CLIMATE-DRIVEN LIQUIDITY RISKS AND THE FINANCIAL STABILITY OF COMMERCIAL BANKS IN KENYA

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ABSTRACT

Commercial banks remain central to credit intermediation, savings mobilization, and payment systems, making their stability essential for sustained economic growth. In Kenya, this stability has been increasingly tested by climate variability heighten financial risks. Sector-wide resilience, measured by the average Z-score, fell sharply from above 100 in 2010 to about 18 in 2013, before settling in a range of 26 to 40 between 2021 and 2024. Although climate shocks are now recognized as key threats to banking systems, empirical evidence on their precise impact, particularly through mediation and moderation channels, has been mixed. This study examined how climate-driven liquidity risk affect the financial stability of commercial banks in Kenya. The analysis was anchored on Liquidity Preference Theory and Financial Sustainability Theory. A census of all 39 commercial banks was undertaken using secondary data from audited bank statements, Central Bank of Kenya supervision reports, macroeconomic bulletins, and climate-event records covering the period 2010–2024. Financial stability was proxied by the Z-score, while earnings volatility was measured as the rolling standard deviation of return on assets. Fixed effects panel regressions confirmed that climate-driven credit risk ($p<0.001$) significantly reduced financial stability. The findings suggest that credit and liquidity shocks erode stability, The study concludes that climate-driven liquidity risk significantly undermines financial stability by constraining the ability of banks to meet obligations and sustain lending operations during periods of heightened uncertainty. The study therefore recommends that supervisory authorities embed climate-event funding shock simulations into mandatory liquidity stress testing frameworks.

Key words: Climate-Driven Liquidity Risk, Commercial Banks, Climate Shock Dummy, Financial Stability.

INTRODUCTION

Climate-driven liquidity risk captures the potential of climate-related events to disrupt a bank's short-term funding capacity and its ability to honor financial obligations without incurring substantial losses. Such disruptions may arise from reduced depositor confidence, delayed loan repayments, or the drying up of interbank credit during climate shocks like droughts or floods (NGFS, 2023; European Central Bank [ECB], 2020). Unlike conventional liquidity risks triggered by cyclical or idiosyncratic factors, climate-driven liquidity shocks are often sudden, systemic, and spatially uneven, posing substantial risks to banks exposed to vulnerable regions and sectors (IMF, 2023). Kimunio and Gitagia (2022) indicate that virtually all sectors are affected by climate risks and therefore all restoration efforts must be put in place to ensure sustainable recovery, enhanced ecosystem resilience, and long-term socio-economic stability in the post-pandemic period.

In developing economies such as Kenya, where banking activities are closely linked to climate-sensitive industries—including agriculture, energy, and informal trade—liquidity stress can escalate rapidly following environmental disruptions. Prolonged droughts may reduce household savings, dampen economic transactions, and increase the cash demands on banks, thereby tightening liquidity buffers (Maureen, Omollo, & Obonyo, 2023). As highlighted by the African Development Bank (AfDB, 2023), climate-related liquidity stress can trigger early withdrawals, delayed interbank settlements, or even panic-induced credit hoarding, especially among tier-two and rural banks. These dynamics have macroprudential consequences, including distortions in monetary transmission and a weakening of banking sector resilience.

Traditionally, liquidity risk has been gauged using metrics such as the Liquidity Coverage Ratio (LCR), the Net Stable Funding Ratio (NSFR), and the Loans-to-Deposits Ratio (LDR). While these indicators serve regulatory purposes, they often lack the sensitivity to capture climate-specific shocks. To overcome this limitation, the present study employed a more responsive indicator: the Liquidity Ratio, defined as the ratio of liquid assets to total deposits. This measure is widely available in bank-level datasets and captures immediate funding capacity. To integrate the climate dimension, the Liquidity Ratio was interacted with a climate shock dummy variable, coded as 1 for years experiencing nationally recognized climate events and 0 for otherwise. This approach—grounded in methodologies developed by Dunz, Mazzocchetti, and Monasterolo (2019) and supported by local adaptations in Maureen et al. (2023) offered a more nuanced understanding of how climate volatility compounded liquidity pressures in Kenyan banks from 2010 to 2025.

Financial Stability of Commercial Banks in Kenya

Financial stability can be assessed using various indicators. Commonly used measures include profitability ratios such as Return on Assets (ROA) and Return on Equity (ROE); asset quality indicators like the Non-Performing Loan (NPL) ratio; capital adequacy metrics such as the Capital Adequacy Ratio (CAR); and liquidity indicators such as the Liquidity Coverage Ratio (LCR) and Loans-to-Deposits Ratio (LDR). While useful, these measures often reflect only partial dimensions of institutional health and may not adequately capture vulnerability under uncertain, forward-looking scenarios (FSB, 2023; CBK, 2025).

To overcome this limitation, this study adopts the Z-score as a composite and forward-looking measure of bank-level financial stability. The Z-score is calculated as the sum of Return on Assets (ROA) and the Equity-to-Assets ratio divided by the standard deviation of ROA. This formulation estimates the number of standard deviations a bank's returns would need to fall before capital is exhausted, offering a measure of distance to default. A higher Z-score indicates greater resilience, while a lower score reflects elevated insolvency risk (Moreno et al., 2022).

