“The moderating effect of bank size on the interest rate – risk-taking relationship: Insights from Vietnam”

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ARTICLE INFO	Huy Lam Tan Ngo and Linh Thuy Do Tran (2026). The moderating effect of bank size on the interest rate – risk-taking relationship: Insights from Vietnam. *Investment Management and Financial Innovations*, *23*(3), 49-65. doi:10.21511/imfi.23(3).2026.05
DOI	http://dx.doi.org/10.21511/imfi.23(3).2026.05
RELEASED ON	Friday, 10 July 2026
RECEIVED ON	Tuesday, 03 February 2026
ACCEPTED ON	Saturday, 06 June 2026

JOURNAL	"Investment Management and Financial Innovations"
ISSN PRINT	1810-4967
ISSN ONLINE	1812-9358
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10,
Sumy, 40022, Ukraine
www.businessperspectives.org

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THE MODERATING EFFECT OF BANK SIZE ON THE INTEREST RATE – RISK-TAKING RELATIONSHIP: INSIGHTS FROM VIETNAM

Type of the article: Research Article

Received on: 3rd of February, 2026
Accepted on: 6th of June, 2026
Published on: 10th of July, 2026

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Conflict of interest statement:
Author(s) reported no conflict of interest

Abstract

This study examines how interest rates influence bank risk-taking within Vietnam's transitional banking system, with a particular focus on how bank size moderates this relationship. While previous studies have linked prolonged low interest rates to increased risk-taking, Vietnam's banking context – characterized by strict credit limits, frequent interventions, opaque ownership structures, and a tendency toward evergreening during tightening periods – suggests a reversed pattern. Using the System Generalized Method of Moments on annual data from 24 Vietnamese banks over 2014–2024, the findings indicate that higher interest rates are associated with significantly greater risk-taking. Specifically, the rediscount rate exerts the most significant impact on bank risk, followed by refinancing and interbank rates. Bank size also shows a negative baseline association with the Z score, suggesting that larger banks tend to take on more overall risk. This baseline risk in larger institutions is primarily driven by aggressive revenue diversification into volatile non-interest activities. Yet size also plays a crucial moderating role: larger banks demonstrate greater resilience when interest rates rise, as reflected in larger improvements in Z-scores and lower risk sensitivity compared with smaller banks, which are more vulnerable. Quantitatively, the adverse effect of interest rate shocks on the Z-scores significantly diminishes from the 25th to the 75th size percentile. This happens because larger banks successfully manage rising rates through funding advantages and diversified credit portfolios, while smaller banks react to these pressures by evergreening loans to conceal worsening asset quality.

Keywords interest, risk-taking, size, banking, corporate behavior, monetary policy

JEL Classification E43, G21, G32, P34

INTRODUCTION

In the business environment, corporate behavior, particularly risktaking, is strongly shaped by regulatory changes. This tendency is especially evident in the banking sector, which serves as the first tier to absorb the impact of central bank policy rate adjustments.

Risk-taking behavior is particularly pronounced in transitional institutional environments, such as Vietnam's banking system, where banks respond differently to varying interest rates. Specifically, when interest rates are low, Vietnamese banks tend to adopt a more cautious stance, especially in the aftermath of highprofile bad-debt cases, fraud scandals, and the takeover of failing institutions (Vietnam Investment Review, 2023; CNBC, 2024; Reuters, 2024). These notorious events have discouraged banks from engaging in "search for yield" strategies during periods of monetary easing. By contrast, when the central bank tightens monetary policy and interest rates rise, banks often intensify risktaking to meet regulatory thresholds for nonperforming loans (NPLs). In this circumstance, banks may aggressively extend credit to highrisk borrowers or affiliated entities, thereby increasing financial fragility. Taken together, these contrasting behaviors suggest that in Vietnam's transitional banking environment, risktaking may paradoxically increase under high interest rates rather than decrease.

Furthermore, bank size may intensify the relationship between interest rates and risktaking. Large banks often benefit from diversification, economies of scale, and more stable funding sources, which generally enhance their resilience and reduce exposure to risks arising from central bank policy rate changes. In Vietnam, however, major financial institutions, particularly StateOwned Commercial Banks (SOCBs) and leading Joint Stock Commercial Banks (JSCBs) such as Vietcombank, VietinBank, BIDV, Techcombank, and ACB, operate under distinctive constraints. These banks are frequently tasked with quasifiscal responsibilities, including absorbing distressed assets from weaker institutions during restructuring efforts and maintaining systemwide stability (Reuters, 2024). Such obligations expose them to higher levels of risktaking despite their size.

