IJAAF; Vol. 10, No. 3, Summer 2026, Serial 36

Ferdowsi University of Mashhad

Iranian Journal of
Accounting, Auditing & Finance

Quarterly

RESEARCH ARTICLE

Macroprudential Policy and the Risk Exposure of Commercial Banks

Nafiseh Keshtgar*

Faculty of Literature and Humanities, University of Birjand, Birjand, Iran

Seyed Hossein Mirjalili

Institute for Humanities and Cultural Studies, Tehran, Iran

How to cite this article:
Keshtgar, N. and Mirjalili, S. H. (2026). Macroprudential Policy and the Risk Exposure of Commercial Banks. Iranian Journal of Accounting, Auditing and Finance, 10(3), 79-93. doi: 10.22067/ijaaf.2026.47852.1599
https://ijaaf.um.ac.ir/article_47852.html

ARTICLE INFO

Article History
Received: 2025-10-08
Accepted: 2026-02-14
Published online: 2026-07-12

Keywords:
Banking Risk, Commercial Banks, Financial Stability, Macroprudential Policy, Systemic General Method of Moments

Abstract

This paper evaluates the effectiveness of macroprudential policy in reducing commercial banks' risk exposure in Iran. In this study, an empirical model is developed using dynamic panel data techniques and the generalized method of moments (GMM) estimator to examine the impact of macroprudential policy on the risk-taking behavior of Iranian banks during the period 2010-2024. The analysis evaluates the potential effects of four macroprudential instruments aligned with policy objectives: the loan-to-income ratio (LTI), the loan-to-deposit ratio (LTD), the leverage ratio (LVR), and liquidity requirements (LIQ). As a result of stronger macroprudential oversight, commercial banks are significantly less likely to take on risk. In the context of financial sanctions and Iran's unique economic environment, macroprudential tools remain highly effective in mitigating banking risks. As such, LTD instruments have a time lag, whereas LVR instruments have an immediate impact on risk. Additionally, no single instrument is more effective than the composite macroprudential index at reducing risk-taking. A more secure, less vulnerable banking system in Iran is possible through macroprudential policies, as the results show.

https://doi.org/10.22067/ijaaf.2026.47852.1599

NUMBER OF REFERENCES
33

NUMBER OF FIGURES
1

NUMBER OF TABLES
5

Homepage: https://ijaaf.um.ac.ir
E-ISSN: 2717-4131
P-ISSN: 2588-6142

*Corresponding Author: Nafiseh Keshtgar
Email: nkeshtgar@birjand.ac.ir
Tel: 09156551774
ORCID: 0009-0002-9938-6654

1. Introduction

The growing dangers commercial banks face in the current global financial landscape underscore the need for more robust risk management systems. The importance of macroprudential regulation in protecting financial institutions from both known and unknown threats has been widely acknowledged (Acharya et al., 2022). For countries like Iran, where financial sanctions, macroeconomic instability, and ongoing policy uncertainty all heighten credit and operational risks for banks, this strategy is crucial.

In recent decades, Iran's banking system has faced persistent challenges, including high levels of non-performing loans, insufficient capital, and weak regulatory oversight. In addition to disrupting economic growth, capital flows, imports, and exchange rates, financial sanctions have exacerbated these problems (Heydarian et al., 2021, 2022, 2023, 2025). As a result, commercial banks have become increasingly exposed to credit, operational, and liquidity risks and are frequently facing liquidity pressures. The role that banks play in financing investment and supporting macroeconomic growth makes them a direct threat to both economic and financial stability.

Considering the volatile exchange rates, economic uncertainty, and chronic inflation, Iranian banks must manage their risks effectively. There is a lack of data about the effectiveness of macroprudential policies in Iran, despite claims that they can stabilize banks and dampen financial cycles.

Despite the growing body of international evidence on the effectiveness of macroprudential policy, current knowledge remains highly concentrated in advanced economies or in cross-country panel settings. Iran's unique macro-financial context is characterized by persistent sanctions, chronic inflation, high exchange rate volatility, and structural fiscal imbalances (Safari et al., 2024).

Also, the Iranian studies that have been done so far mostly rely on aggregate financial data and don't go into enough detail about how different banks differ. Also, private banks in Iran differ significantly in size, ownership structure, funding models, and exposure to foreign currencies. This suggests that policy tools may not work the same way on all institutions. There isn't much evidence about these effects on distribution right now, so policymakers don't have clear information on how to choose tools and focus them.

Finally, the interaction between macroprudential actions and episodes of sanctions, as well as volatile macroeconomic conditions, remains unexplored. The topic of which of the capital-based tools, borrower-level restrictions, or liquidity requirements is more effective in containing risk in moments of strong external pressure is still an unresolved empirical subject. Filling this gap is critical to develop robust regulatory frameworks to protect financial stability in fragile emerging markets. With a focus on sanctions dynamics and institutional heterogeneity, this study demonstrates how macroprudential policy can influence Iranian commercial banks' risk exposure.

Accordingly, the main research question of this study is: “What impact does macroprudential policy have on the risk exposure of commercial banks in Iran?” and how can this effect be explained under the country’s specific economic conditions?

In light of this, the paper examines the effectiveness of macroprudential policy in mitigating Iranian commercial banks’ risk-taking behavior, using the Z-score as a measure of insolvency risk and of banks' ability to absorb unexpected losses. Over the period 2010–2024, we examined the impact of macroprudential instruments on banking risks using dynamic panel data from 16 Iranian commercial banks and the GMM-SYS estimator. Macroprudential instruments include loan-to-income ratios (LTI), loan-to-deposit ratios (LTD), leverage ratios (LVR), and liquidity requirements (LIQ). This paper contributes to the broader literature on macroprudential regulation by offering new insights into how this policy operates in highly uncertain and sanctions-constrained economic environments.

We extended the time horizon to a 15-year panel data set, substantially broader than the 8-year

periods used previously. A model designed around the disaggregation of macroprudential instruments into four transmission-channel categories. By integrating sanctions into the System GMM framework, the study isolates the net effect of macroprudential policy from the dominant impact of external shocks. With this contribution, we provide a critical policy insight for economies under persistent pressure and demonstrate a level of modeling precision that Iranian banks have never achieved.

