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Dynamics Of Credit, Liquidity and Solvency Risk: A Multidimensional Panel Approach in Case of Pakistan's Banking Sector

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ABSTRACT

This paper examines the dynamic relationship between credit risk, liquidity risk, and solvency risk in the Pakistani banking sector. The study uses a panel dataset of commercial banks over the period 2012–2023 and applies fixed effects, random effects, and Two-Step System Generalized Method of Moments (GMM) estimators to account for persistence and endogeneity in bank stability, measured by the Z-score. The results indicate significant persistence in bank stability, suggesting gradual adjustment over time. Credit risk and earnings volatility negatively affect stability, while profitability, capital adequacy, and effective risk management improve resilience. Excessive liquidity holdings are found to weaken solvency, particularly under macroeconomic uncertainty. Robustness analysis across pre-pandemic and post-pandemic periods confirms the consistency of the results. Overall, the study provides empirical evidence on the role of risk interactions and key financial indicators in shaping bank stability in Pakistan.

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1. Introduction

Financial system is a key part of the contemporary economies as it distributes resources effectively, it facilitates investment and efficient system of payment. On an elementary level, the banking sector carries out the banking segment undertakes the intermediary critical roles of turning on the savings into useful investment, and pass across the monetary policy (Berger & Sedunov, 2024). There can also be no sustainable economic growth without the bank stability that can lead to the systemic crisis as the 2007/8 Global Financial Crisis, and the COVID-19 resulted in drastic declines in the output and employment. The synergy of the three basic risk dimensions, which encompass the credit risk, the liquidity risk and the solvency risk, are some of the leading factors in driving the instability in banking. Credit risk is in which the quality of assets is affected by default of the borrowers, liquidity risk is in which the banks fail to get their short-term funding requirements without

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the assets losing their value and solvency is in which the assets lack enough capital reserves to cover up the losses. Such risks are interconnected: with the growth of the credit risk, withdrawal may take place, which will trigger sale of assets undermining the capital and worsening the solvency risks.

The distinguishing characteristics of emerging markets are that, they have poor capital markets, bank finances, poor institutions and rising macroeconomic volatility to the extent that they amplify the transmission of shocks and nonlinear risk dynamics. The macroeconomic performance, fiscal sustainability, and financial inclusion parts of the banking sector are applicable to Pakistan as more than three-quarters of financial assets are in the banking industry (Latifannisa et al., 2025). Despite this regulation such as adoption of Basel III, tighter control still, the banks are vulnerable to several weaknesses they are facing, and these include Inflation, risks posed by the depreciation of the exchange rates, a state of imbalance in the fiscal front, and a large number of non-performing loans. It is a complex scenario which is further entrusted by the existence of conventional and Islamic banking. The Islamic banks are managed based on the Shariah principles with an emphasis on the assets-based funding and profit sharing and it minimizes the risks of credit, though at the cost of delivering liquidity, since there is a paucity of Shariah-compliant instruments. In such a way, the risk dynamics between the Islamic and conventional banks though the same macroeconomic and regulatory environment exists is attributed to the necessity to establish certain regulatory and risk managing systems.

These three risks (credit risk, liquidity risk and solvency risk) have a way of interacting with each other making the banks stable; however, empirical study particularly in emerging economies has mainly been done individually. Currently, available nonlinear methods of risk amplification, as well as endogenous feedbacks and dynamic shock transmission are not well applied in the existence of endogenous shock transmission, which are most prominent in the dual banking systems, including the one found in Pakistan. It is also observed that despite the introduction of Basel III and greater regulation by the State Bank of Pakistan, the effects of non-performing loans, liquidity pressure, and instability of the current capital are still noticeable. This demonstrates that there exists a highly severe lack in the knowledge of the dynamic interdependence of banking risks. The econometric based framework of the system is therefore required during proper risk interactions during the effective formulation of risk management and regulation policies to make the right decisions. The research that is available in Pakistan is likely to consider either credit, liquidity, or solvency risks in isolation and uses a model that is not dynamic with feedback as a result and delayed reactions of many factors amongst others. In addition, there are threshold effects and nonlinearities that are likely to be ignored but would be relevant in the example of emerging markets when interactions on risks can become more pronounced.

This study is based on theories of banking risk, financial fragility, and prudential regulation, which, in combination, justify dynamical interdependence of multiple risks of credit, liquidity, solvency, and bank stability in general. The article is based on the financial fragility hypothesis that argues that maturity transformation and leverage, a feature of banks, makes them susceptible to asset quality and funding shock. In that regard, the structural credit risk model by Huang et al. (2020) would give the means through which the decline in the quality of assets predisposes the defaults and undermines the positions of the banks to be solvent. Furthermore, the modern banking theory, including the works by Adrian and Shin (2010), supports the liquidity-risk nexus, as it highlights the fact that financial instability is enhanced by the liquidity conditions and leverage cycles. Liquidity implosion may push banks to fire sales, decreasing the liquidity values of the assets and leaving capital diminished, which can impact the shocks of liquidity risk into the solvency risk. The mechanism is compatible with the wider financial accelerator framework, according to which balance sheet vulnerabilities support macro-financial instability.

Moreover, under the Basel III framework, prudential regulation theory emphasizes capital adequacy and liquidity buffers to aid in the mitigation of systemic risk. An increase in the capital adequacy ratios increases the loss-absorbing capacity of banks, whereas sufficient liquidity decreases exposure to funding shocks. These regulation principles explain why capital adequacy (CAR), liquidity (LIQ) and profitability (NIM) were used as major factors of stability in the empirical model. The theoretical basis of the study defines a risk interdependency conceptualization where credit risk,

liquidity risk, and solvency risk are interrelated through feedback. High credit risk (with measurement in terms of non-performing loans) decreases revenues and capital, which undermines solvency. Equally, lack of liquidity can compel the sale of assets at a discount, which will further weaken capital positions. On the other hand, good profitability and capital buffers are associated with resilience and increase bank stability, as the Z-score indicates. These risks are compounded by macroeconomic instability, especially inflation, which reduces real returns and elevates default risks.

