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BANK LEVERAGE DYNAMICS AND FINANCIAL FRAGILITY OF NIGERIAN BANKING SECTOR: EVIDENCE FROM PANEL VECTOR AUTOREGRESSIVE APPROACH

[1]Makinde, Kayode Olanrewaju, [2]Adeoye, Babatunde Wasiu, [3]Balogun, Emmanuel Dele
[1-3]Department of Economics, University of Lagos, Akoka, Lagos, Nigeria
[1]Corresponding Author: mko4cisa@yahoo.com

Abstract
The study investigates the linkage between bank leverage and financial fragility of banking system in Nigeria, employing panel vector autoregression (PVAR) model on quarterly bank-level and industrywide panel data (2006–2023). Empirical findings from the study reveal the existence of nexus between bank leverage and financial fragility. The results demonstrate how bank leverage moderately reduces financial fragility among banks in Nigeria, thus suggesting a forward-looking supervisory oversight for the DMBs characterized with such a higher debt ratio. The policy implication from the study is that, in curbing the excessive risk-taking behavior of banks in Nigeria, the regulatory authorities should initiate punitive measures. These should entail treating a percentage of the banks' excess credit above the sectorial limit as a charge against the eligible capital used in computing their capital adequacy ratio. Finally, the study advises Central Bank of Nigeria to sustain its ongoing policy of stabilizing Naira through curtailing DMBs' credits to the private sector during the periods of wide fluctuations of foreign exchange rate or acute supply of foreign exchange.

Key Words: Bank Leverage, Basel Accords, Capital Requirements, Financial Fragility, PVAR, Nigeria

JEL Classification Codes: E58, G18, G21, G28

1. Introduction

The procyclical nature of bank leverage exposes banks to the adverse effect of macroeconomic risk and uncertainty, (Istiak & Serletisy, 2021). Fire sales of banks' securities during the economic recession have often led to drastic shrinkage in their balance sheet. Evidence of such value erosion abounds in financial crisis literature, (Adrian & Shin, 2014 and Fender & Lewrick, 2016). Lack of depth and dynamic nature of the economy expose financial system to vagaries of innovation and globalization. This makes the financial system, particularly in the emerging markets, inherently and continuously prone to fragility. Financial fragility, if left unchecked, can negate the

monetary policy transmission objective. This will inhibit the economic growth process, as more pressure is exerted on the banking system during the stress period, (IMF, 2020).

Following the consensus among researchers and policy makers that lower bank leverage will invariably enable individual banks to build capital buffers and such safeguards can cushion adverse effect of losses and prevent the spread of risk to the financial system, (Ghani, 2013 and Thakor, 2019). Corroborating this, many researchers are concerned with how increased capitalization will insulate banks from the aftermath of default risk, (Capponi et al., 2017 and Begenau, 2020). Results obtained from the empirical studies on reduced bank leverage via the enhancement of capital requirements are mixed. Placing limits on currency and maturity mismatches has strengthened the bank's position, (Chui, Kuruc & Turner, 2016). Conversely, the ceiling on credit growth has achieved little success in taming bank instability, (Kraft & Jankov, 2005).

The improved capitalization in the global financial system has resulted in the capital adequacy ratio (CAR) specified in the Basel II Capital Accord to limit bank leverage. Despite the reduction in bank leverage, the scourge of financial crisis remains unabated. The distress experience of two internationally active banks in Switzerland during the global financial crisis (GFC) of 2009 clearly points out the major drawbacks inherent in the current capitalization regime. Although Swiss economy was not enmeshed in the GFC of 2009, but the two large banks were among the best-capitalized financial institutions in the world prior to the crisis period. A post-mortem review indicted the regulatory authorities for their failure to detect the presence of excessive leverage in the affected banks. Even though the Basel II risk-adjusted CAR failed to reveal the scourge, an imposition of a simple computation of bank leverage ratio requirement would have uncovered the threats, (Hildebrand, 2008).

It is against this background that this study aims at establishing the linkage between bank leverage and financial fragility of banking system in Nigeria.

2.0 Literature Review

2.1 Conceptual Review

Bank Leverage

Merriam-Webster (n.d) defines leverage as "the use of credit to enhance one's speculative capacity". According to Villar Burke (2013), leverage is defined as an entity's debt obligations to a party(ies) outside its equity owners. Away from these loose definitions, Papanikolaou and Wolff (2013) restrict the term to banking circle. They define it as the banks' financing of additional assets and investment from a debt source(s), particularly wholesale funding. This definition throws up

a gap as it implies that leverage can only apply to the acquisition of new assets and investment. Whereas, European Banking Federation (2010), gives a fuller definition as the bank leverage is said to occur whenever the bank's equity is below its total assets.

The externally-financing nature of leverage confers an advantage of maximising returns on investment over that of equity financing, (D'hulster, 2009). By leveraging, banks express an optimism that potential returns from leveraged investments will outweigh their cost of financing. D'Hulster (2009), categorises bank leverage into three namely balance sheet, economic, and embedded. Balance sheet leverage refers strictly to a condition in which bank's assets surpass its equity base. Generally, banks maximise their earnings potential through the extra income obtained from the assets/investment financed from borrowed funds. Conversely, economic leverage arises from a bank having more change in exposure position than the cost consideration. Examples include off-balance sheet engagements, which if crystalised, can be booked against the bank despite their exclusion. While embedded leverage refers to a bank's position in which the underlying market factor is less than its exposure value. A classic example involves a bank's ownership of a non-controlling interest in an equity fund that is entirely funded by loans. Of all three, embedded leverage is the most rigorous to quantify.

BCBS (2014), through its committee on banking supervision, introduced a leverage ratio which aimed at complementing the capital adequacy ratio and checkmating bank procyclicality tendency. The committee prescribes a maximum of 3% for the leverage ratio which is defined as Capital Measure divided by the Exposure measure. While the numerator refers strictly to Tier 1 Capital, the denominator comprises both on- and off-balance shee6t exposures inclusive of derivative and other securities financing transactions. Thus, this study will adopt the inverse of BCBS's definition of bank leverage, which is calculated as (TA to EQ), as it is all-encompassing and more comprehensive than others.