The remainder of this paper is structured as follows. Section 2 provides the theoretical background. Section 3 reviews the relevant empirical literature on macroprudential policy and banking risks. The methodology, including data, variables, and econometric models, is discussed in Section 4. Section 5 reports and discusses the empirical findings. Finally, Section 6 concludes the paper.

2. Theoretical Background

The central bank can rely on macroprudential supervision and regulation to monitor banking risks. The critical point is the notion of negative externalities arising from disruptions or failures in financial institutions, such as commercial banks, financial markets, or financial instruments.

In addition to providing credit to the economy, macroprudential policy typically leverages banks. However, with the expansion of capital market activities and market-based financing, macroprudential policymakers must also monitor systemic risks arising outside the banking system and develop and implement policy responses to contain these risks.

Credit growth caps have been used by some countries when credit expansion has been high and systemic risks have risen rapidly.

As Borio (2014) emphasizes, instruments such as the leverage ratio are specifically designed to limit excessive procyclical lending and constrain credit risk before macroeconomic shocks materialize. Claessens (2015) indicated that tools directly targeting households and credit markets tend to be highly effective in reducing financial vulnerabilities.

Macroprudential policy instruments can influence bank risk-taking behavior. Liquidity tools aim to reduce systemic liquidity risk by ensuring that banks maintain sufficient liquid assets to meet obligations under stress conditions. Interbank and funding markets are stabilized by macroprudential policy through the enforcement of minimum liquidity standards. The leverage ratio is a macroprudential tool designed to enhance the resilience of the banking system by limiting banks' exposure. By restricting excessive leverage, it curbs risk-taking behaviors and contains the buildup of systemic vulnerabilities.

Empirical literature review

In the last ten years, there has been a proliferation of empirical research on macroprudential policy (MPP), with studies varying along three key dimensions: (i) the number of countries studied and the type of institutions they belong to, (ii) the methodology and data structure used to conduct the research, and (iii) the particular tools and results that were analyzed. Instead of analyzing studies sequentially, this section synthesizes earlier findings across these categories to illustrate what is established, where results diverge, and how the Iranian example fits into and differs from the literature.

International cross-country and regional evidence: A large body of cross-country and multi-country banking studies finds that macroprudential tools are, on average, effective in restraining bank risk-taking and mitigating systemic vulnerabilities. Using bank-level data from advanced and emerging economies, Altunbas et al. (2018) and Andries et al. (2017) show that tighter capital-based and borrower-based instruments are associated with lower bank risk and reduced contributions to

systemic risk. Researchers in this field usually use dynamic panel or fixed-effects frameworks to account for persistence in risk metrics and rely on large panels of banks across different jurisdictions. Although the size and timeliness of the effects vary across institutional settings, a common thread in this study is that capital-related instruments (such as leverage or capital buffers) yield larger and more immediate benefits than borrower-based measures.

Single-country evidence from emerging economies: Complementary insights emerge from country-specific studies that exploit richer institutional detail. Zhang et al. (2018) and Zhao et al. (2023) found that under macroprudential supervision, banks in China and Vietnam are less likely to take risks, and that this effect is amplified when multiple instruments are used simultaneously (Do et al., 2025). These publications focus on heterogeneity across banks and use longer bank-level panels than cross-country research. They indicate that the effectiveness of macroprudential instruments is conditional on the balance-sheet structure and funding mechanisms. At the same time, results are sensitive to model specification and to whether instruments are examined individually or through composite indices, highlighting the importance of instrument-level analysis.

Empirical research focusing on Iran remains relatively limited and methodologically constrained. There is a systematic problem with the literature that uses short data spans and a narrow set of instruments, which prevents the identification of lagged effects and countercyclical dynamics crucial to macroprudential policy (Borio, 2014). This leaves a clear empirical gap in the provision of a disaggregated, time-consistent assessment of macroprudential instruments and their dynamic effects within Iran's specific institutional context.

Analysing the differences and identifying the gaps: All things considered, there is clear evidence from previous research that supports three main points: first, that banks are less likely to take risks when using macroprudential tools; second, that the effectiveness of these tools varies depending on the type of instrument and the characteristics of the bank; and third, that the results vary greatly depending on the context. However, there are still significant gaps. A limited amount of empirical evidence exists on Iran (i), which uses sufficiently long panels to identify delayed and cyclical effects, (ii) compares macroprudential instruments within a unified empirical framework, and (iii) explicitly takes financial sanctions and constrained monetary policy autonomy into account.

Linking international evidence to Iran’s institutional context: The international literature largely abstracts from persistent external shocks such as comprehensive financial sanctions, which directly affect funding conditions, risk perceptions, and policy transmission. For Iran, sanctions constitute a structural constraint rather than a temporary disturbance, suggesting that results from advanced and typical emerging economies may not be directly transferable. Despite limited domestic evidence, macroprudential effectiveness has not been systematically examined to determine whether and how it differs between sanctioned and non-sanctioned periods, nor has it been examined how institutional characteristics such as central bank independence and Islamic banking structure affect instrument performance.

Overall, the worldwide empirical literature provides strong evidence that macroprudential policies matter for bank risk-taking, but it gives only partial guidance for the Iranian instance. However, it only gives some advice for the Iranian case. A structured review of previous research shows that the main problems that remain to be solved are how well instruments work, how they change over longer periods, and how macroprudential policy interacts with structural restraints unique to each country. Because of these gaps, there needs to be a focused empirical study of Iran that is both grounded in and distinct from the current international and domestic literature.

3. Methodology

To examine the effectiveness of macroprudential policy on the risk-taking behavior of commercial

banks, a Systemic Generalized Method of Moments (GMM-SYS) regression model was employed to assess its impact on banks' risk-taking behavior. This model is particularly suitable for addressing potential endogeneity concerns, which often arise from the dynamic relationship between macroprudential policy actions and bank risk variables.

