

Assessment of Nigeria's Financial Services Sector Stability and Diversity

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Research Paper 448

AFRICAN ECONOMIC RESEARCH CONSORTIUM
CONSORTIUM POUR LA RECHERCHE ÉCONOMIQUE EN AFRIQUE

Assessment of Nigeria's Financial Services Sector Stability and Diversity

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AERC Research Paper 448
African Economic Research Consortium, Nairobi
July 2021

THIS RESEARCH STUDY was supported by a grant from the African Economic Research Consortium. The findings, opinions and recommendations are those of the author, however, and do not necessarily reflect the views of the Consortium, its individual members or the AERC Secretariat.

Published by: The African Economic Research Consortium
P.O. Box 62882 - City Square
Nairobi 00200, Kenya

ISBN 978-9966-61-146-8

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List of abbreviations and acronyms

AFDI	Aggregate Financial Diversity Index
AFSI	Aggregate Financial Stability Index
AMCON	Asset Management Corporation of Nigeria
CBN	Central Bank of Nigeria
DMBs	Deposit Money Banks
EWS	Early Warning Systems
FDI	Financial Development Index
FPI	Foreign Portfolio Investment
FSCI	Financial Stability Condition Index
FSI	Financial Stress Index
FSIs	Financial Soundness Indicators
FSR	Financial Stability Report
FVI	Financial Vulnerability Index
GDP	Gross Domestic Product
IMF	International Monetary Fund
NDIC	Nigeria Deposit Insurance Cooperation
NPL	Non-Performing Loans
NSE	Nigerian Stock Exchange
OECD	Organization for Economic Co-operation and Development
PCA	Principal Component Analysis
RECI	Regional Economic Climate Index
UBA	United Bank for Africa

Executive Summary

The global financial crisis of 2007-2009 and the ensuing widespread economic dislocations, has rekindled interest in the monitoring and identification of sources of fragility and assessment of financial system resilience. Indeed, a key lesson of the crises is the reminder of the nexus between financial system stability and resilience, and macroeconomic stability. There is currently a consensus in the central bank community that the financial stability objective is to achieve a level of stability in the provision of financial services which will support the economy in attaining maximum sustainable economic growth (. Consequently, regulators and supervisors of the banking sector now undertake periodic monitoring and identification of macroprudential leading indicators signalling incipient risks to the banking system with the overarching objective of ensuring that the banking system is stable and resilient to headwinds.

The role of a diversified economy in economic stability remains a focal point of a large and growing theoretical-, empirical- and policy-oriented literature. Similarly, financial diversity is meant to improve the financial stability of an economy. Whether this is the case with the Nigerian economy is yet to be verified empirically. In this regard, the key objective of this study is to assess Nigeria's financial system stability and diversity, first by developing an aggregate financial stability index that is reflective of the intrinsic structure of the Nigerian financial services sector; develop a financial diversity index for the Nigerian financial services sector; investigate the determinants of Aggregate financial stability index and financial diversity index in Nigeria. as well as the relationship between financial diversity and financial stability. However, given the fact that the effect does not depict causation, this study moves the analysis further by examining the causal relationship between financial diversity and financial stability.

Using annual and quarterly banking sector data for the period 2006-2015 and employing Principal Component Analysis, Hirschman-Herfindahl (HH) Index, Simpson Index, Simple Regression and Granger Causality, the study establishes that the Nigerian financial system shows a cyclical movement, and yet to achieve diversity. The study also found that, financial diversity positively influences financial stability and that there exists a bidirectional causal relationship between financial diversity and financial stability running from diversity to stability and vice versa.

The study recommends the following:

- The regulatory and supervisory authorities in Nigeria should include the diversity of financial services in their policy design as this will enhance, not only the stability of financial system, but also the economy as a whole
- The Central Bank of Nigeria can also regularly monitor banks' funding models to ensure that banks set up diverse funding plans to preempt a systemic crisis.

Abstract

A key lesson from the global financial crisis of 2007-2009 and the ensuing widespread economic dislocations is the reminder of the nexus between financial system stability and resilience, and macroeconomic stability. Also, emerging research efforts at exploring financial system stability, resilience and economic welfare have underscored the importance of diversity in the financial system. This study assessed Nigeria's financial system stability and diversity. Specifically, the study sought to develop an Aggregate Financial Stability Index that is reflective of the intrinsic structure of the Nigerian financial services sector; develop an Aggregate Financial Diversity Index for the Nigerian financial services sector; investigate the determinants of aggregate financial stability index; and also investigate the relationship between the aggregate financial stability index and aggregate financial diversity index. Using annual and quarterly banking sector data for the period 2006-2015 and employing Principal Component Analysis, Hirschman-Herfindahl (HH) Index, Simpson Index, Simple Regression and Granger Causality, the study establishes that the Nigerian financial system shows a cyclical movement, and yet to achieve diversity. The study also found that, financial diversity positively influences financial stability and that there exists a bidirectional causal relationship between financial diversity and financial stability running from diversity to stability and vice versa. The study recommends that regulatory and supervisory authorities in Nigeria should include the diversity of financial services in their policy design as this will enhance, not only the stability of financial system, but also the economy as a whole. The Central Bank of Nigeria can also regularly monitor banks' funding models to ensure that banks set up diverse funding plans to preempt a systemic crisis.

Key words: Financial stability, financial diversity, Simpson index, financial resilience, principal component analysis, granger causality

JEL classification: C4, C38, C43, G, G2

1. Introduction

Background of the study

The global financial crisis of 2007-2009 and the ensuing widespread economic dislocations, has rekindled interest in the monitoring and identification of sources of fragility and assessment of financial system resilience. Indeed, a key lesson of the crises is the reminder of the nexus between financial system stability and resilience, and macroeconomic stability. There is currently a consensus in the central bank community that the financial stability objective is to achieve a level of stability in the provision of financial services which will support the economy in attaining maximum sustainable economic growth (Frait & Komárková, 2011). Consequently, regulators and supervisors of the banking sector now undertake periodic monitoring and identification of macroprudential leading indicators signalling incipient risks to the banking system with the overarching objective of ensuring that the banking system is stable and resilient to headwinds.

Nigeria banking system has evolved over time from the colonial era to the post-colonial era. It boasts one of the most robust banking systems in Africa and this fact has been all too evident in the fact that many banking institutions indigenous to Nigeria have established offshore operations on many other African economies (Soludo, 2004). According to Ojukwu-Ogba (2009), Nigeria's banking regulatory authority has introduced several reforms over time, and these reforms have impacted on the outlook, nature and the operations of the banking system. Such reforms include the banking sector consolidation which increased the minimum capital base of banks from NGN2 billion to NGN25 billion and consequently reduced the number of deposit money banks operating in Nigeria from 89 to 25 at the close of the year 2005. The essence of the reforms was to retain public confidence and maintain equilibrium in the Nigerian financial system (Ojukwu-Ogba, 2009).

Banking sector operators often see stability and resilience to comprise mainly of improved capital holdings of banks, an often dangerous implicit assumption. 'Diversity' of the financial system, the banking sector inclusive, has been identified as one veritable means of improving financial system stability and resilience that promotes competition in the financial sector. This is also now a major policy objective in some climes such as the United Kingdom. Financial system diversity entails healthy systems that have a diversity of actors who occupy a variety of different niches in the

system and employ various strategies to thrive. The relationship between diversity and financial system stability are many-sided, underscoring the different dimensions of diversity and how they impact on the behaviour and performance of the financial sector. These dimensions include ownership/corporate diversity, competition, balance sheet resilience and geographic spread. These different components of diversity and their relevance to stability are discussed in the subsection on conceptual literature.

According to Albuлесcu (2010), policy makers in general, and central bankers in particular, have allocated increasing resources to monitor the potential threats to financial system stability and to elaborate a framework to achieve this goal. This is because attaining financial system stability has become a significant policy thrust of monetary authorities in all climes. This stems from the fact that a stable and resilient financial system engenders trust and builds confidence, and ensures the optimal allocation of capital resources which enables the financial system to play its crucial role of financial intermediation in the economy. Regulators, therefore, aim to detect symptoms of frailty in the financial system and prevent crises to avert their concomitant adverse impacts on the real economy. Initial efforts to measure financial system stability and resilience focused on microprudential analysis which seeks to ensure that financial institutions have adequate buffers (capital adequacy) and can meet their payment obligations (liquidity).

Over the years, however, especially after the Asian financial crisis of 1997, and the global financial crisis of 2007-2009, the emphasis has shifted to the macroprudential analysis of banking system stability and resilience with a focus on identification and mitigation of banking system vulnerability risks and the resilience of financial systems. Macroprudential analysis entails identifying all sources of threats to banking system stability as a whole. It involves the monitoring, assessment and mitigation of systemic risk, namely the likelihood of failure of a significant part of the banking system. It is pertinent, therefore, to view systemic risk as partly endogenous and depends on the collective behaviour of banking institutions and their interconnectedness, as well as the interaction between the banking sector and the macroeconomy. Macroprudential analyses aim to develop approaches and evaluation methods for the timely identification of sources of financial vulnerability and design appropriate responses. They also seek to prevent, or at least contain, the build-up of financial imbalances and ensure that the banking system can withstand their unwinding and be resilient to shocks (Papademos, 2009).

The identification and prediction of the state of the banking system and sources of vulnerability is crucial for policy purposes. It is a necessary first step in developing Early Warning Systems (EWS) to provide timely warnings for imminent systemic events. The development of stress indicators, and their aggregation into a composite index of systemic stress, offers insights into the propagation channels of specific events and the extent to which a financial crisis affect segments of the financial system (Dimitrios & Angelos, 2013). Macroprudential analyses, therefore, enhance banking system stability by identifying sources of threats and strengthens the system's resilience to shocks. Macroprudential analyses emphasise an all-inclusive slant to monitoring the

stability of banking systems by observing macroeconomic and market-based data, as well as qualitative and structural information (Sere-Ejembi et al., 2014). A major aspect of the macroprudential policy is the need to determine, in a timely basis, any potential stresses accumulating in the financial or banking sector, in order to implement measures to prevent a crisis (Jordan & Smith, 2014). On the other hand, the diversity-stability relationship offers insight into the broader question of competition in banking and extends beyond traditional measures of market structure.

Research issue/motivation

First introduced by Chinitz (1961), the role of a diversified economy in economic stability remains a focal point of a large and growing theoretical-, empirical- and policy-oriented literature (Wagner, 2000; Dissart, 2003; Noseleit, 2015). Similarly, financial diversity is meant to improve the financial stability of an economy. Whether this is the case with the Nigerian economy is yet to be verified empirically. In this regard, this study sought to investigate the relationship between financial diversity and financial stability. However, given the fact that the effect does not depict causation, this study moves the analysis further by examining the causal relationship between financial diversity and financial stability. The primary motivation behind studying banking system stability and resilience is obviously the impact of banking system instability and vulnerability on the real economy, and the social costs that it usually entails. However, the stability and resilience of Nigeria's banking sector are important for myriad reasons. First, Nigeria is home to some major African cross-border banks (Beck et al., 2014). In the aftermath of a successful banking sector consolidation exercise in 2005 and the resultant high capitalization and liquidity levels, Nigerian banks expanded into other markets on the continent, especially where entry requirements were low, thus, becoming a significant hub for cross-border banking in Africa. For example, Nigeria's United Bank for Africa (UBA) has operations in 20 African countries. Consequently, this poses an enormous systemic risk for possible contagion as instability in the Nigerian banking sector could quickly spread to other markets on the African continent.

Another pertinent motivation for studying Nigeria's banking sector stability and resilience is to assess the level of exposure to external vagaries, and the transmission of external shocks to the Nigerian financial system, primarily through the flow of Foreign Portfolio Investment (FPI) into the Nigerian capital market. It is also important to assess the response of the Nigerian banking system to monetary policy adjustments in major economies to determine the vulnerability/resilience of the Nigerian banking system to monetary policy pronouncements and adjustments in developed economies. It is also imperative to empirically assess the impact of crude oil price volatility on the Nigerian financial system, the country being a near mono-product export economy. One of the major transmission channels through which the global financial crisis hit the Nigerian economy was crude oil sales in the international commodities market. When the global economy contracted, and major

oil-consuming economies drifted into recession, crude oil prices fell from an all-time high of US\$147 per barrel in July 2008 to less than US\$40 per barrel in December 2008 due to weak demand. This precipitous fall in Nigeria's primary income stream exposed the country's vulnerability to the global economic crisis. A study of the Nigerian financial system stability and resilience is also vital to elicit salient information on the nature of ownership structure, concentration and competitiveness, different funding models and geographic concentration.

