Original Research Article

The Nexus between Liquidity and Credit Risks and Their Impact on Bank Stability

Abstract

This study examines the nexus between liquidity and credit risks and their impact on bank stability in Nigeria. In order to achieve the research objectives, this study utilizes secondary data, which covers 12 Nigerian banks from 2010 to 2021. The Generalized Method of Moment (GMM) was estimated using the Arellano and Bond estimation technique. The result revealed that both credit and liquidity risk negatively and significantly impact bank stability individually and jointly in Nigeria. Furthermore, we deduced that there was a positive correlation between credit risk and liquidity risk, with the correlation result statistically significant. Further investigation using the Pairwise Dumitrescu-Hurlin Panel Causality Tests indicated a one-way (uni-directional) causality that runs from liquidity risk to credit risk. Further analysis showed that other internal bank-related indicators significantly impact bank performance. Bank Size, Equity, and Capital Adequacy positively and significantly impact bank performance. Likewise, macroeconomic indicators such as economic growth have a positive and significant impact on bank performance, while inflation rate has a negative but insignificant impact on bank stability in Nigeria. Based on the findings, the study recommends joint management of credit and liquidity risks since a rise in liquidity risk will cause credit risk, resulting in bank instability. Thus, the results support bank regulation that places more emphasis on the reduction of credit and liquidity risks in the banking sector since credit and liquidity risks have an attendant adverse effect on bank stability.

Keyword: Bank stability, Credit risk, Liquidity risk, Z-score

Introduction

The banking sector continued to be a significant driver of economic growth in any country. Moreover, globalization and the drive for global economic integration have reaffirmed banks' vital role in a country's economic growth (Abba et al., 2019). Banks promote economic growth by mobilizing financial resources from various sectors of the economy and channeling them into productive businesses through lending to investors and consumers. However, achieving sustainable economic growth that positively impacts citizens' well-being requires a sound and stable financial system (Batayneh, 2021). In addition, the effect of the 2007-2009 global financial crisis, which led to the failure of banks worldwide, has revived policy measures that engender banking stability (Ghenimi et al., 2017). Banks, like other institutions, operate in an economic system fraught with risks and uncertainties. Therefore, a stable macroeconomic environment is a critical condition for stability in the financial services sector (Didier & Schmukler, 2014; Tinoco Zermeño et al., 2018).

From an operational perspective, credit creation or lending is the main income-generating activity for banks. Accordingly, an appropriate structure for effective credit risk management is required (Zou & Li, 2014). However, given that banks derive a more significant proportion of their revenues from lending to deficit sectors of the economy, credit risk cannot be fully mitigated. In addition to lending, banks' exposure to risks extends to various financial assets, commitments and guarantees, and the settlement of transactions (Kaaya & Pastory, 2013). Thus, the higher the exposure of a bank to credit risk, the higher the tendency of the banks to experience financial crisis and vice-versa (Joshua & Oluoch, 2018). According to Mwaurah et al. (2017), the pro-cyclical nature of credit risks driven by global systemic factors has precipitated unprecedented volatility in stock returns in the banking sector. These cyclical fluctuations in credit risk have caused huge losses to equity investors. As a result, effective credit risk management is among the contents identified by the Basel Committee. An effective credit risk management will help banks increase profitability, which will enable the banking system to contribute to financial system stability, and better allocate capital in the economy (Sang Tang My, 2022).

Over time, some studies have shown that lending leverages a bank's liquidity position, creating a strong link between liquidity, credit, and profitability. The creation of loans and other financial assets also exposes banks to liquidity risk. According to the Basel Committee on Banking Supervision (2008), liquidity refers to a bank's ability to fund asset increases and meet its obligations at maturity without incurring unacceptable losses. According to the Central Bank of Nigeria (2013), liquidity risk is the inability of an institution to purchase or otherwise obtain the required funds, either by generating more liabilities or discounting its liquid assets to meet maturing obligations as they fall due, without substantial loss in value (Sokefun, 2014; Kumar & Yadav, 2013; Maaka, 2013).

Insufficient liquidity in banks can lead to brand erosion and loss of depositors' confidence, which can lead to the bank winding up (AL-Ardah & Al-Okdeh, 2022). Furthermore, insufficient liquidity may affect the performance and stability of banks, which is why the recent global financial crisis of 2007-2009 is also referred to as a liquidity crisis (Ahmad et al., 2019). Accordingly, the Supervision, Basle Committee on Banking (2013) has specified the liquidity coverage ratio (LCR) for banks. This ratio requires all commercial banks to maintain sufficient liquid assets, enabling them to remain under market pressure for 30 days (AL-Ardah & Al-Okdeh, 2022). The LCR ensures that banks have a sufficient stock of unencumbered high-quality liquid assets that can be converted to cash easily to meet their liquidity needs for a 30-day liquidity stress scenario (Supervision, 2013). In order to effectively manage liquidity, Matis and Matis (2015) suggested the diversification of funding sources and longer average debt maturities. All these measures aim to bridge the gap between assets and liabilities and create liquidity reserves based on immediately attainable assets.

In addition, the 2007-2009 global financial crisis demonstrated that market liquidity is an important systematic risk globally, with severe impacts on banks' performance (Liang & Wei, 2012). The resultant effect of the crises led to the emergence of global tension in the financial sector. Moreover, inadequate liquidity in Nigeria has led to increased interbank rates and default risk, leading to regulatory intervention in the banking sector. The increase in default risk resulted in a substantial increase in loan loss provisions, negatively impacting bank returns to investors. Consequently, to restore confidence in the system, the CBN injected over $620 billion, or approximately $4.1 billion, into the banking system in 2010 (Mordi, 2010). The current liquidity ratio fixed by the CBN for all commercial banks in Nigeria is 30%. To ensure the continued existence of banks, bank treasurers must balance the maintenance of adequate liquidity, profit maximization, and risk minimization (Abwao, 2018).