This approach aligns with previous empirical studies, such as Akinci and Olmstead-Ramsay (2018) and Ely et al. (2021), in capturing the complex interactions between regulatory policies and risk factors in the banking system. The model is formulated as follows:

$$Risk_{it} = \beta_0 + \beta_1 Risk_{i,t-1} + \beta_2 MAPP_{it} + \sum \beta^b BankSpecific_{it} + \sum \beta^M Macro_t + u_{it} \quad (1)$$

Where i=1,…, N and t=1,…,t denote banks and time periods, respectively. In equation (1), $Risk_{it}$ denotes the bank risk variable for bank i at time t, which is regressed on its own lag. $MAPP_{it}$ denotes macroprudential policy tools, $BankSpecific_{it}$ includes control variables such as bank size, net loans-to-total-assets ratio, income diversification, cost management efficiency, and lending index. $Macro_t$ includes macroeconomic variables such as GDP growth (LGDP), inflation rate (GNP Deflator), and a financial sanction dummy variable (FSAN), and u_{it} is the error term.

According to Equation 1, ∑βb denotes the coefficients of the bank-specific factors that serve as independent variables in the model. In contrast, ∑βM denotes the coefficients of the macroeconomic variables included as another set of independent variables in the specification.

Measurement of Bank Risk: The Z-score indicates the probability of bank insolvency. Lepetit and Strobel (2015) argue that the logarithm of the Z-score represents a measure of bankruptcy risk. Houston et al. (2010) and Fang (2016) also confirm the use of the inverse Z-score as a proxy for bank default probability the higher the inverse Z-score, the greater the bankruptcy risk.

In this paper, the Z-score is used to measure the dependent variable, bank risk, as it is a widely used risk indicator in multiple studies, including Laeven and Levine (2009) and Lepetit and Strobel (2015). The Z-score is calculated as the sum of return on assets (ROA) and the equity-to-asset ratio (E/A) divided by the standard deviation of ROA:

$$Z_{it} = \frac{ROA_{it} + \frac{E_{it}}{A_{it}}}{Sd.(ROA)_{it}} \quad (2)$$

Where ROA_{it} denotes return on assets for bank *i* at time *t*; EA denotes the equity-to-asset ratio; and $Sd.(ROA)_{it}$ denotes the standard deviation of asset returns. Due to the high skewness of the Z-score distribution, the natural logarithm is typically used as a transformation. Profitability and capitalization are correlated with Z-scores, as are income volatility and instability. Consequently, a higher Z-score indicates lower risk and a more stable bank (De Nicolo et al., 2010).

According to Figure 1, from 2010 to 2024, Khavar Miane Bank, Pasargad Bank, and Karafarin Bank exhibit the highest financial stability and thus the lowest risk-taking. In contrast, Sarmayeh Bank, Ayande Bank, Shahr Bank, and Day Bank demonstrate the lowest financial stability and the highest risk-taking (Figure 1) [1].

[1] Data are extracted from banks' balance sheets.

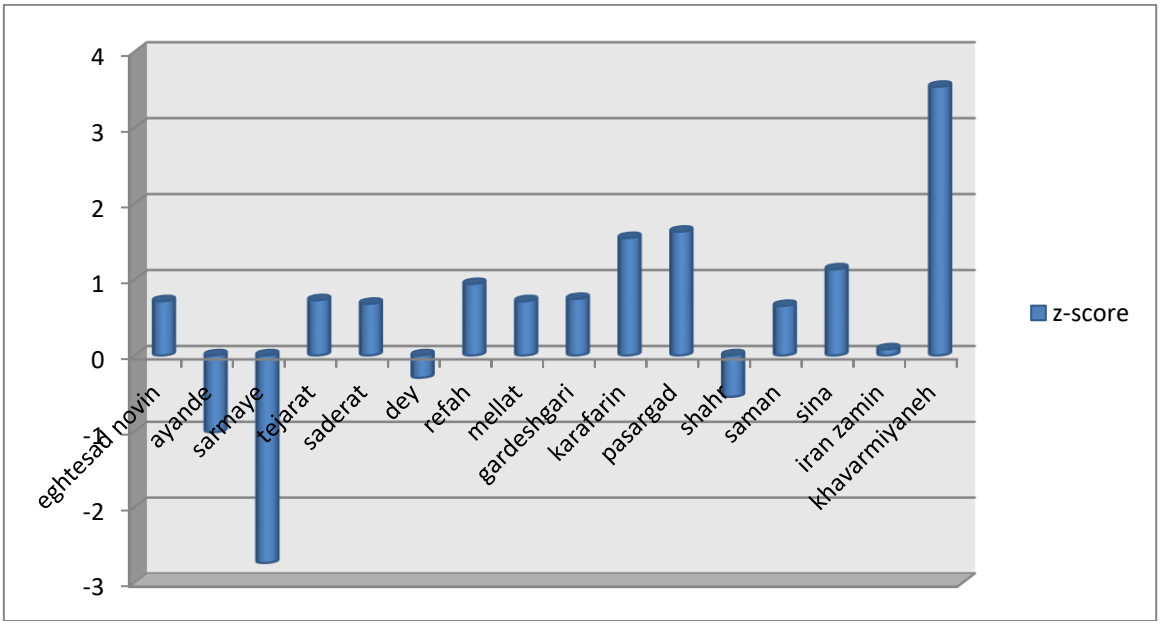

Figure 1. Average Z-score index for commercial banks during 2010–2024

Macroprudential Policy Tools: For conducting our analysis, we rely on the macroprudential policy indices available in the Integrated Macroprudential Policy database [1] (iMaPP) developed by Alam et al. (2025), which is based on the annual review of macroprudential policy by the International Monetary Fund.