Financial Fragility

The concept of financial fragility is as old as the modern financial system. Many economists have defined the phenomenon based on the prevailing circumstances and contexts. Hence, financial fragility has no universally accepted definition. The term, financial fragility, generally refers to the vulnerability of a financial system to wide-scale crises that arise from slight shocks", (Lagunoff & Schreft, 2001; Allen & Gale, 2004; Order, 2006 and Giordani & Kwan, 2019). The authors unanimously agree that the presence of financial fragility connotes the incapacitation of a financial system to withstand economic shocks. Their definition

is, however, fraught with a major limitation of restricting the source of financial fragility to only small shocks. Craigwell and Polius (1998) equate financial fragility to bank fragility which they define as a state in which a good number of financial institutions are technically or potentially insolvent. According to the authors, the banks in question should constitute a substantial part of the total assets and liabilities of a financial system. As precise as Craigwell and Polius's (1998) definition appears, it erroneously assumes the absence of financial fragility when the share of insolvent banks is less significant.

According to Taleb et al. (2012), financial fragility refers to an instance of a disproportionate increase in welfare loss as determined by a stressor. This must indicate a negative variance from the existing trend. Adopting this view may result in a vague definition as non-standardization of choice and composition of stressors are its inherent inadequacies. Researchers like Tymoigne (2007), Schroeder (2009), & Hume and Sentance (2009) view financial fragility from two prisms. First, under a static approach in which financial fragility is a one-off event that is synonymous with financial instability. Whereas the other perspective, which is evolutionary, views financial fragility as a process that evolves over a while and of which there is a clear delineation between it and financial instability. A major drawback of the static definition of financial fragility lies with the use of financial instability indicators such as the downward trend in the real GDP growth, rising NPL ratio, falling profitability, and rising spreads among others used as a proxy for financial fragility. This could make point of crisis detection close to its occurrence as the time an economy witnesses a falling growth rate or increasing NPL ratio, the financial crisis would have become inevitable.

Under the evolutionary stance, financial fragility is built up during the "good time" when banks are declaring huge profits, rising banks' net worth, low customers' default rates, stable interest, inflation, and exchange rates as well as an increasing trend in economic growth rate. Rather than defining financial fragility within the confine of these indicators, financial fragility is viewed as an adverse change in the financing and funding practices of economic agents within an economy. As later propounded by Minsky (1982), the economy is financially fragile "when modest changes in cash flows, capitalization rates, and payment commitments adversely affect the ability of private units to meet their financial commitments". Unlike the static view definition that muddles up both financial fragility and financial instability, the evolutionary definition approach distinctively separates the former from the latter.

2.2 Review of Theoretical Literature

This subsection, which draws from Toporowski (2005); Allen, Babus & Carletti (2009), and Detzer and Herr (2014) among other researchers, reviews various theories of financial fragility relating to the study. These theories offer insights into the nature of financial fragility, bank leverage, credit and financial crisis garnered from the ideas expressed by various camps of ideological persuasions.

Theory of Endogenous Financial Crisis

The endogenous theory holds that financial crisis is a natural consequence of irrational expectations connected with the boom-bust cycles, Allen, Babus and Carletti, (2009). The endogenous theory shares a similar view with Irving Fisher's debt-deflation hypothesis. Fisher posits that financial crisis stems from the combined forces of excess debt and falling prices in the economy, Zaman (2019). The crisis erupts from the endogenous build-up of financial fragility of inherently unbalanced modern capitalist economies, Allen, Babus and Carletti, (2009). An endogenous rise in financial fragility leads to a corresponding endogenous decline in the real and financial sectors. This is ensued as the two sectors witness a sharp increase in the input costs, worsened terms of trade, rising domestic and foreign interest rates, Calomiris and Gorton (1991) and Kindleberger (2000).

As Kindleberger (2000) observes, financial fragility becomes noticeable immediately after the expansion phase of the business cycle. At this stage, the decline in turnover and profits of firms impedes their ability to honour existing loan obligations. Consequently, the firms resort to obtaining additional debt to refinance existing loan commitments and finance fresh capital investment. Some other firms may consider selling off their assets to repay the loans. In response, lenders will overhaul their risk assessment criteria. This means that the banks will decline requests for additional credit or call for liquidation of existing non-performing loans.

Theory of Bank Leverage

This theory, propounded by Modigliani and Miller in their 1958 seminal work, holds that a firm's profitability is not influenced by the nature of its financing. This implies that a firm's net worth and long-term survival remain unperturbed whether it is entirely financed from equity or debt or by any combination of the two. Modigliani and Miller (1958), however, issued a caveat that the theory applies to firms that incur zero transaction costs, pay no tax and operate under an ideal business climate of stable price regime. The theory was criticized as the underlying ideal business environment assumption, which is characterized with low

inflation, no transaction costs and taxation, is too simplistic and unrealistic.

Responding to the criticism in 1963, Modigliani and Miller modified the earlier theory. Although the new theory still retains the assumption that finance leverage is not connected with financial performance, it, however, adjusts for the occurrence of tax and other associated costs. The reformulated theorem considers these costs in determining both the firms' cost of equity and weighted average cost of capital (WACC). The theorem holds that the firm's WACC increases as more debt is introduced. This requires the equity holders to demand higher cost of equity as compensation for the increased debt which may result in the firm's bankruptcy, (Modigliani & Miller 1963).