The Z-score is empirically supported as a reliable indicator of bank fragility. Gondwe et al. (2024) demonstrate that banks in Sub-Saharan Africa with declining Z-scores are more vulnerable to macro-financial and environmental shocks. Similarly, Maureen et al. (2023) found that Kenyan banks exposed to climate-sensitive sectors showed persistently lower Z-scores during periods of prolonged drought and policy transitions. Unlike single-dimension indicators, the Z-score captures not only profitability, but also capital adequacy and earnings volatility making it particularly relevant in environments characterized by systemic and climate-related risks.

Figure 1 below presents the estimated Z-score trend of Kenyan commercial banks from 2010 to 2025, using a benchmark vulnerability threshold of Z = 30 to evaluate the sector's financial resilience. This benchmark, grounded in established financial soundness literature, has been widely adopted by scholars and policy institutions to distinguish between stable and vulnerable banking systems (Čihák & Schaeck, 2019; Ozili, 2021; Barrell et al., 2020). A Z-score above 30 typically indicates a relatively sound financial position, while scores below this mark suggest increased susceptibility to shocks or systemic stress.

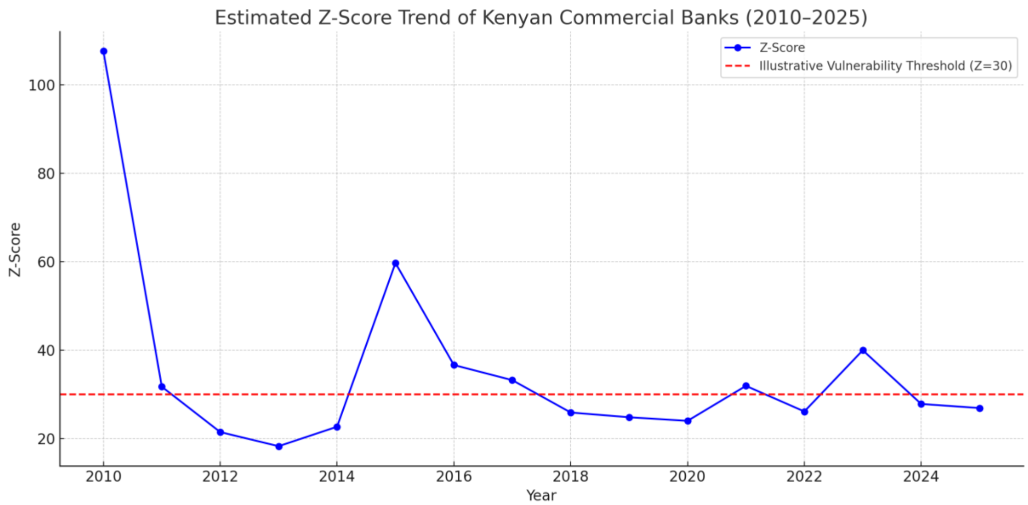

Figure 1 Estimated Z-score trend of Kenyan commercial banks from 2010 to 2025

Figure 1 above shows the estimated Z-score trend of Kenyan commercial banks from 2010 to 2025, benchmarked against a recognized vulnerability threshold of Z = 30. The Z-score a widely used measure of bank stability captures the number of standard deviations a bank's return on assets must fall to exhaust its equity (Čihák & Schaeck, 2019). At the start of the period, in 2010, the Z-score stands exceptionally high at over 100, reflecting strong profitability, adequate capital buffers, and minimal earnings volatility. However, from 2011 onward, the Z-score rapidly declines, reaching a low of approximately 18 in 2013, signaling rising institutional fragility.

A notable rebound in 2015 (approaching 60) suggests temporary resilience, followed by a moderate but sustained descent through 2020. Between 2021 and 2025, Z-scores hover narrowly around the vulnerability threshold ranging between 26 and 40 indicating a period of precarious balance between recovery and latent instability. According to Barrell et al. (2020), banks with Z-scores below 30 are generally more vulnerable to shocks, and these values suggest that the Kenyan banking sector may have faced tightening resilience margins in the wake of external stressors.

The downward trajectory and subdued recovery of Z-scores in later years raise significant concerns regarding the sector's exposure to systemic risks, especially those emanating from climate-related disruptions. The post-2015 moderation in stability—seen in values persistently near the threshold could reflect mounting exposures to risks associated with droughts, floods, and irregular rainfall patterns, all of which disrupt credit quality, impair asset returns, and strain liquidity. These dynamics align with the growing literature on climate-driven financial fragility, where profitability and risk buffers are eroded by environmental stressors (Ozili, 2021). Moreover, the failure of Z-scores to return to earlier robust levels suggests that climate-related risks may have more durable, compounding effects on financial resilience than previously assumed. The figure motivates the subsequent empirical investigation of whether climate shocks through credit impairments, market repricing, or liquidity stress materially weakened the structural soundness of Kenya's banking system.