The macroprudential tools employed in the models are defined as follows. Among demand-based instruments, we selected the LTI ratio, which imposes limits on lending relative to borrower income. As a measure of capital relative to non-risk-weighted exposures, the LVR limits bank leverage and was utilized for capital requirements instruments. We use the LTD ratio, a tool from the loan-supply-based toolbox that regulates banks' lending relative to their deposit base and penalizes them for exceeding it. Finally, we implemented the Liquidity measure to meet the liquidity requirements. This measure seeks to reduce financing and systemic liquidity risks by establishing minimum standards for liquid asset ratios and liquidity coverage.

Before performing calculations, variables are normalized to ensure consistent units when determining the MPP index. We use the four weighted and normalized tools in accordance with the composite index method suggested by Briguglio (1995). Because different macroprudential tools target different dimensions of systemic risk, a composite macroprudential index is constructed by averaging them with equal weights. Moreover, using equal weights avoids subjective judgment about the supervisory priority of each instrument. The macroprudential literature provides no internationally accepted consensus on the relative importance of different instruments. This neutral, conservative approach helps avoid bias when evaluating the relative significance of the four instruments by assigning equal weights to each. The adoption of equal weights in this study is justified by the principles of neutrality and the absence of any theoretical or empirical basis for determining the relative importance of macroprudential instruments in the Iranian economy.

The normalization formula is defined as follows:

$$X_i^S = (X_i - minX)/(maxX - minX) \quad (3)$$

Where X_i denotes the observed value for period I, X_i^S denotes the standardized observation, and

[1] Integrated Macroprudential Policy Database

$minX$ and $maxX$ are the minimum and maximum observed values, respectively.
The MPP index is then calculated as:

$$LTI_t^s = (LTI_t - minLTI)/(maxLTI - minLTI) \quad (4)$$

$$LTD_t^s = (LTD_t - minLTD)/(maxLTD - minLTD) \quad (5)$$

$$LVR_t^s = (LVR_t - minLVR)/(maxLVR - minLVR) \quad (6)$$

$$LCR_t^s = (LCR_t - minLCR)/(maxLCR - minLCR) \quad (7)$$

$$MAPPINDEX_t = (LTI_t^s + LTD_t^s + LVR_t^s + LCR_t^s)/4 \quad (8)$$

Bank-Specific Characteristics: Three characteristics are considered. Bank size (SIZE), measured by the logarithm of total bank assets. Net loan to total assets ratio (NLTA). Cost efficiency (CI) is calculated as the ratio of operating costs to total income. Lending variable, derived from the logarithm of total credit. Income diversification index (DIVL), calculated as:

$$DIVL = 1 - \left|{}^{RI - OI}/_{TI}\right| \quad (9)$$

RI denotes the bank's share of interest income, non-interest income by OI, and total income by TI. Interest income refers to income from lending, net of depositor shares, and non-interest income includes items such as foreign exchange gains, fees, and commissions.

The control variables for bank-specific variables were size, loan-to-asset ratio, equity ratio, non-interest income-to-total income ratio, and cost efficiency. Among these, bank size is a key determinant of risk-taking behavior. Franchise value theory suggests that higher franchise value, including large size, may limit a bank's incentives to take risks. The Danisman and Demirel (2019) study found that higher loan-to-asset ratios indicate greater credit risk. Under the Modigliani-Miller framework, holding more equity can reduce the risk and required risk premium to compensate investors for default costs (Allen et al., 2011). According to the fixed-leverage hypothesis, banks may be more willing to accept higher risk if leverage is reduced by increasing equity (Godlewski, 2005). Numerous subsequent empirical studies confirm that the use of risk-based capital ratios reduces bank risk (Ariff, 2008). Many empirical studies support the view that diversification reduces instability, as highlighted in Rossi et al. (2009). However, diversification can also be a source of banking risk due to several factors: increased volatility in non-interest income, higher fixed costs, lower regulatory capital requirements for non-lending activities, lack of managerial expertise, insufficient information about new product markets, exposure to new types of risk, and the fact that non-interest income can be riskier and more correlated with interest income (Acharya et al., 2006). Additionally, franchise value theory predicts that reduced management efficiency will encourage banks to take on more risk. Williams (2004) found that poorly managed banks tend to extend lower-quality loans. Mwaurah (2013) noted that managerial ability significantly influences banks' risk-taking decisions. For macroeconomic factors, economic growth (measured by GDP growth rate) and inflation (measured by the Consumer Price Index) are considered control variables. Salas and Saurina (2002) showed that during periods of economic growth, Spanish banks tend to expand lending activities to increase market share, often at the expense of credit quality. Boyd and Champ (2003) argue that inflation reduces the supply of credit available to businesses, affecting both the banking sector and the broader economy. Inflation also lowers the real return on assets and savings while simultaneously encouraging borrowing. This increase in personal and bank lending can, in turn, raise the probability of default. Banks may respond to this by setting higher interest rates, which can mitigate the impact on real returns but also increase the likelihood of default. A summary of the variables is presented in

Table 1.

Table 1. Summary of variables

Variable	Measurement
INDEPENDENT VARIABLE (RISK)	
Zscore	Ln((ROA+EA)/ Sd.ROA)*(-1)
MARCROPRUDENTIAL POLICY INSTRUMENTS	
MaPPLVR	Lim et al. (2011)
MaPPLiq	Lim et al. (2011)
MaPPLTD	Lim et al. (2011)
MaPPLTI	Lim et al. (2011)
MPI(Macroprudential Policy Index)	Briguglio composit index (1995)
BANK SPECIFIC FACTORS	
TA (Bank size)	Natural logarithm of total assets
CI (Cost management)	Operational cost/Total income
Credit (credit growth)	Natural logarithm of Credit
NPL	Non-performing loans to total gross loans
DivI (Income diversification)	Non-interest Income/ Total income
MACRO FACTORS	
GDP (economic growth)	Real GDP growth rate
Inflation	GDP Deflator
Financial Sanction	Dummy 1 for intensified financial sanctions and 0 for non

Source: The authors synthesize from previous studies

In Table 1, the dependent variable, the Z-score, is accompanied by the independent variables, including macroprudential policy instruments, the Briguglio composite index, bank-specific variables, and macroeconomic factors such as inflation and financial sanctions.