This theoretical framework directly serves as the basis for specifying the empirical model in which bank stability is modeled as a dynamic form of its previous values and other critical risk variables. Lagged dependent variables attempt to capture the persistence, and the explanatory variables include credit risk, liquidity, profitability, and capital adequacy to capture the channels of transmission identified in the theoretical literature. Therefore, the model offers an empirically testable framework that works with existing banking theory and the financial stability literature.

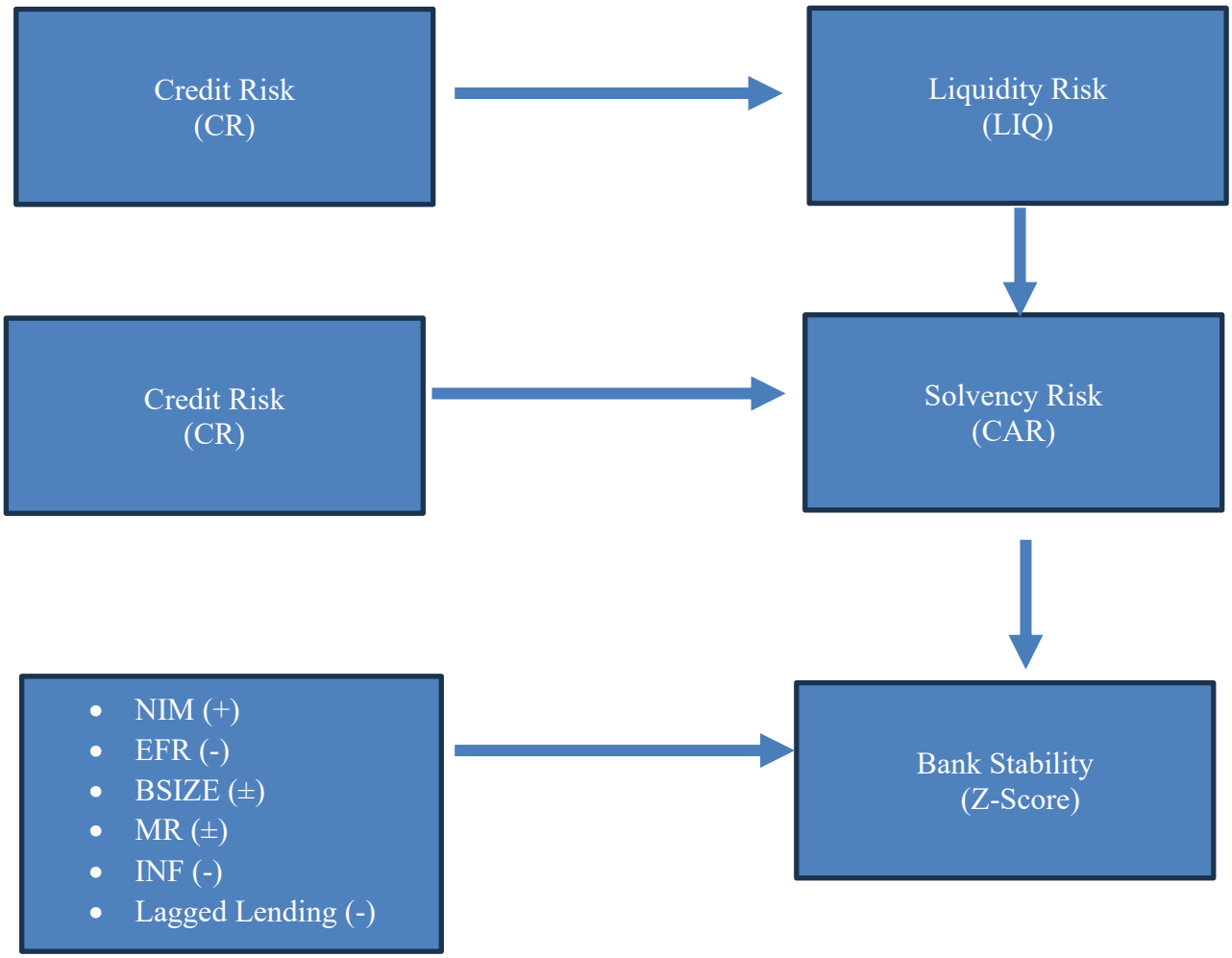

Figure 1: Theoretical framework

The current study deploys a dynamic panel data model, grounded on a two-step Generalized Method of Moments (GMM) estimator to determine the interrelationships among credit, liquidity and solvency risks using yearly data for the period 2012 to 2023, encompassing 21 conventional banks. This methodology can be mastered effectively and vividly captures the persistence, unobserved heterogeneity and endogeneity, which are key features of banking data. The dynamic specification enables the investigation of the effects of past stability on the present solvency, keeping in mind the use of major risk factors as well as macroeconomic factors. A robustness test based on alternative model specifications and sub-sample estimates is also included in the empirical approach to ascertain the reliability and stability of the findings in a variety of economic conditions.

2.1 Objectives of the study

1. To use the two-step GMM estimation to determine the correlation among credit risk, liquidity risk and solvency risk and its effect on the general stability of the bank.
2. To determine the scale and trend of the effects of these risks over time, with or without feedback, in a dynamic panel model.
3. Investigate the role of nonlinearities in risky behavior in increasing bank stability in a variety of economic settings, as represented by interaction terms and threshold effects in the GMM model.
4. To explore the impact that the bank-specific characteristics, such as ownership structure, asset-liability management, and corporate governance cause on such risk dynamics.

The article has the following structure: Section 2 presents the review of literature, Section 3 describes the data sources and research methodology, Section 4 presents a summary of the investigation and discussion of the empirical research, and Section 5 contains a conclusion and policy implications.