Over the past three decades, Nigeria has experienced several periods of banking system instability and some incidences of full-scale financial crises. The most recent being in 2009 in the aftermath of the global financial crisis which had severe effects on the economy. Crisis in the Nigerian banking sector came to a head when according to Sanusi (2011), the balance sheet of banks became eroded to the extent that some banks remained for some time on "life support" from the central bank, inter-bank rates spiked as banks tried to borrow at any rate in order to remain afloat, and the size of non-performing loans significantly increased. As a crisis management option, the Central Bank of Nigeria (CBN) injected an estimated NGN1.75 trillion, which represented about 6% of Nigeria's GDP of NGN29.498 trillion as at end December 2010 into the Nigerian financial system to restore stability. Also, a "bad bank" – the Asset Management Corporation of Nigeria (AMCON) was established by national legislation to absorb the toxic assets of banks in exchange for government bonds to rebuild the balance sheets of banks.

In a bid to entrench macroprudential analysis in the supervision and regulation of the financial system, and avert the sort of crisis experienced in Nigeria in the wake of the global financial crisis, the International Monetary Fund (IMF) developed a set of Financial Soundness Indicators (FSIs) to provide insight into the financial health and soundness of financial institutions and support economic and financial stability analysis. However, simultaneous multidirectional movements of these indicators make their set of trends difficult to interpret (Arzamasov & Penikas, 2014). Given the difficulty in understanding these indicators, there have been efforts to develop an aggregate index through which financial system stress could be discerned. Aggregating the indicators into a single index provides better clarity on the health and soundness of the financial system. The unique integral index based on these parameters should potentially solve the problem (Arzamasov & Penikas, 2014). One of such integral indexes is the Aggregate Financial Stability Index (AFSI) – a single snapshot indicator of the health and strength of the financial system.

Also, emerging research effort at exploring financial system stability and resilience has underscored "diversity" as an important factor in enhancing stability and improving competitiveness. Authors argue that diverse financial markets may lead to broader financial market development than less diverse ones (Weller & Zulfiqar, 2013). Perhaps, because diverse financial systems could lower liquidity constraints more than concentrated markets. A diverse financial system may also help to mobilize more domestic savings than less diverse systems, consequently reducing the need to attract potentially destabilizing portfolio capital inflow. One good effort at exploring

the diversity-stability nexus include Michie and Oughton (2013) who developed a Financial Diversity Index (D-Index) to provide insight into this relationship and measure the impact of ownership structure, concentration and competitiveness, different funding models and geographic concentration (four sub-indexes of diversity). Butzbach (2016) identified a lack of diversity in banking as a severe source for systemic risk that is worth specific regulatory attention. Similarly, HM Treasury (2010) notes that the need to maintain diversity in the financial services sector remains a potential policy objective.

Three strands of thought have emerged in the financial diversity literature. The first, championed by Ayadi et al. (2009) consists of documenting the knowledge of the diversity of banking business model, across and within national banking systems and the facts that different business or banking model does not perform equally regarding efficiency, profitability and risk. The second strand emphasises promoting corporate diversity in the financial sector (Michie, 2011). The last strand, advocated by researchers like Acharya and Yorulmazar (2007) argues that diversity is valuable as a guarantee of a stable financial system. Despite the importance of diversity in financial services' sector stability, studies in Nigeria have hardly focused on the diversity of financial services in Nigeria.

Objectives of the study

The overall objective of this study is to assess the stability and diversity of Nigeria's financial services sector. Specifically, the study seeks to:

1. Develop an Aggregate Financial Stability Index that is reflective of the intrinsic structure of the Nigerian financial services sector.
2. Develop a Financial Diversity Index for the Nigerian financial services sector.
3. Investigate the determinants of Aggregate Financial Stability Index and Financial Diversity Index in Nigeria.
4. Investigate the relationship between Aggregate Financial Stability Index and Financial Diversity Index in Nigeria.

2. Literature review

Conceptual literature

Since the global financial crisis of 2007-2009, there has been a renewed interest amongst central bankers and policy makers on financial system stability and resilience assessment. According to Nayn and Siddiqui (2014), the significant costs of these crises, both direct (such as the cost of recapitalizing the deposit takers) and indirect (such as the loss of real economic activity), have highlighted the need to develop a body of—preferably high frequency—statistics that could help policy makers in macroprudential analysis, that is, in identifying the strengths and vulnerabilities in their countries' financial systems. The primary objective of an analysis of financial system stability is to examine the different relationships, detecting negative trends, as well as economic, regulatory and institutional determinants for assessing the state of the financial system and its vulnerabilities (Imanov et al., 2017).

The International Monetary Fund (IMF) developed a set of core and additional Financial Soundness Indicators (FSIs) for deposit-taking financial institutions, other financial corporations, non-financial corporations, etc. The FSIs aim to serve as early warning signals of vulnerabilities in the financial system, to prompt policy makers' preemptive measures. However, for manageability, there is need to aggregate the most salient FSIs and selected macroeconomic variables into a composite index that would serve as a one-stop-shop in detecting fragilities that may have significant implications for financial system stability (Sere-Ejembi et al., 2014).

Following the FSIs developed by the IMF, several efforts have been made to develop various forward-looking financial system stability index for the financial services sector in several climes. According to Jordan and Smith (2014), given the renewed focus on avoiding a financial crisis and maintaining a resilient and stable financial sector, many countries have pursued the important task of constructing an apparatus for measuring and monitoring financial stability within their countries. One of such indexes is the aggregate financial stability index. The construction of an aggregate financial stability index (AFSI) represents, besides the early warning systems and the stress-tests, one of the quantitative methods for measuring the stability of a financial system (Albulescu, 2010). Also, since the crisis, researchers, governments and regulators have been examining the structure and characteristics of the financial services sector in order to improve the understanding of the causes of the crisis and

ways of averting a recurrence, and one of the key findings from these endeavours is that diversity is an important and hitherto neglected source of systemic stability and resilience (Michie & Oughton, 2013).

Conceptually, a stable financial system is one in which financial intermediaries, markets and market infrastructure facilitate the smooth flow of funds between savers and investors and, by doing so, help promote growth in economic activity (Reserve Bank of Australia, 2019). Schinasi (2004) sees financial stability as whenever the “financial system is capable of facilitating (rather than impeding) the performance of an economy and dissipating financial imbalances that arise endogenously or as a result of significant adverse and unanticipated events”. In essence, financial stability is defined in terms of its ability to facilitate and enhance economic processes, manage risks and absorb shocks. Also, Alawode and Sadek (2008) defined financial system crisis as a crisis with the potential to affect a large part of the financial system, not one with potential macroeconomic or welfare costs. On the other hand, the Reserve Bank of Australia (2019) sees a resilient financial system as one in which there are well-developed crisis management arrangements for handling distressed financial institutions in such a way that public confidence in the financial system will not be undermined. Consequently, this study will adopt the definition of financial stability as given by Schinasi (2004).

Diversity in the financial system is conceptualized to mean that the financial system has a range of banking institutions differentiated by size, clients and product (Weller & Zulfiqar, 2013). Drawing from the diversity literature, there are four sub-indexes of diversity, namely, ownership and corporate diversity; market competition; balance sheet structure resilience; and the geographic spread/regional concentration. These sub-components help in the construction of the Financial Diversity Index (D-Index). The four dimensions of diversity, as used in this study, are discussed below, given their relationship with financial system stability.

Dimensions of diversity and financial services

Ownership and corporate diversity: The ownership or corporate type of banks or financial institutions play a significant role in the financial services sector. The behavioural difference in the financial system is closely connected to the ownership type. For example, government-owned banks are less likely to be profit-oriented than privately owned banks as contained in their article of association. Similarly, foreign-owned banks are more likely to have access to capital because of their link with their parent offices than domestic banks. The relevance of ownership/corporate diversity in improving stability is in having banks that manage risk in different ways through the different business models, thereby ensuring systemic stability. Again, it helps to enhance competition through various business models.

Market competition: Diversity in the financial system encourages competition among banks. Before the global financial crisis of 2007-2009, the worry about competition in the banking sector was focused on the inhibiting effect of market concentration on the competition with consumers having to grapple with higher prices

of product/low quality, economic inefficiency and deadweight welfare loss (Michie & Oughton, 2013). With the financial crisis, attention has shifted to the aspect of the concentration problem of the financial sector that has to do with ‘too big to fail’. This problem had earlier been recognized, but the financial crisis reinforced the devastating practical implications. The argument is that the big banks receive an implicit subsidy from the government, notably because depositors and other creditors expect them to receive more government support during the crisis. Michie and Oughton (2013) noted two other effects that large banks enjoy beyond their large market shares; namely, first, the ability to borrow more cheaply in the financial market because of creditors’ optimism, and secondly, the benefits of actual government subsidy in case of failure. Another effect is the issue of post-crisis merger, which will increase market concentration. Studies have shown that there is “a tendency, all things being equal, for markets to be less competitive when more concentrated than when there is diversity” (U.K House of Common Treasury Committee, 2011), while Michie and Oughton (2013) noted that increased competition (often reduced degree of concentration) could potentially bring positive benefits to consumers.

Balance sheet structure resilience: This has to do with the funding model adopted by financial institutions. For example, are banks’ funding models relying on retail deposits or wholesale funding? This is important to avert a credit crisis. The more diverse the funding model, the more resilient the financial institution. Haldene and May (2011) maintained that the more the decline in the funding model diversity, the higher the possibility of systemic risk. The extent to which banks depend on other institutions within the industry for wholesale funding increases the fragility of the institution. On the other hand, when banks rely on alternative funding windows such as the money market or capital market, this will improve diversity and reduce systemic risk.

Geographic/regional diversity: The importance of the geographic/regional diversity sub-index lies in the fact that the regional concentration of financial services evokes direct and indirect effects on the performance of an economy. The direct impact comes from employment and income generation in the sector and its geographic spread or regional concentration. On the other hand, the indirect effect is linked to the central role provided by the financial services sector in providing finance to industry, consumers, and the consequent development of the non-financial sector, that is financial inclusion. The geographic concentration of financial services tends to create a dichotomy in the poverty profile of the people as well as lead to skewed inequality. A more diverse financial services sector, on the other hand, will spread prosperity more and reduce regional inequality. On the aggregate, the more diverse the financial services sector, the more stable and resilience the financial system will be.

Financial stability, systemic risk and “too-big-to-fail”

This section examines stability and resilience of the financial services sector, systemic risk and too-big-to-fail, focusing on how systemic risk is propagated in

the banking system especially in developing economies (Nigeria inclusive) where distorted incentives of decision-makers and propensity for excessive risk-taking could trigger a disturbance in the entire financial system given the increasing level of interconnectedness. Different authors have conceptualized systemic risk. For example, Zigrand (2014) sees systemic risk as the risk to the proper functioning of the system as well as such risk that is equally brought about by the system itself. Also, there is the probability that a disturbance in the financial system such as bank failure or market disruption may activate economy-wide disturbance of the stability of the entire financial or banking system (Nakorji et al., 2017).

The Nigerian financial services sector is interconnected, and this connectedness could provide a fertile ground for the transformation of idiosyncratic risk (transforming from a single institution) into systemic risk. However, interlink among operators results in the financial system in a positive outcome, and as this will culminate in a more robust and much better spread of financial risks in normal time, sometimes, through the application of innovation in derivatives and financial instruments. On the downside, the interconnectedness of the financial system, which also links the balance sheets of banks, through their participation in joint financial infrastructure, can also lead to easy transmission of shocks from one bank to the entire system (throughout the nation) and even across the border) and sometimes amplify those shocks.

This explains the reason financial system regulators and authorities endeavour to ensure a healthy banking system to avoid such systemic disturbance in the system which can escalate to economy-wide risk (Zhou, 2009). Smaga (2014) as cited in Nakorji et al. (2017) classified systemic risk into: (i) groups (common exposure to asset price bubbles, liquidity provision and mispricing of assets, multiple equilibria and panics, contagion, sovereign default and currency mismatch [Allen & Carletti, 2011]); (ii) dimensions (macroeconomic and microeconomic [Nier, 2009]); and (iii) type (macro shocks, failure chains and reassessment failures [Bancarrewicz, 2005]). Another important phenomenon is that the concept of “too-big-to-fail” which assumes that large banks that are systemically important in the financial system cannot be allowed to fail because of their strategic importance and the ripple effect (domino effect) that will arise from such failure.