Although much of the existing literature suggests that higher interest rates are typically associated with lower risktaking, the behavior of Vietnamese banks does not always align with this pattern. This divergence highlights the unique dynamics of Vietnam's transitional banking environment. Moreover, there is limited empirical research on how bank size moderates the interest rate–risktaking relationship in emerging markets. To address this gap, the present study examines the effect of interest rates on Vietnamese banks' risktaking, as measured by the Zscore, and investigates the moderating role of bank size in this transmission channel.

1. LITERATURE REVIEW AND HYPOTHESES

Over the past decades, extensive research has examined the nexus between interest rates and bank risktaking. A wellestablished body of literature, both theoretical and empirical, argues that changes in the central bank's policy rate significantly influence banks' incentives to take risk: higher policy rates (monetary tightening) generally restrain risktaking, while lower rates (monetary easing) encourage greater exposure.

From the theoretical perspective of the risk-taking channel, Borio and Zhu (2012) argue that accommodative monetary policy alters banks' financial behavior by incentivizing them to lend, invest, and assume greater risks in pursuit of higher returns.

From empirical viewpoints, Dell'Ariccia et al. (2014) show that increases in short-term policy rates are negatively associated with bank risktaking, indicating that contractionary monetary policy curbs risk appetite. Similarly, Delis and Kouretas (2011), Angeloni et al. (2015), and Passos et al. (2024) find that lowinterestrate environments stimulate riskier lending and investment behavior. Additionally, empirical evidence from emerging markets reinforces this view: Rajan (2006) highlights the "searchforyield" mechanism, whereby banks facing low interest rates pursue riskier assets to sustain profitability. Consistent with this, Chen et al. (2017), in a study of 1,000 banks across 29 emerging economies, show that prolonged "lowforlong" interest rates encourage excessive risktaking.

Nevertheless, these prior findings may not be fully applicable to the Vietnamese banking context. Empirical evidence suggests that risk-taking behavior in Vietnamese banks differs from conventional patterns observed in developed markets. Specifically, banks in Vietnam appear to increase risk-taking during periods of high interest rates, while becoming more conservative when interest rates are low. This countercyclical behavior can be explained as follows: during periods of monetary tightening, rising interest rates place greater financial pressure on borrowers, increasing the likelihood of distress and default. As credit risk intensifies, banks may respond by extending additional credit to troubled borrowers, effectively restructuring or rolling over existing loans to delay the recognition of non-performing loans (NPLs) (this lending practice is known as evergreening). In other words, the high interest rates compel Vietnamese

http://dx.doi.org/10.21511/imfi.23(3).2026.05

banks to increase risk-taking not to seek yield, but to conceal borrowers' insolvency and avoid regulatory breaches on NPL ratios. Meanwhile, in periods of expansionary monetary policy, as reflected in a low-interest rate environment, Vietnamese banks tend to exhibit more conservative risk-taking behavior rather than engaging in the conventional "search for yield." Despite abundant liquidity and lower policy rates, banks' lending activities remain constrained by institutional and regulatory factors. Firstly, the central bank's credit growth quota system acts as a binding constraint, limiting banks' ability to aggressively expand lending even when monetary conditions are accommodative (IMF, 2024). This administrative control weakens the traditional transmission mechanism whereby lower interest rates stimulate credit growth and risk-taking. Secondly, the Vietnamese banking sector has been shaped by a history of stringent regulatory interventions and restructuring efforts. Notably, the compulsory "zero-dong" acquisitions of troubled institutions such as OceanBank, GPBank, and CBBank in 2015 (Vietnam Investment Review, 2023), along with the placement of banks such as DongA Bank and SCB under special control (CNBC, 2024), have reinforced regulatory discipline within the system. These regulatory shocks have instilled a deep fear of discipline and loss of reputation, significantly heightening risk aversion and discouraging banks from pursuing aggressive 'search for yield' strategies even in periods of low policy rates.

As a result, contrary to the standard risk-taking channel presented in prior studies (Delis & Kouretas, 2011; Borio & Zhu, 2012; Angeloni et al., 2015; Passos et al., 2024), financial fragility in Vietnam is likely exacerbated during periods of monetary tightening rather than easing. Therefore, this study contributes to the literature by examining the interest rate–risk-taking nexus within a transition economy context, thereby offering new insights into how policy rates affect bank behavior beyond the standard pattern.