2.3 Empirical Literature Review

A strand of financial crisis literature such as (Gropp & Heider, 2010; Panetta & Angelini, 2009; Damar, Meh & Terajima, 2010; Adrian & Shin, 2010; Wolff & Papanikolaoua, 2010; Bruno, Cartapanis & Nasica, 2013; Wu & Hu, 2017 and Rahim A., et al., 2021) provided an empirical benchmark for considering the impact of bank leverage on the financial fragility of banks. Bank leverage refers to the use of funds from deposit sources and bond proceeds to augment bank's equity capital in funding new loans and investments, (Wolff & Papanikolaoua, 2010). It enables economic agents in the acquisition of assets above their net worth, (Geanakoplos, 2010).

The norm in empirical literature is to investigate whether a leveraged banking system is insulated from a banking crisis. In combating fragility, bank regulators around the world institute regulatory regimes that favour higher capital requirements, (Thakor, 2019). Following the failure of Basel II capital requirements to prevent the 2007 financial crisis, Basel III is introduced to strengthen various regulatory measures aimed at achieving financial system stability. As established in Capponi et al., (2017), the long-term effects of bank capital can insulate it from losses arising from default risk. The authors used a simulation-based study to investigate whether capital requirement-oriented systemic risk control policies are superior to those targeting default resolution. Their results imply that bank capital buffers, as evidenced in low bank leverage, perform a dual role of absorbing operating losses and reducing default rates.

This is further reinforced by the findings in the empirical work conducted by Begenau (2020), where the author considers the impacts that capital requirements have on the stability of the banking system. The study, which focuses on the US banking system, finds that increase in regulatory capital requirements has led to a rise in banks' lending. This was achieved via a fall in the

banks' cost of capital and a corresponding drop in their deposit base. The author also observes that increased capitalization has raised overall efficiency within the banking sector due to the net benefits realized from reduced bank leverage. Despite the objection to increased bank leverage in the global financial order, the scourge of financial crisis remains unabated.

Recent study by Bruno et al. (2013) investigates the factors that influence bank leverage ratio and how they can trigger financial fragility. The results show a reduced financial fragility amidst a fixed level of bank leverage ratio. The feat was enabled by the presence of a less-volatile operating environment, realizable value of collateral and risk-free interest rate regime. Contrary to the fixed ratio recommended in the Basel III regulation, the authors canvas for the introduction of an adjustable leverage ratio. Whereas researchers such as Wu and Hu (2017) attributed the GFC of 2008 to the procyclical tendency of bank leverage. The study on commercial banks in China, covering the period 2006-2015, employed panels and dynamic model. The results indicate bank leverage with higher rate of increased procyclicality during the economic boom than the rate of decrease experienced the economic recession.

Rahim A., et al. (2021), employing fixed effect regression approach on twenty-five banks in the Asian region, evaluate the effect of financial leverage on banks' performance. Their study, which aligns with the signalling theory, confirms the existence of positive and significant correlation between the bank leverage and their growth.

Using monthly data from 147 developing countries from 1980 to 2016, Haan, Fang and Jing (2020) found that banks with high potential risks have the following: low levels of current assets and domestic financial liabilities, high levels of foreign liabilities and financial leverage.

Despite the benefits overtly conferred on bank leverage, its rising beyond a certain level can be harmful. Abubakar (2015), uses descriptive and correlation analyses to explore the relationship between financial leverage and financial performance of banks in Nigeria, covering 2005 to 2013. The study reveals a significant positive relationship between banks' financial leverage and financial performance. The results show that about 84% of the banks' total assets are financed by debts. This however suggests that Nigerian banks engage in excessive risk taking which can trigger financial fragility. To avoid banking crisis, the level of safety for bank leverage must be specified. Ebiringa and Ezeji (2012), applied log likelihood method to determine the extent by which financial leverage maximises returns to banks' shareholders in Nigeria. The study

underscores the relevance of bank leverage in ensuring the survival of banking entities. It, however, cautions excessive use of bank leverage beyond a point of engendering financial fragility.

Babajide et al. (2015) adopt Cox Proportional Hazards Model variant of survival analysis approach. In the study, the authors used panel data covering a period from 2003 to 2011 to predict possible occurrence of banking crisis in Nigeria. The research identifies high NPL and operating expense to average total assets ratios as key indicators of banking crisis in Nigeria. However, the study is fraught with the use of wrong model specifications. It only identifies symptoms of financial distress as against detecting their fundamental causes and forming.

Utilizing a linear least square approach, Fadare (2011) analysed the factors that cause illiquidity among the Nigerian banks. He also investigated the extent to which the global financial meltdown of 2007-2009 dried up their liquidity. The study concludes that monetary policy rate (MPR), lagged loan-to-deposit and liquidity ratios determine the state of liquidity in the Nigerian banking sector. The findings from the study provide some useful guides to the monetary authorities. Fixing the optimal rates during the crisis period would engender the survival of banks with liquidity squeeze. Simultaneous reduction in the MPR and liquidity ratio during the crisis period can cause an increase in the loan-to-deposit ratios. Whereas an increase in the cash reserve ratio (CRR) can also result in a declined loan-to-deposit ratios. Although key findings from the study align with the economic theories, it would have been more robust with comparative analysis of similar countries.

Extending the causes of financial fragility beyond liquidity factors, Ache et al. (2019) utilize Autoregressive Distributed Lag (ARDL) approach in Nigeria from 1970-2013. The study traces the vulnerability of the Nigerian banking system to other variables. These include capital inadequacy (high bank leverage), volatile interest and exchange rate regime, and poor quality of loan assets. To forestall a systemic banking crisis, the empirical research suggests to supervisory authorities to develop a comprehensive regulatory capital framework for banks and imbibe a sound risk management culture.

More profoundly, Ozili (2019) employs an OLS estimation approach on the banking sector and macroeconomic data from 2003 to 2016. The study seeks to determine factors that influence the Z score. It is treated as a variable of banking fragility which measures the probability of bank insolvency in Nigeria. The results indicate the quality of risk assets and capital, bank efficiency level, level of financial deepening, and banking concentration as key variables that shape

banking stability in Nigeria. The study advocates for a capital requirement regime that mandates banks to hold more of tier-1 capital in their capital structure in conformity with Basle III prescription. As important as bank leverage is to the stability of the banking system, (Allen & Gale, 2004; Lei & Song, 2013; Chen et al., 2015 and Chouchène, Ftiti & Khiari, 2017), the study conspicuously omitted it as one of the key drivers of banking stability.