As a result, the State will be ever-ready to intervene when such systemically important banks run into a problem. This has remained a perennial policy issue even in Nigeria as this has led to some distorted incentives and behaviour by some Chief Executive Officers of some big banks. Labonte (2018) noted that policy makers tend to justify government use of public resources to rescue big banks because of their systemic importance. This may significantly explain the reason some banks were placed on life support by the Central Bank of Nigeria (CBN) and Nigeria Deposit Insurance Cooperation (NDIC) when they had a problem. The initial measures/initiative taken by the CBN in conjunction with the NDIC and the Federal Ministry of Finance was the injection of about NGN620 billion into nine banks and the replacement of the chief executive/executive directors of eight of the nine banks. Also, the Asset Management Corporation of Nigeria (AMCON) was established in 2010 to be a key

stabilizing and revitalizing tool to revive the financial system by efficiently resolving the non-performing loan assets of banks in the Nigerian economy all in a bid to avoid systemic disturbance.

However, the notion of “too-big-to-fail” appears not to hold firmly as NDIC (2015) noted that size is a necessary but not a sufficient factor in determining systemic importance. Hence, the report suggests that all banks identified as systemically important should be subjected to higher capital and other regulatory requirements than those that are not systemically important as “too-big-to-fail” alone now hardly guaranty stability or survival. The technical committee of the International Organization of Security Commission (2011) has identified size (too-big-to-fail), interconnectedness, lack of transparency and the behaviour of market participants as some of the sources through which systemic risk can be propagated in the market. Lauren et al. (2010) noted that the “too-big-to-fail” (size) factor appears to be one of the most important factors because the bigger the size of the bank, the more devastating the failure of such bank will be to the entire financial system.

This may explain why banks are often classified as “too-big-to-fail” based on their size. Similarly, the more interconnected the financial system, the more likely it is that failure in one bank can be transmitted to other banks. This has gathered much more momentum through globalization (such as the increasing emergence of cross-border institutions), innovative finance, etc. The Nigerian banking sector consolidation/recapitalization has led to increasing globalization of the financial system with many of the banks operating cross-border banking; having branches in many African countries and other continents.. Researchers have explained the relevance of participants/stakeholders’ behaviour in the propagation of systemic risks. The Global Financial Report (2010) maintained that certain macroeconomic variables, namely, a long period of a low rate of interest, low-risk premiums, can affect the behaviour of stakeholders. Such factors may predispose participants to take excessive risk and leverage. In essence, participants behaviour may lead to distorted pricing of assets and exposure to risk from multiple sources in the banking industry.

Overview of different approaches of constructing stability and diversity indexes

In recent years, there has been a renewed effort by policy makers, government and financial institutions to produce a single robust statistical index that captures all relevant information on financial system stability. Financial system stability is often not easy to define as a result of the interdependence and complex interactions of diverse elements of the financial system among themselves and with the economy. This, according to Gadanez and Jayaram (2009) is further complicated by the time and cross-border dimensions of such interactions. Financial system stability is quite purely connected with banking stability. Banking stability helps to determine the strengths of an economy to withstand both internal and external shocks. Banking stability depends on the efficacy of several parameters of individual banks, such as

asset quality, liquidity, capital adequacy and profitability. A range of approaches has been employed in the development of an aggregate index for financial stability or banking stability index.

One of such approaches is the one that enables a mechanical comparison between the individual stability indicators characterizing different financial systems. This comprises of a hierarchy of individual indicator values (the aggregate index components). This is a non-parametric method. It has its inconveniences which come from the minimum difference between the values of indicators having the same weight within the aggregate index. Another method of constructing aggregate financial stability index is the use of a weighted average of individual indicators. This method has been used by Rouabah (2008), and it is being used currently by the National Bank of Turkey. Other approaches employed in the development of aggregate financial stability index involves the use of normalization and aggregation procedures. Authors construct this aggregate based on experiences and judgment, as seen in Gersl and Hermenek (2006). Similarly, some researchers have developed aggregate stability index based on daily financial markets data (share prices or prices of other banking assets) as applied in Nelson and Perli (2005) which they referred to as financial fragility index.

Different authors have employed diverse methods to establish weightings for the different variables used in developing their indexes. While some of these researchers have relied more heavily on econometric analysis to develop the weightings of the variables used in constructing their aggregates, others have relied on equal weighting in composing the variables for the aggregate index. Studies like Van den End (2006) equally established an only small discrepancy between equal weighting and weighting by econometric validations. This paper employed Principal Component Analysis (PCA) in constructing the Aggregate Financial Stability Index. This is because the PCA approach helps eliminate arbitrariness in the selection of variables and the determination of the weights used for the computation of the composite indicator. The Principal Component Analysis can capture the individual importance of each indicator from a large pool of indicators. The method transforms a number of correlated variables into a smaller number of uncorrelated variables by identifying orthogonal eigenvectors of the variance-covariance matrix of data. Each eigenvector (known as a factor) captured embodies a linear combination of data and capable of explaining a certain percentage of the overall variability in the original data.

The construction of a composite index involves two main tasks, namely, data selection and weighting. To overcome these twin challenges, this paper employed Principal Component Analysis following Akosalet al. (2018), Mirna (2015), Karanovic and Karanovic (2015) and Mingione (2011), but differs, by not only using the same set of variables (the well known robust IMF-recommended financial soundness and macroprudential indicators) which fit well in this study, but also by introducing some variables that reflect the intrinsic nature of the Nigerian financial system and the inter-linkage with the external economies. Such variables include the United States Federal funds rate and the Net Foreign Portfolio Investment. Unlike the Aggregate

Financial Stability Index, the literature on the development of diversity index in the financial service sector is still scarce and emerging. Notwithstanding, Michie and Oughton (2013) developed a diversity index for the U.K financial services market and have provided a lot of insight to the authors in the present study.

Empirical literature

The idea of developing an Early Warning System (EWS) first occurred in 1975 (Arzamasov & Penikas, 2014). However, the numerical index on bank vulnerability, based on factor analysis technique, was developed by the Federal Reserve Bank of New York in 1977 (Goodhart, 2011). Since these efforts, a burgeoning body of empirical literature has emerged, applying various indexes of financial system stability assessment. Illing and Liu (2003) developed an index of financial stress – the Financial Stress Index (FSI) for the Canadian financial system. Albulescu (2010) developed an aggregate stability index for the Romanian financial system to enhance the set of analysis used by authorities to assess the financial system stability. The index took into consideration indicators related to financial system development, vulnerability, soundness and also indicators which characterize the international economic climate. The constructed aggregate index captured the financial turbulence periods in Romania and the 2007 subprime crisis.

Verlis (2010) developed an aggregate financial stability index (AFSI) for Jamaica using banking system data. The AFSI builds on previous work for Jamaica by aggregating microeconomic, macroeconomic and international factors indicative of banking sector performance into a single measure of financial stability. The index was successful in capturing critical periods of financial instability during the sample period. Van den End (2006) developed a Financial Stability Condition Index (FSCI) for the Netherlands. The index incorporates interest rates, effective exchange rate, real estate and stock prices, the solvency of the financial institutions, as well as volatility of the stock index of financial institutions. The application of the FSCI to the Netherlands and six other Organization for Economic Co-operation and Development (OECD) countries shows that the index indeed reflects the typical boom/bust cycle which might be a harbinger of financial crises.

Nicholas and Isabel (2010) constructed an aggregate financial stability index (AFSI) for Macao using 19 individual partial indicators grouped into three broad categories, namely, financial soundness index (FSI), financial vulnerability index (FVI) and regional economic climate index (RECI). The study results show that the AFSI captures the stress times in Macao's financial history and mirrors financial stability development in the SAR. Karanovic and Karanovic (2015) developed an aggregate financial stability index (AFSI) for measuring financial stability in the Balkans. The index juxtaposes some well-known IMF financial soundness and macroprudential indicators with the World Bank development indicators and CESifo measures of aggregate stability index. Michie and Oughton (2013) developed a diversity index for the United Kingdom financial services market based on four sub-indicators: ownership diversity; competitiveness;

balance sheet/resilience; and geographic spread. The D-Index provides a measure of corporate diversity in the financial services sector, offering policy makers a means to track the movements in diversity.

Contribution/value addition

While there exist a plethora of studies to develop the Aggregate Financial Stability Index (AFSI) in other countries (for example, Albulescu (2010) – Romania, Verlis (2010) – Jamaica, Nicholas and Isabel (2010) – Macao), there has not been a successful effort to develop an AFSI for Nigeria. Previous attempts to develop a semblance of a financial stability index for Nigeria include Sere-Ejembi et al. (2014), Udom and Doguwa (2015) and Udom et al. (2018). These efforts failed to incorporate all the salient financial soundness indicators required by the IMF, and the relevant macroeconomic variables that reflect the intrinsic structure of the Nigerian financial system. These observed limitations have enormous policy consequences. Also, the biannual Financial Stability Report (FSR) of the Central Bank of Nigeria (CBN) only capture assets, capital and income/expense-based indicators, a very narrow approach to financial system stability assessment. This study differs from previous attempts and contributes to the literature in many ways.

First, this study developed a robust Aggregate Financial Stability Index (AFSI) that reflects the intrinsic structure of the Nigerian economy which describes the state of the Nigerian financial services sector using a combination of financial soundness indicators, financial development indicators, financial vulnerability indicators and global economic climate indicators. Second, this study computed the sub-indices of the Aggregate Financial Stability Index (AFSI) and explored their contributions and variability. Third, the study identified macroprudential leading indicators that signal incipient risks to the Nigerian financial system. Fourth, the study considered the experiences of the global financial crisis of 2007-2009 and incorporates indicators for global economic climate for global spillover effects and shock transmission channels as further determinants of financial system stability and resilience. Fifth, the study investigated the relationship between financial stability and financial diversity using the traditional regression method and also employing the Granger causality test to explore the causal relationship. To the best knowledge of the researchers, there has not been any effort to develop a financial diversity index for the Nigerian financial system. This study, therefore, is the precursor of future studies on financial diversity index in Nigeria. Also, to the best knowledge of the researchers, there has not been any study that investigated the relationship between financial stability index and financial diversity index. This study, therefore, is the precursor of future studies on the relationship between financial stability index and financial diversity index.

3. Methodology

Deriving the Aggregate Financial Stability Index

In order to construct a robust aggregate financial stability index, there is the need to choose variables that capture events in the financial services sector. Twenty-five indicators were carefully selected for the construction of the aggregate financial stability index in this study. The variables selected are those that are considered relevant for financial stability and often used in the financial stability literature because of their potential implication for financial system stability. In addition to the IMF-recommended financial soundness variables, this study included additional financial and macroeconomic variables that underscore the inter-linkage between the Nigerian economy and the global economy. Most of these indicators are understandably banking indicators because the banking sector is the most significant within Nigeria’s financial services sector.

Nevertheless, the study also incorporated some indicators such as the ratio of capitalization to GDP to reflect the development of the capital market given the importance of the Nigerian capital market. For ease of data management, and also drawing from existing literature, these variables were grouped, ranging from functional to sectoral to form sub-indices. This study, however, uses grouping by partial dimensions or sub-indices of stability, namely, financial development, financial vulnerability, financial soundness and global economic climate, as can be seen in Table 1.

Table 1: Individual indicators for developing Aggregate Financial Stability Index for Nigeria

Category	Indicator
Financial Development Index (FDI)	
	Market capitalization/GDP
	Total credit/GDP
	Net foreign portfolio investment
	M2/GDP
Financial Soundness Index (FSI)	
Capital Adequacy	Capital adequacy ratio
	Ratio of non-performing loans net of rovisions to capital

Asset Quality	Ratio of non-performing loans to total loans
Liquidity	Ratio of liquid assets to total assets
	Loans to deposits ratio
Profitability	Return on assets
	Interest margin to gross income ratio
	Non-interest expense to gross income
Financial Vulnerability Index (FVI)	
External Sector	Current account balance to GDP ratio
	Ratio of money supply to foreign reserves
	Ratio of external assets to total assets of DMBs
	Ratio of foreign currency assets to foreign currency liabilities of DMBs
Financial Sector	DMBs domestic credit to GDP
Real Sector	Inflation
	GDP growth rate
	Budget deficit/surplus (% of GDP)
Global Economic Climate Index (GECI)	
	GDP growth rate of the U.S
	GDP growth rate of China
	U.S federal funds rate
	Global economic growth rate
	Price of crude oil

IMF Financial Soundness Indicators Compilation Guide, 2019

Financial Development Index (FDI)

Financial development increases a country's resilience and boosts economic growth. It mobilizes savings, promotes information sharing, improves resource allocation and facilitates diversification and management of risk. It supports financial stability to the extent that deep and liquid financial systems with diverse instruments help dampen the impact of shocks. As noted by the World Bank (2016), countries with better-developed financial systems tend to grow faster over long periods, and a large body of evidence suggests that this effect is causal: financial development is not merely an outcome of economic growth; it contributes to this growth. The Financial Development Index (FDI) measures the level of financial system development and consists of the market capitalization of the stock exchange and the ratio of total credit to Gross Domestic Product (GDP), financial deepening variable (M2/GDP), and net portfolio investment. Market capitalization as a share of GDP captures the development of the capital markets, while the ratio of total credit to GDP provides information on the ability of credit institutions in carrying out their intermediation functions (Verlis, 2010). The study estimates the potential of systemic risk and financial system vulnerability arising from capital market exposure considering that the Nigerian bourse was one of the best performing in the world in the immediate period before the global financial crisis, and subsequently witnessed a significant downturn during the period of the crisis.