1.1. The role of bank size and its moderating effect in the context of risk-taking

Bank size plays a crucial role in shaping banks' operational strategies, particularly their risk-taking behavior. However, the empirical literature provides mixed evidence regarding the relationship between bank size and risk. On the one hand, several studies argue that larger banks tend to exhibit lower risk due to diversification benefits, economies of scale, and better access to funding (Boyd & Runkle, 1993; Hakenes & Schnabel, 2011; Bertay et al., 2013).

On the other hand, a growing body of research suggests that larger banks are associated with higher risk-taking (De Nicolo, 2000; Bhagat et al., 2015). For instance, De Nicolo (2000) finds that bank size is positively associated with risk, suggesting that larger institutions may take on more risk due to their systemic importance. Similarly, studies show that large banks contribute to systemic risk and are more likely to engage in excessive risk-taking, partly due to "too-big-to-fail" expectations and implicit government protection (Laeven et al., 2014; Bellia et al., 2022). To explain, a primary mechanism facilitating this tendency is revenue diversification. Driven by increasing competition, banks are shifting away from sole reliance on interest income to expand into non-interest revenue streams (Laeven et al., 2016; Hunjra et al., 2021). Consequently, although the benefits of such diversification remain uncertain, large banks are generally considered riskier than their smaller counterparts because expanding into volatile non-interest activities increases total bank risk (De Nicolo, 2000).

The dynamics of revenue diversification are particularly pronounced in emerging economies, where banks adopt diversification strategies to mitigate operational inefficiencies (Wu et al., 2020). In Vietnam, large financial institutions such as Techcombank, VietinBank, ACB, Vietcombank, and BIDV have aggressively expanded into high-volatility sectors, including investment banking, foreign exchange, and bancassurance, to offset low Net Interest Margins (NIM). In contrast, smaller banks lack the infrastructure for such diversification. Therefore, through revenue diversification, larger banks are more exposed to volatile business activity or higher risk-taking behavior than their smaller peers.

Furthermore, bank size in Vietnam entails significant political responsibilities. Unlike in developed markets, where "Too-Big-To-Fail" implies a safety

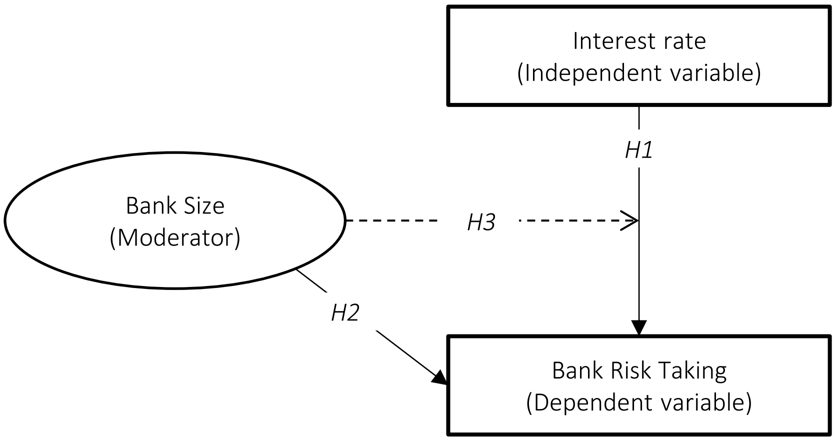

Figure 1. Theoretical framework

net for banks (Afonso et al., 2014), in Vietnam, the big 4 State-Owned Commercial Banks (SOCBs) and some big Joint Stock Commercial Banks (JSCB)s act as quasi-fiscal agents of the state. They are frequently mandated to participate in the restructuring of weak credit institutions to maintain systemic stability. A prime example is the forced assignment of large lenders (such as Vietcombank, MB, and VPBank) to support or manage "zero-dong" banks (CBBank, OceanBank, GPBank) (Reuters, 2024) and, more recently, to provide liquidity support for SCB under special control (Retail Banker International, 2022). This "burden-sharing" mechanism compels large banks to absorb bad assets, increasing their risk exposure.