In conclusion, the reviewed literature so far establishes numerous benefits of lower bank leverage through the enhanced capital buffer requirement. The benefits include ensuring the absorption of operating losses, crashing of banks' growing default rate and stable banking system to a mild post-crisis recession. However, some other studies indicated high capital buffer requirement as the major cause of abandonment of banks' traditional lending function. This is achieved by showing a penchant for more attractive fee-based activities and the exorbitant cost of lending to borrowers.

The reviewed literature reveals the existence of a few studies on the impact of bank leverage on financial fragility. Even the few available ones show contradictory results. Authors such as **(**Osterberg & Thomson, 1996; Panetta & Angelini, 2009; Wolff & Papanikolaoua, 2010; Wu & Hu, 2017 and Rahim A., et al., 2021) confirm the evidence of a positive relationship between bank leverage and financial fragility. While Gropp & Heider (2010), Adrian & Shin (2010) and Bruno et al. (2013) uphold an inverse relationship between the two variables. Studies by Ebiringa and Ezeji (2012) and Abubakar (2015) confirm restrictive positive relationship between them. Consequently, this study will resolve the imbroglio by establishing the nature of the relationship that exists between bank leverage and financial fragility.

3.0 Methodology and Data Issues

3.1 Model Specification

The theoretical framework underpinning the study is based on insolvency risk theory. The choice of the theory is informed by its relevance in capturing the issues raised in the research objectives. The theory posits that the risk of bank financial fragility is a direct response to the interaction among its earning capacity, return volatility and quantum of capital reserves available for the absorption of shocks, (Garcia-Marco & Robles-Fernandez, 2008). The theory holds that fragility arises from firm's exposure to operating losses which erode the capital reserves earmarked unexpected shocks.

Following the insolvency risk theory developed in (Lin, Penm, Gong & Chang, 2005; Garcia-Marco & Robles-Fernandez, 2008 and Awartany & Alzubi, 2020), we

adopt their model which assumes that bank's financial fragility occurs at:

$$FF= \frac{\frac{\pi}{TA}\text{i,q} + (TEC\text{i,q}/TA)}{\sigma(\frac{\pi}{TA}i,q)} \qquad 3.1$$

We further regroup the explanatory variables along their traditional domain. The two key explanatory variables, namely, bank leverage and profitability are prominently stated in equation (3.1). Bank-specific (micro prudential) variables of capital (CAR), asset quality (NPL), managerial efficiency (MER), earnings (EAR) and liquidity (LIQ)-CAMEL as well as industry-specific variables, concentration are captured in the model as control variables. Consistent with (Gonzalez-Hermosillo, Pazarba-sioglu, & Billings, 1996 and Rezaee et al. 2022), the macroeconomic factors (*MACRO*) are further decomposed into real gross domestic product growth rate, real exchange rate and monetary policy rate into the model of the determinants of financial fragility. Thus, equation (3.1) is transformed into equation (3.2) as follows:

$$\begin{aligned}\ln FF_{z*t} = \aleph \ln BLEV_{z*t} + \Omega lnMACRO_{z*t} + \tau lnCAR_{z*t} + \vartheta lnNPL_{z*t} + \varphi \ln MER_{z*t} \\ + \omega lnEAR_{z*t} + \zeta lnLIQ_{z*t} + \psi \ln HHI_{z*t} + \mathfrak{G} \ln RGDP_{z*t} + \Phi \ln RER_{z*t} \\ + \xi \ln MPR_{z*t} \qquad 3.2\end{aligned}$$

3.2 Specification of the Panel Vector Autoregressive (PVAR) Model

The study employed a panel vector autoregression (PVAR) model, a panel-data version of the traditional vector autoregression (VAR) propounded by Sims (1980). The approach suits the analysis of determinants of the financial fragility of banking system. A typical VAR analysis offers some benefits. First, all the variables in the model are treated as endogenous and independent as less concern is paid to the direction of causality. Second, every variable in the model is partly influenced by its own lags and the lagged values of other variables. Further, VAR estimation strategy gains popularity for policy simulation due to its robust features of Impulse Response Function (IRF), Forecast-Error Variance Decomposition (FEVD) and Granger-Causality Test.

Stemming from VAR is a Panel VAR (PVAR) estimation strategy which adds cross-sectional dimension to basic VAR. It also accounts for unobserved individual heterogeneity and enhances the quality of asymptotic results. According to Canova and Ciccarelli (2013), PVAR model possesses the ability to capture both static and dynamic interdependencies; treat the links among variables in an unrestricted fashion and recognize time variations in both the coefficients and shock variance.

The developed theoretical model (3.2) for identifying the determinants of financial system fragility in Nigeria is expressed as:

$$\begin{aligned}\ln FF_{z*t} = \aleph \ln BLEV_{z*t} + \Omega lnMACRO_{z*t} + \tau lnCAR_{z*t} + \vartheta lnNPL_{z*t} + \varphi \ln MER_{z*t} \\ + \omega lnEAR_{z*t} + \zeta lnLIQ_{z*t} + \psi \ln HHI_{z*t} + \beth \ln RGDP_{z*t} + \Phi \ln RER_{z*t} \\ + \xi \ln MPR_{z*t} \qquad 3.3\end{aligned}$$

Its reduced form is obtained by setting.