The instability of banks in Nigeria dates back to the period between 1994 and 2003; this period was characterized by a sudden wave of banking distress that severely impacted the economy (Abe, 2012). Afterward came different levels of banking distress in the country with its negative impact on bank employees and depositors and the economy. Consequently, these continuing banking failures require prophylactic measures capable of stemming the tide (Olaniyi & Olabisi, 2011). The global financial crisis (2007-2009) that also hit Nigerian banks further exacerbated the issue of financial system instability. During the global crisis, several banks in developed and emerging economies reported numerous non-performing loans and a significant increase in credit risk (Kolapo et al., 2012). The spillover effect of the 2007-2009 financial crisis remains in the banking sector and continues to threaten the stability of banks (Adegbie & Adebanjo, 2020). The panacea for effective credit risk management lies in compliance with good corporate governance practices. A good corporate governance framework prohibits insider abuse, non-compliance with the single obligor limit, and other irregularities in the lending process.

Moreover, several measures have been taken by the CBN and the federal government to ensure the relative stability of the Nigerian financial system. The CBN issued the revised prudential guidelines in June 2010 as part of its efforts to improve the quality of banks' assets. Key areas also covered credit risk management, insider credit, credit limits, capital adequacy and liquidity requirements, and reserve funds. Other measures include:

i. an increase in the capital base of banks from twenty billion naira to seventy-five billion naira,
ii. the introduction of a risk-adjusted capital ratio, and
iii. the commencement of risk-based audits.

To further support banks, the Asset Management Corporation of Nigeria (AMCON) was established to take over banks' "*toxic assets*" or non-performing loans. This economic bail-out by AMCON provides banks with the liquidity and capital they need to strengthen their operations and position them for future success and stability (Owojori et al., 2011). These measures were aimed at keeping Nigeria's financial system stable and robust.

Several studies have been conducted on credit and liquidity risks and their impact on banking stability. However, the results of the previous studies were inconsistent across countries. Some studies found a negative effect (Imbierowicz & Rauch, 2014; Mensi & Labidi, 2015; Hakimi & Zaghdoudi, 2017; Matey, 2021), while others were positive (Ghenimi et al., 2017; Setiawan et al., 2021; Siyanbola & Adebayo, 2021). Likewise, some studies have found no significant impact of risk on bank stability (Adusei, 2015; Tan, 2016). The divergent results provide the foundation for this study, which focuses on examining the relationship between liquidity risk and credit risk and their impact on the stability of banks in Nigeria. This study intends to achieve the following goals:

1. Assess if liquidity and credit risk are interdependent.
2. Examine the relationship between liquidity risk and credit risk.
3. Determine whether credit risk and liquidity risk jointly contribute to bank stability.

This study offers two vital contributions to the existing literature on the nexus between liquidity risk and credit risk and its impact on bank stability. Firstly, this study enriches the literature on the nexus between liquidity and credit risks and its impact on bank stability, the empirical results of which have been mixed. Secondly, the paucity of studies on the impact of liquidity and credit risks on bank stability in Nigeria underscores the relevance of this study. Thirdly, this study uses Z-score (Roy, 1952) to proxy bank stability as an index that adequately captures a bank's overall risks rather than the return on assets or equity.

.The Concept of Liquidity Risk

Liquidity is the lifeline of any banking institution, and its unavailability will impact the smooth running of banking activities. Thus, liquidity is of the utmost importance for a bank's efficiency, sustainability, and stability (Sekoni, 2015). In fulfilling its financial intermediation role, a bank must maintain sufficient liquidity to meet the needs of depositors and, at the same time, meet the demand for already approved credit lines. As a result, a bank can be illiquid if it is not in a position to meet its maturing obligations without incurring a substantial loss. Therefore, liquidity measures the cash and other assets banks have at their disposal to quickly discharge their short-term trade and financial obligations as they mature. In other words, it is the ease with which a bank's non-cash assets can be converted to cash to meet its maturing obligations with little or no loss.

The absence of liquidity is illiquidity, and if it persists over time, it may lead to the solvency and eventual liquidation of the bank. Hence, a bank should implement safeguards against the mismatch of maturities between its assets and liabilities. As such, an effective liquidity management strategy should be in place to avoid significant gaps in the maturity profile of assets and liabilities. The banks in Nigeria are required to hold a minimum 30% liquidity ratio to avoid running into liquidity problems. Liquid assets consist of highly rated securities whose market value and liquidity would be preserved during adverse market conditions. Some authors have identified different types of liquidity – central bank liquidity, market liquidity, and funding liquidity; however, this paper focuses on funding liquidity.

The risk of liquidity refers to the possibility that a bank cannot satisfy its maturing obligations or can do so only through overly high borrowing or disposing of other assets at a loss (Nikolaou, 2009). Liquidity risk arises from an institution's inability to purchase or otherwise obtain the necessary funds, either by increasing liabilities or converting assets, to meet on- and off-balance sheet obligations as they come due without incurring unacceptable losses (CBN, 2008). According to Nikolaou (2009), the probability of not being liquid would suggest that there is liquidity risk; thus, the higher the probability, the higher the liquidity risk. Liquidity refers to a bank's capacity to satisfy its maturing commitments as they become due, as well as the ability to have access to credit in the interbank financial market to meet those obligations. The study uses the ratio of total loans to total deposits (LDR) as a proxy for liquidity risk.

The Concept of Credit Risk

Banks' financial dealings include interbank dealings, swaps, bonds, equities, options, foreign exchange trading, acceptances, and guarantees. All these activities expose banks to credit risk in the ordinary course of business; however, lending is the most prominent. The prominence of lending arises from the fact that for most banks, loans form the most significant portion of their risk asset portfolio and hence a major source of credit risk. Therefore, banks must create an appropriate framework to effectively manage the credit risks inherent in their risk asset portfolio. Interest on loans, no doubt, forms a substantial portion of banks' earnings. In the same vein, exposure to credit risk also continues to be a leading concern for banks. However, the goal of credit risk management is to minimize risk and lift the risk-adjusted rates of return of the bank by assuming and retaining credit exposure within appropriate parameters (Kanchu & Kumar, 2013). Consequently, banks must adhere to the risk management frameworks recommended from time to time by the Basel Committee to ensure long-term profitability and stability.