Turning to the moderating role of bank size, prior research has treated size as a moderator in various contexts, such as its interaction with capital (Laeven et al., 2016), market discipline (Bertay et al., 2013), and non-interest income (De Jonghe et al., 2015). However, none have examined its moderating influence within the interest rate transmission channel, as this study does. The most closely related works we identified are those by Dang & Nguyen (2021) and Rakshit & Bardhan (2023), which demonstrate that bank size significantly moderates the impact of monetary policy shifts on lending and liquidity. However, to our knowledge, no empirical research has examined how bank size influences the relationship between interest rates and bank risk-taking in Vietnam.

Therefore, based on the above comprehensive review of the literature, our research aims to investigate how interest rates affect banks' risk-taking behavior within Vietnam's evolving banking sector, with particular attention to the moderating role of bank size in this relationship, by empirically testing the proposed hypotheses:

H1: *Interest rates are positively associated with bank risk-taking.*

H2: *Size is positively associated with bank risk-taking.*

H3: *Size moderates the effect of interest rates on bank risk-taking.*

Accordingly, the following theoretical framework is presented to address the relationship between interest rates and risk-taking, as well as the moderation effect of bank size.

2. METHODOLOGY

This study analyses annual data collected from 24 banks (list of banks is provided in Appendix A) in Vietnam from 2014 to 2024, excluding banks undergoing restructuring (i.e., Dong A, Ocean, and Construction Bank) and small banks (ABBANK, Bao Viet, PG Bank, and NCB). However, during the study period, our samples still accounted for more than 80% of the total market share of assets in the Vietnamese banking sector.

The dataset consists of an unbalanced panel with 264 observations. The data on interest rates and macroeconomic variables are sourced from Vietnam's Government official websites, such as

http://dx.doi.org/10.21511/imfi.23(3).2026.05

the General Statistics Office (GSO) and the State Bank of Vietnam (SBV). On the other hand, data on banks' financial indicators are primarily collected and calculated from their audited consolidated financial statements.

The following describes variables used in our study.

2.1. Dependent variable

The existing literature employs various measures to assess bank risk-taking. For instance, some papers use accounting-based risk measures, such as the NPL ratio, risk-weighted assets, and the loan-to-asset ratio, to represent the bank's asset quality; however, these measures are merely asset indicators and may not accurately predict any default events the bank may face (Brana et al., 2019). Indeed, these financial indicators may signal deteriorating asset quality, but they do not necessarily signal the risk of insolvency. Moreover, banks often manipulate SBV's acceptable NPL ratios to fall within the SBV's thresholds; therefore, using NPL ratios may not provide a precise assessment of a bank's risk-taking. To this end, the study employs the traditional Z-score, the most widely used risk measure in the literature, to assess a bank's vulnerability by determining whether it has sufficient capital to cover losses given its earnings volatility (Rivard & Thomas, 1997). The concept underlying the Z-score is that a bank is insolvent when its losses exhaust its equity. Hence, a higher Z-score indicates a lower probability of insolvency (López-Penabad et al., 2022).

2.2. Independent variables

Interest rates: We use the refinance rate (for short-term loans), the rediscount rate (to discount eligible papers), and the overnight lending rate on the interbank market (for loans between banks) to represent the interest rate indicator. Not only advanced markets but also emerging economies, such as Vietnam, have increasingly used these tools to conduct monetary policy more effectively (Dang, 2020). This approach allows us to concurrently and comprehen-

Table 1. Summary of key variables

Variable	Notation	Measure	Source
Dependent variables	**Risk-taking measure**		
Z-score	LnZscore	Log of (ROA+equity/assets)/σROA	Roy (1952); López-Penabad et al. (2022); Bushman & Williams (2012); Brana et al. (2019)
Independent variables			
Interest variables			
Interbank overnight rates	Intbank	Average yearly interbank overnight rates set by SBV (%)	Dang (2020)
Refinance rates	Refin	Average yearly refinance rates set by SBV (%)	
Rediscount rates	Redis	Average yearly rediscount rates set by SBV (%)	
Bank control variables			
Cost-to-income ratio	CIR	Total operating expenses/total operating income (%)	Berger & DeYoung (1997); Dietrich & Wanzenried (2011 & 2014).
Loans to total assets ratio	LAR	Total loans/total assets (%)	Cornett et al., (2011); Rizki & Gunarsih (2024); Imbierowicz & Rauch (2014)
Loans to Deposits ratio	LDR	Total loans/total deposits (%)	
Capital ratio	CAP	Total equity/average total assets (%)	Berger (1995); Dong et al. (2023)
Capital adequacy ratio	CAR	(Tier 1 + Tier 2 capital)/Risk-weighted assets (%)	Quoc & My (2023)
NPL Coverage ratio	NPLcoverage	Loan loss provisioning/total NPLs (%)	Alessi et al. (2021); Wheeler (2019)
Macro-economic variables			
Gross domestic product	GDP	Yearly GDP growth rate (%)	Athanasoglou et al. (2008); Klein & Weill (2022).
Headline Inflation	INF	Yearly percentage change in CPI (%)	
Moderator variable			
Total assets	Size	Log of the bank's total assets	Bani Yousef et al. (2024)
Total loans (for robustness)	Loans	Log of the bank's total loans	
Total deposits (for robustness)	Deposits	Log of the bank's total deposits	