4. Empirical testing of the model and findings

In this study, five different models were estimated, and the empirical results are presented in Table 4. Before estimating the models, it is necessary to evaluate the statistical properties of the data, as shown in Table 2, and the stationarity tests, as presented in Table 3. The results of the Levin, Lin, and Chu unit root test indicate that all variables in the model are stationary. Furthermore, the modified Wald test for heteroskedasticity rejects the null hypothesis of homoscedasticity. Table 4 presents the results of the model estimation.

Table 2. Descriptive statistics of variables.

Dependent variable	Mean	Std.Dev	Min	Max	obs
Zscore	0.022	5.786	-42.469	9.970	240
Main regressors (MaPP)					
MaPPLiq	453.765	3293.800	-80.744	44900	240
MaPPLTD	7.672	9.130	0.164	76.091	240
MaPPLTI	12.144	8.423	0.068	83.333	240
MaPPLVR	7.021	8.697	-11.834	70.899	240
MPI	0.321	0.173	-0.022	1.227	240
Control variables					
TA	41.606	50.611	-29.240	418.678	240
CI	1.063	1.514	0.000	12.568	240
Credit	12.085	1.920	6.214	17.475	240
NPL	0.150	0.168	0.000	0.942	240
DIVl	0.575	0.404	0.000	3.406	240
RGDP	4.298	9.662	-4.299	36.255	240
Inflation	28.180	15.673	9.000	54.500	240
Sanction	0.800	0.4008	0.000	1.000	240

Table 2 presents the descriptive statistics, including the mean, standard deviation, minimum and maximum values, and the number of observations, for the banking risk variable and the independent and control variables used in the estimations.

Table 3. Model Variables: Stationary Test

Variable	Levin-Lin-Chu Test Statistic	Probability	Degree of stationarity	Difference or level
Zscore	-3.450	0.000	I(0)	Stationary at the level
MaPPLiq	-223.800	0.000	I(0)	Stationary at the level
MaPPLTD	-3.733	0.000	I(0)	Stationary at the level
MaPPLTI	-2.469	0.006	I(0)	Stationary at the level
MaPPLVR	-2.019	0.021	I(0)	Stationary at the level
MPI	-3.2102	0.000	I(0)	Stationary at the level
TA	-6.520	0.000	I(0)	Stationary at the level
CI	-1.980	0.023	I(0)	Stationary at the level
Credit	-42.220	0.000	I(0)	Stationary at the level
NPL	-11.890	0.000	I(0)	Stationary at the level
DIVl	-2.030	0.025	I(0)	Stationary at the level
RGDP	-37.660	0.000	I(0)	Stationary at the level
Inflation	-8.700	0.000	I(0)	Stationary at the level
Sanction	-8.623	0.000	I(0)	Stationary at the level

Table 3 presents the results of unit root tests for the banking risk, independent, and control variables, all of which are found to be stationary in levels.

Table 4. Results of the study

	Model 1	Model 2	Model 3	Model 4	Model 5
$Zscore_{t-1}$	1.152^{***}	0.825^{***}	0.255	1.113^{***}	0.957^{***}
$MaPPLTI_t$	0.081				
$MaPPLTI_{t-1}$	0.034				
$MaPPLTD_t$		-0.005			
$MaPPLTD_{t-1}$		0.105^{**}			
$MaPPLiq_t$			-0.018		
$MaPPLiq_{t-1}$			0.218^{***}		
$MaPPLVR_t$				0.076^{**}	
$MaPPLVR_{t-1}$				0.003	
$MaPPIndex_t$					2.143
$MaPPIndex_{t-1}$					1.257^{**}
TA	1.466	-0.005^{**}	-0.859^{*}	2.363^{*}	-0.480
CI	-0.812	-0.543^{***}	-0.737^{***}	-0.299	-0.764^{***}
DIVL	0.239^{*}	1.771^{***}	1.387^{**}	1.143	-0.222
LnCredit	-1.216	-0.000^{***}	-0.000^{***}	-1.462^{*}	0.623
NTLA	-2.036	-1.360	-0.315	-2.407^{***}	-2.159
LnGDP	0.076	-0.119	-0.102	-0.770^{*}	0.028
Deflator	-0.016^{*}	-0.002	-0.011^{***}	-0.002	0.003
SAN	-0.614	-0.473^{**}	-0.584	-1.235^{***}	-0.342^{***}

*, **, *** statistical significance at 10%, 5% and 1%.

Statistical significance and direction (positive or negative) of the relationship between banking risk and the five models are summarized in Table 4.

The estimated γ coefficient in our dynamic model is statistically significant, indicating a stable, highly persistent process in the credit risk of Iranian banks. In addition to model specification tests, the Sargan test confirms the robustness of the estimation approach. Consequently, the estimate of γ

is statistically reliable. It reflects the persistence of bank credit risk in the Iranian banking system.

The estimated dynamic coefficient γ in the baseline model lies in the interval $0 < \gamma < 1$, with a value close to 1. This result reflects a high degree of persistence in the Z-Score indicator of bank stability. Accordingly, shocks affect bank risk gradually over several periods and are consistent with risk-taking behavior in the Iranian banking system.

Using the (LTI) as the macroprudential indicator in the first model, we examine bank risk-taking using banking-specific variables (log of total assets, income diversification index, loan-to-asset ratio, cost efficiency) as well as macroeconomic variables (GDP growth rate, inflation, financial sanctions).

According to the results, the coefficient on the lagged Z-score variable increases the Z-score, indicating that an increase in the previous period's Z-score leads to an increase in the current period. According to the coefficient of 1.152, Iranian commercial banks exhibit a self-reinforcing dynamic, whereby conditions in the previous period become more severe in the subsequent period. This finding underscores the importance of macroprudential intervention, as in the absence of such tools, banking risk cycles may become self-amplifying.