According to Poudel (2012), credit risk occurs when a creditor, counterparty, or bondholder is exposed to loss that fails to satisfy its obligation pledged under a contract. Credit risk refers to the risk that a borrower will default in making repayment and fail to adhere to a contractual obligation in accordance with the agreed terms. Credit risk describes the risk of default by a borrower who fails to repay the money borrowed (Rehman et al., 2019). As a result, credit risk emanates from exposure to loss due to the borrower, counterparty, or an obligator's failure to honor the terms of the contract (CBN, 2008). Stephanou and Mendoza (2005) further define credit risk as default risk, that is, the risk of loss from a borrower/counterparty's failure to repay the amount owed (principal or interest) to the bank in a timely manner based on a previously agreed payment schedule. The ratio of non-performing loans to loans and advances is the proxy for credit risk in this study.

The Concept of Bank Stability

The concept of bank stability differs from bank profitability, although the two are often used interchangeably. Pessarossi et al. (2020) found that high profitability does not reduce the occurrence of bank distress but instead found limited evidence that high profitability leads to a greater occurrence of bank distress. High profitability could predict banking distress over three to four years because the push for more profitability could expose the banks to credit and liquidity risks (Pessarossi et al., 2020). Empirical studies provided mixed opinions on the impact of profitability on bank stability. Cole and White (2011) observed a negative link between bank profitability and bank failure. In the same vein, Poghosyan and Cihak (2011) found evidence of a negative impact of return on equity (ROE) on the occurrence of distress. On the other hand, Betz et al. (2014) observed that ROE is not significant in explaining bank distress while return on assets (ROA) was significant and positive, implying that profitability would even encourage bank distress. Martynova et al., (2015) argued that profitable banks have more incentives to take risks because banks with a profitable core business can borrow more and then take greater risks which can lead to a greater tendency of distress.

Bank stability refers to the long-run survival of the bank, while profitability focuses on the return on investment per time without taking cognizance of the inherent risks in the firm's operations (Bencharles & Nwankwo, 2021). This view aligns with the risk-return trade-off concept, which states that a higher return is associated with higher risk. Any bank making risky investments with the expectation of high profitability with adequate focus on risk management may be courting banking distress in the long run. According to Ozili (2019), banking stability refers to the 'absence of abnormal disruption in credit supply, payment systems, and banking services'. According to Deutsche Bundesbank (2003), banking system stability refers to the steady state in which the financial system efficiently performs its critical economic functions, such as allocating resources, spreading risk, and settling payments (Jahn & Kick, 2012). The stability of any bank will therefore hinge on its ability to put in place an efficient framework to manage all the inherent risks in its operations to sustain greater profitability in the long run.

Empirical Review

Several studies have examined the connection between credit and liquidity risks and their impact on bank stability; however, the discussion has remained inconclusive. Extensive literature exists on the topic of risks and their impact on bank stability across the world with mixed or different results. The nature of the banking business in providing the mechanism for mobilizing savings and directing them to productive investments exposes the banks to varied risks that, if not well managed, may result in insolvency and eventual liquidation. Therefore the study of the impact of risk management on bank stability has continued to realize more relevance. As rightly observed by Zaghdoudi (2019), the bank exists because it provides liquidity and reduces transaction costs, information asymmetries, and risks.

Diaconu and Oanea (2015) investigated the determinants of bank stability and found that profitability is influenced by liquidity ratio. In the same vein, they found that credit activity has a significant positive impact on profitability and a significant negative impact on stability. They also observed that higher profitability does not imply higher stability. Similarly, Setiawan et al. (2021) identified two fundamental risks affecting bank stability: liquidity and credit risk. The study used a sample of 28 conventional banks in Indonesia from 2013 to 2017, and the results showed that credit risk had a negative impact on default probability while liquidity risk had a positive impact. On the other hand, the simultaneous equation models showed that credit and liquidity risks neither influence each other nor have a reciprocal relationship. In contrast, Matey (2021) carried out a study to determine how liquidity and credit risks separately and interactively impact bank stability in Ghana using a sample of nine banks from 2008 to 2018. The findings showed that liquidity risk had a statistically negative relationship with bank stability, which emphasizes the need to invest in interest-earning securities to increase bank profitability and improve bank stability. On the other hand, credit risk revealed an insignificant negative relationship between credit risk and bank stability. Furthermore, the study recommended that banks should control loanable funds to clients to reduce the exposure of banks' too much fragility.

Imbierowicz and Rauch (2014) investigated the link between liquidity and credit risks and how it impacted bank default in the United States between 1998 and 2010. The results showed that both risk categories do not have an economically meaningful reciprocal contemporaneous or time-lagged relationship. However, they influence banks' probability of default as both risks increase the probability of default separately. Moreover. Amara and Mabrouki (2019) examined the effect of liquidity risk and credit risk on banking stability in Tunisia using panel data from eight banks from 2006 to 2015. The results showed that credit risk and liquidity risk do not have an economically significant, contemporaneous reciprocal, or time-lagged relationship. However, both risks separately affect bank stability, and their interaction contributes to bank instability. Similarly, Ghenimi et al. (2017) used a sample of 49 banks operating in the MENA region to analyze the relationship between credit and liquidity risks and their impact on bank stability. The findings revealed that there is no economically significant reciprocal contemporaneous or time-lagged link between credit risk and liquidity risk. However, both risks separately influence bank stability, and their interaction contributes to bank instability.