sively evaluate the impact of the examined interest rates on bank risk-taking behaviors.

Bank determinant variables: Given that our database includes banks with varying characteristics, it is essential to control for bank heterogeneity. Hence, some bank determinant variables, such as the cost-to-income ratio (CIR), loans to total assets (LAR), loans to deposits (LDR), capitalization as measured by the equity to asset ratio (CAP), capital adequacy ratio (CAR), and non-performing loan (NPL) coverage ratio.

Macro-economic variables: We also control the macroeconomic environment at the country level using the GDP growth rate and headline inflation (INF). In a more favorable macroeconomic landscape, banks tend to increase lending to local businesses to support market expansion, thereby pushing yields higher. Especially in bank-based economies, such as Vietnam, banks should assume higher risks to meet more inelastic demand for credit (Delis & Kouretas, 2011; Bitar et al., 2018).

Moderator variable: Our study is motivated by the fact that a vast amount of research has been conducted on the effect of size on bank performance; however, the debate remains unsettled regarding the sign and magnitude of its influence (Boyd & Runkle, 1993; Bertay et al., 2013; Rashid & Jabeen, 2016; Laeven et al., 2016). Given the above literature review confirming heterogeneity in bank characteristics, it is essential to investigate whether and how the correlation between interest rates and bank risk-taking varies across bank sizes in Vietnam. Therefore, given the variability in bank size, we use the logarithm of total assets as the size indicator, and the interaction between Int and Size (Int x Size) captures the marginal effect of size on the impact of interest rates on bank risk-taking.

Regarding the robustness check, the paper replaces bank size (total assets) with total loans and total deposits.

2.3. Econometric models

Using the described data set, the following econometric model will be applied for hypothesis testing:

Model without an interaction

$$Risk_{i,t} = \alpha_0 + \alpha_1 Int_t + \alpha_2 Size_{i,t} + \alpha_3 BV_{i,t} + \alpha_4 Macro_t + \varepsilon_{i,t}, \quad (1)$$

Model with an interaction

$$Risk_{i,t} = \alpha_0 + \alpha_1 Int_t + \alpha_2 Size_{i,t} + \alpha_3 Int_t \cdot Size_{i,t} + \alpha_4 BV_{i,t} + \alpha_5 Macro_t + \varepsilon_{i,t}, \quad (2)$$

where $Risk_{i,t}$ is the dependent variable, representing the risk-taking of bank *i* in year *t*; (Int_t) is referred to as levels of interest rates in year *t*; $(Size_{i,t})$ is referred to as the size of bank *i* in year *t*; $(Int_t \cdot Size_{i,t})$ is used to capture the marginal impact of Size on the effects of interest rate changes on bank risk-taking; $(BV_{i,t})$ are bank determinant variables of bank *i* in year *t*, and $(Macro_t)$ displays macroeconomic indicators in year t, and $\varepsilon_{i,t}$ denotes the error term. Since our study focuses only on Vietnam, we exclude year-fixed effects from the models, as all banks in the dataset are subject to the same monetary policy in each year.

The first model serves as the baseline, examining the direct effects of interest rates and size on bank performance without a moderator. The second model builds on the baseline by incorporating the interaction between interest rates and bank size to assess whether the correlation identified in the first model persists and to explore the moderating role of bank size in this relationship.

3. RESULTS AND DISCUSSION

The results and discussion are presented in the following order: descriptive statistics, the main regression results on the relationship between interest rates and risk-taking (including the moderation effect), and finally, robustness checks to validate the findings.