2. Literature Review

2.1 Credit Risk and Bank Stability

Credit risk, which is the likelihood of buyer default is generally known as one of the major factors that determine bank instability. It has through impact on the profitability and quality of assets due to the accumulation of non-performing loans (NPLs). Empirical evidence in the context of Pakistan takes the credit risk to be closely related to the macroeconomic situation, the quality of governance, and institutional inefficiency. Indicatively, Abid et al. (2024) establish that economic volatility, political instability, and lending concentration are important factors that escalate credit risk in Pakistani banks. On the same note, Hassan et al. (2022) note that poor credit appraisal systems and unfavorable macroeconomic factors promote increasing NPLs.

The exposure on sectors also increases the exposure to credit risks, especially in the cyclical sectors like the textile and real estate where declines result in an increased rate of defaults. The negative credit risk and the bank performance and stability are also supported by the international evidence (Ahmadyan, 2018; Cheng et al., 2020; Kolapo et al., 2012; Saeed et al., 2024). In theory, the structural credit risk model by Robert C. Merton is the model describing how the decline in the value of assets exposes the firm to greater risks of default and lower the ability of other banking organizations to survive, which can be applied directly to the banking sector. On the whole, the credit risk in literature is consistently found to have negative impacts on the bank stability by way of deterioration in asset quality and decreased earnings capacity. But, the majority of the studies are rather concerned with the immediate implications of credit risk, which there is limited description of the dynamic interaction between credit risk and other risk dimensions, including liquidity and solvency.

2.2 Liquidity Risk and Funding Vulnerability

Liquidity risk is a situation where the banks find themselves facing failure to fulfill their short-term liabilities without suffering huge losses usually on the basis of mismatches between their asset and liability or where the banks are hit by a shock in the flow of funds. Liquidity risk in emerging economies like Pakistan is increased due to macroeconomic turbulence, inflationary pressures and over reliance on short-term sources of funds. Research evidence suggests that the liquidity crunch can easily undermine banking stability. Qadri et al. (2025) discover that the insufficiency of capital buffers and overexposure to government securities lowers the capacity of a bank to respond to liquidity shocks. The research conducted in different regions Hao and Li (2021); Moharuma and Bwana (2024); Musiega et al. (2017) state that the risk of liquidity is negatively correlated with better financial performance and susceptibility to exogenous shocks.

In the modern banking theory, emphasis is made on how the liquidity increases financial

instability. The article by Tobias Adrian and Hyun Song Shin emphasizes the positive feedback between the liquidity circumstances and the leverage cycles, and how the two factors foster systemic risks. Asset fire sells and the deterioration of asset prices and capital can be caused by liquidity stress, and therefore these shocks can spread to solvency. Comprehensively, the literature sources substantiate that liquidity risk is such a crucial factor in financial stability, especially even in the times of economic stress. Nevertheless, most of the literature considers liquidity risk in isolation and its engagement with credit risk little or not properly and its indirect implications on solvency are not well-constrained.

2.3 Solvency Risk, Capital Adequacy, and Regulation

The solvency risk is a reflection of inadequate capital buffers that make the bank unable to take in losses and is usually the increase of the long-term stresses on credit and liquidity. Capital adequacy can take a key role in ensuring solvency in offering cushioning against the occurrence of unforeseen losses. Experimental research accentuates the significance of capital capability and regulatory frameworks in promoting financial stability. According to Mekonen et al. (2025) leverages, asset quality, and capital sufficiency are some of the main predictors of solvency in new markets. Ullah et al. (2023) also establish that there is a strong way the institutional quality and governance affect capital stability especially in nations where the regulatory environment is weak.

Regulatory frameworks have also enhanced the need to have sufficient capital and liquidity reserves in order to curb systemic risk like Basel III. Arnone et al. (2024) show that with unfriendly macroeconomic factors, too high a percentage of banks in emerging economies lose capital requirements, which indicates that solvency turns out to be extremely shaky amid systemic stress. Also, it is indicated by evidence on stress testing, that macroeconomic shocks, including inflation, exchange rate depreciation, and interest rate rises can severely impact capital positions and raise insolvency risk. These results support the opinion that solvency is not a single phenomenon which develops by means of the interaction of various risk factors. Comprehensively, though the literature collective highlights the role of capital adequacy and regulations in improving bank resilience, the empirical evidence of the dynamism of solvency risk to other risk dimension is still limited, particularly in the emerging economies.

2.4 Interdependence of Banking Risks and Research Gap

The recent literature has begun to acknowledge that credit risk, liquidity risk and solvency risk are not isolated but are interrelated so that they engage with each other in response to dynamic feedbacks. Risk interdependence implies that shocks in one dimension can spread out to the other and that the effect would cumulative to bank stability. Indicatively, Oino (2021) demonstrates that the credit risk has the ability to instigate the liquidity pressure, which in turn undermines the solvency stance. On the same point, Akhtar et al. (2017) establish evidences of two-way relationships between credit and liquidity risks in developing economies. These theories (nonlinear) also point out that such interactions become more pronounced during stressed conditions Sharma and Jain (2025) show that the negative implications of credit and liquidity risks on the stability increase with the depletion of capital buffers. Dual banking structures become yet another source of complication in the context of Pakistan. Islamic banks, although less vulnerable to credit risk since they are asset-backed financed, have more liquidity restrictions owing to less Shariah-compliant instruments (Ahmed & Akram, 2026; Rehman et al., 2021; Ul Mustafa et al., 2012).

In spite of the developments, the literature that exists is still disjointed in a number of critical aspects. First, despite the fact that it is necessary to analyze the aspects of risk on an individual level, in the vast majority of works, the authors do not simultaneously manifest the interaction of factors in a common empirical approach. Second, minimal application of dynamic panel methodologies that effectively represents persistence, endogeneity, and feedbacks structural are applied in banking information. Third, empirical research on this in developing economies, specifically in Pakistan is still very incomplete and inconclusive. As such, this paper fills these gaps by collaboratively discussing credit risk, liquidity risk, and solvency on a dynamic panel model that is estimated using the System

GMM estimator. The use of both bank-specific and macroeconomic variables also offers the study a more complete and situation-specific picture of the interconnection of various risk dimensions in their effect on bank stability in the banking industry in Pakistan.