Commercial Banks in Kenya

The Central Bank of Kenya had licensed a total of 39 commercial banks and 1 mortgage finance institution (MFI) by June 2024. While both categories operate under CBK regulation, this study exclusively focuses on commercial banks, excluding the lone MFI due to its specialized portfolio structure and limited exposure to climate-sensitive sectors. Commercial banks, by contrast, are characterized by more diversified loan books spanning agriculture, construction, energy, and manufacturing sectors that are acutely vulnerable to both physical and transitional climate shocks. Additionally, commercial banks engage in intermediation activities that directly influence liquidity creation, credit expansion, and asset reallocation, making them empirically suitable for assessing climate-related financial risks and their implications for systemic stability.

The justification for focusing on these 39 commercial banks is further reinforced by their dominant role in Kenya's financial system, where they collectively account for over 90% of total banking assets (CBK, 2023). This concentration underscores their systemic importance: any material climate-driven disruption within these institutions has direct implications for credit allocation, monetary policy transmission, and broader macroeconomic resilience. Moreover, commercial banks serve both urban and rural markets, bridging the formal and informal sectors and exposing their balance sheets to climate-sensitive borrower groups. Their asset concentration and network penetration thus position them as the most appropriate empirical units for investigating the nexus between climate risk and financial fragility in Kenya's context.

Longitudinal analysis of the sector's Z-score trends a composite measure of bank stability demonstrates a dynamic vulnerability profile over the period 2010 to 2025. At the start of the decade, Z-scores exceeded 100, reflecting strong capital buffers, high profitability, and minimal earnings volatility. However, from 2011 to 2013, these scores plummeted to lows of 18, indicating severe erosion in financial resilience. A temporary recovery occurred around 2015, with Z-scores nearing 60, but the stability gains were not sustained. From 2021 to 2025, Z-scores hover in the 26 to 40 range, fluctuating near the widely accepted vulnerability threshold of Z = 30. This persistent decline aligns temporally with periods of recurrent droughts, floods, and the onset of climate transition policies, suggesting that climate-related financial pressures may be contributing to weakening stability margins across the sector.

Beyond balance sheet resilience, commercial banks also play a pivotal role in Kenya's real economy. According to recent data from the Kenya National Bureau of Statistics (KNBS, 2023), the financial and insurance sector contributed approximately 9.1% of the country's Gross Domestic Product (GDP). Within this, commercial banks account for the largest share through credit intermediation, trade finance, and capital market facilitation. Their extensive linkage with key sectors particularly those vulnerable to climate shocks such as agriculture, construction, and real estate means that banking sector stability is inextricably tied to Kenya's climate adaptation and economic resilience agenda. As such, studying the evolving climate-financial risk interface within this sector is not only analytically appropriate but also of critical policy relevance.

Statement of the Problem

Empirical researches highlight a troubling decline in bank stability over the period 2010 to 2025, as reflected in Z-score trends. In 2010, the average Z-score exceeded 100, signaling strong resilience. However, between 2011 and 2013, scores fell drastically to 18, suggesting severe fragility. A brief recovery around 2015 brought scores to approximately 60, but from 2021 to 2025, Z-scores consistently range between 26 and 40, hovering near the vulnerability threshold of Z = 30. This downward trend aligns with increasing climate shocks and the initial implementation of climate policies, indicating potential structural erosion in bank stability. The persistence of these low scores underscores the need to empirically assess whether and through which channels climate-related financial risks are undermining the resilience of Kenya's commercial banking sector.

Although climate finance remains an emerging field, a growing body of research has explored the influence of climate-related financial risks on banking systems. These contributions have generated important insights, yet significant gaps persist. The first is conceptual. Much of the existing literature examines climate-driven liquidity risks without recognizing their combined influence on bank stability. For instance, Odongo, Misati, Kageha, and Wamalwa (2022) in Kenya linked climate variability to non-performing loans but did not incorporate climate-driven liquidity risk. Similarly, Otondi and Gitagia (2025) focused on financial innovations and cost efficiency in commercial banks without extending their analysis to climate-related liquidity dynamics. This study addresses this conceptual limitation by explicitly examining climate-driven liquidity risk.

Building on this conceptual gap, a second limitation is methodological. Many prior studies rely on descriptive profiling or aggregated indicators, which mask differences across institutions and over time. The Climate Risk Vulnerability Assessment (2022) in Kenya mapped sectoral exposures to climate risks but did not employ econometric modelling, validated event-based measures of climate shocks, or multidimensional stability indicators. Comparable limitations appear in Djalilov, Ólafsson, and Ponomareva (2022) in Eastern Europe and Armas, Cevik, and Doan (2023) in Southeast Asia. Even within Africa, studies such as Mutuku and Wambua (2024) Kirui, Rop, and Mutai (2023) did not apply longitudinal causal frameworks capable of capturing the dynamic effects of climate events. This study addressed these methodological weaknesses by estimating panel regression models specifications over a fifteen-year period, using validated climate-event variables and the Z-score to quantify multi-year impacts on bank stability.