Financial Soundness Index (FSI)

This sub-index comprises a set of indicators that measure the soundness and health of a country's financial system as well as that of the corporate and household sectors. The introduction of Financial Soundness Index (FSI) dates back to the 1990s. In theory, this index functions as tools for macroeconomic policy as its evolution helps to reveal potential vulnerabilities of the financial services sector and points to possible weakness. Furthermore, this index consists of a vital and integral part of a regulatory authority's macroprudential surveillance toolkit. The FSI essentially adopts the broad framework of the core set of FSIs recommended by the IMF for monitoring and assessing the soundness and stability of the financial services sector. The core set is a small set of indicators that are widely agreed to be essential and operationally useful for periodic monitoring of the soundness and vulnerabilities of the banking sector (Nicholas & Isabel, 2010). This sub-index focuses on capital adequacy, asset quality, liquidity and profitability. Capital adequacy ratio and the ratio of non-performing loans (NPL) net of provisions to capital are measures of capital adequacy. Asset quality is measured by the ratio of NPL to total loans. The ratio of liquid assets to total assets, and the loan-to-deposit ratio measure liquidity, while profitability is measured by return on assets, interest margin to gross income ratio, and non-interest expenses to gross income ratio.

Financial Vulnerability Index (FVI)

The global financial crisis of 2007-2009 provided an important lesson for economic managers and became an eye-opener of sorts to maintain financial system stability. This necessitates the imperative for regular assessment of vulnerabilities in the financial system. Regular assessment will help to reveal early signs of weakness in the financial system and provides a basis for corrective actions that could prevent losses in the real economy and support financial system stability. Financial system vulnerability involves conditions that expose the financial system to future stress. Its degree may be reflected in the exposure of the financial system to a particular risk (Pasruicha, 2013). Identifying vulnerabilities in the financial system help to detect imbalances within a financial system that could signal future episodes of financial stress. Financial Vulnerability Index (FVI) focuses on three key areas indicative of macroeconomic conditions, including the external sector, financial sector and the real sector. The external sector is measured by current account balance to GDP ratio (significant trade deficits require capital inflows and thus raise sustainability concerns); the ratio of the money supply to foreign reserves (the growth of money supply over international reserves provides an indication of reserve adequacy and measures the ability to withstand external shocks and ensure the convertibility of the local currency); the ratio of external assets to total assets of DMBs (measures the external position of the local banking sector); and the ratio of foreign currency assets to foreign currency liabilities of DMBs (measures the mismatch of foreign currency asset and liability positions to assess the potential vulnerability of banks to foreign

exchange movements). The financial sector is measured by DMBs domestic credit to GDP ratio (rapid loan growth is often accompanied by declining loan standards and precedes banking crisis); inflation; GDP growth rate; and budget deficit/surplus (% of GDP).

Global Economic Climate Index (GECI)

There is no gainsaying the fact that the interconnectedness of the global economy has made it impossible to make domestic financial and economic decisions without considering global financial conditions. For example, following the global financial crisis, rising U.S interest rates coupled with stronger U.S dollar and trade tension triggered a reversal in portfolio flows, an increase in borrower's costs, and weakening of local currencies in some emerging economies (International Monetary Fund, 2018). In some cases, external vulnerabilities and country-specific risks could lead to outsized currency depreciation, thereby increasing the concern about the health of domestic banks and the possibility of spill-over to other countries. The Global Economic Climate Index (GECI), which is a synthesis of important global economic indicators consist of indicators that fundamentally impact local and foreign investors' confidence level in the financial system. These include the GDP growth rate of some of Nigeria's major trading partners; the global economic growth rate; and global inflation rate and the price of crude oil. This study included the price of crude oil in the international commodities market. The role of the oil sector in the Nigerian economy cannot be overemphasized, and as such, it is important to incorporate it in the global economic climate index. Although the oil sector accounts for about 10% of Nigeria's GDP (contributing less than 10% in 2019) compared to other sectors like agriculture or manufacturing, it is however, the largest revenue and export earner in Nigeria; contributing about 80% of federal revenue and 90% of Nigeria's export earnings in 2019 (National Bureau of Statistics (2019)).

Standardization of indicators

All selected individual indicators are available in quarterly frequency. As all the indicators used in the study are in different units and their values are of a different order of magnitude, a preliminary transformation procedure was applied. To create indicators that are on the same scale and to avoid having some variables exerting more significant influence on the aggregate index due to scale measurement, the indicators included in the analysis were transformed (standardized). The standardization of the variables entailed subtracting the sample mean from each observation in the sample and, further on, the difference is divided with the standard deviation of the sample. The standardization of variables was undertaken with the following formula:

$$z = \frac{x - \mu}{\delta} \quad (1)$$

Where, z is the standardized value or z-score, x is the observation of the variable/indicator, μ is the sample mean and δ is the standard deviation of the sample.

The standardized variables have a normal distribution with zero mean and standard deviation of 1- $N(0,1)$. The z-score, or standardized value of an observation y , is its distance from the mean measured in units of standard deviation. Positive z-scores lie above the mean, while negative z-scores lie below the mean. This type of statistic is called a measure of relative standing. Standardization of financial indicators is often applied in the construction of composite variables, especially financial stability or financial stress indices (Popovska, 2014), such as the indices of Hanschel and Monnin (2005), the National Bank of Turkey, the National Bank of Albania, among others. Standardization is also recommended in the guidelines for constructing composite indicators by Saisana and Tarantola (2002). After the standardization process, indicators were combined into their respective sub-indexes, after which Principal Component Analysis (PCA) was employed to compute the aggregate indices for the four sub-indices, namely: Financial Development Index (FDI), Financial Soundness Index (FSI), Financial Vulnerability Index (FVI) and Global Economic Climate Index (GECI), and also the overall Aggregate Financial Stability Index for the Nigerian financial services sector.

Construction of aggregate financial stability index using principal component analysis

Following Akosah et al. (2018) Mirna (2015), Karanovic and Karanovic (2015), Mingione (2011) and Brave and Butters (2011) this study adopted Principal Component Analysis to construct the Aggregate Financial Stability Index (AFSI). This approach is attractive because it helps eliminate arbitrariness in the selection of variables and the determination of the weights used for the computation of the composite indicator. The PCA is used to estimate the weight given to each indicator. The benefit is in its ability to determine the individual importance of a large number of indicators so that each indicator receives weight that is consistent with its historical importance to fluctuations in the broader financial system. Such indices have the advantage of capturing the interconnectedness of financial markets – a desirable feature allowing for an interpretation of the systemic importance of each indicator. The more correlated an indicator is with its peers, the higher the weight it receives. This allows for the possibility that a small deterioration in a heavily weighted indicator may mean more financial stability than a substantial deterioration in an indicator of little weight. However, the principal component analysis has its limitations. For example, the choice of which financial indicators to include is often restricted by the frequency of

data availability, as well as the length of time for which data are available. Studies such as Stock and Watson (2002) have shown how to relax some of these constraints, and in this study, the availability in quarterly series of modified IMF-backed financial soundness data for stability with broad coverage help to relax these constraints. The details of the procedure of the Principal Component Analysis are given in the appendix section (see Appendix 2).

Constructing financial diversity index (D-Index) for Nigeria

There is increasing emphasis on the role of diversity in promoting financial stability and resilience of the financial system. One cardinal objective of this research is to measure the diversity of Nigeria's financial services sector. In developing a financial diversity index for the Nigerian financial system, this study followed Michie and Oughton (2013). Four measures of diversity have been identified in the literature which includes: ownership and corporate diversity; market competition; balance sheet structure and resilience; and geographic spread and concentration of financial services. Aggregated, all four measures/components gives the Financial Diversity Index (D-index).

Ownership and corporate diversity

We compute the corporate diversity using the Gini-Simpson Index of Diversity given as:

$$\lambda = - \sum_1^z \pi_j^2 \quad (2)$$

Where, π_j is the share of the total population that belongs in each of the groups or types. This will be subtracted from 1 to give the Gini-Simpson Index of Diversity as:

$$D = 1 - \sum_1^z \pi_j^2 \quad (3)$$

Applying this index will give an index of corporate diversity based on the number of corporate forms/types and their respective market share.

Market competition: Too big to fail

This is measured by the concentration ratio, or the Hirschman-Herfindahl Index. The 5-firm concentration ratio (C5) may be defined as the ratio of the retail deposits of the largest financial institutions to the total market for deposits, respectively. For example, C5, measured in terms of deposits, is attained by ranking all banks from the largest to smallest according to their deposits, identifying the deposits of the five largest, and dividing the collective holding of these five largest by the total deposits in the sector as a whole:

$$C5_d = \frac{\sum_1^5 d_i}{\sum_1^n d_i} \quad (4)$$

Where, the subscript, i , denotes firms, where $i=1,2,3,\dots,n$; and n is the number of firms or banks in the industry. This measure gives equal weight (one) to the five largest institutions and zero weight to institutions outside the top five. Theoretically, it lies between $5/n$ and 1, or expressed as a percentage, between close to zero and 100%.

The concentration ratio (5-firm or 4-firm), while frequently being used because it requires only data on the top 4 or 5 firms and the market as a whole, it is fraught with some limitations. Prominent among which is the fact that it fails to pick inequality within the top 5 or within the tail (firms outside the top 5) of the distribution. The Hirschman-Herfindahl (HH) index is a more comprehensive index which considers individual market share of each firm in a market, S_i , and combines these into an index by weighting each firm's market share by itself:

$$HH = \sum_{i=1}^n S_i^2 \quad (5)$$

HH index is dependent on the number of firms and the market share of each firm or the degree of inequality in firm size. It lies between $1/n$ and 1. For a pure monopoly, the index equals 1, but for a competitive industry with a large number of firms, the lower bound of the index approaches zero.

Balance sheet structure and resilience

The way the balance sheets of financial institutions are managed is very critical to the resilience of the institutions. The way the balance sheets evolve is a pointer to the way the business is run as well as indicates the interconnection with other institutions. Our concern in this measure is the funding risk which has been recognized as being critical during a crisis. This is because, during a crisis, firms that rely on wholesale funding, particularly on short maturities are soon to find out that they were not able to roll over their funding lines. Borrowing its funding from other institutions indicates interconnectedness in the system but at the same time add to the fragility of the system when there is a problem. One notable indicator of the different funding model used by banks at different time periods is the customer funding gap which is measured as the difference between loans and deposits expressed as a proportion of the total loans (i.e., Loans-Deposit/Loans).

To check the changes in the funding gap, this study constructed a concentration index in loan/deposit ratios that can be subtracted from 1 to give an index of funding

model diversity. The HH (loan/deposit) concentration index measures the sum of the weighted shares of each bank's loan to deposit ratio in the sum of the loan to deposit ratios for the sector as a whole. The concentration index is based on the standard Simpson, HH formula defined as:

$$HH_{LD} = \sum_i^n \left[\frac{\left(\frac{L}{d}\right)_i}{\left(\sum \left(\frac{L}{d}\right)_i\right)} \right]^2 \quad (6)$$

Based on the formula (6) above, we can construct the diversification index by subtracting HH_{LD} from 1. This falls as the number of banks increases showing greater diversity and lower risk because of less concentration of lending.

To capture funding model diversity, this study combined HH index of funding model and the market concentration of loan to deposit ratios with equal weight using the diversity counterpart of the HH Loan to Deposit Concentration index, D_{LD} given by:

$$D_{LD} = 1 - \sum_i^n \left[\frac{\left(\frac{L}{d}\right)_i}{\left(\sum \left(\frac{L}{d}\right)_i\right)} \right]^2 \quad (7)$$

and the inverse of the funding gap spread (FGS) as a measure of resilience:

$$\frac{1}{FGS} = \frac{1}{\left(\left(\frac{L-D}{L}\right)_{MAX} - \left(\frac{L-D}{L}\right)_{MIN}\right)} \quad (8)$$

to yield an index of funding model diversity.