Zaghdoudi (2019) examined the effects of risks on the stability of Tunisian banks and identified liquidity risk and credit risk as some of the significant risks threatening bank stability. The study showed that there exists a significant positive relationship between liquidity risk and bank stability. Although, credit risk has no significant impact on bank stability. However, the interaction of both credit and liquidity risks significantly and negatively impacts bank stability. Bencharles and Nwankwo (2021) examined the impact of credit risk on banks' stability using a sample of deposit money banks in Nigeria from 2009 to 2019. The result showed that, as measured by Non-Performing loans, credit risk had an insignificant negative relationship with bank stability. Based on research findings, the study indicated that credit risk management is vital for deposit money institutions' stability in Nigeria.

Ahmad et al. (2019) examined the nexus between credit risk and liquidity risk and their impact on the financial performance of banking institutions in Pakistan from 2008 to 2018. They found that the impact of credit and liquidity risks on bank performance is negative, increasing the tendency for bankruptcy. The result showed that credit risk and bank performance are inversely related, which implies that bank stability decreases as credit risk increases. Furthermore, the study found the influence of liquidity risk on bank stability to be negative and significant, indicating that banks with adequate liquidity are more stable than those with inadequate liquidity. Similarly, the impact of the interrelationship between credit risk and liquidity risk on bank stability was significantly negative. The results, therefore, revealed that credit and liquidity risks negatively influence bank stability.

Ejoh et al. (2014) examined the relationship between credit and liquidity risks and their effect on bank default risk with a specific focus on First Bank of Nigeria Plc. The results revealed that there is a positive relationship between liquidity risk and credit risk. The study also found that liquidity risk and credit risk jointly contribute to bank default risk. In their study on the determinants of bank stability, Diaconu and Oanea (2015) opined that bank stability is determined mainly by some internal factors such as capital ratio and efficiency ratio. The study, however, found that lending significantly impacts bank stability. Al Hussaini (2019) looked at the relationship between credit risk and financial stability and observed that credit risk significantly impacts financial stability. In a similar study, Siyanbola and Adebayo (2021) examined the effect of credit risk on the financial sustainability of banks in Nigeria. The result showed that credit risk management significantly and positively affects the financial sustainability of banks in Nigeria. Recently, Sang Tang My (2022) investigated the influence of credit risk on bank financial stability of Vietnamese commercial banks. The result revealed that credit risk positively impacts bank financial stability.

Olaniyi and Olabisi (2011) investigated the causes and impacts of the global financial crisis on bank performance in Nigeria from 2004 to 2009. The result revealed that the global financial crisis had a negative impact on the performance of Nigerian banks despite defiance of the high liquidity possessed by these banks immediately after the consolidation exercise of 2005. Therefore to guide against the multiplier effect syndrome, the study recommends that banks desist from financing other banks' investments in securities. Sokefun (2014) examined the relationship between liquidity risk and profitability of Nigerian banks from 2006 to 2010 and found that liquidity positively affects bank profitability.

Adegbie and Adebanjo (2020) conducted a study to determine the impact of credit risk management on banks in Nigeria and the result showed a significant relationship between credit risk and bank stability. In a recent study to ascertain the effect of credit risk on bank stability in Vietnamese commercial banks, Anh and Phuong (2021) found that credit risk has a negative effect on bank stability. The results further re-emphasizes commercial banks' need to improve credit risk management capacity.

Methodology

The research will employ the analytical research design using the panel data econometrics analysis. This research data is a micro panel in nature with a time interval of 2010 - 2021 and a cross-section consisting of twelve banks. For data analysis, the study used data obtained from the annual report and Factbook publications of the Nigerian stock market (obtained from www.nse.com.ng), the listed companies' annual financial statements, and the statistical bulletin of the Central Bank of Nigeria for 2021.

Model specification

To accomplish the prime objective of this paper, we used the panel regression model from the study of Ahmad et al. (2019), which examined the nexus between credit risk and liquidity risk and their impact on bank financial performance of banking institutions in Pakistan from 2008 to 2018. This study broadens Ahmed et al. (2019) model to explore the impact of the independent variables on dependent variables over time using the following models:

$$Y_{it} = \alpha_i + \beta X_{it} + \lambda W_{it} + \delta Z_{it} + \mu_{it} \qquad (1)$$

Y represents the dependent variable Bank stability of *i* bank cross-section, time-series *t* from 2010 through 2021; *αi* is the unobservable time-invariant effect of each variable that can decompose into fixed individual effect and random effect. X is a vector of explanatory variables, which includes Credit Risk (CR) and Liquidity Risk (LR). *W* represents other internal banking variables that may influence bank stability, and this includes Bank Size (BS), Capital Adequacy Ratio (CAR), and Equity. *Z* represents macroeconomic variables that may also affect bank stability, which includes Gross Domestic Product Growth Rate (GDPGR) and Inflation Rate (INFL). B, λ, δ are parameters that show the coefficients of the relationship, and μi is a random unobserved component that reflects unobserved shocks affecting bank stability. Explicitly, the model is stated as:

$$Y_{i,t} = \alpha_i + b_1CR_{it} + b_2LR_{it} + b_3CAR_{it} + b_4Equity_{it} + +b_5Size_{it} + b_6GDPGR_{it} + b_7INFL_{it} + \epsilon_{i,t} \quad (2)$$

Where; α_i represents the individual cross-section unobserved latent variable, which could be fixed or random, and the stochastic term follows a two-way error component for the time interval and cross section given as:

$$\epsilon_{it} = \mu_i + V_{it} \quad (3)$$

μ_i and V_{it} are error components representing time interval and cross sections residuals.

The Wald test will be used to determine if credit risk and liquidity risk jointly impact bank stability. This is tested as follow;

H_0: $b_1 = b_2 = 0$ (Jointly Statistically Insignificant)

H_1: $b_1 = b_2 \neq 0$ (Jointly Statistically Significant)

According to financial literature such as Ahmad et al. (2019); Setiawan et al. (2021); Amara and Mabrouki (2019) amongst others, bank stability can be measured using the z score which is computed as;

$$z\ score = \frac{(u+k)}{\sigma} \quad (4)$$

Where; *u* is defined as bank asset which is measured in terms of Return on Assets (ROA). *K* is the capital ratio which is measured as equity as a percentage of total asset. σ

represents volatility of returns which is measured as the standard deviation of ROA. An increase in the Z-score implies a better bank stability and thus the likelihood of bankruptcy decreases.