3. Methodology

This research design has used empirical research design to assess the dynamic relationship between credit risk, liquidity risk, earnings volatility with profitability, and institutional quality as well as the macroeconomic conditions. A dynamic panel data model is followed because the changes of the bank over time are stable, and it is based on the past situation. The method is appropriate because through its assistance the heterogeneity may be measured between the cross-sectional banks and the time dynamics in a bank. The empirical research is conducted and using Two-step System GMM estimator, which has been widely used in the banking research, is the persisting, endogeneity, and unobserved heterogeneity type of study.

3.1 Data Sources

Commercial banks working in Pakistan are in the targeted sample, where a balanced panel data set of 21 commercial banks is taken over the period 2012 to 2023. The level of financial information about banks comprises annual reports of the banks, banking statistics of Pakistan, and other publications of the State Bank of Pakistan. Government and international statistical sources provide economic indicators such as inflation.

3.2 Research Hypotheses

Subject to the theoretical and empirical model, the following hypotheses are developed to test the determinants of bank stability in the Pakistan, as given below:

H_1: Credit risk (CR), measured by NPLs to total loans, has a negative and statistically significant effect on bank stability. ($\beta_2 < 0$)

H_2: Liquidity position (LIQ), measured by liquid assets to total assets, has a significant effect on bank stability, with excessive liquidity expected to negatively affect stability due to inefficient asset utilization. ($\beta_3 < 0$)

H_3: Profitability (NIM) has a positive effect on bank stability, as higher earnings improve internal capital generation. ($\beta_5 > 0$)

H_4: Capital adequacy (CAR) has a positive effect on bank stability, consistent with prudential regulation theory. ($\beta_4 > 0$)

H_5: Bank size (BSIZE), measured as lagged total assets, has a significant effect on stability, with larger banks potentially experiencing negative effects due to complexity and moral hazard. ($\beta_6 \neq 0$, expected negative)

H_6: Inflation (INF) has a negative effect on bank stability, as macroeconomic instability reduces real returns and increases default risk. ($\beta_7 < 0$)

H_7: Bank stability exhibits dynamic persistence, such that past stability (lagged Z-score) has a positive effect on current stability. ($\beta_1 > 0$)

3.3 Measurement of variables

The dependent variable is bank stability.

The Z-score is a list of profitability, capitalization, and variance of earnings meant to determine the distance of insolvency of a bank used to determine the stability of a bank. Z-score is determined as.

$$Z_{it} = \frac{ROA_{it} + CAR_{it}}{\sigma(ROA_{it})} \quad (1)$$

Where, the return on assets is denoted by ROA_{it}, the capital adequacy is mentioned by CAR_{it}, while the $\sigma(ROA_{it})$ highlight the deviation form of returns on assets. A higher Z-score indicates significant financial stability and a lower probability of insolvency.

Table 1: Description of the Variables and Expected Signs

Variable	*Description*	*Formula / Measurement*	*Expected Sign*	*Data Source*	*Conceptual Role*
CR	Credit Risk	Non-Performing Loans / Total Loans	-	Audited annual reports of banks, SBP publications	Risk Indicator
LIQ	Liquidity Risk	Liquid Assets / Total Assets	+	Audited annual reports of banks, SBP publications	Risk Indicator
CAR	Capital Adequacy	(Tier 1 + Tier 2 Capital) / Risk-Weighted Assets	+	Audited annual reports of banks, SBP publications	Stability Measure
NIM	Net Interest Margin	Net Interest Income / Average Earning Assets	+	Audited annual reports of banks, SBP publications	Performance Variable
EFR	Earning to Funding Ratio	Interest Income / Interest Expense	+	Audited annual reports of banks, SBP publications	Performance Variable
BSIZE	Bank Size	log (Total Assets)	+ / -	Audited annual reports of banks, SBP publications	Moderating Variable
MR	Market Risk	KSE-100 volatility / Bank Beta	-	Bloomberg / KSE Data	Risk Factor
INF	Inflation	Annual CPI growth (%)	-	Pakistan Bureau of Statistics, IMF	Macro Control Variable
LogLI	Lending	log (Loans or Net Advances)	+	Audited annual reports of banks, SBP publications	Bank Activity

Source: Author's Estimation

3.4 Model specification

The general model estimated using System GMM is:

$$Stability_{it} = \alpha + \beta_1 Stability_{i,t-1} + \beta_2 CR_{it} + \beta_3 LIQ_{it} + \beta_4 CAR_{it} + \beta_5 NIM_{it} + \beta_6 BSIZE_{it} + \beta_7 INF_t + \varepsilon_{it}$$

Where:

- $Stability_{it}$= Bank stability (Z-score) for bank $i$at time t
- $Stability_{i,t-1}$= Lagged stability
- CR= Credit risk
- LIQ= Liquidity measure
- CAR= Capital adequacy ratio
- NIM= Profitability measure
- $BSIZE$= Bank size
- INF= Inflation

- ε_{it}= Error term

3.5 Estimation Strategy: Two-Step System GMM

The two-step GMM model is used to deal with the endogeneity, unobserved heterogeneity, and dynamic persistence in bank stability. This method, devised by Arellano and Bover (1995) and Blundell and Bond (1998) is specifically appropriate to a panel dataset having a rather limited time dimension and a bigger cross-sectional one, and to models which possess a lagged dependent variable. The second important attribute of the System GMM estimator is that the internal instruments are based on lagged values of the variables. In this paper, variables are grouped according to their endogeneity. Lagged dependent variable (Z-score), core risk variables, credit risk (CR), liquidity (LIQ), earnings volatility (EFR) and profitability (NIM) are considered endogenous, because any of them can be jointly determined by bank stability and are subject to reverse causality. These variables will be instrumented by levels and differences through their suitable lagged levels. There are bank-specific control variables, including bank size (BSIZE), lagged lending (Log LI), which are considered predetermined, i.e., they can be correlated with previous error terms, but not with the current error terms. The deeper lags are used to instrument these variables to validate their use. The exogenous variables are the macroeconomic variables especially inflation (INF) since they are not established within the banking system and are not shaped by the actions of individual banks.