Geographic spread and concentration of financial services

The headquarters of all commercial banks in Nigeria are located in Lagos, Nigeria's major commercial centre. This affects the regional distributions of banks, the way they are concentrated, and how they create wealth and income. Modifying Michie and Oughton (2013) given data consideration, this study created the geographic concentration index by computing the polarization of banks' branches across States in Nigeria.

The Diversity Index (D-Index) for Nigeria's financial services sector

The four sub-indices (corporate diversity, competition, funding gap model diversity, and geographic spread) were combined to derive the Financial Diversity Index (D-Index).

Investigating the relationships between financial diversity and financial stability

To execute this objective, first, the study employs the traditional econometric regression method and also the Granger causality model. The traditional regression helps to investigate the effect of financial diversity on financial stability econometrically. The Granger causality analysis helps to reveal which of the variables granger cause the other, thereby extending the analysis beyond just effect relationship.

The causal effect relationship between financial stability and financial diversity

We estimated a fairly simple model using Nigerian banking data from Bankscope. The financial stability measure is constructed using the Principal Component Analysis (PCA) while the financial diversity index was constructed using both Hirschman-Herfindahl Index and Gini-Simpson Index of Diversity. We regress the financial diversity and set of control variables (interest rate, inflation rate and exchange rate) on the financial stability measure. The model is specified thus:

$$FS_t = \beta_0 + \beta_1 FD_t + \beta_2 int_rate_t + \beta_3 Exch_rate_t + \beta_4 inf_rate_t + \mu_t \quad (10)$$

Where the control variables are as defined earlier, while β_0 = intercept; $\beta_1, \beta_2, \beta_3, \beta_4$, are the partial slope coefficient or parameters of regressors; μ_t = Error term.

To examine the causal relationship between Financial Stability (FS) and Financial Diversity (FD), we employed the simple Granger-Causality test to test whether financial diversity “Granger Cause” financial stability and vice versa. Based on this, we estimated two OLS equations:

$$(FS)_t = \alpha + \sum_{i=1}^m \beta_i (FS)_{t-i} + \sum_{j=1}^n \phi_j (FD)_{t-j} + \varepsilon_t \quad (11)$$

$$(FD)_t = \phi + \sum_{i=1}^p \gamma_i (FD)_{t-i} + \sum_{j=1}^q \psi_j (FS)_{t-j} + \mu_t \quad (12)$$

Based on the estimated OLS coefficients for equations 1 and 2, four different hypotheses about the relationship between financial stability and financial diversity can be formulated:

1. Unidirectional Granger-Causality from Financial Stability (AFS) to Financial Diversity (FDiv). In this case, an increase in financial stability increases the prediction of the diversity of the financial system but not vice versa.
2. Unidirectional Granger-Causality from Financial Diversity to Financial Stability. In this case, increase or improved financial diversity increases the stability of the financial system but not vice versa.
3. Bidirectional (Feedback) causality. In this case, improvement or increase in financial stability will also increase or improve financial diversity and vice versa.

4. Independence between Financial Stability and Financial Diversity. In this case, there is no Granger Causality in any direction. Thus, financial stability does not Granger cause financial diversity neither does financial diversity Granger cause financial stability.

Data for the study/estimation

This study utilized secondary data (quarterly and annual frequency) from the Central Bank of Nigeria (CBN) and the Bankscope Database, spanning the period Q1, 2006 to Q4, 2015. The choice of this period is informed by the banking sector consolidation exercise of 2004-2005, capturing the post-consolidation era through the period of the global financial crisis of 2007-2009, and the post-crisis period. Additional data were sourced from the World Development Indicators and the International Monetary Fund (IMF). Seventeen deposit money banks (DMBs) were used for the study out of the existing 23 banks after consolidation and subsequent mergers due to data availability and consistency. The estimation was carried out in STATA.

4. Results and discussion

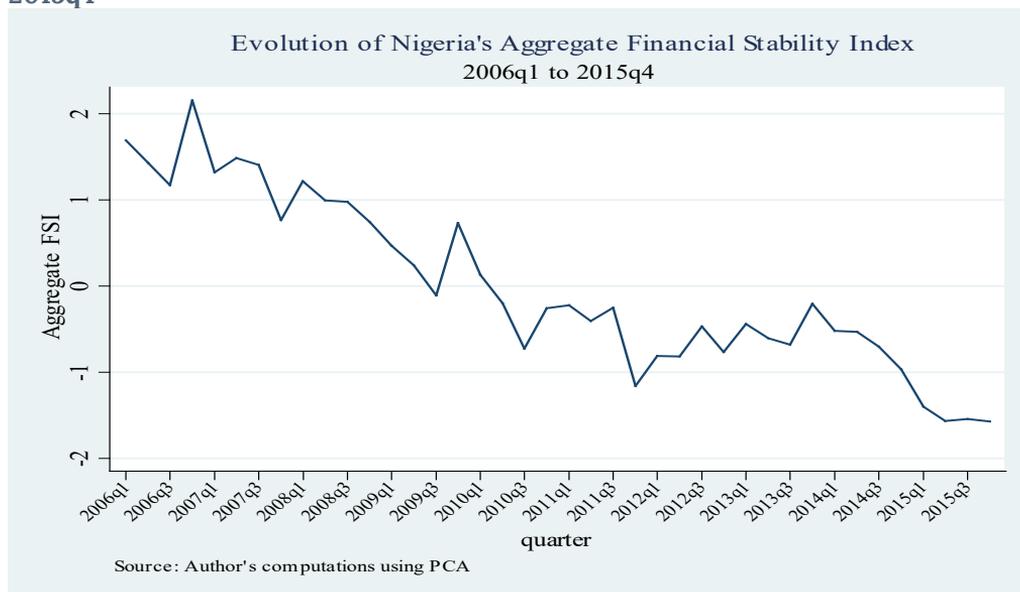
Aggregate Financial Stability Index

From Figure 1, it can be observed that the Aggregate Financial Stability Index (AFSI) showed apparent instability and did not maintain any definite pattern of movement. For example, there was a deterioration of the AFSI immediately after the banking sector consolidation exercise. A positive evolution only began in the third quarter of 2006 and lasted until the third quarter of 2007. There was further general negative evolution of the AFSI immediately after the third quarter of 2007 through the second quarter of 2009 where the index improved albeit marginally, and further deteriorated till 2015. It is pertinent to note that from the second half of 2008 till 2015, the index remained below the benchmark point of 1.0. This result corroborates earlier studies by Sere-Ejembi *et al.* (2014) and Udom and Doguwa (2015) who maintained that the negative evolution of the stability index in the first quarter of 2009 was because of the contagion effect of the global credit crunch which manifested from the end of August 2008.

This result is against all expectations, given the numerous reforms and interventions that have taken place in the Nigerian financial services sector. For example, with the banking sector reform and consolidation, banks' minimum capital base was raised from NGN2 billion to NGN25 billion, corporate governance was thought to be improved, unethical practices also presumed to be eliminated, and more importantly, depositors' confidence was restored as the Central Bank of Nigeria (CBN) assured investors and depositors that with the NGN25 billion capitalization, Nigerian banks have become strong and resilient to shocks. Indeed, about NGN406 billion was raised by banks from the capital market during the consolidation exercise, while the process led to the inflow of foreign investment of US\$652 million and 162,000 pounds sterling. Besides, the Asset Management Company of Nigeria (AMCON) was established in the second quarter of 2010 as a "bad bank" with the special mandate of acquiring, managing and disposing of non-performing assets of banks, essentially mopping up of banks' toxic assets all in a bid to ensure stability in the financial system. The instability in the financial sector is worrisome and has some policy implications as there is a need for the supervisory authorities (Central Bank of Nigeria) to pay close attention to critical financial soundness indicators. For example, in 2018, two banks; Skye Bank and Diamond Bank slide into a dire situation and Skye Bank was taken over by a bridge

bank arrangement and subsequently changed the nomenclature to “POLARIS BANK”, while Access Bank acquired Diamond Bank.

Figure 1: Evolution of Nigeria's Aggregate Financial Stability Index, 2006q1 to 2015q4



Source: Authors' computation using PCA.

Quarterly movements in the components of Aggregate Financial Stability Index, 2006 to 2015

Figure 2 shows the movements of the different components of the Aggregate Financial Stability Index (Financial Development Index, Financial Soundness Index, Financial Vulnerability Index and Global Economic Climate Index) for the period 2006 to 2015. The result reveals that the Financial Development Index (FDI) was stable and consistent from Q1 2006, rising sharply in Q1 2013 before it started a downward trend in 2015. However, the sharp downward spiral of the FDI in 2009 could be explained partly by the spill-over effect of the global financial crunch and the decline in the market capitalization of the Nigerian Stock Exchange (NSE) which fell from NGN12 trillion in 2008 to between NGN4 trillion and NGN5 trillion in Q3 2009. The global financial crisis led to outflow of funds from the capital market as the capital market became bearish, and according to Udom and Doguwa (2015), the ratio of total market capitalization to GDP fell from 39.7% at the end of 2008 to 28.5% at the end of 2009.

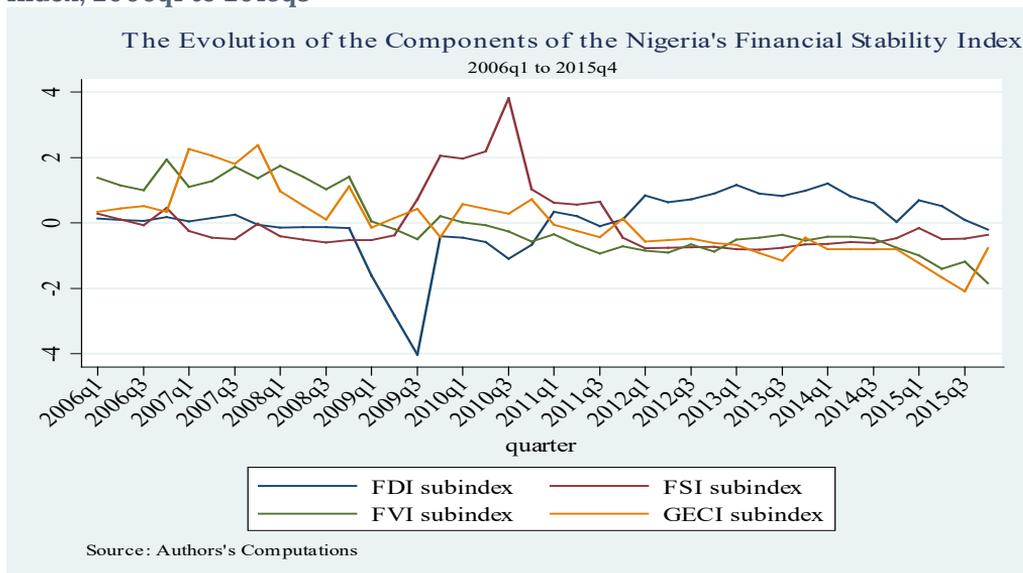
This result was expected as the collapse of the capital market within this period eroded investors' confidence and the withdrawal of foreign institutional investments. However, with the intervention of government through bailout and other stimulus packages, the banking sector soon picked, and the FDI recorded some improvement until 2015 where the country experienced an economic recession which probably

affected the FDI in 2015 as could be observed in Figure 2. Furthermore, the Financial Vulnerability Index (FVI) and the Global Economic Climate Index (GECI) did not maintain a definite pattern of movement, increasing and declining intermittently between Q1 2006 and Q1 2011 but became reasonably stable below the 2006 level from 2011.

It is instructive to note that Financial Soundness Index (FSI) was the poorest among the four components of the Aggregate Financial Stability Index (AFSI) between 2006 and 2009 but gained momentum and rose sharply in the third quarter of 2010. This sharp rise was, however, short-lived as the FSI had a sharp decline in Q1 2011 remained reasonably stable and constant till 2015. A pertinent point to note is that the Financial Vulnerability Index and the Global Economic Climate Index appear to be the most volatile among the different components of the Aggregate Financial Stability Index (AFSI). This may be largely explained by fluctuations in some macroeconomic fundamentals like global oil price as well as the effect of the GDP growth rate of some of Nigeria’s major trading partners. This result has some policy implications more so as the global macroeconomic climate forms part of the key assumptions underlying the budget of a country.

On the aggregate, the Nigeria financial system was unstable within the period under study. More importantly, the financial services sector witnessed a considerable deterioration in the aggregate financial stability index within the study period. This is against expectation, given the series of reforms and interventions in the sector. Furthermore, the Financial Soundness Index was seen to be the highest and relatively most stable among the four components of financial stability indices while the global economic climate index recorded the lowest though reasonably stable.

