducing the **incumbents' central market power over** the control of financial services delivery (Financial Stability Board, 2017). The engendered increase in the number of financial services providers enhances diversification of risks (liquidity, solvency and security), decision making and record keeping **(Vučinić, 2020;** Financial Stability Board, 2017, 2019a, 2019b), thus making the financial sector more resilient than before.

b) Efficiency

Digitalisation of financial service delivery continues to lower the cost of financial intermediation as all other service providers (including the incumbent) have had to improve their service delivery by employing **technology to be competitive (Vučinić, 2020). The market becomes more** efficient, and financial services become cheaper while demand and output of financial services increase, thus increasing economic output and standards of living.

c) Transparency

FinTechs and incumbents leverage on technology to obtain adequate information for risk profiling of borrowing consumers, thus reducing adverse selection problem, ex-ante. With big data analytics and AI/ML, these firms have the required information to monitor borrowers for effective actions such as early downgrade of credit rating, a development that may discourage default and moral hazard, post-ante, thus improving financial stability.

d) Financial Inclusion

FinTech has helped to deepen financial inclusion as many more individuals who were hitherto excluded become included, and thereafter enjoy higher level of financial access. Besides the mobile money operations through which completely excluded individuals have access to payment account and transactions, other fintech methods such as robo-advisory have given consumers access to other financial services such as wealth management.

III.3   Risks Posed by FinTechs to Financial Stability

FinTech has been noted to possibly pose significant risks to financial stability. Some of these risks, which are categorised into: micro-financial, macro-financial risks (Financial Stability Board, 2017; Vučinić, 2020) and non-financial or operational risks (Beck & Serrano, 2022) are highlighted in the following sub-sections.

III.3.1   Micro-Financial Risks

These risks pertain to a single financial institution or service provider, and result from the quality of decisions and actions taken on financial instruments that these firms deal in. They include maturity mismatch, liquidity mismatch and leverage (Financial Stability Board, 2017).

III.3.2   Macro-Financial Risks

These are risks that could amplify shocks across the financial system as a result of digitilisation of finance by FinTechs. They include:

i.   Systemic Importance Risks

The economies of scale of mostly BigTech, some incumbents and sometimes FinTechs (when aggregated and viewed as a block) which arise from their DNA, and market structure (Oligopoly and sometimes a natural monopoly) poses a systemic risk to the entire financial system because of their control of a new business segment/model (e.g. the digital wallet, DLT, etc.), compete with existing business system (traditional payments, central clearing), with a potential to replace them.

ii.   Excess Volatility Risks

These stem from the speed of transactions using FinTech tools which magnifies market movements in either direction. They also originate from similarity in the algorithms of the businesses (homogeneity of business model) (Financial Stability Board, 2017; Vučinić, 2020) resulting in e-herding behavior in a very fast-paced environment.

iii.   Contagion

The fast flow of information and similarity in business model exposes FinTechs and partnering financial institutions to contagion risks as users of a platform may abandon their services when they have the information that another

similar platform is distressed. The rate of user attrition is higher for digital finance providers due to the fast flow of information, speed of placing and completing financial transactions, and high level of market efficiency.

iv. Procyclicality

Financial activities and transactions on fintech platforms rise with economic booms and banking sector expansion but fall with economic contractions during which non-performing loans rise and credits dry up. There are possibilities that these e-transactions may influence economic activities in **either way. For instance, P2P lending, crowdfunding and even BigTech's** direct credits to customers may heighten credit expansions that results in economic boom, which often precedes bursts and contractions, as induced lax in credit quality subsequently triggers a spiral of credit reversals.

III.3.3   Nonfinancial (Operational) Risks

FinTechs and incumbents relying on fintech channels face these risks as a result of their business model, information system, human error, management failure and external influence (Beck & Serrano, 2022; Financial Stability Board, 2017). These risks include:

i.   Concentration/Business   Risks   of   Critical   Financial   Market Infrastructures

A few FinTechs and incumbents relying on fintech channels are often in control of critical financial market infrastructure (e.g. the cloud) upon which the entire financial industry depends for service delivery. Therefore, any disruption in the operation of such infrastructure-controlling firms can lead to financial instability (Beck & Serrano, 2022).

ii.   Governance/Regulatory Control Risks

This risk arises from inadequate coverage of FinTechs, and those of their service suppliers by the financial regulations. The more some of these operations are not regulated, the higher the risks posed to the financial system.

iii.   Cyber Risks

The business models of FinTechs and incumbents relying on fintech channels have them more predisposed to cyberattacks than other financial service providers whose activities and operation are less critically dependent on

internet. The preponderance of these firms in the financial sector heightens cyber risks that can affect the financial system as a whole.

iv.   Esotericism, Opacity and Obsolescence

Extensive use of AI/ML in financial service delivery sometimes make financial digitalisation process so complex and abstruse that they become very difficult to understand by many human operators. Thus, digitalisation become so esoteric that its development is left to a few, leading to opacity, stunted innovations and eventually, obsolescence. In addition, these technologies may lead to financial instability if financial institutions whose services use these technologies do not fully understand them.