Liquidity Risk = Bank financing gap/Total Assets. Bank financing gap is the difference between bank loans and deposits of customers.

Credit risk = ratio of non-performing loans to total loans

The study carried out the dynamic panel analysis using Arellano and Bond's (1991) dynamic panel data estimation. In contrast to static panel data models, dynamic panel data models incorporate lagged levels of the dependent variable as regressors. The inclusion of a lagged dependent variable as a regressor violates strict exogeneity since the lagged dependent variable may be correlated with the random effects or the general errors (Baltagi, 2006).

$$\Delta Y_{it} = \alpha_i + \sum_{j=1}^{p-1} \beta_{ij}^{*} \Delta Y_{i,t-j} + \sum_{j=0}^{q-1} \phi_{ij}^{*} \Delta X_{i,t-j} + u_{it} \quad (5)$$

Y_{it} (Represents Z-score) X_{it} is a k-dimensional vector of explanatory variables (credit risk, liquidity risk, bank size, capital adequacy ratio, equity, Gross Domestic Product Growth Rate, Inflation Rate) for group i; α_i represent the time invariant effects; the coefficients of the lagged dependent variables, λ_{ij}, are scalars; and δ_{ij} are k dimensional coefficient vectors. In the following, we assume that the disturbances uit, *i = 1, 2, . . . ,N ; t = 1, 2, . . . , T,* are independently distributed across *i* and *t,* with zero means, variances σ^2_i, and are distributed independently of the regressors X_{it}.

Panel Causality Test

The Dumitrescu-Hurlin (DH) test will be used to test for causality. DH provides an extended test designed to detect causality in panel data. The underlying regression writes as follows:

$$Y_{i,t} = \propto_i + \sum_{K=1}^{K} \beta_{ik} Y_{i,t-k} + \sum_{K=1}^{K} \lambda_{ik} X_{i,t-k} + e_{i,t} \tag{6}$$

Where $X_{i,t}$ and $Y_{i,t}$ are the observations of two stationary variables for individual *i* in period *t*. Coefficients are allowed to differ across individuals (note the *i* subscripts attached to the coefficients) but are assumed time-invariant. The lag order *K* is assumed to be identical for all individuals and the panel must be balanced.

The procedure to determine the existence of causality is to test for significant effects of past values of *X* on the present value of *Y*.

The null hypothesis is therefore defined as:

H0 : $\lambda_{i1} = \lambda_{i2} = \ldots\ldots = \lambda_{ik} = 0 \ \forall I = 1,2,\ldots\ldots.,N$

Which corresponds to the absence of causality for all individuals in the panel. The test assumes there can be causality for some individuals but not necessarily for all. The alternative hypothesis thus writes:

H1 : $\lambda_{i1} = \lambda_{i2} = \ldots\ldots = \lambda_{ik} \neq 0 \ \forall I = 1,2,\ldots\ldots.,N$

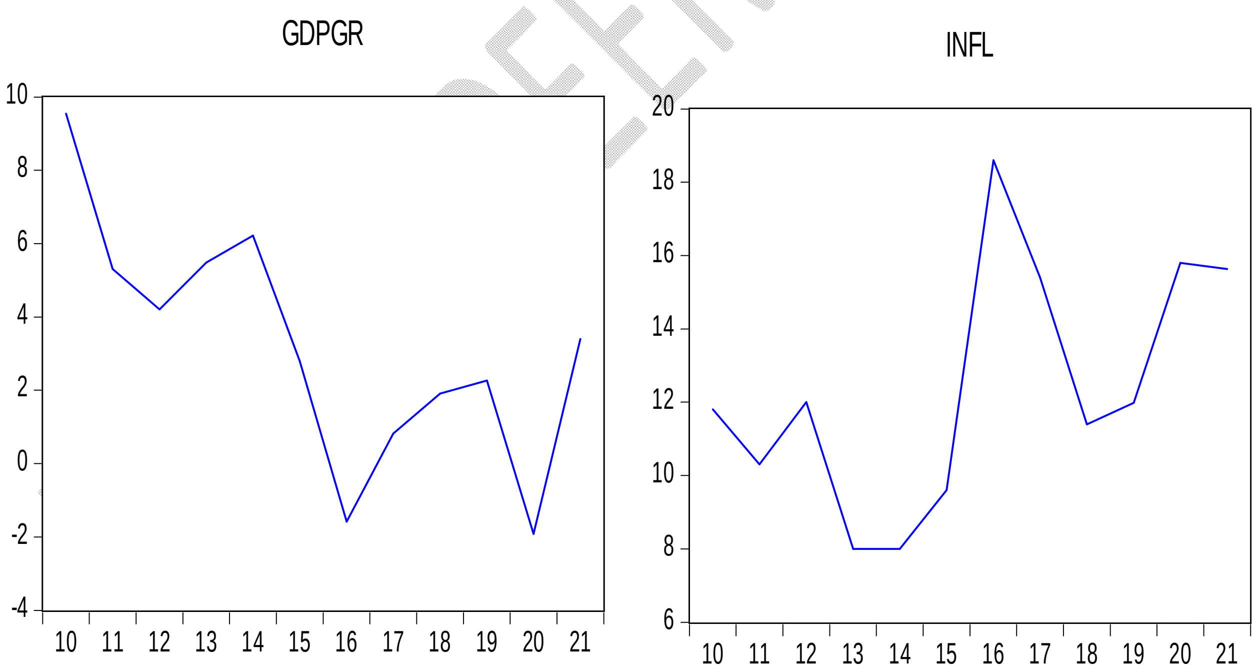
$\lambda_{i1} \neq 0$ or…….or $\lambda_{ik} \neq 0 \qquad \forall I = N_1 +1, \ldots\ldots.,N$

Where, $N_1 \in [0;N -1]$ is unknown. If $N_1 = 0$, there is causality for all individuals in the panel. N_1 is strictly smaller than N, otherwise there is no causality for all individuals and H_1 reduces to H_0.