Figure 2: The evolution of the components of the Nigeria’s Financial Stability Index, 2006q1 to 2015q3



Source: Authors’ computation using PCA.

Determinants of Aggregate Financial Stability Index (AFSI)

The results of the factor loading for the different components of the Aggregate Financial Stability Index are shown in Appendix 3. As regards the Financial Development Index, the results from the rotated factor loadings suggest that market capitalization, the ratio of total credit to GDP and the financial deepening variable determine the Financial Development Index in Nigeria. This result agrees with Behn et al. (2016) which found that recapitalization is vital in banking sector development and helps to predict banking sector vulnerability.

Similarly, the result on the Financial Soundness Index shows that four variables, namely, capital adequacy ratio, the ratio of non-performing loans to total loans, the ratio of non-performing loans to net of provision to capital and loans to deposit ratio are the key factors that determine the soundness of the Nigerian financial services sector. These results tend to corroborate studies like Aruwa & Naburgi(2014) who found that capital adequacy ratio in Nigeria influences banking performance. Regarding the Financial Vulnerability Index, the result reveals that the ratio of money supply to foreign reserves, the ratio of foreign currency assets to foreign currency liabilities of deposit money banks (DMBs) and the ratio of budget deficit/surplus as a ratio of GDP are all determinant factors in financial vulnerability. The result also suggests that the GDP growth rate of the U.S and GDP growth rate of China, determine the Global Economic Climate Index. This is in line with the findings of Behn et al. (2016) that global variables contribute to predicting banking sector vulnerabilities.

Constructing the Financial Diversity Index for Nigerian financial services sector

As noted earlier, recent research efforts on financial system stability have underscored the importance of 'diversity' in maintaining stability and ensuring competition in the financial system. In this section, we followed Michie and Oughton (2013) and Oughton (2017) to construct the financial diversity index for Nigeria based on four sub-indicators, namely, ownership or corporate diversity; market competition; balance sheet structure/resilience; and geographic or regional concentration. The results are as discussed below.

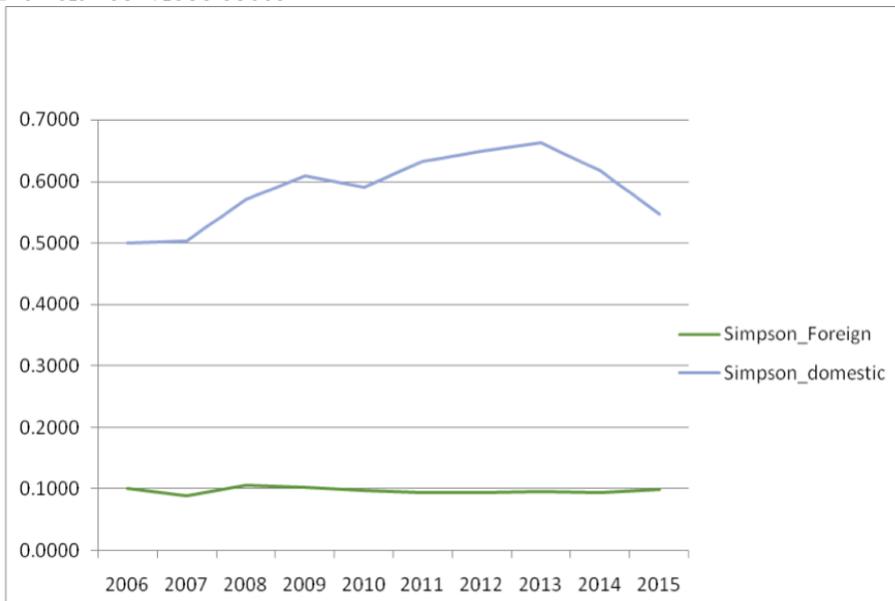
Ownership and corporate diversity

One central feature in the measurement of corporate diversity is the identification of distinct types or forms of corporate firms (Michie, 2011), which also underlie the organizational objectives and behaviour. Two types of banks were identified based on ownership – either foreign-owned or local/domestic. Incidentally, all the domestic or locally-owned banks are listed on the Nigerian Stock Exchange (NSE) while the foreign-owned banks are not listed. Domestic banks have the advantage of lending to “soft information” firms which allows them to lend more and at higher rates without

substantially higher default rate. On the other hand, foreign banks have the advantage of access to external liquidity from their parent banks which lower their deposit costs. The ownership and corporate diversity index in the Nigerian financial services sector was measured from the deposit side of their balance sheets.

The banking sector reform or consolidation of 2004-2005 propelled banks to woo shareholders to improve their shareholding base and woo customers to attract substantial deposits through the introduction of different kinds of products and services, and this increased their market shares in the sector. The higher the number of products, the higher the diversity index. The result equally shows that in the run-up to the global financial crisis, there was increased diversity in the domestic banks, perhaps due to increased shareholdings and product diversifications post-bank consolidation. However, there was a dip in diversity in 2010, 2014 and 2015. This suggests that at a certain stage, domestic banks became homogenous and no longer diversified their products and services (supplying similar product and services) as the banks virtually provide identical services. On the other hand, the foreign banks were less diversified immediately following the bank consolidation period between 2006 and 2007 but improved from 2007 and remained relatively diversified. This may be explained by the fact that foreign-owned banks tend to garner more customer confidence and remain more stable and reasonably diversified.

Figure 3: Simpson index on ownership and corporate diversity in the Nigerian financial services sector

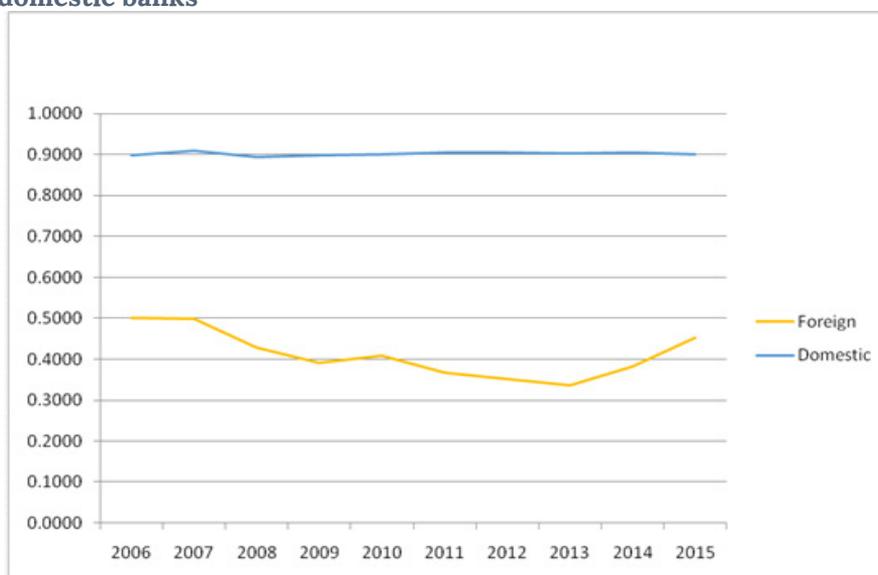


Source: Authors' Computation

Market Competition Index

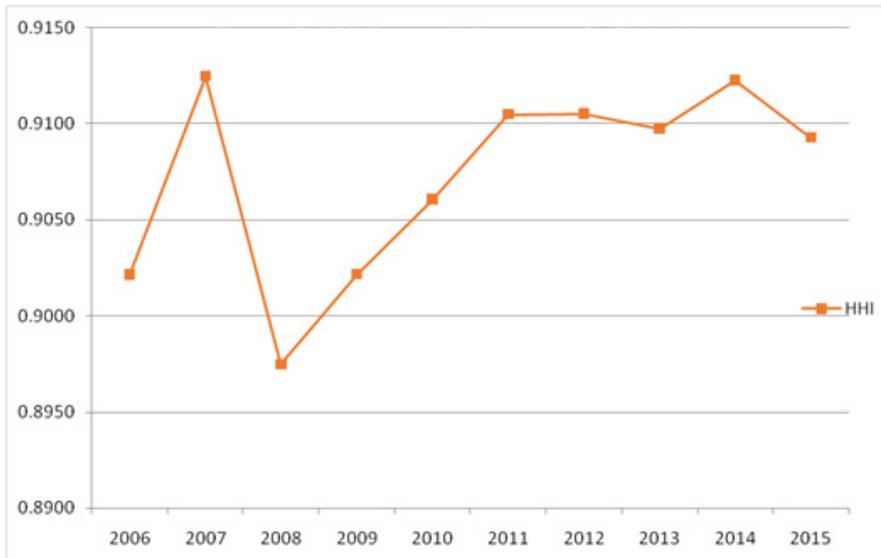
The Hirschman-Herfindahl Index (HH Index) was used to measure market competition for domestic banks, foreign banks and the entire financial services sector. The results of the measurement are contained in figures 4 and 5. The result in Figure 4 shows that there was a transitory rise in competition among domestic banks in the post-consolidation period in the run-up to the crisis in 2008. It is pertinent to note that the banks remain remarkably concentrated since the credit crunch up to 2015. The result shows a tendency for few banks towards monopolizing the industry probably due to their market share in the industry or funding model. This may not augur well for the sector as competition reduces the tendency for few banks to dominate the industry.

Figure 4: Hirschman-Herfindahl index of market competition by foreign and domestic banks



Source: Authors' Computation

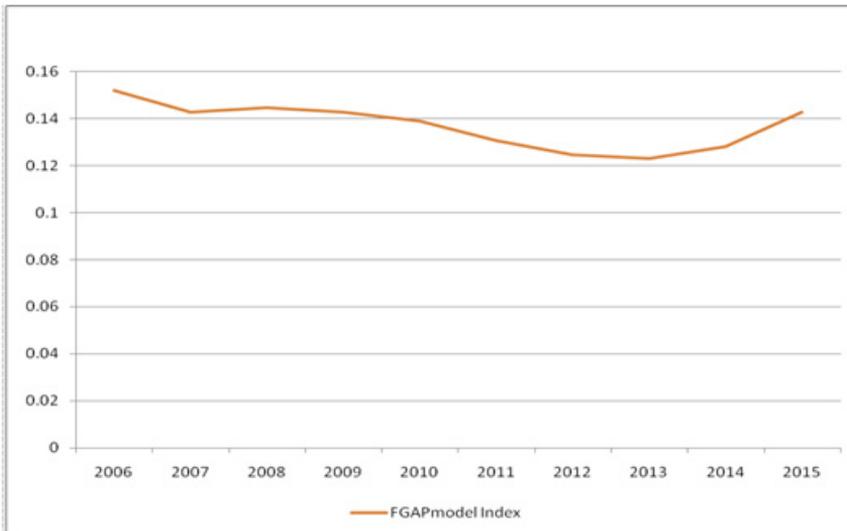
However, a look the HH-Index for market competitiveness of all banks reveals a cyclical situation in which there was increased competition in the run-up to the financial crisis (2007), decreased in 2008, rose again till the second half of 2010 where the market became concentrated till 2013. Interestingly, there was increased competition between 2013 and 2015, where the market became less competitive. The cyclical nature of competition does not make for predictable stability and could have implication for investment decisions.

Figure 5: HHI competitiveness - All banks30

Source: Authors' Computation

Balance sheet structure and resilience

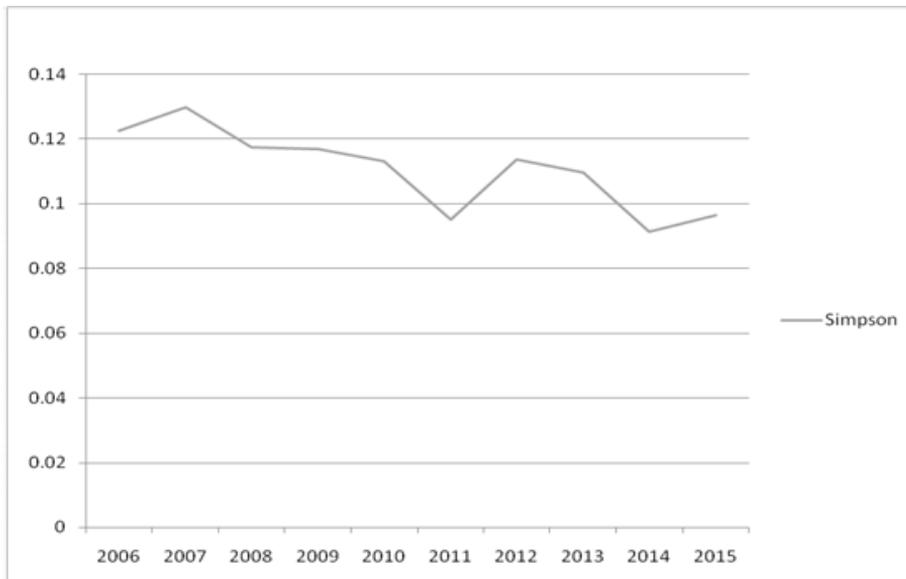
The balance sheet structure across the financial system tends to reveal the management approaches as well as the interconnectedness of institutions, including risk-taking. The balance sheet structure and resilience deal with the funding model of institutions. As Michie and Oughton (2013) noted, funding risk is one of the key risks that become apparent during a period of crisis and hence the need to curtail risky behaviour of banks by looking at how banks diversify risks. Figure 6 shows that the Nigerian banking sector is fairly diversified in terms of funding risk. This means that there is a reduced rate of within-institution borrowing more so as there has been a reduction in banks' over-reliance on the Central Bank of Nigeria expanded discount window to meet credit demand. This ought to be a useful component of stability and resilience, but this has to be witnessed in other sub-indicators of diversity.