$\aleph = \alpha_1; \Omega = \alpha_2; \tau = \alpha_3\ ; \vartheta = \alpha_4; \varphi = \alpha_5; \omega = \alpha_6; \zeta = \alpha_7; \psi = \alpha_8; \beth = \alpha_9; \Phi = \alpha_{10}; \xi = \alpha_{11}$

Incorporating the parameters, ($\alpha_1 - \alpha_{11}$) that represent the elasticities of the explanatory variables as fully specified in equation (3.3), and introducing $\alpha_0, as\ the\ constant\ and\ \boldsymbol{\mu}$ as stochastic error terms (other factors) that influence financial fragility but are not captured in the model into equation (3.4) to produce the determinants of financial fragility of banking system in Nigeria are specified as follows:

$$\begin{aligned}FF_t = \alpha_0 + \alpha_1 \Delta BLEV_{z*t} + \alpha_2 \Delta MACRO_{z*t} + \alpha_3 \Delta CAR_{z*t} + \alpha_4 \Delta NPL_{z*t} + \alpha_5 \Delta MER_{z*t} \\ + \alpha_6 \Delta EAR_{z*t} + \alpha_7 \Delta LIQ_{z*t} + \alpha_8 \Delta HHI_{z*t} + \alpha_9 \Delta RGDP_{z*t} + \alpha_{10} \Delta RER_{z*t} \\ + \alpha_{11} \Delta MPR_{z*t} + \mu \qquad 3.4\end{aligned}$$

3.3 A priori Expectations

In this model, a priori that financial fragility of banking system is positively influenced by bank leverage, macroeconomic factors (Monetary Policy Rate, Real Exchange Rate), Non-Performing Loans and Concentration variables. Conversely, a negative relationship is expected to exist between the financial fragility of the banking system and Growth in Real GDP, Capital Adequacy Ratio, Managerial Efficiency, Earnings and Liquidity Ratio. Variables contained in the model of interest are as described in Table 3.1:

Table 3.1 Descriptions of Variables

Variable	Description	Source
Financial Fragility (FF)	This is defined as the summation of individual bank's ROA and ratio of total equity capital to total assets divided by the standard deviation of the individual bank's ROA.	Quarterly Financial Statements extracted from the individual bank's website, regulatory returns submitted to the Nigerian Exchange Group's website.

Bank Leverage Ratio (BLEV)	This is defined as the ratio of total assets (including off balance sheet engagements) to total equity capital.	Quarterly Financial Statements extracted from the individual bank's website, regulatory returns submitted to the Nigerian Exchange Group's website.
Growth rate of Real Output (RGDP)	Percentage change in the quarterly Real Gross Domestic Product. That is, $(RGDP_{t+1}-RGDPt)/(RGDP_t)$.	Central Bank of Nigeria's Statistical Bulletin (various editions).
Real Exchange Rate (RER)	Nominal Exchange rate multiplied by the ratio of US inflation rate to the Nigeria inflation rate.	Central Bank of Nigeria's Statistical Bulletin (various editions).
Monetary Policy Rate (MPR)	The Monetary Policy Rate (MPR) as announced by the Central Bank of Nigeria.	Central Bank of Nigeria's Statistical Bulletin (various editions).
Capital Adequacy Ratio (CAR)	This is the ratio of individual bank's total qualified tier I & II capital relative to its total risk-weighted assets.	Quarterly Financial Statements extracted from the individual bank's website, regulatory returns submitted to the Nigerian Exchange Group and data from the Bank scope's website.
Asset Quality Ratio (NPL)	*This is derived by dividing* individual bank's non-performing loans with the total loans and advances.	Quarterly Financial Statements extracted from the individual bank's website, regulatory returns submitted to the Nigerian Exchange Group's website.
Managerial Efficiency Ratio (MER)	This ratio is measured by dividing individual bank's operating expenses with its total income.	Quarterly Financial Statements extracted from the individual bank's website, regulatory returns submitted to Nigerian Exchange Group's website.
Earnings (EAR)	*This is individual bank's net interest income to the average of its total assets* $period_{(t-1)}$ and total assets $period_{(t)}$	Quarterly Financial Statements extracted from the individual bank's website, regulatory returns submitted to the Nigerian Exchange Group's website.

Liquidity Ratio (LR)	*This ratio is measured by* individual bank's specified liquid assets relative to its total qualified deposits.	Quarterly Financial Statements extracted from the individual bank's website, regulatory returns submitted to Nigerian Exchange Group's website.
Herfindahl-Hirschman Index (HHI)	It represents relative market share concentration of each of the banks in the financial system as measured by Herfindahl-Hirschman Index (S_A^2 + S_B^2 ……+S_Z^2) where S is the square of each of the bank's market share.	Quarterly Financial Statements extracted from the individual bank's website and regulatory returns submitted to the Nigerian Exchange Group and various editions of Central Bank of Nigeria's Financial Stability Report.
$(\boldsymbol{\alpha_1 - \alpha_{11}})$	These are parameters to be estimated in the system of equations	
$\boldsymbol{\alpha_0}$	This is the intercept of the model	
$\boldsymbol{u_t}$	This is stochastic error term that captures other factors that influence financial fragility but not specified in the model.	

Source: Author's compilation (2024)

3.4 Data Requirements, Measurements and Sources

The study population is the entire institution within the spectrum of financial system. However, investigation into how bank leverage influences the banking sector fragility will secure the overall financial system.

The study obtained quarterly bank and industry-level data from the publicly available financial data-Nigerian Exchange Group. The data were specifically drawn from a sample of 15 out of 33 deposit money banks, which constitutes over 80 percent of the industry's total assets.