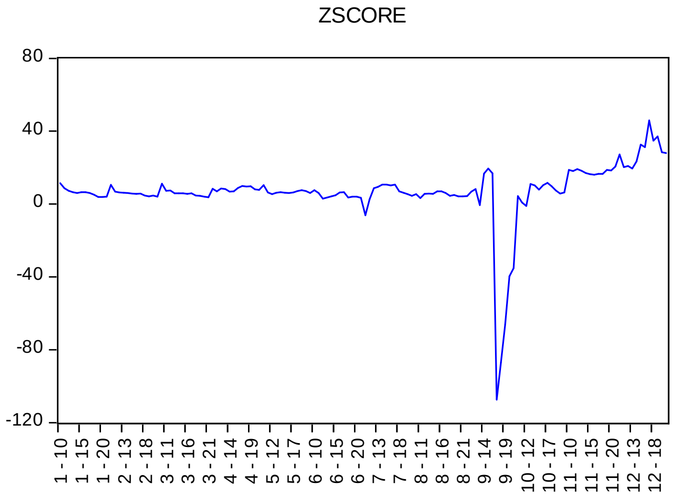
Data Analyses and Interpretation of Results

Figure 1

Periodogram



Graphical analyses were carried out in order to observe trends' flows in the variables under consideration.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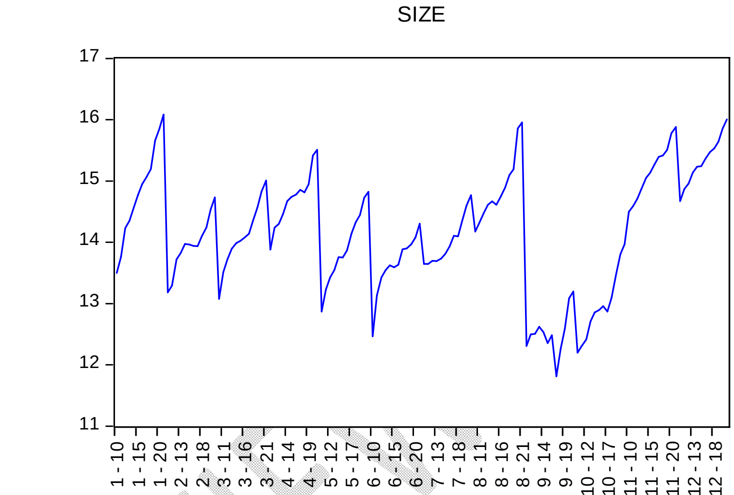
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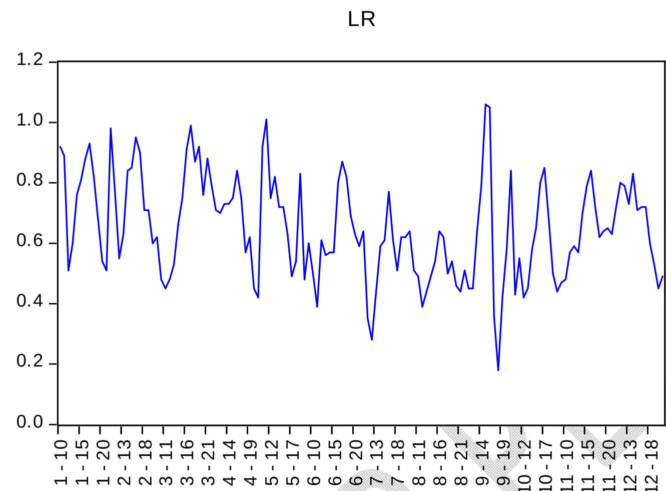
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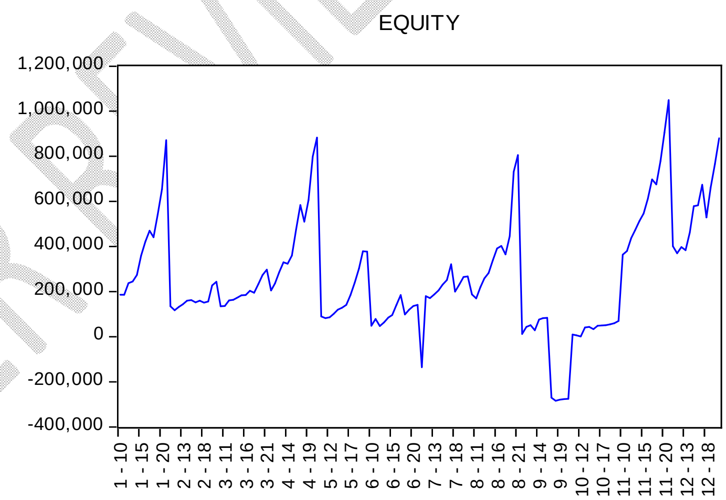
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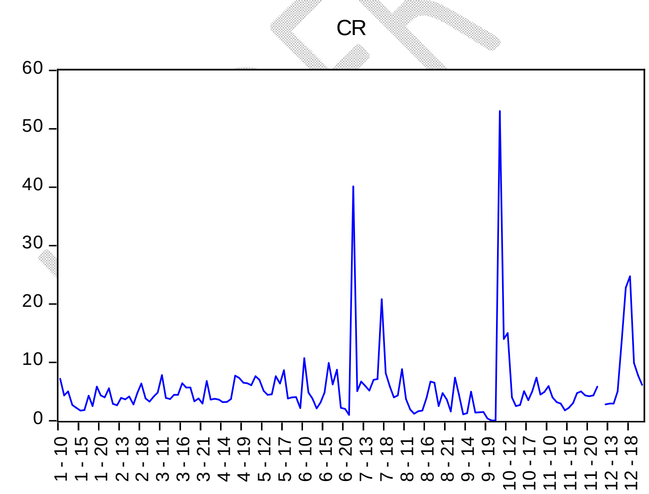
CR
60
50
40
30
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0
1 - 10
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2 - 13
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3 - 11
3 - 16
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4 - 14
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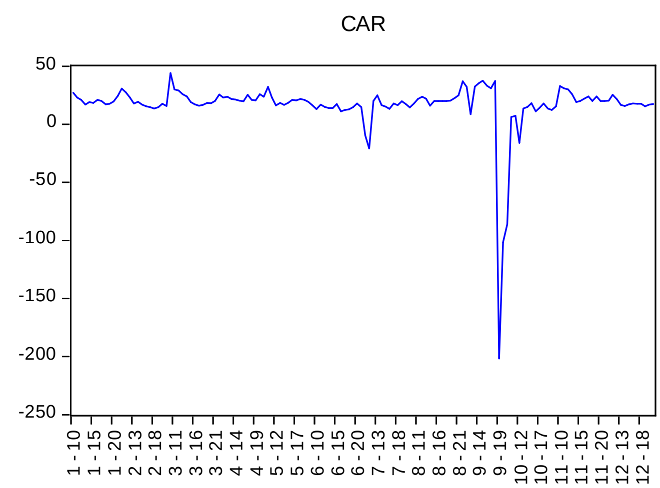
CAR
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0
-50
-100
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-250
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Graphically, the analysis showed that all the variables under study were volatile at one point or the other during the period under review. The volatility can be attributed to government policies and global financial events that would have affected some of the variables.