Figure 6: FGAP model index

Source: Authors' Computation

Geographic spread and concentration of banks

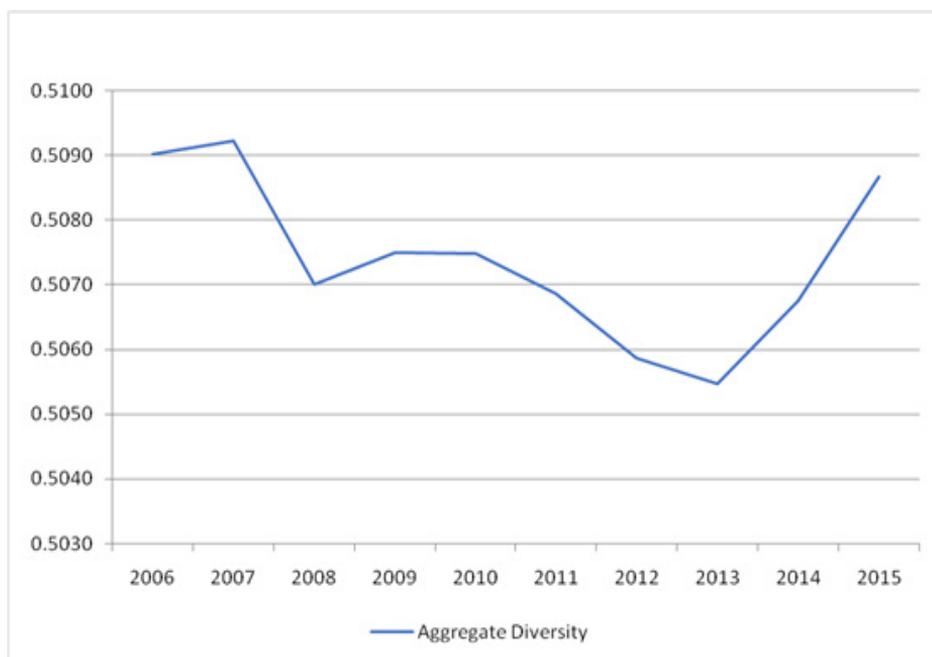
Like in so many countries where there is an apparent regional pattern in the concentration of financial services, the Nigerian financial services sector suffers the same feat. Nearly all banks in Nigeria have their headquarters in Lagos, the country's commercial centre. This also tends to affect the pattern of income and wealth distribution, thereby creating a regional problem. Nevertheless, a remarkable difference is that the banks equally have branches in all the 36 States (sub-national levels of government) in the country and the Federal Capital Territory, though disproportionately. Hence, the index of branch concentration was computed to see how polarized or concentrated the bank branches are. Figure 7 shows the nature of banks' branch concentration. Despite having headquarters in Lagos, the graph reveals that the banks are fairly diversified in terms of branch/regional concentration. As the government intensifies its financial inclusion drive, geographical diversification of bank branches becomes very imperative to avoid increased inequality in access to financial services, income and employment.

Figure 7: Simpson diversity index of branch concentration

Source: Authors' Computation

Aggregate Financial Diversity Index (D-Index) for Nigeria's financial services sector

As stated earlier in this study, the four components of the Aggregate Financial Diversity Index (D-Index) – corporate and ownership, market competition, funding model, and geographic spread index interact to produce the combined aggregate effect in the financial system. The D-Index mirrors the pattern of the four sub-indicators discussed earlier. Figure 8 shows that the Aggregate Financial Diversity Index maintained a cyclical pattern of movement, which consequently will have a similar effect on the stability and resilience of the financial services sectors. For example, when there is diversity in ownership and market competition, there will be a tendency for increased diversification of risk through product/services and shareholder diversification. Again, more market competition will reduce concentration and weaken the monopoly power of a few big banks, which will also improve the incentive for investment and help in household welfare improvement. Similarly, diversity in funding model and banks' concentration helps to reduce systemic risk and promote reasonably equitable distribution of prosperity. All these sub-indicators if well-diversified, will improve financial stability and resilience. Given the numerous reforms and intervention in the Nigerian financial services sector, these results are far from expectation and therefore call for policies to address the cyclical pattern of diversity in the sector to improve stability and resilience.

Figure 8: Aggregate financial diveristy index for Nigeria

Source: Authors' Computation

Relationship between Aggregate Financial Stability Index and Financial Diversity Index in the Nigerian financial services sector

The effect of financial diversity on financial stability

Table 2: Regression results of the effect of diversity on stability

	Stability_index	Diversity_index
Diversity_index	509.2053* (0.0002)	
Stability_index		0.0006* (0.0002)
Exchangerate	0.0443 (0.6538)	-6.1600 (0.3132)
Interestrates	-0.3557 (0.6493)	0.0005* (0.0473)
Inflation	-0.1530 (0.2601)	-0.0001* (0.0423)
c	-258.4393* (0.0002)	0.5000* (0.0000)
N	40	40
Adj R²	0.3303	0.4265

Notes: P statistics in parentheses; + p < 0.10, * p < 0.05.

The result of our analysis reveals that the data on the Nigerian banking sector within the period under study support one clear general observation from literature. That is, there is a direct relationship between financial diversity and financial stability. The result in Table 2 reveals that the more diverse the Nigerian financial services sector, the more stable it is. This indicates that there is a significant positive relationship between financial diversity and financial stability. This result corroborates Deller and Watson (2015) who found that more diversified economies will enhance economic stability. The result further reveals that among the control variables included in the model, inflation and interest rate show a negative relationship with stability index but their effects were not significant. Similarly, the second regression which investigates the effect of stability on diversity also shows that financial stability has a significant effect on diversity. This implies that the more stable the financial services sector is, the more likely the sector will be diverse. Furthermore, we sought to investigate the causal relationship between financial stability and diversity in the Nigerian financial services sector using the Granger causality test. The result is as shown in Table 3.

Table 3: Granger causality tests between diversity and stability

gcause Stab_index Divers_index, lag(1)	
Granger causality test	Sample: 2006Q1 to 2015Q4
obs = 40	
H0: Divers_index does not Granger-cause Stab_index	
F-Statistics = 1.105	
Prob > F = 0.2999	
gcause Divers_index Stab_index , lag(1)	
Granger causality test	Sample: 2006Q1 to 2015Q4
obs = 40	
H0: Stab_index does not Granger-cause Divers_index	
F_Statistics = 3.3917	
Prob > F = 0.0736	

In investigating the relationship, the study tries to establish any of the four relations in Section 3. The Granger causality analysis result above revealed that financial diversity granger causes stability, while stability, in turn, granger causes diversity. This implies that there is bidirectional causality running from financial diversity to stability and from financial stability to diversity. This result is significant and has policy implications as to what should be the effort of policy makers.

5. Conclusions, policy implications and recommendations

This study assessed financial system stability and diversity in Nigeria using annual and quarterly banking sector data from 2006 to 2015. The study applies Principal Component Analysis (PCA), Hirschman-Herfindahl (HH) index, Simpson's index, simple regression and Granger causality analysis to develop an Aggregate Financial Stability Index (AFSI), Aggregate Financial Diversity Index (AFDI) and investigate the determinants of both AFSI and AFDI as well as the relationship between the AFSI and AFDI in Nigeria. For the AFSI, the study used financial development index, financial soundness index, financial vulnerability index and global economic climate index to derive the AFSI. On the other hand, the financial diversity index was constructed using ownership/corporate diversity, market competition, balance sheet structure/resilience and geographic spread and concentration index. The result shows that the Nigerian financial system shows a cyclical movement. The financial development sub-index is fairly more stable while the financial soundness sub-index is the least stable. Furthermore, this study concludes that the Nigerian financial system is far from achieving 'diversity' which has been identified in recent policy and academic debates as a veritable factor in ensuring stability and resilience to avoid a crisis. An interesting outcome of the study is that financial diversity positively influences financial stability in the same way financial stability influences financial diversity. In the same vein, there is a bidirectional causality relationship between financial stability and financial diversity.

Given the findings, the study recommends that regulatory and supervisory authorities in the Nigerian financial services sector should include the diversity of financial services in their policy design as this will enhance, not only the stability of the financial system, but also the economy as a whole. The Central Bank of Nigeria can also regularly monitor banks' funding models to ensure that banks set up diverse funding plans to preempt a systemic crisis.

Recent literature is replete with the opinion that greater diversity of the financial services sector will enhance stability, and this is shaping public policy discourse on the importance of achieving greater diversity in the financial services sector. The findings that the Nigerian financial system is far from attaining diversity has policy implications. In this regard, more considerable effort is required by the regulatory and

supervisory authorities to ensure that diversity is key in the financial services sector policy design. In this regard, attention should also be focused on the components of the D-Index as this provide the regulators with means of tracking progress made.

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Appendixes

Appendix 1: Table showing different studies that applied different approaches for constructing AFSI

Table A1

Author(s)	Methodology Applied	Country Examined and Period Covered	Key Findings	Significant Explanatory Variables
Albulescu, C. (2010)	Stochastic simulation model.	Romania (1999-2010)	Deterioration of financial stability in 2009, influenced by the estimated decline in the financial and economic activity.	Economic and financial indicators.
Arzamasov, V. and Penikas, H. (2014)	Dependent variable and principal component method.	Israel (1Q2003-3Q2013)	Commercial real estate loans to total loans is the best predictor for economic resilience.	Commercial real estate loans to total loans.
Dimitrios, P.L. and Angelos, T.V. (2013)	Principal component method, multivariate GARCH model.	Greece	Financial systemic stress index is able to provide a precise periodization of crises.	
Frait, J. and Komárková, Z. (2011)	Macro-prudential framework and traditional monetary policy framework.	Czech Republic	Authorities can use relevant tools to prevent systemic risks or mitigate its impacts. Different tools are used in the materialization phase, preventing de-escalating elements of instability is priority to forestall panic adjustment by financial institutions and other clients in response to revision of expectations, and to mitigate the negative impacts of the significantly worse conditions.	

Hanschel, E. and P. Monnin (2005)	Variance-equal weight method.	Switzerland (1987-2002)	Banking stress can show up in different ways. Again, model incorporating Swiss and European GDP, credit and investment ratios to national GDP, the stock price index and housing prices is able to explain a large part of the Swiss banking sector's stress level.	Swiss and European GDP, credit and investment ratios to national GDP, the stock price index and housing prices.
Imanov, G.C., Alieva, H.S. and Yusifzadeh, R.A. (2017)	Employed intuitionistic fuzzy to assign weights to the different sub-indices in the process of normalizing the indicators.	Azerbaijan (2005-2015)	The study found that the fuzzy assessment of the aggregate financial stability index is more capable compared to standard approach in capturing the dynamics of financial stability.	Financial market indicators, financial vulnerability indicators, financial soundness indicators and world economic index.
Jordan, A. and Smith, L. (2014)	Principal Component Analysis.	Bahamas	The study shows three distinct periods in the evolution of financial stability.	Financial soundness index; financial development index; financial development index; financial vulnerability index and the economic climate index.
Mingione, F. (2011)	Signalling approach, Different Principal Component Analysis and ARDL.	Jamaica (1996Q1 to 2011Q1)		Forecasting method does not provide with a good out of sample performance when it is used to predict the EWS. Instead it significantly improved its prediction power in the case of the AFSI. Indeed, the ADL model with PCA factors resulted to be superior to benchmark models when forecasting a financial aggregate single index.