The quarterly macroeconomic data of consumer price index (CPI), gross domestic product, exchange rate, interest rate, credits to the private sector, deposit and foreign liabilities of DMBs were extracted from the CBN Statistical Bulletin, Volume 32, 2023. Similarly, data on consumer price index (CPI) for US economy used in deriving the real exchange rate were obtained from the IMF, *International Financial Statistics (2023).*

4.0 Empirical Results and Discussion

4.1 Time Series Properties and Tests

4.1.1 Descriptive Statistics

The descriptive statistics of the panel data for the variables used in the study are reported in Table 4.1. The Table shows the mean and other moment conditions for each of the

variables. From the Table, average financial fragility (FF) indicator is 0.32, which is generally high because it is close to the overall median of 0.92. This shows that the banking system in Nigeria is inherently prone to financial instability since it is fragile. The standard deviation of the FF score is 4.55 which is much larger than the mean value, showing that the level of financial fragility varies significant among the banks. The level of susceptibility to banking instability is highly heterogenous with some banks having far more chances of instability than others.

Table 4.1: Descriptive Statistics

Variable	Mean	Median	Max.	Min.	Std. Dev.	Skew.	Kurt.	J-B (Prob.)
FF	0.32	0.92	13.73	-49.20	4.55	-6.18	52.52	0
BLEV	11.22	9.75	49.43	-16.40	13.06	0.07	66.38	0
CAR	0.12	0.15	0.79	-2.14	0.26	-6.10	47.03	0
HHI	56.52	20.21	874.01	0.00	89.81	3.44	21.34	0
MER	-0.10	-0.31	30.20	-31.47	1.54	-0.84	296.01	0
EAR	0.29	0.12	0.44	-0.14	0.53	1.45	245.36	0
RGDPG	0.14	0.04	10.25	-0.17	1.13	8.77	78.48	0
RER	-0.003	-0.02	0.58	-0.37	0.10	2.61	19.96	0
MPR	11.85	12.00	18.75	0.00	3.07	-0.65	4.80	0

Source: Author' computation

4.1.2 Panel Unit Root and Cointegration Tests

It is also crucial to test for the level of stationarity and long run dependence of the panel data used in this study. Hence, the tests for unit root or test for level of stationarity of data are also performed for the variables in the study. Panel data unit root tests that consider both the homogenous-character (i.e., the Levin, Lin and Chu (LLC)), and the heterogenous-character (i.e., Imp, Pesaran and Shin (IMP)) of the panel dataset are adopted. The tests results are presented in Table 4.2. From the Table, the LLC test statistics for all the variables are significant at the 1 percent level (except for MPR is not significant even at the 5 percent level) for the variables in levels. The test statistics of IMP is significant at the 1 percent level for all the variables except MPR which failed the test at the 5 percent level. Based on this result, it can be demonstrated that the variables are all integrated at order zero, given that they are all stationary in levels, except MPR which is integrated of order 1.

Table 4.2: First Generation Unit Root Test Result

Variable	*Levin, Lin, and Chu*				*Im, Pesaran, and Shin W-stat*				Order
	Level		First diff		Level		First diff		
	stat.	*prob.*	*stat.*	*prob.*	*stat.*	*prob.*	*stat.*	*prob.*	
FF	-5.39**	0.00			-7.87**	0.00			I(0)
BLEV	2.73**	0.01			-2.86**	0.00			I(0)
CAR	-3.55**	0.00			-7.53**	0.00			I(0)
HHI	-9.54**	0.00			-6.63**	0.00			I(0)
EAR	-5.74**	0.00			-6.52**	0.00			I(0)
MER	-2.85**	0.00			-6.82**	0.00			I(0)
RGDP	-29.42**	0.00			-23.89**	0.00			I(0)
MPR	1.79	0.98	-18.22**	0.00	0.45	0.93	-14.21**		I(1)
RER	-22.29**	0.00			-20.67**	0.00			I(0)

Source: Author's computation

As noted earlier, the presence of cross-sectional dependence in the data suggests that the first-generation unit root tests above may not fully capture the level of stationarity of the data. In general, applying methods that account not only for the time-series dimension but also for the cross-sectional dimension provides increased power of prediction for estimation with panel data. Thus, we report the results of the second-generation test of unit root based on the Cross-sectionally augmented Im-Pesaran-Shin (CIPS) procedure.

Tabe 4.3: Second Generation Unit Root Test Result (CIPS)

Variable	*Level*			*First diff.*		Order of Integration
	stat.	**crit. val.**		**stat.**	**crit. val.**	
FF	-2.547*	-2.25		-7.184	-2.25	I(0)
BLEV	-1.663	-2.25		-6.657	-2.25	I(1)
CAR	-3.699*	-2.25		-8.206	-2.25	I(0)
HHI	-1.725	-2.25		-5.457	-2.25	I(1)
EAR	-1.614	-2.25		-4.883	-2.25	I(1)
MER	-2.942*	-2.25		-5.471	-2.25	I(0)
RGDP	2.601*	-2.25		4.922	-2.25	I(0)
MPR	-2.950*	-2.25		-5.819	-2.25	I(0)
RER	-2.489*	-2.25		-5.213	-2.25	I(0)

Source: Author's computation

This method of unit root test accounts for cross-sectional dependence in the panel data. The result reported in Table 4.3 shows that the integration order of the variables are mixed with some variables integrated at order zero (I(0)) and others integrated at order one (I(1)).

The results of cointegration tests for the Equations of the study are presented in Table 4.4. Both the Pedroni and Kao panel cointegration tests are conducted based on the goal of the analysis. While the Pedroni test is specific in terms of the heterogeneity assumptions, the Kao test considers random relationships over the cross-sections of the data (Wooldridge, 2010). The results of the within-group tests and the between-group tests for the models for RGDP, RER, and FF all show that the null hypothesis of no cointegration can be rejected for the each of the equations at the 5 percent level. This is based on the Panel PP and the Panel ADF statistics. The cointegration test results imply that there is cointegration among the variables for each of the three Equations in the study. Essentially, this test establishes a significant long run relationship among the variables in each of sustainable development equations. The results of the Pedroni tests are also corroborated by the Kao tests (which also shows that the MPR equation is cointegrated) based on the significant coefficients that indicate that cointegration exists among the variables.