Descriptive Analysis

Table 1

Descriptive statistics

Variable	Mean	SD	CV	J-B
ZSCORE	6.747552	16.82585	4.020151	3389.897
SIZE	14.16305	0.969310	1.334179	2.753611***
LR	0.648881	0.169332	4.071621	1.681870***
EQUITY	268688.6	252096.2	9.021312	12.62884
CR	5.596014	6.141995	5.356823	6221.296
CAR	16.40350	24.09727	8.245637	16537.34
INFL	12.39035	3.207351	1.460768	7.683849
GDPGR	3.190280	3.146084	1.405494	1.355916***

Source: Authors computation

****** p < 0.001; ** p < 0.01; * p < 0.05***

Table 1 shows the descriptive statistics for the Z-score credit risk, liquidity risk, bank size, capital adequacy ratio, equity, Gross Domestic Product growth rate, and inflation rate, respectively. The first column shows the mean values for the variables and is all positive. The second column shows the standard deviations, while the third column shows the coefficient of variation, which shows the relative dispersion of the variables. It is possible to deduce from the coefficient of variation that Size has a slight variation than the other variables, followed by GDPGR and INFL. The coefficient of variation predicts the high degree of instability of Equity. The Jarque-Bera probability values in the fourth column are significant for GDPGR, LR, and Size, indicating that these variables follow a normal distribution.

Table 2

Correlation Analysis

Correlation Probability	ZSCORE	SIZE	LR	EQUITY	CR	CAR	INFL	GDPGR
ZSCORE	1.000000							

SIZE	0.446122	1.000000						
	0.0000	-----						
LR	0.262095	0.031722	1.000000					
	0.0016	0.7068	-----					
EQUITY	0.557118	0.889832	0.003102	1.000000				
	0.0000	0.0000	0.9707	-----				
CR	0.165763	-0.084704	0.102901	-0.016014	1.000000			
	0.0479	0.3145	0.0013	0.8494	-----			
CAR	0.433274	0.172029	0.091580	0.315829	-0.006901	1.000000		
	0.0000	0.0399	0.2767	0.0001	0.9348	-----		
INFL	-0.048293	0.233778	0.124536	0.230410	0.065682	-0.079075	1.000000	
	0.5668	0.0050	0.1384	0.0056	0.4357	0.3478	-----	
GDPGR	0.067602	-0.322598	-0.108950	-0.250370	0.157478	0.110683	-0.689619	1.000000
	0.4224	0.0001	0.1952	0.0026	0.0603	0.1882	0.0000	-----

Source: Authors computation

The table shows the pairwise correlation between the variables. There is a significant positive association between the Z-score (bank stability) and size; Z-score and LR; Z-core and Equity; Z-score and CR; Z-core and CAR. There exist a positive but insignificant correlation between Z-score and GDPGR. There is a negative correlation between Z-score and inflation; however, the result is statistically insignificant. From the result, credit risk (CR) and liquidity risk (LR) are positively related. The relationship is statistically significant. The result implies that credit risk is independent of liquidity risk.

Relationship Between Credit Risk and Liquidity Risk

Table 3

Pairwise Dumitrescu Hurlin Panel Causality Tests

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
LR does not homogeneously cause CR	9.94280	11.8211	0.0000
CR does not homogeneously cause LR	2.04595	0.97145	0.3313

Source: Authors computation

From the causality test result, if can de deduced that Liquidity Risk (LR) causes Credit Risk (CR) as indicated from the low probability given as 0.0000. on the other hand, Credit Rsk does not cause Liquidity risk as indicated in the result.

This implies a one-way (uni directional)causality that runs from liquidity risk to credit risk.

Panel Test of stationarity

The unit root test is essential to determine the stationarity property of the variables used to carry out the panel data analysis. Panel unit root tests were conducted with Levin Lin Chu (LLC) and Breitung's test statistic. Using a multiple-unit root test allows for comparing the results of both tests to identify the actual stationarity property of the variables and avoid spurious regression.