IV.   Financial System Stability and Macroprudential Policy

An increasing number of regulators are deploying macroprudential tools and adapting them to new financial developments and risks. It is important to state that, in deploying macroprudential policies, regulators and supervisors must appreciate the circumstances including the sources of the risks under consideration.

Macroprudential policy should usually start with a broad and rigorous analysis of systemic risks and vulnerabilities. An assessment should be made on the build-up of risks over time ("time dimension"), which should consider (i) economy-wide risks and vulnerabilities from an excessive growth in total credit; (ii) sectoral risks and vulnerabilities arising from credit growth to the household; (iii) sectoral risks and vulnerabilities from exposures to the corporate sector; and (iv) risks and vulnerabilities arising from excessive maturity and foreign exchange mismatches within the financial sector and other sources of risks arising from transition into new products, services and technologies. The analysis of risks and vulnerabilities should also consider the potential for feedback between asset prices and credit. To assess structural risks within the financial system ("structural dimension"), the analysis should consider vulnerabilities from linkages within and across key classes of intermediaries and market infrastructures. These risks and vulnerabilities, once identified, should be appropriately mapped to macroprudential policy tools.

IV.1   How to Map Vulnerabilities to Macroprudential Policy Tools

Macroprudential measures should be tailored to material sources of vulnerability and consider the transmission mechanisms of various tools in

addressing risks. Risks and vulnerabilities from excessive credit growth can be addressed by tools that affect all credit exposures of the banking system (broad-based tools). For instance, the use of countercyclical capital buffers (CCBs) and dynamic provisioning system which affect a wide range of banking activities will no doubt increase the resilience of the financial system and may also moderate the pro-cyclicality of credit.

Where risks and vulnerabilities arise from unwarranted credit growth to the household and procyclical feedback between credit and prices of asset, an array of sectoral tools that target a given credit class, which include sectoral capital requirements (risk weights), loan-to-value, and debt-service-to-income ratios, can be used to address these risks.

However, where systemic risks and vulnerabilities arise from upsurge in exposures to the corporate sector, like those arising from increases in leverage, lending to commercial real estate or from foreign exchange lending to the corporate sector, specific sectoral tools, such as sectoral capital requirements (risk weights) and exposure caps, would be more appropriate in addressing these risks.

Increases in risks and vulnerabilities due to systemic liquidity and currency risks can largely be addressed by liquidity tools, such as quality liquid asset buffers, stable funding requirements, and limits on open positions. By limiting bank funding to address systemic liquidity risk, liquidity tools can also impact credit growth.

The case of structural risks of contagion arising from interlinkages within the financial system can be managed through range of tools, including liquidity and capital surcharges for systemically important institutions, and measures to control interlinkages in funding and derivatives markets.

IV.2   Communicating Macroprudential Policy

It is recommended that macroprudential policy be communicated openly by the regulators/supervisors. Clear communication of policy intentions can improve transmission of macroprudential action, both when measures are taken and when they are relaxed (International Monetary Fund, 2013, 2014; Giese et al., 2013). Communication can also improve the understanding of the public on the need for macroprudential measures. It is also likely to counter biases in favor of inaction and enhance validity and accountability of macroprudential policy.

IV.3   Managing Digitalisation-Induced Risks to Financial Stability: The Role of Macroprudential Policies

Virtually all aspects of financial system operations have been digitalised, given the benefits of digitalisation for all its stakeholders: the financial institutions, consumers, and even the governments. Digitalisation of the financial system, driven largely by FinTechs poses several benefits and risks to financial stability, and hence economic growth and development.

IV.3.1 Macroprudential Approach to Regulating FinTech

FinTechs have been noted not to pose a significant threat to financial stability as their business models are constrained from assuming a scale that disruptively compete with the incumbent traditional banking system (Rodríguez & Ortún, 2020). Notwithstanding, regulatory authorities have sought to manage the actual (and potential) financial stability risks of these firms, using two approaches: (i) extending the existing regulation to cover FinTech and blocking the loopholes, (ii) use of regulatory sandboxes to promote stability-enhancing innovations. Regulations of FinTech, which falls under these two approaches, pertain to banking-related functions (Rodríguez & Ortún, 2020).

1)   Regulations on Deposit-taking-like Functions

Deposit-taking as a tightly regulated activity though remains exclusive to licensed banks, the activities of FinTech with credit operation are being drawn under supervisory surveillance and regulation, given the deposit-generating effects and their implication for financial stability. While the European Central Bank (ECB) issued guidance on authorisation requirements for FinTech with credit activities, financial authorities in the UK encourages such firms to obtain a banking license with a view of bringing them under existing regulations (Rodríguez & Ortún, 2020).