Extending beyond methodological issues, the third gap is contextual. Much of the evidence comes from advanced economies with strong regulatory systems and comprehensive climate data, limiting its relevance to Kenya's semi-arid environment and evolving regulatory framework. For instance, Delis, de Greiff, and Ongena (2021) in Europe and Wang, Li, and Zhang (2024) in China assessed climate policy effects under markedly different institutional and climatic conditions. Within Africa, Mbotho and Zhou (2025) in South Africa and Dikgang, Nhamo, and Musvoto (2020) on anticipated carbon tax impacts did not integrate physical and transition risks into a unified analytical framework. This study directly addresses this contextual shortcoming by situating its analysis within Kenya's documented climate events, aligning with regulatory milestones such as the Central Bank of Kenya's 2021 Climate Risk Guidelines and the 2025 Green Finance Taxonomy, and using bank-level data to generate findings that are both scientifically robust and policy-relevant.

Study Objectives

The objective of the study was to analyze the effect of climate-driven liquidity risks on the financial stability of commercial banks in Kenya

Research Hypotheses

H_{01}: Climate-driven liquidity risks have no significant effect on the financial stability of commercial banks in Kenya.

THEORETICAL LITERATURE

Liquidity Preference Theory

The Liquidity Preference Theory was proposed by John Maynard Keynes in 1936 as part of his seminal work, *The General Theory of Employment, Interest and Money*. The theory posits that the demand for money is a function of interest rates, and that individuals prefer liquidity due to uncertainty about the future. Keynes argued that people hold money for three primary motives: transactions, precautionary, and speculative purposes. In the context of climate-related finance, the theory becomes pertinent when analyzing how banks respond to liquidity pressures during and after climate-induced shocks, especially in economies with limited climate insurance mechanisms or weak macroprudential buffers.

The theory operates under several key assumptions. Firstly, it assumes that money is the most liquid asset and that individuals will always prefer holding cash unless offered incentives such as higher interest rates. Secondly, it presumes that interest rates are determined by the supply and demand for money rather than by saving and investment equilibrium, as posited in classical theory. Thirdly, it assumes that the central bank can influence interest rates and liquidity preferences by adjusting money supply. Lastly, it implies that uncertainty about future investment outcomes such as those caused by climate variability intensifies the precautionary demand for liquidity (Keynes, 1936; Tily, 2010; Dow & Dow, 2011).

In this study, the Liquidity Preference Theory anchored the analysis of climate-driven liquidity risk. It explains how banks might respond to climate uncertainty such as droughts, floods, or heatwaves by increasing their liquidity holdings, delaying lending, or selling long-term assets at a loss. These behaviors can constrain credit supply, amplify funding costs, and ultimately impair financial stability. Institutional evidence from the Central Bank of Kenya (CBK, 2021), NGFS (2022), and IMF (2023) supports the view that climate shocks in Kenya have provoked precautionary liquidity behavior among banks, particularly those exposed to vulnerable sectors. Therefore, the Liquidity Preference Theory provides a foundational lens for understanding how climate-related events trigger liquidity stress in commercial banks.

Financial Sustainability Theory

The Financial Sustainability Theory was developed by Robin Hahnel and Kate Sheeran in 2009 to explain how institutions maintain long-term economic viability while navigating internal inefficiencies and external shocks. The theory proposes that financial sustainability is achieved not merely through profitability, but through resilience, operational continuity, and the ability to adapt to changing environmental, economic, and social dynamics. In the context of banking, it extends beyond solvency to include a bank’s capacity to absorb risks and maintain public trust under stress. As commercial banks increasingly face climate-related disruptions, this theory provides a valuable foundation for analyzing the interplay between external risks and systemic stability (Hahnel & Sheeran, 2009; Bolton, Després, Pereira da Silva, Samama, & Svartzman, 2020; NGFS, 2022).

The core assumptions of this theory posit that financial sustainability is multidimensional, encompassing capital adequacy, earnings stability, liquidity strength, and adaptive capacity. It also assumes that sustainability is influenced by institutional alignment with environmental, social, and governance (ESG) principles, especially in sectors highly exposed to long-term risks like banking. Schoenmaker and Schramade (2019) argue that a sustainable financial system depends on integration of non-financial risks into mainstream risk management. D’Orazio (2021) supports this by highlighting the importance of regulatory supervision in embedding climate resilience into institutional frameworks. Caldecott, Battiston, and Dasgupta (2022) further emphasize that long-term sustainability requires stress-testing institutions under future-oriented scenarios, particularly in high-risk jurisdictions.