To prevent the issue of instrument proliferation which, like the Hansen / Sargan-tests, can attenuate the endogenous variables and be overfitted, a number of measures are made. First, the instrument matrix is reduced, eliminating the number of instruments and maintaining explanatory strength. Second, the lag depth of instruments is also kept within small range so that instrument generation is not excessive. Consequently, the number of instruments (74) is much less than the number of cross-sectional units (21 banks), and this satisfies the recommended econometric considerations. The instrument set validity is tested in the Sargan test of over-identifying restrictions, where a p-value of a large value implies that the instruments are valid ones and have no correlation with the error term. Also, the Arellano-Bond tests of serial correlation are used to ensure there is not a second-order autocorrelation between the differenced residuals. The consistency of the estimator is also confirmed by the absence of significant AR (2), although first-order autocorrelation (AR (1)) is expected in first differences. Moreover, the Two-Step estimator uses a strong weighting matrix, the (Windmeijer, 2005) finite-sample adjustment of the standard errors and provides sound statistical inference. Cumulatively, the estimation approach has been well-structured to guarantee the soundness, stability, and authenticity of dynamic panel findings.

4. Empirical Results

Table 2 presents the descriptive statistics of the main variables that will be used to determine the dynamics of credit, liquidity, and solvency risks within Pakistani banks. Mean Z-score which is an indicator of bank stability is 2.82, and the standard deviation is 1.95 with the extreme being -2.83 and the extreme being 8.98. The credit risk (CR), which is a ratio of the number of non-performing loans to the total loans, has a mean and standard deviation of 55.64 and 13.07, respectively, hence a difference in asset quality, with a higher value indicating a shortage of asset quality, as concluded by (Mahmood et al., 2023). The mean of earnings flexibility (EFR) is 0.27 which has low dispersion and net interest margin (NIM) which can be considered as a measure of profitability, is 3.10 with variation in the earnings of different banks as described by (Hasan, 2025). Liquidity (LIQ) ranges correspondingly at 8, which is moderate and lagged bank size (BSIZE) is 20.15 which is relatively homogeneous. The average of market risk (MR) is 0.18 and has both positive and negative values with market risk exposures. The average capital adequacy (CAR) is 16.80 and indicates a general satisfactory level of capital buffer in Pakistani banks, as emphasized by (Salehi, 2022). Macroeconomic pressure, which is represented by the inflation (INF) has the average of 10.04 with a big spread that denotes the variance in the economic conditions. Lastly, there is loan growth (Log LI): it tends to average 0.01, with a variability that is not so high. These statistics, in general, demonstrate that bank risk profile is highly heterogeneous, and that a dynamic panel method should be employed to capture both time-varying and interdependent risk measures, as highlighted by (Sajid et al., 2023).

Table 2: Descriptive Analysis

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Z-SCORE	252	2.82	1.95	-2.83	8.98
BSIZE	252	20.15	1.08	17.37	22.62
CAR	252	16.80	4.90	5.38	38.51
LIQ	252	8.00	2.71	3.09	25.40
EFR	252	0.27	0.09	0.09	0.64
CR	252	55.64	13.07	22.96	107.55
NIM	252	3.10	1.02	0.65	9.40
CIR	252	1.55	1.20	0.18	11.75
INF	252	10.04	7.63	2.53	30.77
MR	252	0.18	0.25	-0.15	0.55
OR	252	0.02	0.01	0.01	0.04
Log LI	231	0.01	0.01	-0.02	0.05

Source: Author's Estimation

Table 3: Correlation Matrix

Variable	*BSIZE*	*CAR*	*LIQ*	*EFR*	*CR*	*NIM*	*CIR*	*INF*	*MR*	*OR*
BSIZE	1.00									
CAR	0.06	1.00								
LIQ	-0.02	0.00	1.00							
EFR	-0.43	-0.03	0.27	1.00						
CR	-0.39	-0.05	-0.09	0.34	1.00					
NIM	-0.20	-0.06	0.15	-0.15	-0.15	1.00				
CIR	-0.08	-0.01	0.18	0.07	0.05	-0.01	1.00			
INF	0.30	0.01	-0.11	-0.57	-0.18	0.37	0.01	1.00		
MR	-0.17	-0.01	0.18	-0.11	-0.19	0.26	-0.03	0.30	1.00	
OR	-0.46	0.01	-0.02	0.69	0.31	0.25	0.12	-0.07	0.24	1.00

Source: Author's Estimation

The correlation analyzes the linear relationships among the variables in empirical model as demonstrated by Table 3. Most of the coefficients are low (less than 0.50), which implies that there are weak linear relations and low regard to multicollinearity, this is consistent with recent study (Demirgüç-Kunt et al., 2021). The most significant and positive correlation between operation ratio (OR) and earnings flexibility (EFR) of 0.69 meets the VIF diagnostics, which shows the relationship between the earnings volatility and performance within operations. The BSIZE reveals low negative correlations with EFR (-0.43) and credit risk (-0.39) which claims that larger banks gain more predictable income sources and less credit risk, as observed by (Berger et al., 2022). EFR shows a negative relationship with inflation (-0.57) which implies that the earnings flexibility during the inflation period is lower according to the macroeconomic outcomes of the macroeconomic theory on

inflationary pressure on the profitability of banks theories discussed by (Saleem, 2024). The other variables like liquidity (LIQ), profitability (NIM), market risk (MR), capital adequacy (CAR), and leverage (Log LI) do not correlate very well and this proves the absence of strong linear relations. In the majority of cases, the correlation scheme attests to the fact that the issue of multicollinearity is not a critical challenge, which proves the validity of dynamic panel estimates. Although the EFR-OR correlation (0.69) is moderate, it is not large enough to be problematic, and does not bias the results, this aligned with the study by (Serfraz et al., 2023).