The term self-reinforcing dynamics refers to high persistence and the strong influence of past-period risk on current-period risk. This concept is directly related to the coefficient on the lagged dependent variable (γ) in the GMM model. When γ is positive and large (close to 1), this indicates self-reinforcing dynamics, meaning that credit risk in the previous period plays a substantial role in determining current credit risk. In the Iranian banking system, a high γ coefficient indicates that stability or instability (Z-score risk) is a persistent property.

Table 5. Model specification tests

	Model specification tests									
	Model 1		**Model 2**		**Model 3**		**Model 4**		**Model 5**	
	statistic	**prob**	**statistic**	**prob**	**statistic**	**prob**	**statistic**	**prob**	**Statistic**	**prob**
Arellano and Bond AR(1)	-1.750	0.080	-2.457	0.014	2.024	0.042	-3.227	0.001	-2.195	0.028
Serial autocorrelation test AR(2)	-0.401	0.688	-1.268	0.205	1.038	0.299	-0.990	0.320	-1.089	0.275
Sargan test	4.308	1.000	1.239	1.000	6.152	1.000	4.360	1.000	4.995	1.000
Wald test	1779.140	0.000	1970.610	0.000	4894.470	0.000	4568.770	0.000	7314.690	0.000

Finally, Table 5 reports the results of the model specification tests, highlighting the combined effect of macroprudential instruments on commercial banks' risk-taking behavior.

Because the coefficient for LTI is positive at 0.081 and the coefficient for the lagged LTI is positive at 0.034, the LTI limit lowers bank risk. However, neither of these terms is statistically significant. This might be because Iran's banks don't use the LTI tool effectively, and other risk factors, such as balance sheet gaps and bad loans, are more important.

As a result of inflationary pressures and structural shocks, LTI is insignificant in Iran.

The second model uses the (LTD) as the macroprudential indicator. The coefficient of the lagged Z-score variable is positive and significant, at 0.825. The positive coefficient of 0.105 on the lagged LTD indicates that bank risk decreases as the Z-score improves, indicating reduced risk-taking by banks.

The results demonstrate that the impact of LTD on the Z-score is positive but small in the current period, but becomes positive and substantial with a lag. However, in the long run, it improves financial stability by lowering liquidity demands and adjusting loan portfolios. This highlights the importance of a long-term perspective in evaluating the effectiveness of macroprudential tools in Iran.

In the third model, the LIQ is used as the macroprudential indicator. According to the results,

although the coefficient of the lagged Z-score is positive, it is not statistically significant. This indicates that, when controlling for macroprudential tools, macroeconomic conditions, and bank-fixed heterogeneity, there is no clear evidence of short-term stability in bank risk, and shocks and policy interventions play a more dominant role than the system's internal memory.

The effect of the LIQ variable on the Z-score is insignificant, but its lagged effect is positive and significant at 0.218. LIQ can mitigate systemic risk in two ways: first, by directly influencing credit growth, and second, by creating a liquidity buffer that can be used to reduce the severity of liquidity crises when needed. The findings indicate the delayed impact of this macroprudential tool.

In Iran's banking system, the effects of liquidity regulations are gradual and medium-term in nature. In the context of GMM, the medium-term horizon is derived from the persistence parameter (γ) and is approximately 3–4 years, i.e., the time needed for half of the MPP effect on the Z-score to dissipate. This implies that MPP in Iran must be implemented with a long-term outlook rather than with expectations of immediate results.

In the fourth model, we utilize the effective LVR as the macroprudential indicator. According to the results, the coefficient of the lagged Z-score variable increases the Z-score. Since the coefficient is at 1.113, it indicates that the risk of Iranian commercial banks exhibits a self-reinforcing dynamic.

The positive and significant coefficient of the leverage ratio, at 0.076 in the current period, indicates that higher bank capital immediately increases stability and reduces bankruptcy risk. However, the lagged effect of this variable, although positive, is not significant. This suggests that the effect of capital strengthening in Iran's banking system is mostly immediate and short-term and may lose its persistence in the medium term due to structural issues such as low asset quality, accumulated losses, and the accounting nature of capital increases. A higher leverage ratio in Iran is an immediate means of improving banking stability, but it is not sufficient to guarantee long-term risk sustainability.

In the fifth model, the combined effect of macroprudential tools (MAPP) on bank risk-taking is examined alongside other variables. The coefficient of the lagged Z-score is positive and significant at 0.957, thereby increasing the Z-score. The coefficient of MAPP is 2.142 and statistically insignificant, while the lagged MAPP coefficient is positive and significant at 1.257. This indicates that the combined use of macroprudential tools has the greatest impact on the Z-score and, consequently, on bank risk-taking compared to the other models.

In all five models, the three bank-specific variables consistently enhance financial stability and reduce bank risk-taking by enhancing the Z-score. As a result, the debt-to-asset ratio (LVR) has the greatest impact on the Z-score.

The coefficient on bank size (SIZE) is negative and significant in two of the five models. Larger banks do not necessarily exhibit lower risk (i.e., higher Z-scores). This may be due to greater risk-taking by large banks that anticipate government support. The effect of bank size in Iran is nonlinear and complex. In the Iranian economy, larger bank size does not automatically imply greater stability. This finding aligns with international studies in developing countries, which show that large size, without risk management and asset quality control, can negatively affect banking stability.

Two out of five models have a positive and statistically significant income diversification index (DIVL) coefficient, suggesting that diversifying income sources made the banking industry more stable. Depending on the state of the economy and the quality of the income, income diversification may or may not help banks mitigate risk. In all models, the net loan-to-asset ratio (NLTA) coefficient is positive but not statistically significant. This suggests that lending volume is not a reliable risk indicator, particularly in countries like Iran, where lending is either mandatory or asset quality is low. The actual risk effect depends more on loan quality and credit management.

The insignificance of NLTA reflects the failure of asset-growth restrictions to mitigate the risks

embedded in non-productive assets within Iranian banks.

Three of five models have a negative and significant cost-efficiency index (CI), suggesting that higher cost-to-income ratios, indicative of less efficiency, are associated with higher risk. This highlights that cost control and operational efficiency are important factors in banking stability. The lending volume index (LCRE) coefficient is negative and significant in two out of five models, indicating that high credit volumes in some banks are associated with increased risk, likely due to concentration in high-risk or low-quality loans. This is in line with NLTA's insignificance and demonstrates that distribution and quality of loans are more important than quantity alone.