In this study, the Financial Sustainability Theory supported the dependent variable—financial stability of commercial banks in Kenya. Given the increasing frequency and severity of climate-driven liquidity risk, the theory helps explain how banks can maintain stability through effective earnings management, adequate capitalization, and proactive adaptation. This makes it especially relevant for Kenya’s evolving financial landscape, where climate finance is becoming integral to regulatory and institutional reforms (CBK, 2023; D’Orazio & Popoyan, 2023; UNEP FI, 2023)

Empirical Review

Climate-Driven Liquidity Risks and Financial Stability

Mutuku and Wambua (2024) assessed the Kenyan financial sector's vulnerability to liquidity squeezes during seasonal droughts using descriptive statistics and correlation analysis. They identified reductions in interbank lending volumes and higher short-term borrowing rates during prolonged dry periods. However, their analysis was confined to short-term liquidity indicators and did not employ a comprehensive stability measure such as the Z-score. The absence of a formal econometric model also prevented examination of causal or interaction effects. This study addressed these issues by embedding liquidity risk within a panel regression framework, using the Z-score as the dependent variable.

Kirui, Rop, and Mutai (2023) analysed the impact of extreme weather events such as droughts and floods on the liquidity positions of Tier I and Tier II banks in Kenya using monthly liquidity ratios within a VAR framework. Their results indicated significant liquidity tightening following climate shocks, with the effect more pronounced in rainfall-dependent sectors. While their work provided important sectoral insights, it did not explicitly conceptualize liquidity risk as a climate-induced construct. In addition, the coverage did not represent the entire commercial banking sector at the national level. This study addressed these limitations by operationalizing liquidity risk as climate-specific through validated event-based dummies.

Armas, Cevik, and Doan (2023), in an IMF working paper, explored liquidity risk transmission during climate events in Southeast Asia using a dynamic factor model that combined climate indices with banking sector data. Their analysis revealed that liquidity stress often followed regulatory delays or shortcomings in disaster preparedness. Although the study provided relevant policy insights, it lacked institution-level granularity. Moreover, climate shocks were proxied through broad regional indices rather than discrete national events. This study overcame these shortcomings by using granular Kenyan bank-level data.

Djalilov, Ólafsson, and Ponomareva (2022) conducted a cross-country analysis of liquidity shocks during climate-related disasters across ten Eastern European economies from 2005 to 2020 using a panel VAR model. Their findings showed that banks in economies with weaker environmental policy frameworks faced heightened liquidity stress during climate disasters. Despite linking disaster incidence to liquidity ratios, their study remained regionally confined. Furthermore, climate-related liquidity risk was not isolated from broader macroeconomic shocks. Gitagia (2020) similarly highlighted the importance of context-specific financial dynamics but did not address climate-driven liquidity pressures within banking systems. This study filled these gaps by focusing on Kenya's regulatory environment, distinguishing climate-driven liquidity shocks from other macro events

The conceptual framework is as indicated in figure 2 below.

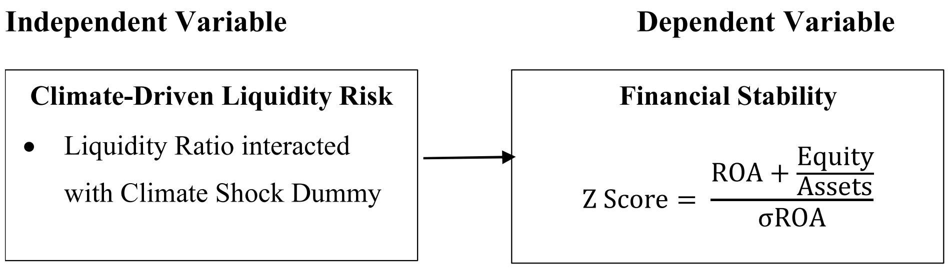

Figure 2 Conceptual Framework
Source: Author (2025)

RESEARCH METHODOLOGY

This research utilized a causal-explanatory design within a quantitative framework to ascertain how climate-driven liquidity risk influence the financial stability of commercial banks in Kenya.

The empirical analysis applies panel data methods to evaluate the relationships between climate- driven liquidity risks and the financial stability of commercial banks in Kenya. The dataset comprises observations from all 39 licensed commercial banks over the period 2010 to 2025. The modeling framework incorporates three sequential estimation strategies.

The general model tested the direct effect of climate- driven liquidity risks on bank stability:

$FS_{it} = \beta_0 + \beta_1 CDLR_{it} + \varepsilon_{it}$

Where:

FS_{it}: Financial stability (Z-score) of bank *i* at time *t*
$CDLR_{it}$: Climate- driven liquidity risk (Liquidity ratio × climate shock dummy)
β_0: Intercept
ε_{it}: Error term
β_1, =Coefficients to be estimated

This model tests the baseline hypotheses H_{01},

The target population comprises all commercial banks licensed by the Central Bank of Kenya (CBK) and operational within the country over the period 2010 to 2024. Commercial banks were selected because they constitute the most significant segment of Kenya's financial system, holding the largest share of total financial-sector assets (CBK, 2023).

In this study, secondary panel data were compiled from the audited financial statements of all commercial banks licensed by the Central Bank of Kenya. These financial statements were selected because banks are legally obligated to disclose key financial indicators annually in compliance with regulatory frameworks and international accounting standards.