2)   Regulation on Payments and Other Store-of Value Services

One great example of this regulation is the extension of the regulatory perimeter of Payment Service Directives (PSD) by the European Union (EU) to cover services beyond the existing payment initiation services (PIS) and aggregation of information services (AIS) to include services of electronic money institutions (EMIs).

Unlike PIS and AIS where service providers do not need to operate the payment account, but instead can access the information or initiate operations (with the consent of the customer) in the payments accounts one holds with other banking institutions, EMIs offer store-of-value services (similar to traditional banks) in forms of digital wallets, and are thus specially regulated. They are only allowed to hold client money when they issue electronic money that is equal to the fiat currency deposited by the client. In addition, they are not allowed to **intermediate or invest customers' funds** (Rodríguez & Ortún, 2020).

3) Lending

FinTech and BigTech issuing credits with their own funds are regulated under the existing policy framework governing non-bank financial institutions providers of credit. This framework does not cover those with platforms that merely connect borrowers and lenders such as P2P lending and crowdfunding as they are separately regulated (Rodríguez & Ortún, 2020).

IV.3.2   Macroprudential Approach to Regulating BigTech

Given their scale factor and the implication of their store-of-value services, BigTech are required to deposit these funds with commercial banks, as a way **of safeguarding customers' funds. BigTech credits are so huge that their** lending activities have to be subjected to regular existing regulatory framework or macroprudential policies.

IV.4   Macroprudential Regulation of Digital Finance in Nigeria

In Nigeria, relevant financial authorities including the CBN, SEC and NCC have issued guidance and frameworks to manage financial digitalisation process to ensure that the process does not undermine the macroprudential stability of the Nigerian financial system. Some of these regulations include:

IV.4.1   The CBN Framework for Regulatory Sandbox Operations, 2021

The CBN in 2021, issued the Framework for Regulatory Sandbox Operation that defines the establishment, rules, and operations of a Regulatory Sandbox for the Nigerian Payments System. The objectives are to promote effective competition, embrace new technology, encourage financial inclusion, improve customer experience, and promote public confidence in the financial system.

IV.4.2   The CBN Open Banking Framework, 2021

The CBN issued this framework, in line with one of its functions of ensuring Nigerian financial system stability, to promote efficiency of the financial system and foster the sharing and leveraging of customer-permissioned data by banks with third party firms (largely FinTech) to build solutions and services. The issuance of this framework followed the CBN's realisation of increasing integration of banks and other financial institutions with innovators in the financial services space and the growing adoption of Application Programming Interface (API) based integrations in the industry.

IV.4.3   Security and Exchange Commission (SEC) Crowdfunding Rules, 2021

These rules seek to regulate one of the most pronounced financial activities of FinTech in the investment space: crowdfunding. By specifying the basic rules of operations, the Crowdfunding Rules have established the framework for effective operation of FinTech investments/lending activities in Nigeria for financial sector growth and progress while minimising their risks to financial stability.

IV.4.4   Supervisory Framework of Payment Service Banks, 2018

This is part of the larger efforts of the CBN in promoting stability of the financial system. This framework is aimed at regulating the Payment Service Banks, which are primarily expected to leverage on technology to provide services that would be easily accessed by the unbanked population and those who are in hard-to-reach areas of the country. It focuses on ensuring that sound risk management practices are embedded in the operations of these banks while putting in place mechanisms governing pertinent issues such as KYC and AML/CFT, data infrastructure and cyber security, interoperability, integration to the Global Standing Instruction (GSI) platforms, among others.

IV.5   The Role of Deposit Insurance in Macroprudential Regulation of Digital Finance in Nigeria

Deposit Insurance System (DIS) is one of the financial safety net arrangements (FSN), to ensure the stability of the financial system. It is used by governments to ensure the stability of the banking systems and to protect depositors, in full or in part, in the event of bank failure. The main objective of the DIS is to protect depositors' money in licensed deposit-taking financial institutions. This builds confidence of depositors in the banking system, makes issues of bank run less likely and entrenches stability of the financial system.

Among other components of FSN such as (i) supervision, prudential regulation and resolution (ii) lender of the last resort function of the central bSanks, (iii) solvency provision of the last resort function of the Sovereign Treasury, DIS has been identified as one of the most popular component of the FSN, which has immensely contributed to entrenching financial system stability through promoting public confidence, and deterring liquidity panics (Schich, 2008; Cerda, Brewer and Evanoff, 2001; Moskow, 2001) as well as forestalling bank runs while protecting small depositors (Beck, 2003).