Tabe 4.4: Cointegration Test Result

Test	***H1: common coefs. (within-dimension)***				***H1: individual coefs. (between-dimension)***	
	t-Stat.	**Prob.**	**W- t-stat.**	**Prob.**	**t-stat.**	**Prob.**
Model: RGDP						
rho-Stat.	-18.695	0.000	-18.039	0.000	-18.695	0.000
PP-Stat.	-26.344	0.000	-26.102	0.000	-26.344	0.000
ADF-Stat.	-14.211	0.000	-15.062	0.000	-14.211	0.000
Kao	-3.682 (0.00)					
Model: MPR						
rho-Stat.	2.071	0.981	1.918	0.973	3.367	1.000
PP-Stat.	2.474	0.993	2.254	0.988	3.510	1.000

ADF-Stat.	3.593	1.000	3.473	1.000	4.795	1.000
Kao	-2.729 (0.00)					
Model: RER						
rho-Stat.	-16.425	0.000	-17.006	0.000	-16.290	0.0000
PP-Stat.	-25.178	0.000	-26.028	0.000	-29.743	0.0000
ADF-Stat.	-4.160	0.000	-4.570	0.000	-4.079	0.0000
Kao	-4.782 (0.00)					
Model: FF						
rho-Stat.	-2.402	0.008	-7.900	0.000	-6.647	0.000
PP-Stat.	-4.130	0.000	-9.950	0.000	-14.868	0.000
ADF-Stat.	-1.791	0.037	0.565	0.714	0.786	0.784
Kao	-5.031 (0.00)					

Source: Author's computation

Table 4.5: PVAR Estimate for the Model

Variable	**Sampled Banks**	
	FF (a)	***BLEV (b)***
FF (-1)	0.770***	0.006
	(0.000)	(0.367)
BLEV (-1)	0.304*	0.955***
	(0.073)	(0.000)
MER (-1)	-2.224**	-0.017
	(0.030)	(0.798)
EARN (-1)	0.199	0.091
	(0.357)	(0.549)
MPR (-1)	-0.100*	0.030*
	(0.063)	(0.094)

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$ p values in parenthesis/ ***Source:*** *Author's Computation with Stata, 2024.*

4.1.3 PVAR Result Analysis

Table 4.5 presents the PVAR results. Firstly, from model (a), with financial fragility as explained variable, the results reveal that the influence coefficient of financial fragility on itself is 0.770, which indicates that financial fragility has a strong self-promoting effect. At 1% significance level, the impact coefficient of bank leverage on financial fragility is 0.304. This indicates that if bank leverage increases by 1%, the level of fragility of the banking system will rise by 0.30%, implying that bank leverage contributes to the level of financial fragility.

The finding of the positive relationship between the bank leverage and financial fragility is consistent with the conclusion of Osterberg and Thomson (1996), Wolff and Papanikolaoua (2010), Abubakar (2015), and Haan et al. (2020). This shows that patterns of banking sector fragility in Nigeria are significantly impacted by the degree of leverage in the sector. Thus, higher leverage in the banking sector leads to significant increase in the fragility of banks in Nigeria. This implies that bank leverage is a critical medium for addressing fragility in the banking sector in Nigeria. The result, therefore, suggests the need for the enactment of an appropriate bank leverage policy that will reduce financial fragility and promote the stability of the banking system.

Further, the coefficient of managerial efficiency passes the significance test at the 5 percent level and is negative and significant, which shows that improved managerial efficiency tends to also inhibit susceptibility of Nigerian banks to financial fragility. Similarly, the coefficient of MPR is negative and significant at 10 percent level, while that of EAR is positive. This demonstrates that increase in the monetary policy rate tends to lower financial fragility in the banking sector. On the other hand, banks' quest for higher earnings may result in excessive risk-taking (for instance, relaxation of credit risk assessment criteria) and ultimately lead to the increased fragility of the sector.

Model (b) at 1% significance level shows that the influence coefficient of bank leverage on itself is 0.955, which indicates that it has a strong self-promoting effect. However, the impact coefficient of financial fragility of banking sector on bank leverage is 0.006, indicating a positive weak influence of financial fragility on bank leverage.

The results of the VAR-Granger Causality Wald Test for the Model are presented in Table 4.6 below. The task is to ascertain whether the bank leverage can be used to predict value of financial fragility– that is, whether bank leverage Granger-causes financial fragility. In respect of the sampled banks, the null hypothesis of the model is that bank leverage does not Granger-cause FF as it is not rejected at levels between 1% and 5%. However, at 10%, the null is rejected, because of the value of Chi-sq test and probability (p-

value=0.073< 10%). Therefore, that bank leverage has Granger causality on financial fragility. Conversely, in determining whether financial fragility Granger-causes bank leverage, the result shows no evidence of such Granger-causality as the value of Chi-sq test and probability (p-value=0.367> 10%).

Table 4.6: PVAR-Granger Causality Wald Test for the Model

Sampled Banks			
FF: Dependent Variable			
Independent Variable	**chi2**	**Df**	**Prob > Chi2**
BLEV	3.220	1.000	0.073
ALL	3.220	1.000	0.073
BLEV: Dependent Variable			
Independent Variable	**chi2**	**Df**	**Prob > Chi2**
FF	0.815	1.000	0.367
ALL	0.815	1.000	0.367

Source: *Author's Computation with Stata, 2024.*

4.1.4. Impulse Response Function

The self-pulse diagrams of financial fragility and bank leverage of the sampled banks are as shown in Figure 4.1. First, the response of BLEV to BLEV in Figure 4.1 When the bank leverage is impacted by itself, it presents a positive effect during the first period and maintains the same level thereon to the tenth period. The response of FF to FF in Figure 4.1 shows the self-impact of financial fragility. When financial fragility impacts itself, it has a weak positive effect on promotion in the first period, then declines to 0 from the second period onward as it fails to be affected by itself.