Table 4

Panel Unit Root Test

Variable	LLC Statistic	Prob	Decision	IPS Statistics	Prob	Decision
ZSCORE	-2.71519	0.0032	I(0)	-4.38401	0.0000	I(0)
SIZE	-2.02608	0.0214	I(0)	-5.83892	0.0000	I(0)
LR	-4.94594	0.0000	I(0)	-4.08175	0.0000	I(0)
EQUITY	-2.30939	0.0105	I(0)	-4.32903	0.0000	I(0)
CR	-1.70736	0.0439	I(0)	-2.39773	0.0047	I(0)
CAR	-3.12090	0.0009	I(0)	-2.41458	0.0079	I(0)
INFL	-2.99242	0.0014	I(0)	-2.53255	0.0057	I(0)
GDPGR	-5.29956	0.0000	I(0)	-2.84688	0.0022	I(0)

Source: *Computed using E-Views 11 Software Package*

From the unit root test, all the variables were stationary at all levels, as shown by LLC and IPS test statistics. The LLC and Breitung's unit root tests yield similar results for all the variables. All the variables are integrated at order zero, which implies that the variables were all stationary at level.

Table 5

GMM Result - *Dependent Variable: ZSCORE*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CR	-0.264357	0.143642	-1.840390	0.0481
LR	-22.18115	5.251887	-4.223463	0.0000
INFL	-0.398315	0.337813	-1.179100	0.2407
GDPGR	1.011249	0.389641	2.595334	0.0106
EQUITY	0.000102	1.18E-05	8.670334	0.0000
CAR	0.051634	0.003800	13.58567	0.0000
SIZE	6.950818	3.191423	2.177968	0.0313
C	-115.3869	44.77495	-2.577042	0.0112
Model Diagnostics				
R-squared	0.767158			
Adjusted R-squared	0.728987			
F-statistic	17.30281			
Prob(F-statistic)	0.000000			

Source: *Computed using E-Views 11 Software Package*

The result presented the GMM analysis from Table 5, a unit increase in CR on average will lead to a 0.264357 unit decrease in Z-score (bank stability). The result is statistically significant at a 5 percent level of significance, as indicated by the probability value of 0.0481, which is lower than 0.05. A unit increase in LR on average will lead to a 22.18115 unit decrease in Z-score. The result is statistically significant at a 5 percent level of significance, as indicated by the probability value of 0.000, which is lower than 0.05. A unit increase in INFL on average will lead to a 0.398315 unit decrease in Z-score. However, the result is statistically insignificant at a 5 percent level of significance, as indicated by the probability value of 0.2407, which is higher than 0.05.

Furthermore, a unit increase in GDPGR on average will lead to a 1.011249 unit increase in Z-score. The result is statistically significant at a 5 percent level of significance, as indicated by the probability value of 0.0106, which is lower than 0.05. Also, a unit increase in Equity, CAR, and Size will lead to 0.000102, 0.051634, and 6.950818 increase in Z-score. The variables are statistically significant due to their low probability value. In the same vein, the coefficient of determination (R^2) shows that 76% of the variations in bank stability are explained by the explanatory variables in the model, which is above 50%. Moreover, even after taking into consideration the degree of freedom, the adjusted coefficient of determination (adjusted R^2) still shows that a 72% variation in bank stability is explained by the explanatory variables. The F-statistic 17.30281 (0.000000) confirmed the fitness of the coefficient of the model and shows an overall significant level of the explanatory variables jointly in explaining bank stability.

Joint impact of Credit Risk and Liquidity Risk

Table 6

Wald test for joint significance of Credit Risk and Liquidity Risk

Wald Test:

Test Statistic	Value	df	Probability
F-statistic	10.44922	(2, 122)	0.0001
Chi-square	20.89844	2	0.0000

Null Hypothesis: C(2) = C(1) = 0

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(2)	-22.18115	5.251887
C(1)	-0.264357	0.143642

Restrictions are linear in coefficients.

From Table 6, the result showed that credit risk and liquidity risk jointly impact bank stability in Nigeria. The Wald test statistics and its probability show that the result is significant, which implies that both credit risk and liquidity risk jointly impact bank stability negatively.

Conclusion and Recommendations

The primary objective of this study is to analyse the impact of credit risk and liquidity risk on bank stability in Nigeria. The results of the various econometrics analyses from this study revealed that both credit and liquidity risks negatively and significantly impact bank stability individually and jointly in Nigeria. The results are consistent with previous studies such as Ahmad et al. (2019), Setiawan et al. (2021), and Amara and Mabrouki (2019), who also observed a negative and significant impact of credit risk and liquidity risk on bank stability.

Moreover, it was deduced that there was a positive correlation between credit risk and liquidity risk, with the correlation result being statistically significant. Further investigation using the Pairwise Dumitrescu Hurlin Panel Causality Tests indicated a one-way (unidirectional) causality that runs from liquidity risk to credit risk. This study, therefore, provides evidence that there is a link between liquidity risk and credit risk, such that liquidity risk causes credit risk in Nigeria. The findings are consistent with the study of Zaghdoudi (2019), who also observed some relationship between credit risk and liquidity risk in Tunisia. However, other studies such as Imbierowicz and Rauch (2014), Amara and Mabrouki (2019) Ghenimi et al. (2017) did not find any economically deduced relationship between credit risk and liquidity risk.

Further analysis showed that other internal bank-related indicators significantly impact bank stability. Bank Size, Equity, and Capital Adequacy all positively and significantly impact bank stability. Likewise, macroeconomic indicators such as economic growth have a positive and significant impact on bank stability, while inflation rate has a negative but insignificant impact on bank stability in Nigeria.

Based on the findings, the study recommends joint management of credit and liquidity risk since a rise in liquidity risk will cause credit risk, which will result in bank instability. Thus, the results support bank regulation that places more emphasis on the reduction of credit and liquidity risk in the banking sector since credit and liquidity risk have an attendant adverse effect on bank stability.

Also, bank managers should closely monitor and control important financial indicators such as capital adequacy, size, and equity to improve bank stability. Bank capital and equity should be appropriately managed and increased since they positively impact bank stability.

The study also recommends the use of monetary policies such as a contractionary monetary policy to pursue inflation targeting in the economy. The CBN should implement policy measures that will help achieve moderate inflation rates consistent with economic growth and development, which is necessary because inflation negatively affects bank stability in Nigeria.

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