One of the macroeconomic variables that has a negative and significant impact on most models is financial sanctions (FSAN). This means that sanctions increase bank risk by restricting access to foreign resources, reducing liquidity, and creating uncertainty. As a result, the Z-score goes down. As a result of banks' reliance on government policies, mandated lending, or structural economic volatility, GDP growth is insignificant across all models with mixed signs, indicating that economic growth does not directly or sustainably affect bank risk in Iran. The inflation variable (GDP deflator) is negative and significant in two models, indicating that high inflation reduces banking stability; real asset values decline, and credit costs rise, thereby increasing risk.

In Iran, bank credit risk is primarily influenced by structural shocks rather than cyclical factors, and by multicollinearity between GDP and sanctions.

5. Conclusion and policy recommendations

The empirical evidence confirms that MPP is vital for curbing excessive risk-taking in Iran. However, its effectiveness depends heavily on the specific tool selected and its associated time horizon. A key finding is that, when viewed from an instrument-hierarchy perspective, leverage ratios are the best immediate risk mitigation. In contrast, long-term liquidity requirements are necessary for medium-term stability. Second, regarding the lag factor, macroprudential interventions in Iran do not yield immediate results, except for capital-based ratios, which require a long-term policy outlook of 3 to 4 years to achieve a significant impact. Third, on structural obstacles, the dominance of financial sanctions and persistent inflation reduces the efficacy of cyclical tools, necessitating a shift toward resilience-buffer instruments. Fourth, on internal vs. external drivers, bank-specific factors, specifically operational efficiency and loan quality, are more predictive of stability than macroeconomic growth. The ultimate solution to banking stability in Iran is to strengthen capital through leverage limits and to apply liquidity tools to mitigate the deep-seated risks posed by inflation and external shocks.

It is recommended that the Central Bank of Iran adopt a tiered strategy for implementing macroprudential tools to enhance banking stability. In this regard, the priority would be immediate stability through the leverage ratio. To this end, the action needed is to designate the leverage ratio (LVR) as the primary, central anchor of the macroprudential framework. The timeline would be short-term. The rationale is that, unlike other tools, the leverage ratio has an immediate impact on reducing bankruptcy risk and increasing stability. In contrast to demand-based tools, it is an immediate capital buffer that does not suffer from implementation delays.

The second priority would be medium-term resilience through liquidity controls. To this end, the action needed is to implement and maintain strict loan-to-deposit ratios and liquidity requirements (LIQ). The timeline would be medium-term (3–4 years). The rationale is that these tools exhibit a lagged effect. Their benefits in reducing liquidity pressures and credit growth only become significant after the system memory adjusts. Policymakers must maintain these restrictions for at least 3–4 years to allow half of the policy effect to manifest in the Z-score.

The third priority would be sequencing and tool combination. To this end, the necessary action is

to shift from isolated tool use to a coordinated macroprudential package. In terms of sequencing, the Central Bank needs to begin with LVR to stabilize capital, followed by the simultaneous deployment of LTD and LIQ to manage credit expansion over the medium horizon. The focus should be on moving away from demand-based tools like Loan-to-Income (LTI) ratios, which are currently ineffective in Iran due to high inflation and structural shocks.

The fourth priority would be addressing internal bank efficiency. To this end, the necessary action is to enforce strict cost-efficiency (CI) and loan-quality mandates rather than focus on lending volume. The rationale is that high credit volumes are currently associated with increased risk due to low-quality or mandated lending. Efficiency and internal risk management are more influential for stability than bank size or simple volume restrictions.

References

1. Acharya, V. V., Bergant, K., Crosignani, M., Eisert, T. and McCann, F. (2022). The anatomy of the transmission of macroprudential policies. *The Journal of Finance*, 77(5), pp. 2533-2575. https://doi.org/10.1111/jofi.13170
2. Acharya, V. V., Hasan, I. and Saunders, A. (2006). Should banks be diversified? Evidence from individual bank loan portfolios. *The Journal of Business*, 79(3), pp. 1355-1412. https://doi.org/10.1086/500679
3. Akinci, O. and Olmstead-Rumsey, J. (2018). How effective are macroprudential policies? An empirical investigation. *Journal of Financial Intermediation,* 33, pp. 33-57. https://doi.org/10.1016/j.jfi.2017.04.001
4. Alam, Z., Alter, A., Eiseman, J., Gelos, G., Kang, H., Narita, M., Nier, E and Wang, N. (2025). Digging deeper—Evidence on the effects of macroprudential policies from a new database. *Journal of Money, Credit and Banking,* 57(5), pp. 1135-1166. https://doi.org/10.1111/jmcb.13130
5. Allen, F., Carletti, E. and Marquez, R. (2011). Credit market competition and capital regulation. *The Review of Financial Studies*, 24(4), pp. 983-1018. https://doi.org/10.1093/rfs/hhp089
6. Altunbas, Y., Binici, M. and Gambacorta, L. (2018). Macroprudential policy and bank risk. *Journal of International Money and Finance*, 81, pp. 203-220. https://doi.org/10.1016/j.jimonfin.2017.11.012
7. Andries, A. M., Melnic, F. and Nistor, S. (2017). Effects of macroprudential policy on systemic risk and bank risk taking. *Czech Journal of Economics and Finance, Forthcoming*, 68(3), pp.1-22. https://dx.doi.org/10.2139/ssrn.3021278
8. Ariff, M. and Ahmad, N. H. (2008). Multi-country study of bank credit risk determinants. *International Journal of Banking and Finance*, 5(1), pp. 135–152.
9. Borio, C. (2014). The financial cycle and macroeconomics: What have we learnt*?*. *Journal of Banking & Finance,* 45, pp. 182-198. https://doi.org/10.1016/j.jbankfin.2013.07.031
10. Boyd, J. and Champ, B. A. (2003). Inflation and financial market performance: what have we learned in the last ten years? *Monetary Policy in Low-Inflation Economies,* 1(1), pp. 259-301. https://doi.org/10.26509/frbc-wp-200317
11. Briguglio, L. (1995). Small island developing states and their economic vulnerabilities. *World Development,* 23(9), pp. 1615-1632. https://doi.org/10.1016/0305-750X(95)00065-K
12. Claessens, S. (2015). An overview of macroprudential policy tools. *Annual Review of Financial Economics,* 7(1), pp. 397-422. https://doi.org/10.1146/annurev-financial-111914-041807
13. Danisman, G. O. and Demirel, P. (2019). Bank risk-taking in developed countries: The

influence of market power and bank regulations. J*ournal of International Financial Markets, Institutions and Money,* 59, pp. 202-217. https://doi.org/10.1016/j.intfin.2018.12.007