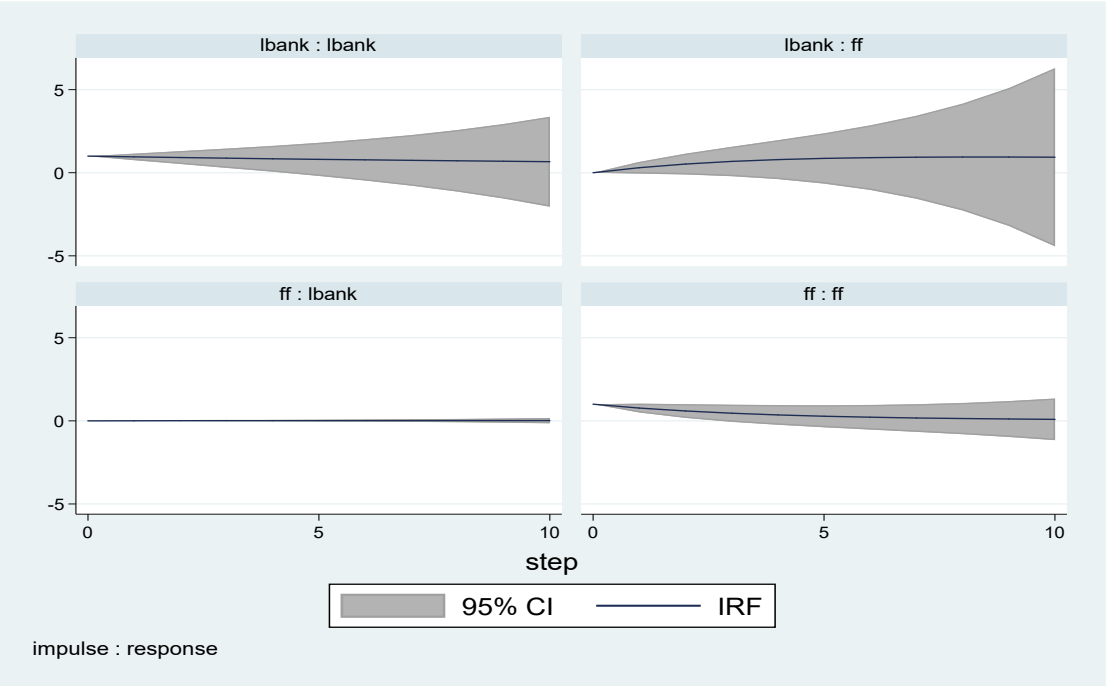

Figure 4.1: Impulse Response Function for the Model

Source: *Author's Computation with Stata, 2024.*

The response of FF to BLEV shows that, in the short to medium term of the first six years, the pattern of fragility of banks in Nigeria is not influenced by the degree of leverage in the banking sector. This outcome is important because it suggests that increasing bank leverage is essentially a long-term affair for the banking sector in terms of improving stability. Thus, both internal and regulatory policy aimed at addressing leverage of the banking sector needs to target long-term banking stability.

4.1.5 Forecast Error Variance Decomposition (FEVD)

From Table 4.7, financial fragility maintains a significant self-variance contribution, which remains at over 0.93 in the tenth period. This is complemented by the bank leverage, which accounts for the rest of the variation that stands at less than 0.07 as of the end of the tenth period. Likewise, the variance contribution of bank leverage, which majorly emanates from itself, closes at over 0.995 in the tenth period, with the balance of 0.005 is being sourced from the financial fragility of the banking sector.

Table 4.7: Forecast Error Variance Decompositions for the Model

Sampled Banks:				
Horizon	***FF:***		***BLEV:***	
	FF	***BLEV***	***FF***	***BLEV***
0	0.000	0.000	0.000	0.000
1	1.000	0.000	0.001	0.999
2	0.998	0.002	0.000	1.000
3	0.994	0.006	0.001	0.999
4	0.988	0.012	0.001	0.999
5	0.980	0.020	0.002	0.998
6	0.971	0.029	0.002	0.998
7	0.961	0.039	0.003	0.997
8	0.951	0.049	0.003	0.997
9	0.941	0.059	0.004	0.996
10	0.931	0.069	0.005	0.995

Source: *Author's Computation with Stata, 2024.*

5.0 Policy Implications of Results and Recommendations

Following an extensive review of theoretical and empirical literature anchored on the premises that bank leverage exerts a considerable influence on financial fragility of Nigerian banking sector. The specific conclusions reached in the study are as follows:__First, the study, using PVAR approach, finds evidence that the macroeconomic variable of real exchange rate and, to a lesser extent, economic growth, are the only macroeconomic factors that can be used to directly tame the fragility of Nigerian banking system. This result, displaying negative but significant influence of real exchange rate on financial fragility, reflects an incompleteness of financial markets espoused in the "original sin" hypothesis, (Eichengreen & Hausmann, 2000). Furthermore, regression results from the study reveal that bank leverage, at 0.304, moderately reduces financial fragility among banks in Nigeria. Thus, suggesting that Nigerian DMBs characterized with such a higher debt ratio require forward-looking supervisory oversight. Regardless, the results demonstrate how leveraged banks often maintain higher capital adequacy ratios to provide better larger buffers that absorb shocks and reduce banks' susceptibility to financial fragility in Nigeria.

Based on the above findings, key recommendations are: First, the regulatory authorities in Nigeria are advised to initiate

punitive measures that will treat a percentage of the banks' excess credit above the sectorial limit as a charge against the eligible capital used in computing their capital adequacy ratio. This would guard against the excessive risk-taking behaviour of banks as they would be compelled to cut down on their credit concentration to the high-risk sectors of the economy. Finally, given the significant influence of the real exchange rate on the financial fragility of Nigerian banks, CBN should sustain its ongoing policy of stabilizing Naira through curtailing DMBs' credits to the private sector during the periods of wide fluctuations of foreign exchange rate or acute supply of foreign exchange. This is to limit foreign exchange rate volatility and speculation attacks on local currency

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