In Nigeria, the NDIC administers the DIS with the mandate of deposit guarantee, bank supervision, failure resolution and bank liquidation. The NDIC generally contributes to financial system stability by promoting public confidence and reducing the incidence of bank runs through extension of deposit insurance coverage to depositors of all licensed deposit-taking financial institutions which, as at July 2021, include 32 DMBs, 874 MFBs, 33 PMBs and 3 PSBs.

Regarding financial digitalisation, the NDIC extends deposit insurance coverage to Deposit-Like Products (DLPs) or Digital Store Products (DSPs) as a means of encouraging more people to be financially included, especially those currently using DSPs instead of formal traditional products. DLPs or DSPs include mobile money, card-based electronic money and internet-based electronic money but not mobile banking or digital currency. It therefore continues to foster public confidence and promote financial inclusion by extending deposit insurance coverage to subscribers of mobile money operators (MMOs) in Nigeria, relying on the NDIC Framework for the establishment of Pass-through Deposit Insurance[1] (PTDI) for Subscribers of Mobile Money Operators in Nigeria in 2015. The PTDI has promoted continuous sustenance of Mobile Payment System (MPS) and financial inclusion in Nigeria.

The NDIC also supports the CBN in enforcement of all macroprudential policies through bank supervision, entrenching enhanced risk management practices to improve financial stability through differential-premium assessment process and monitor fraud in the banking system and fintech-related channels.

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[1] Pass-Through Deposit Insurance scheme" is the protection provided by the NDIC to mobile money subscribers, whereby the Corporation insures funds that are deposited by a Mobile Money Operator (MMO) in the deposit money banks (DMBs). The MMO acts as a custodian on behalf of the one or more subscribers who are actual owners of the funds as if those actual owners have deposits in the deposit money banks (DMBs).

V.   Conclusions and Recommendations

Globally, financial systems have passed through various stages of evolution, culminating in the current level of financial digitalisation driven by revolutionary technological advancements in internet, information and communication technology including: distributed ledger technology, big data analytics, AI, and ML, to mention a few. These revolutionary developments bring along numerous benefits including speed and convenience of conducting financial transactions, financial cost reduction and time savings, and wider access to a diverse range of financial product and services.

These benefits notwithstanding, the operations of FinTech and BigTech pose considerable risks to financial stability. Some of these risks are micro-financial in nature, and they include maturity and liquidity mismatches in the financial instruments created by these tech firms and traded by the consumers. Some macro-financial risks posed by FinTech and BigTech include excess volatility risks arising from speed of transaction and market efficiency characteristics of their platforms, contagion - stemming from homogeneous feature of their algorithms - and procyclicality of their operations. FinTech and BigTech also pose nonfinancial and operational risks including concentration risks, governance and regulatory control risks, data privacy and consumer protection risks, among others.

In response to these challenges, regulatory/supervisory authorities have put in place policies to reduce the risks to the barest minimum. These authorities focus on optimising financial digitalisation as a means of achieving the objective of macro-prudential policy: preventing and reducing systemic risk through limiting the disruption in the provision of key financial services, promoting efficient functioning of financial market, and enhancing stability of the financial (monetary and payment) systems.

In line with global best practices, relevant financial and monetary authorities in Nigeria including the CBN, NDIC, SEC and NCC have issued guidance and frameworks to manage financial digitalisation process to ensure that they do not undermine the macroprudential stability of the financial system. Some of these include CBN Open Banking Framework, the SEC Crowdfunding Rules, the CBN Framework for Regulatory Sandbox Operation, the NDIC Framework for the Establishment of Pass-through Deposit Insurance for Subscriber of Mobile Money Operators in Nigeria, among others.

As Regulatory Framework for Sandbox Operations implies, the world of FinTech and BigTech is still evolving, and so is the digitalisation of financial sector. The regulatory and supervisory authorities should endeavor to keep abreast of the developments such that they can always have in place regulatory frameworks that will optimise the process to the benefit of all stakeholders and without prejudice to financial stability.

In this light, it is imperative for the CBN to:

a. undertake analysis and research on how key innovations, such as machine learning, artificial intelligence, distributed ledger technology, and the increased availability of data, can guide policy at the Bank for enhanced supervision, surveillance, improved reporting and compliance by regulated institutions, so as to strengthen the resilience of the financial system;

b. investigate how big data analytics can enhance existing financial sector assessment processes and provide additional insights – in terms of financial sentiment analysis, early warning systems, stress-test exercises, and network analysis;

c. establish research work programme on AI/ML, develop the use of machine learning to understand possible micro and macroprudential implications of widespread adoption and monitor usage of AI/ML by banks as a means of realising the benefits of digitalisation in regulation and supervision;

d. develop a regulatory data strategy to embrace data-driven and intelligence-led risk monitoring;

e. set standards and guidelines for cloud usage without compromising the resilience of the system; and

f. identify and establish an approach for data recovery from malicious cyber-attacks for the Nigerian banking system.

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