14. De Nicolo, G., Dell'Ariccia, G., Laeven, L. and Valencia, F. (2010). Monetary policy and bank risk taking. *IMF Staff Position Note*, New Hampshire, United States. https://doi.org/10.2139/ssrn.1654582
15. Do, H. T., Pham, L. H., Ta, H. T. and Nguyen, H. T. D. (2025). Macroprudential policies and bank risk evidence from Vietnam. *Cogent Economics & Finance,* 13(1), pp. 1-13. https://doi.org/10.1080/23322039.2025.2484653
16. Ely, R. A., Tabak, B. M. and Teixeira, A. M. (2021). The transmission mechanisms of macroprudential policies on bank risk. *Economic Modelling*, 94, pp. 598-630. https://doi.org/10.1016/j.econmod.2020.02.005
17. Fang, Y. (2016). A study on the effectiveness of macro-prudential policies. *The Journal of World Economy*, 39(8), pp. 25-49.
18. Godlewski, C. J. (2005). Bank capital and credit risk taking in emerging market economies. *Journal of Banking Regulation*, 6(2), pp. 128-145. https://doi.org/10.1057/palgrave.jbr.2340187
19. Heydarian, S., Pahlavani, M. and Mirjalili, S. H. (2021). Financial sanctions and economic growth: an intervention time-series approach. *International Economics Studies*, 51(1), pp. 1-14. https://doi.org/10.22108/IES.2020.122915.1083
20. Heydarian, S., Pahlavani, M. and Mirjalili, S. H. (2022). The impact of financial sanctions on capital Inflow and Outflow (case of Iran). *Journal of Money and Economy*, 17(1), pp. 67-88. https://doi.org/10.29252/jme.17.1.67
21. Heydarian, S., Pahlavani, M. and Mirjalili, S. H. (2023). Financial sanctions and the imports of intermediate and capital goods in Iran: DID method. *International Journal of Business and Development Studies,* 15(2), pp. 101-134. https://doi.org/10.22111/ijbds.2024.47819.2090
22. Heydarian, S., Pahlavani, M. and Mirjalili, S. H. (2025). Financial sanction, exchange rate volatility and macroeconomic variables (case of Iran), *Iranian Journal of Finance*, 9(2), pp.70-106. https://doi.org/10.61186/ijf.2025.462663.1476
23. Houston, J. F., Lin, C., Lin, P. and Ma, Y. (2010). Creditor rights, information sharing, and bank risk taking. *Journal of Financial Economics*, 96(3), pp. 485-512. https://doi.org/10.1016/j.jfineco.2010.02.008
24. Laeven, L. and Levine, R. (2009). Bank governance, regulation and risk taking. *Journal of Financial Economics,* 93(2), pp. 259-275. https://doi.org/10.1016/j.jfineco.2008.09.003
25. Lepetit, L. and Strobel, F. (2015). Bank insolvency risk and Z-score measures: A refinement. *Finance Research Letters*, 13, pp. 214-224. https://doi.org/10.1016/j.frl.2015.01.001
26. Lim, C. H., Columba, F., Costa, A., Kongsamut, P., Otani, A., Saiyid, M., Wezel, T and Wu, X. (2011). Macroprudential policy: what instruments and how to use them? Lessons from country experiences, *IMF Working Paper*, United States, pp. 1-59. https://doi.org/10.2139/ssrn.1956385
27. Mwaurah, I. G. (2013). The Determinants of credit risk in commercial banks in Kenya (Doctoral dissertation), *University of Nairobi*, Nairobi, Kenya. https://doi.org/10.21203/rs.3.rs-2038051/v1
28. Rossi, S. P., Schwaiger, M. S. and Winkler, G. (2009). How loan portfolio diversification affects risk, efficiency and capitalization: A managerial behavior model for Austrian banks. *Journal of Banking & Finance,* 33(12), pp. 2218-2226. https://doi.org/10.1016/j.jbankfin.2009.05.022
29. Safari, O., Assadzadeh, A. and Mirjalili, S. H. (2024). Fiscal policy uncertainty and Industrial

Investment in Iran. *International Journal of Business and Development Studies,* 16(1), pp. 229-259. https://doi.org/10.22111/ijbds.2024.49134.2126

30. Salas, V. and Saurina, J. (2002). Credit risk in two institutional regimes: Spanish commercial and savings banks. *Journal of Financial Services Research*, 22(3), pp. 203-224. https://doi.org/10.1023/A:1019781109676
31. Williams, J. (2004). Determining management behaviour in European banking. *Journal of Banking & Finance,* 28(10), pp. 2427-2460. https://doi.org/10.1016/j.jbankfin.2003.09.010
32. Zhang, X., Li, F., Li, Z. and Xu, Y. (2018). Macroprudential policy, credit cycle, and bank risk-taking. *Sustainability*, 10(10), pp. 1-18. https://doi.org/10.3390/su10103620
33. Zhao, Y., Goodell, J. W., Wang, Y. and Abedin, M. Z. (2023). Fintech, macroprudential policies and bank risk: Evidence from China. *International Review of Financial Analysis*, 87, pp. 1-28. https://doi.org/10.1016/j.irfa.2023.102648