The Two-Step System GMM estimation can be used to give insights into the determinants of the bank stability in Pakistan in terms of the Z-score. The lagged Z-score coefficient (0.16, $p<0.05$) is positive and significant, thus, establishing the stability of banks through the years, which is consistent with slow solvency adjustments and long-term risk management decisions, as explained by (Beck, 2023). The concept of credit risk (CR) shows that the effect of the credit risk is substantial and negative on the stability of the banks (-0.03, $p<0.01$), which implies that the more non-performing loans there are, the lower the Z-score is constructed in line with the structural credit risk model. There is also the effect of earnings flexibility (EFR) which shows a negative relationship on the stability (-2.47, $p<0.05$), indicating the destabilizing impact of volatile flows of income. On the other hand, the profitability (NIM) has a positive impact on the stability (0.64, $p<0.01$) so that the capital accumulation is driven by stable earnings, as reported by (Demirguc-Kunt et al., 2023).

Table 4: Findings (Overall) - Two Step GMM

Variable	*Coefficient*	*(Std. Error)*	*Significance*
Z-score (L1)	0.16	-0.08	**
CR	-0.03	-0.01	***
EFR	-2.47	-1.05	**
NIM	0.64	-0.09	***
LIQ	-0.07	-0.01	***
BSize (L1)	-0.35	-0.18	*
MR	1.16	-0.23	***
CAR	0	0	***
INF	-0.04	-0.01	***
Log LI (L1)	-21.19	-8.8	**
C	9.1	-3.56	**
Observations	209		
Groups	21 (Obs per group: Min 9, Avg 9.95, Max 10)		
Instruments	74		
Wald Chi²(10)	803.40 (p=0.00)		
Sargan Test	Chi²(63) =13.62, p=1.00 (valid instruments)		
Arellano-Bond AR (1)	z=-2.45, p=0.014 (expected)		
Arellano-Bond AR (2)	z=-1.37, p=0.17 (no autocorrelation)		

Source: Author's Estimation, Note: * significant at 10%, ** significant at 5%, *** significant at 1%

Liquidity risk (LIQ) has a negative effect (-0.07, $p<0.01$) implying that high levels of liquidity holdings can be an indicator of financial distress and low long-term solvency, as highlighted by(Gao et al., 2024). Lagged bank size produces a negative impact on the stability (-0.35, $p<0.10$), which is in line with the concept of larger scale banks undergoing more operational complexity and moral hazard risk. Market risk (MR: 1.16, $p<0.01$) and capital adequacy (CAR: 0.0005, $p<0.01$) are also positively associated with stability, which is the protective factor of regulatory buffers and good

operational risk management, as discussed by (Allen, 2021). There is a negative impact of inflation (-0.04, p<0.01), which confirms that macroeconomic instability leads to a lower real return and a higher possibility of default. Lastly, there is lagged leverage/lending (Log LI: -21.19, p<0.05), which is a harmful indicator of stability, but this displays the impact of historical credit growth on a long-term basis. In order to validate the consistency of the base estimations, a robustness analysis was conducted where three alternative Two-Step System GMM specifications, which removed specific variables, were implemented as Table 5 indicated. Lagged Z score is significant and positive in both specifications, which validates the bank solvency persistence, consistent with study by (Levine, 2021). All the applicable models demonstrate a negative impact of credit risk (CR) where the decline of the quality of assets worsens solvency. Earnings risk (EFR) has been uniformly negative, meaning that volatility of the level of income undermines the stability of the banks in the long run. Models are positive and significant in profitability (NIM), which suggests that stable interest rates will play a significant role in accumulating capital and increase the solvency, as documented by (Kayani et al., 2021).

Table 5: Robustness Analysis - Two-Step GMM

Variable	*Model – I*	*Model – II*	*Model – III*
Z-score (L1)	0.26**	0.36**	0.27**
	(-0.07)	(-0.06)	(-0.07)
CR	-0.03***	—	-0.03***
	(-0.01)	—	(-0.01)
EFR	-2.36**	-1.79**	-2.16*
	(-0.62)	(-0.48)	(-1.19)
NIM	0.61**	0.55**	0.54*
	(-0.06)	(-0.06)	(-0.12)
BSize (L1)	-0.69*	-0.60*	-0.70*
	(-0.12)	(-0.15)	(-0.14)
CAR	0.00***	0.00***	0.00***
	(0.00)	(0.00)	(0.00)
INF	0	0.02**	0.01
	(-0.01)	(-0.01)	(-0.01)
Log LI (L1)	-21.06**	-14.82**	—
	(-6.59)	(-7.25)	—
C	14.71**	12.30**	14.85**
	(-2.38)	(-3.06)	(-3.02)
Observations	209	210	229
Groups	21 (Obs per group: Min 9, Avg 9.95, Max 10)	21 (obs per group: min 10, Avg 10, Max 10)	21 (Obs. Per group: min 10, Avg 10.904, Max 11)
Instruments	72	71	72
Wald Chi²(10)	1673.94 [0.0000]	2645.85 [0.0000]	3032.34 [0.0000]

Source: Author's Estimation; Note: * significant at 10%, ** significant at 5%, *** significant at 1%: Values in () are standard Errors, whereas values in [] are Probability Values

The negative impact of bank size (lagged total assets) provides evidence of the increased operational risk and moral hazard in large banks. Capital adequacy (CAR) has a positive impact on

stability, which proves that the more robust capital buffers, the more resilient, as suggested by (Siddiqui et al., 2024). The values of lagged leverage and liquidity (Log LI) are negative, indicating that high leverage and low liquidity make it fragile. The variation in the inflation impacts of different models suggests that macroeconomic instability in Pakistan has a significant impact on the bank performance, as highlighted by (Hafez & Hasaneen, 2025). Rigor Model validity is developed with extremely large Wald Chi-square values and the right number of instruments, which proves the reliability of the specifications. All in all, the fact that the key coefficients do not have significant changes in other specifications shows that the model used as a baseline is robust, theoretically sound, and statistically valid.