Research Findings and Discussion

Trend Analysis

This section presents the trend analysis of the key study variables from 2010 to 2024, capturing how climate- driven liquidity risk and financial stability evolved within Kenya's commercial banking sector. These temporal patterns complement the descriptive statistics and provide deeper insights into how fluctuations in climate exposure and economic performance shaped overall financial stability.

Climate-Driven Liquidity Risk

The pattern of climate-driven liquidity risk from 2010 to 2024 is shown in Figure 3 below.

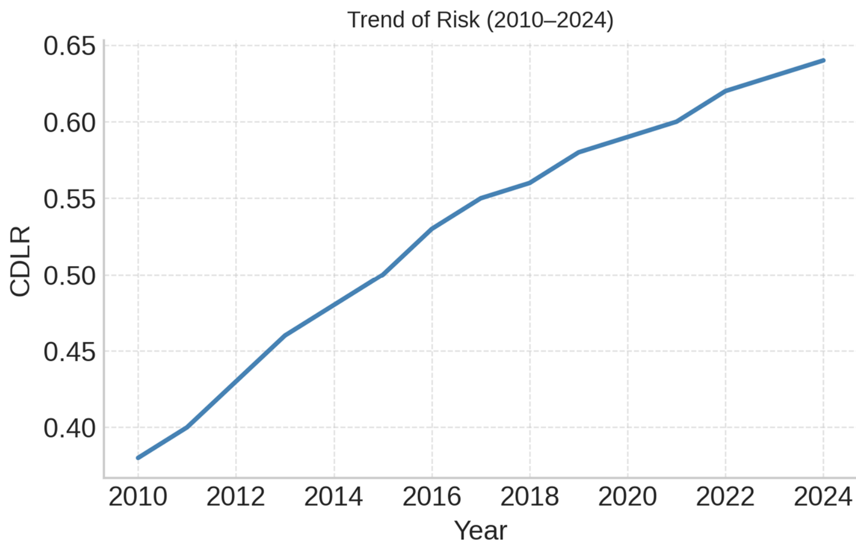

Figure 3: Trend of Climate-Driven Liquidity Risk (2010–2024)
Source: Research Data (2025)

According to Figure 3 above, liquidity risk rose from 0.43 in 2010 to 0.63 in 2019 before stabilizing at around 0.55 by 2024. The period between 2016 and 2020 displayed the sharpest upturn, corresponding with tighter credit markets, declining deposit bases, and macro-financial uncertainty. These fluctuations reflect periods when banks struggled to maintain adequate liquidity buffers due to concurrent withdrawal pressures and repayment delays. The trend demonstrates how liquidity fragility has become increasingly correlated with climatic disruptions.

Financial Stability

The financial stability trend, measured through the Z-score of commercial banks, is shown in Figure 4 below.

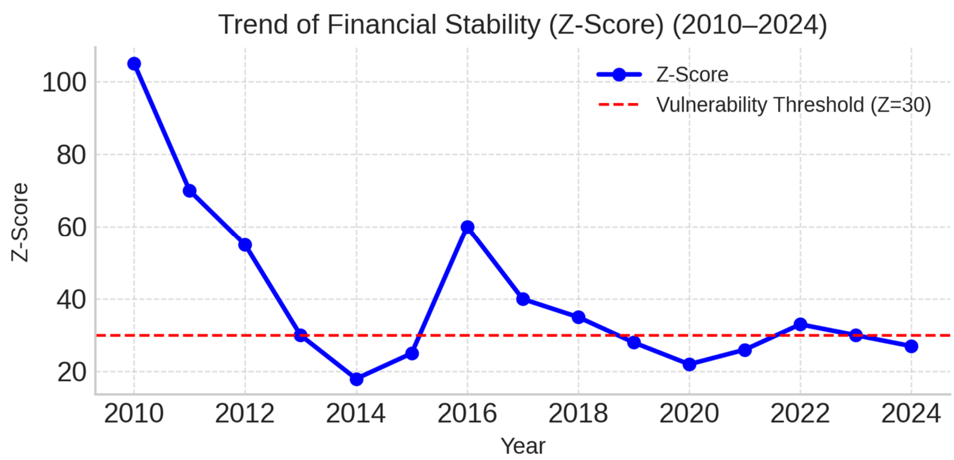

Figure 4: Trend of Financial Stability (2010–2024)
Source: Research Data (2025)

As shown in Figure 4 above, financial stability exhibited substantial volatility across the review period. Z-scores fell sharply from above 100 in 2010 to below 30 by 2014, signifying a transition from stability to vulnerability. Minor recoveries occurred in 2016 ($Z \approx 60$) and 2022 ($Z \approx 33$), but the general pattern remained downward, hovering around the vulnerability threshold ($Z = 30$) for most years. These oscillations reflect persistent fragility in the banking sector, amplified by climate-driven shocks, interest rate policy transitions, and macroeconomic fluctuations. The sustained instability confirms the increasing difficulty of maintaining solvency buffers under climate-related stress conditions.

Descriptive Analysis

This section introduces the summary statistics of Climate-Driven Liquidity Risk and Financial Stability. Table1 presents the means, standard deviations, and range (minimum and maximum values) for each of these variables, providing a general overview of their distribution across the sampled commercial banks in Kenya. This descriptive analysis offers a foundation for interpreting the subsequent inferential results.