Mirna, D. (2015)	Principal component method.	Croatia (2003-2012)	The study finds that the process of risk accumulation in Croatia was to the greatest extent related to strong lending activity. On the other hand, materialization of risks was foremost manifested in bank's balance sheets as an increase in the non-performing loan ratio, which also reflected negative development in the real sector.	Systemic risk accumulation index and systemic risk materialization index.
Nayn, Z.M. and Siddiqui, M.S (2014)	Statistical normalization	Bangladesh	The study finds that Aggregate Financial Stability Index for Bangladesh performed reasonably well in identifying stresses in the financial system during FY 2008-9 and also at the end of 2010, when the country stock market crashed, and the banking system faced liquidity crunch.	Banking soundness, financial vulnerability and regional economic climate.
Nicholas, C. and Isabel, C. (2010)	Macro-prudential analysis	Macao	The result shows that the level of financial stability deteriorated during the Asian crisis of economic recession of the late 1990s and the eruption of the global financial crisis in 2008.	Economic and financial indicators.
Popovska, J. (2014)	Equal weight measure	Macedonia (2005-2012)	The banking system has been continuously stable as a result of the previous conservative policies of the banks and NBRM.	
Sere-Ejembi, A., Udom, I.S., Salihu, A., Atoi, N.V. and Yaaba, B.N. (2014)	Statistical and conference board methodology normalization process	Nigeria (2007Q1 to 2012Q2)	The Banking System Stability Index is capable of acting as an early warning mechanism of signaling frailty.	Bank soundness indicator and Economic Climate Index.

Udom, I.S. and Doguwa, S.I. (2015)	Statistical normalization and empirical	Nigeria (Q1 2008 to Q4 2013)	The study finds signs of instability in the Nigeria's financial system from Q2 2008 at the wake of global financial crisis, worsen in Q3 2009 but stabilized in 2010.	Banking, insurance and capital market Indicators.
Udom, I.S., Eze, O.R. and Inim, V.E. (2018)	Macroprudential approach	1997 to 2016	The study shows that by the end of 2016, clear signs of impending crises had started to emerge in the system.	Indicators of capital adequacy, asset quality and profitability.
Verlis, C.M. (2010)	Empirical normalization and Simulation model.	Jamaica (1997 to 2010)	The study revealed a general improvement in financial stability in Jamaica and also affirms the sensitivity of constructed index to variability in key macroeconomic indicators.	Financial development index, financial vulnerability index, financial soundness index and world economic climate index.
Michie, J. and Oughton, C. (2013)	The Diversity Index (D-Index).	United Kingdom (2000 to 2011)	The D-Index provides a measure of corporate diversity in the financial services sector, offering policy makers a means to track the movements in diversity.	Ownership Index, Competitiveness Index, Resilience Index, Concentration Index.

Appendix 2: Procedure for constructing Aggregate Financial Stability Index using Principal Component Analysis

The principal components of a set of variables are obtained by computing the eigenvalue decomposition of the observed variance matrix.

Let the random vector $X' = [X_1, X_2, \dots, X_p]$ have the covariance matrix Σ with eigenvalues $\lambda_1 \geq \lambda_2 \geq \dots \geq \lambda_p \geq 0$.

Consider the linear combinations, the P principal components Z_1, \dots, Z_p are uncorrelated (orthogonal) linear combinations of the original variable, X_1, \dots, X_p , given as:

$$Z_1 = a_{11}X_1 + a_{12}X_2 + \dots + a_{1p}X_p$$

$$Z_2 = a_{21}X_1 + a_{22}X_2 + \dots + a_{2p}X_p$$

$$Z_p = a_{p1}X_1 + a_{p2}X_2 + \dots + a_{pp}X_p$$

(9)

Zi variance and covariance are as follows:

$$\text{Var}(Z_1) = \mathbf{a}_1' \Sigma \mathbf{a}_1 \quad i=1,2,\dots,p \tag{10}$$

$$\text{Cov}(Z_i, Z_k) = \mathbf{a}_i' \Sigma \mathbf{a}_k, k = 1, 2, \dots, p \tag{4}$$

The principal components are those uncorrelated linear combinations Z_1, Z_2, \dots, Z_p whose variances are as large as possible.

The first principal component is the linear combination with maximum variance. That is, it maximizes $\text{Var}(Y_1) = \mathbf{a}_1' \Sigma \mathbf{a}_1$. It is clear that $\text{Var}(Y_1) = \mathbf{a}_1' \Sigma \mathbf{a}_1$ can be increased by multiplying any \mathbf{a}_1 by some constant. To eliminate this indeterminacy, it is convenient to restrict attention to coefficient vectors of unit length.

At the *i*th step, it is therefore defined

*i*th principal component= linear combination $\mathbf{a}_i \mathbf{X}$ that maximizes

$$\text{Var}(\mathbf{a}_i \mathbf{X}) \text{ subject to } \mathbf{a}_i' \mathbf{a}_i = 1 \text{ and } \text{Cov}(\mathbf{a}_i \mathbf{X}, \mathbf{a}_k \mathbf{X}) = 0 \text{ for } k < i$$

The proportion of total variance due to (explained by) the *k*th principal components is:

$$\text{Proportion} = \frac{\lambda_k}{\lambda_1 + \lambda_2 + \dots + \lambda_p} \quad k=1,2,\dots,p \tag{11}$$

Principal components may also be obtained for the standardized variables

$$z_1 = \frac{(X_1 - \mu_1)}{\sqrt{\sigma_{11}}} \tag{12}$$

$$z_2 = \frac{(X_2 - \mu_2)}{\sqrt{\sigma_{22}}}$$

$$\vdots$$

$$z_p = \frac{(X_p - \mu_p)}{\sqrt{\sigma_{pp}}}$$

In matrix notation,

$$\mathbf{Z} = (\mathbf{V}^{1/2})^{-1} (\mathbf{X} - \boldsymbol{\mu}) \tag{13}$$

Where, $\mathbf{V}^{1/2}$ is the diagonal standard deviation matrix. Clearly, $E(\mathbf{Z})=0$ and $\text{Cov}(\mathbf{Z}) = (\mathbf{V}^{1/2})^{-1} \Sigma (\mathbf{V}^{1/2})^{-1} = \boldsymbol{\rho}$ \tag{14}

The principal components of Z may be obtained from the eigenvectors of the correlation matrix ρ of X

The proportion of total variance explained by the k th principal component of Z is:

$$\text{Proportion} = \frac{\lambda_k}{p} \quad k= 1, 2, \dots, p \quad (15)$$

Where, the λ_k 's are the eigenvalues of ρ

The eigenvalues and eigenvectors pairs (λ_i, e) derived from Σ are, in general, not the same as the ones derived from ρ and this means that the indicators should be standardized (Mingione, 2011).

Appendix 3: Financial stability correlates from PCF

Variable	Factor1	Uniqueness
ld1	0.7907	0.3748
ld2	0.8867	0.2138
ld3	-0.6596	0.5649

Variable	Factor1	Factor2	Factor3	Uniqueness
ls1	0.8412	0.1887	-0.241	0.1988
ls2	0.7207	-0.0559	-0.0922	0.469
ls3	0.9368	-0.1003	-0.0318	0.1114
ls4	-0.2492	0.8091	-0.2632	0.214
ls5	0.5285	-0.5349	-0.3034	0.3425
ls6	-0.0187	0.9163	-0.111	0.1477
ls7	-0.2838	-0.1882	0.763	0.3019
ls8	0.3667	-0.1565	0.782	0.2295

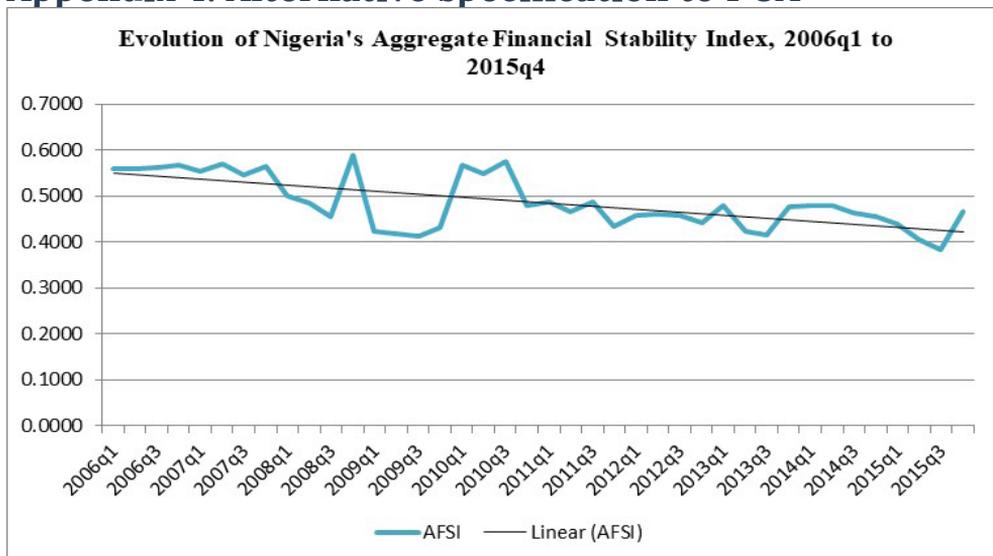
Variable	Factor1	Factor2	Factor3	Uniqueness
lv1	-0.2965	0.5537	-0.2401	0.5479
lv2	-0.8999	0.145	-0.2317	0.1154
lv3	0.1354	-0.0802	0.7843	0.3601
lv4	0.8978	0.1042	-0.2226	0.1335
lv5	0.2257	0.7928	-0.0701	0.3156

lv6	-0.3345	0.5234	0.4965	0.3676
lv7	0.6751	-0.1224	0.4121	0.3594
lv8	0.4149	-0.5921	-0.0424	0.4755

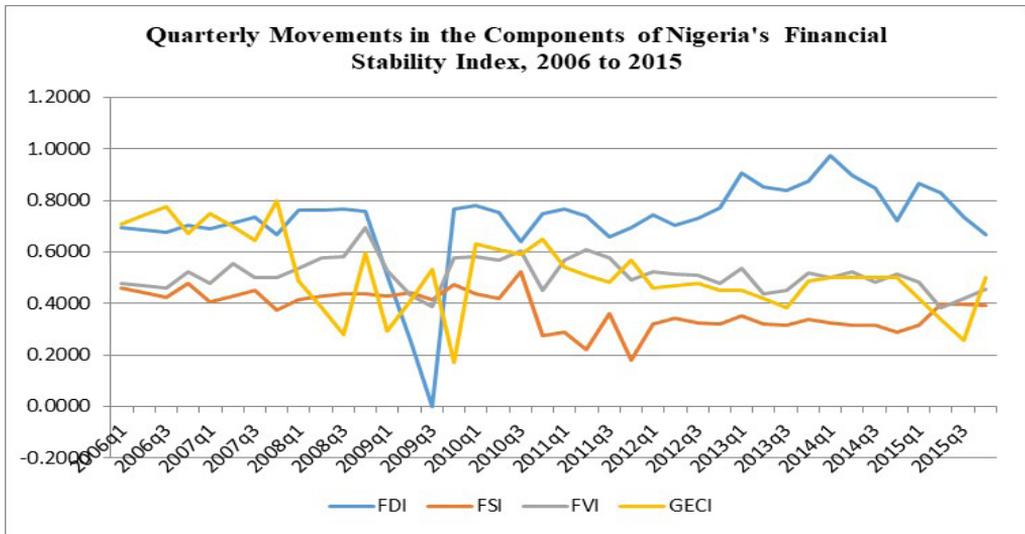
Table A5: Rotated factor loadings (pattern matrix) and unique variances: Global Economic Climate Index (GECI) sub-index

Variable	Factor1	Factor2	Factor3	Uniqueness
lg1	0.5588	0.6079	0.1366	0.2996
lg2	0.7217	0.4808	-0.0476	0.2458
lg3	0.9513	-0.1936	-0.0856	0.0501
lg4	0.8481	-0.3968	-0.2412	0.0651
lg5	0.5721	-0.6004	0.506	0.0563
lg6	0.753	-0.4611	0.393	0.0659
lg7	0.561	0.7585	0.0455	0.1079
lg8	-0.1116	0.4038	0.8382	0.1219
lg9	0.8082	0.1785	-0.3382	0.2006

Appendix 4: Alternative specification to PCA



Source: Authors' Computation.



Source: Authors' Computation.



Mission

To strengthen local capacity for conducting independent, rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa.

The mission rests on two basic premises: that development is more likely to occur where there is sustained sound management of the economy, and that such management is more likely to happen where there is an active, well-informed group of locally based professional economists to conduct policy-relevant research.

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