To further substantiate the baseline outcomes, a sub-sample analysis was done on the 2012 to 2019 period with post-financial crisis regulatory reforms, increased Basel III implementation, increased State Bank of Pakistan (SBP) supervision, and increased macroeconomic volatility. Table 6 illustrates the estimation of four different specifications of the Two-Step System GMM. The statistical validity of the instruments was adequate, and the combined significance of the parameters within all models was statistically significant. The lagged Z-score was analyzed to be positive and significant in all the models, and it confirmed that solvency dynamics continued to take place even in this small sample. This finding corresponds with the body of literature regarding path dependency, regulatory effects as well as long-term adjustments of the balance sheet in bank stability. Credit risk (CR) showed model-dependent behavior; its value was negative and significant in the entire sample, but positive in Model I and non-significant in others, suggesting that aggressive provisioning, regulatory tightening or gigantic government borrowings can result in reversals in the short-term.

Market risk (MR) played a significant role in stability, indicating that diversification in non-interest or market-driven activities could contribute to stabilizing banks under stricter regulations, as discussed by (Allen et al., 2024). The flexibility of earnings (EFR) was composite and negative in each of the models, and this indicates that the sensitivity of income still posed a risk to the stability of a bank, and the positive correlations were more evident since 2012. The positive influence of profitability (NIM) was taken up in a steady way, which confirms the importance of sustainable interest margins as sources of capital and shock absorbers. The negative and significant effects of liquidity (LIQ) were evident in Models I and III but of no significant effect in Model II, implying that the effects of liquidity are environment-specific and conditional on macroeconomic situations. Bank size showed inconclusive effects: positive and significant in Model I but insignificant in the others, showing that, effects of size are conditional on regulations and macroeconomic setting and practice in management. Operational efficiency (CIR) had a positive relationship and of low magnitude, indicating that it did not have a significant contribution to enhancing stability. The positive and significant effect of capital adequacy (CAR) was constant, and it can be concluded that capital buffers are beneficial regarding stability when regulatory changes occur after a crisis, as highlighted by (Salehi, 2022). The inflation turned out to be one of the key risks, increasing the cost of funding, lowering real returns, and deteriorating credit performance. In general, the sub-sample analysis proves the baseline results: in Pakistan, the primary drivers of the bank solvency are profitability, earnings stability, capital adequacy, and macroeconomic variables. Although other specifications were also sensitive to credit risk and bank size, the primary forces of stability were also similar, which proves the strength of the dynamic System GMM model, this aligned with study of (Stiglitz, 2024).

Table 6: Robustness Analysis [Data Range 2012-19]

Variable	***Model – I***	***Model – II***	***Model – III***	***Model – IV***
Z-score (L1)	0.34*	0.40*	0.42*	0.42*
	(0.08)	(0.07)	(0.07)	(0.06)

CR	0.02***	0.00	—	—
	(0.01)	(0.02)		
MR	0.76*	—	—	—
	(0.19)	—	—	—
EFR	-6.51*	-4.67*	-5.51*	-5.74*
	(1.58)	(1.75)	(1.56)	(1.72)
NIM	0.56*	0.51*	0.51*	—
	(0.10)	(0.14)	(0.08)	—
LIQ	-0.10*	-0.04	-0.04***	—
	(0.03)	(0.03)	(0.02)	—
BSIZE (L1)	0.33***	-0.19	-0.03	0.05
	(0.18)	(0.36)	(0.20)	(0.18)
CIR	0.01*	0.01	0.01***	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
CAR	0.06*	0.08*	0.10*	0.09*
	(0.02)	(0.02)	(0.02)	(0.02)
INF	-0.08*	-0.04***	-0.06**	-0.07**
	(0.03)	(0.03)	(0.03)	(0.03)
C	-4.48	4.38	1.21	1.64
	(4.36)	(7.77)	(4.50)	(4.28)
Observations	145	145	147	147
Groups	21 (Obs per group: Min 5, Avg 6.90, Max 7)	21 (Obs per group: Min 5, Avg 6.9047, Max 7)	21 (Obs per group: Min 7, Avg 7, Max 7)	21 (Obs per group: Min 7, Avg 7, Max 7)
Instruments	37	36	35	34
Wald Chi²(10)	540.90 [0.0000]	347.66 [0.0000]	418.88 [0.0000]	531.03 [0.0000]

Source: Author's Estimation; Note: * significant at 10%, ** significant at 5%, *** significant at 1%; Values in () are standard Errors, whereas values in [] are Probability Values

A sub-sample analysis was carried out on the same time period, 20202023 to evaluate how the results of the baseline stood the test of time, which involved the COVID-19 pandemic, SBP regulatory forbearance, emergency financing programs, and the resultant inflationary pressures. There were four other Two-Step System GMM specifications that have been estimated as in Table 7. Diagnostic of the instruments were valid; over-identification was not observed and the joint significance of the regressors was significant in both the models. Lagged Z-score was significantly positive in all specification and this evidence upholds the sheer persistence of the dynamic bank solvency even in the situations of systemic shocks, as reported by (Demirgüç-Kunt et al., 2021). Immobility of capital

and risk management practices that are long term. In Model I, credit risk (CR) was affected strongly negatively since asset quality declined due to the pandemic. The effects of CR were however substantially unimportant in subsequent models that also incorporated market, liquidity, and capital variables, indicating that regulatory forbearance could have postponed the deterioration of credit quality. Market risk (MR) had a strong negative coefficient, which means that it is more sensitive to the market volatility, decrease in the exchange rate, and uncertainty in interest rates in the crisis period. Earnings flexibility risk (EFR) was high and negative, and coefficients were high compared to pre-pandemic times, which proves that the volatility of income turned out to be a significant destabilizing factor. All models had positive and significant profitability (NIM) as indicated that banks in the habit of maintaining interest spreads were more resilient, as discussed by (Beck, 2023).