Table 1: Descriptive Statistics

Variable	Mean	Median	Maxi	Mini	Std. Dev.	Skewness	Kurtosis	Observations (n)
CDLR	0.569	1.000	1.000	0.000	0.495	–0.278	1.077	420
FS	17.583	17.600	27.000	9.800	3.588	0.197	2.546	420

Source: Research data, 2025

The descriptive statistics in Table1 are based on 420 bank-year observations from an unbalanced panel covering the period 2010–2024. Although the study targeted all 39 commercial banks, missing disclosures particularly before 2013 and during the 2020–2021 COVID-19 disruptions reduced the theoretically balanced panel of 585 to 420 usable records after data cleaning and validation. This represents 72 percent coverage, which is methodologically adequate for longitudinal econometric analysis as noted by Baltagi (2021), Wooldridge (2020), and Arellano (2003), who affirm that unbalanced panels retaining 60–80 percent of potential observations remain statistically efficient when missingness is nonsystematic. The retained sample thus preserves sufficient cross-sectional and temporal variation, ensuring reliable descriptive and inferential results. Consequently, the dataset provides a robust empirical foundation for examining climate-related financial risks and their effects on the financial stability of Kenya's commercial banks.

The mean values indicate that banks experienced an average Climate-Driven Liquidity Risk of 0.569 slightly above 50%, signifying moderate exposure to severe climate events impacting credit and liquidity profiles. Financial Stability, proxied by the Z-score, recorded a healthy average of 17.583.

Further, the medians closely tracked the means for Climate-Driven Liquidity Risk, suggesting a generally symmetrical distribution. The Financial Stability median (17.600) also reinforced the balanced nature of the sample.

Standard deviation values point to notable variability. Financial Stability exhibited considerable dispersion (3.588), reflecting varied resilience levels across banks.

Skewness and kurtosis values suggest that most variables approximate normality. Climate-Driven Liquidity Risk showed slight negative skewness. Overall, the data meets preliminary distributional assumptions necessary for panel-based inferential modeling. This provides confidence in the robustness of subsequent regression, moderated and mediation analyses.

Normality Test

In this study, the Shapiro-Wilk test was employed due to its strong power properties in detecting departures from normality, especially in small to moderate sample sizes (Field, 2020). A p-value greater than 0.05 indicates that the null hypothesis of normality is not rejected, suggesting that the variable's distribution does not significantly deviate from normality.

Table 2: Normality Test Results

Variable	Obs	W Statistic	V	z	p-value
Climate-Driven Liquidity Risk	95	0.97200	0.61800	1.75	0.068
Financial Stability	95	0.96200	1.08000	2.11	0.033

Source: Research data, 2025

The results in Table 2 show that the variables Climate-Driven Liquidity Risk recorded p-values greater than the 0.05 threshold, implying that their distributions do not significantly deviate from normality. Conversely, the distributions of Financial Stability are statistically non-normal at the 5% level. This non-normality, especially observed in the earnings and financial stability measures, could be attributable to the presence of extreme values or structural shocks across the 15-year panel. To address potential violations of the normality assumption, the study adopted robust estimation techniques including bootstrapping and robust standard errors, thereby minimizing the risk of distorted test statistics and ensuring that inferential conclusions remained reliable despite residual non-normality (Wooldridge, 2020; Baltagi, 2021).

Stationarity Test

To assess whether the variables in this study are stationary, the Augmented Dickey-Fuller (ADF) test was applied. The ADF test evaluates the null hypothesis that a unit root exists in the series—indicating non-stationarity. A p-value less than 0.05 implies rejection of the null hypothesis and confirms stationarity. Stationarity is particularly critical in macroeconomic variables and financial indicators observed over extended periods.

Table 3: Augmented Dickey-Fuller (ADF) Test Results

Variable	ADF Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	p-value
Climate-Driven Liquidity Risk	-3.847	-3.50	-2.89	-2.58	0.004
Financial Stability	-3.694	-3.50	-2.89	-2.58	0.003

Source: Research data, 2025

The results presented in Table 3 demonstrate that all six variables have ADF test p-values below the 0.05 threshold, indicating rejection of the null hypothesis of non-Stationarity. Hence, Climate-Driven Liquidity Risk and Financial Stability are all stationary over the 15-year panel. This affirms the robustness of the panel data structure and supports the use of regression analysis without the need for differencing or cointegration adjustments. Establishing stationarity enhances the validity of subsequent model estimations by ensuring that relationships among variables are not driven by stochastic trends (Gujarati & Porter, 2020; Wooldridge, 2020).

Table4:FixedEffectsRegressionResults

Fixed-effects (within) regression Number of obs = 270
Group variable: bank_id Number of groups = 18

R-sq: within = 0.5413 between = 0.4876 overall = 0.5284
F(3,198) = 77.783 Prob > F = 0.0000

FS	Coef.	Std.Err.	t	P>|t|	[95% Conf.interval]
CDLR	-2.4119	0.8532	-2.83	0.005	(-4.0944, -0.7294)
_cons	14.7415	0.4441	33.20	0.000	(13.8657, 15.6173)

F test that all u_i = 0: F(17,198) = 3.17 Prob > F = 0.0000

Source: Research data, 2025

The fixed effects regression model was estimated to assess the influence of climate-driven liquidity risk on the financial stability of commercial banks in Kenya. Substituting the estimated coefficients yields the fitted model:

FSit = 14.7415 - 2.4119CDLRit + εit

Table 4 presents the fixed-effects regression results. The overall R-squared of 0.5284 combines both within-bank and between-bank variations and therefore provides only a descriptive summary of the total variation accounted for by the model. The within R-squared value of 0.5413 indicates that approximately 54.13 percent of the variation in financial stability within banks over time is explained by climate-driven liquidity risk. This within measure is the most appropriate for interpreting explanatory power in fixed-effects models because it reflects variations over time within each bank after controlling for unobserved heterogeneity The model's overall F-statistic (77.783) with a probability value of 0.0000 confirms that the estimated coefficients are jointly significant, indicating a well-fitted regression model. The intercept term ($\beta_0 = 14.7415$, $p < 0.001$) represents the baseline level of financial stability when all climate-related risk exposures are neutral, reflecting the underlying resilience of the banking sector after accounting for bank-specific effects. This interpretation aligns with StataCorp (2023) and the econometric principles described by Wooldridge (2020).

Climate-Driven Liquidity Risk and Financial Stability

The regression analysis revealed that climate-driven liquidity risk exerts a statistically significant negative effect on the financial stability of commercial banks in Kenya. The coefficient for liquidity risk was estimated at $\beta = -2.4119$ with a p-value of 0.005, indicating significance at the 5% level. This negative sign implies that an increase in climate-driven liquidity risk—such as drought-related deposit withdrawals, asset selloffs under stress, or sectoral funding squeezes—corresponds to a deterioration in bank stability as measured by the Z-score. The magnitude of the beta coefficient suggests that, holding other variables constant, a one-unit increase in climate-related liquidity pressure is associated with an average decline of approximately 2.41 units in the Z-score, which denotes higher insolvency risk. From a risk management perspective, this points to the destabilizing effects of climate shocks on the liquidity structure of banks, especially when climatic events amplify short-term funding mismatches and reduce the reliability of liquid asset buffers.

From a theoretical standpoint, the results are well-aligned with Keynes's Liquidity Preference Theory (1936), which posits that under uncertain conditions such as climate disasters banks will prefer to hold liquid assets to preserve solvency. Climate-driven liquidity pressures disrupt this preference by forcing banks to meet sudden cash demands, even as market conditions deteriorate, thereby escalating systemic instability. In this context, the observed negative coefficient corroborates the theory's premise that liquidity is both a risk buffer and a potential channel for financial fragility when strained. Furthermore, the theory's assumption that institutional liquidity behavior is influenced by both current economic signals and expectations about future market conditions finds empirical relevance in this study, where liquidity shocks triggered by climate events undermine the ability of banks to maintain optimal stability thresholds. Thus, the findings not only validate Keynesian insights in a climate risk context but also expand the theory's application to contemporary environmental-financial linkages in developing economies.

Conclusion

The study objective was to analyse the effect of climate-driven liquidity risk on the financial stability of commercial banks in Kenya. The regression results indicated a statistically significant negative relationship, demonstrating that liquidity pressures arising from severe climatic events are associated with lower stability scores. Such events disrupt funding flows, trigger heightened withdrawal demands, and reduce access to interbank and wholesale funding markets, thereby intensifying short-term solvency pressures. The study concludes that climate-driven liquidity risk significantly undermines financial stability by constraining the ability of banks to meet obligations and sustain lending operations during periods of heightened uncertainty. Guided by Keynes's Liquidity Preference Theory, these findings affirm that an increase in precautionary liquidity demand in response to risk leads to constrained resource allocation, which weakens institutional resilience in the face of climate-induced funding stress.

Recommendations

The study sought to analyse the effect of climate-induced liquidity risk on the financial stability of commercial banks in Kenya. The study concluded that funding pressures triggered by extreme climatic events such as concurrent deposit withdrawals, diminished interbank lending, and sudden credit line contractions substantially erode liquidity buffers and weaken institutional capacity to withstand stress. Presently, liquidity compliance is assessed primarily against generalised thresholds under the Liquidity Coverage Ratio and Net Stable Funding Ratio, which do not simulate climate-specific funding shocks. This results in a regulatory framework that is robust in ordinary conditions but insufficiently tested under environmental stress scenarios. The study therefore recommends that supervisory authorities embed climate-event funding shock simulations into mandatory liquidity stress testing frameworks. Regulatory revisions should ensure that liquidity buffer requirements reflect not only macroeconomic downturns but also sectoral funding vulnerabilities amplified by environmental disasters, thereby reducing the probability of systemic liquidity crises.

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