There were weak and largely not significant impacts of liquidity (LIQ) which indicated that defensive liquidity accumulation in 20202021 had no meaningful impact on solvency, possibly even obstructing profitability, this is aligned with the study by (Diamond et al., 2017). Bank size did not have significant finding meaning that scale alone would not stabilize the banks in the context of systemic crisis and operational efficiency (CIR) expressed positive but quantitatively insignificant relationships compared to those of capital and earnings variables. Capital adequacy (CAR) remained important and robust in all models, and coefficient greater than pre-pandemic values important in absorbing and recovering crises, as per the Basel III principles. It also served to confirm that inflation has continuously had a negative significant influence as it has strengthened the point that, macroeconomic instability leads to expense escalation, decline in the real returns, and diminished borrower's ability to repay their loans. In general, the 2020 2023 sub-sample analysis confirms the baseline findings: profitability, earnings stability, capital adequacy, and inflation control are major determinants of bank stability in the time of crisis. Although model specification was sensitive to credit risk, liquidity, even the size of the bank, the primary drivers of stability were constant, which lends credibility to the dynamic System GMM model in high systemic stress cases, as discussed by (Stiglitz, 2024).

Table 7: Robustness Analysis [Data Range 2020–2023]

Variable	***Model – I***	***Model – II***	***Model – III***	***Model – IV***
Z-score (L1)	0.39*	0.42*	0.44*	0.45*
	(0.08)	(0.07)	(0.07)	(0.07)
CR	-0.03***	-0.01	—	—
	(0.01)	(0.02)	—	—
MR	-0.68*	—	—	—
	(0.20)	—	—	—
EFR	-7.21*	-6.11*	-6.84*	-7.01*
	(1.73)	(1.82)	(1.69)	(1.77)
NIM	0.59*	0.56*	0.53*	0.55*
	(0.12)	(0.14)	(0.10)	(0.10)
LIQ	-0.09***	-0.03	-0.04	—
	(0.04)	(0.03)	(0.03)	—
BSIZE (L1)	0.12	-0.09	0.04	0.06

	(0.21)	(0.37)	(0.20)	(0.19)
CIR	0.01***	0.01	0.01***	0.00
	(0.00)	(0.01)	(0.00)	(0.00)
CAR	0.09***	0.09***	0.11***	0.11***
	(0.03)	(0.03)	(0.02)	(0.02)
INF	-0.10***	-0.07***	-0.07***	-0.08***
	(0.03)	(0.03)	(0.03)	(0.03)
Constant	-3.61	2.94	0.86	1.24
	(4.78)	(8.21)	(4.97)	(4.65)
Observations	145	145	147	147
Groups	21 (Obs per group: Min 5, Avg 6.90, Max 7)	21 (Obs per group: Min 5, Avg 6.9047, Max 7)	21 (Obs per group: Min 7, Avg 7, Max 7)	21 (Obs per group: Min 7, Avg 7, Max 7)
Instruments	37	36	35	34
Wald Chi²	412.37 [0.0000]	298.54 [0.0000]	365.81 [0.0000]	401.26 [0.0000]

Source: Author's Estimation Note: * significant at 10%, ** significant at 5%, *** significant at 1% Values in ( ) are standard errors, values in [ ] are probability values.

5. Conclusion

This study examined the stability of 21 commercial banks operating in Pakistan by considering the yearly period from 2012 to 2023. The research findings indicate that bank stability is persistent and that previous levels of performance play a significant part in the current level of solvency. Credit risk and Earnings volatility can be seen as the significant forces towards the impediment of stability and profitability, and capital adequacy as the facilitating forces. Liquidity is dualistic, i.e. it is needed to fulfill obligations but could be destructive when piled up. The adverse impact of inflation on stability is that it raises prices and diminishes returns. Robustness tests suggest that earnings, profitability, capital adequacy, and inflation control have been fairly consistent drivers of stability, while the impacts of credit risk and bank size are relative to context. Based on these findings, it is possible to make four cautious policy recommendations:

1. Enhance credit risk and liquidity management through improved loan screening, portfolio diversification, early warning systems, and balanced liquidity buffers.
2. Maintain stable earnings by diversifying revenue sources and safeguarding net interest margins.
3. Hold capital buffers above Basel III minimums, with frequent stress testing to ensure resilience.
4. Coordinate fiscal and monetary policies to manage inflation while incorporating banking risks into macroeconomic planning.

In general, risk management in Pakistani banks is going to help in the stability of their banks,

quality earnings, enhance their capital strength, and macroeconomic stability. Sound policies should be adopted by regulators which are also flexible, but the banks must aim to achieve sustainable profitability and well-constructed risk; this would enable them to create resilience in the volatile environment.

5.1 Limitations and Future Research

The research gives an understanding of the soundness of banks in Pakistan, but is limited in various ways. It is based on a sample of twenty-one commercial banks in a fairly short-term span, which could not be generalized to smaller banks or non-bank financial institutions. Short-term shocks and policy changes may still affect the results. Credit risk, liquidity and bank size are a few important determinants that are sensitive to model specifications and none of the non-financial factors, like the change in technology use, governance, and geopolitical risks, are considered. Also, the data up to 2023 might be insufficient to reflect the latest developments. Further studies can address these limitations by including institutional variables, sampling smaller banks or comparing across countries (e.g. MEA region). It might also serve to reinforce the analysis of the banking system stability by using further econometric models, including non-linear models, machine learning, stress testing, and checks of the regulatory structure (including Basel III).

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