3.1. Descriptive statistics & correlation

The following table presents descriptive statistics for the variables used in this paper. The sample consists of 24 banks from 2014 to 2024. The mean of the Z-score appears to be 2.95, with a standard deviation of 0.56. Looking at this distribution, we

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Table 2. Descriptive statistics of input variables

Variable	Obs	Mean	Std. dev.	Min	Max
Dependent variable					
Zscore	264	2.947615	0.562607	2.011961	4.609272
Interest rate variables					
Redis	264	0.037689	0.007231	0.025	0.045833
Refin	264	0.055606	0.009492	0.04	0.065833
Intbank	264	0.064336	0.010275	0.05	0.075
Bank control variables					
CIR	264	0.48141	0.143623	0.227062	1.085896
LAR	264	0.62757	0.093656	0.225254	0.800625
LDR	264	0.935646	0.154163	0.371874	1.469094
CAP	264	0.090959	0.033005	0.043375	0.228519
CAR	263	0.121661	0.02928	0.0835	0.2453
NPLcover	264	0.687744	0.625054	0.0034	4.243609
Macroeconomic variables					
GDP	264	0.061009	0.017749	0.0255	0.0812
INF	264	0.0293	0.009315	0.006	0.041
Moderator variables					
SIZE (total assets)	264	33.06201	1.176415	30.39251	35.55429
SIZE (total loans)	264	32.58277	1.2558	30.04981	35.25958
SIZE (total deposits)	264	32.66349	1.208454	30.10277	35.20823

observe significant variation among banks in risk-taking measures (as indicated by the wide range of Min and Max and the large standard deviations). Concerning interest rate indicators, we observe that short-term Refin, Redis, and Intbank follow the same pattern.

In this paper, to address multicollinearity, correlation tests among independent variables are conducted prior to the panel data regression. The test result is shown in Table 3. The results show no significant correlations among these independent variables, as most correlations are below 0.8 (Gujarati, 2021). Additionally, the study conducts a variance inflation factor (VIF) test after the regression to recheck for multicollinearity. Especially when including the moderator in the models, as measured by the interaction between Int and Size (e.g., Int x Size), the study employs the mean-centering method (Aiken et al., 1991) to control for multicollinearity. Under this approach, the variance inflation factors (VIFs) for all independent variables are low, with most below 10; thus, no multicollinearity problem exists (O'Brien, 2007).

3.2. Regression results

The analysis begins with a pooled OLS model as a baseline, though this may overlook unobserved bankspecific heterogeneity. A Breusch–Pagan LM test (Breusch & Pagan, 1979) confirms significant individual effects ($p < 0.01$), indicating that pooled

Table 3. Correlations among independent variables

	Redis	Refin	Intbank	SIZE	CIR	LAR	LDR	CAP	CAR	NPLcover	GDP	INF
Redis	1											
Refin	0.9982	1										
Intbank	0.9621	0.9648	1									
SIZE	–0.3383	–0.3402	–0.3543	1								
CIR	0.4078	0.4082	0.3993	–0.5893	1							
LAR	–0.2956	–0.2922	–0.3009	0.4453	–0.2443	1						
LDR	–0.4373	–0.435	–0.4309	0.2896	–0.455	0.465	1					
CAP	–0.0929	–0.0997	–0.1042	–0.3156	–0.1263	–0.1913	0.2119	1				
CAR	0.1921	0.1852	0.1854	–0.4522	0.1848	–0.2905	–0.0937	0.6839	1			
NPLcover	–0.2255	–0.223	–0.1915	0.5113	–0.366	0.0327	0.0863	–0.0259	–0.1523	1		
GDP	0.5374	0.5194	0.5623	–0.0725	0.1449	–0.0367	–0.0507	–0.0173	0.1215	–0.1227	1	
INF	0.0159	–0.0002	–0.0655	0.0774	–0.0404	0.0363	0.0954	0.0103	–0.0808	–0.0454	0.147	1

OLS is inappropriate. We then estimate both randomeffects (REM) and fixedeffects (FEM) models and apply the Hausman test (Hausman, 1978). The significant result ($p < 0.05$) rejects REM in favor of FEM, ensuring control for time-invariant unobserved heterogeneity. Diagnostic tests are subsequently performed on the FEM. The Wooldridge test (Wooldridge, 2010) detects firstorder autocorrelation (Prob > F = 0.0000), and the modified Wald test (Greene, 2000) indicates groupwise heteroskedasticity (Prob > chi2 = 0.0000). Since both issues can reduce efficiency in standard FE estimation, we adopt Feasible Generalized Least Squares (FGLS) following Gujarati (2009). However, when performing the Wu and Hausman test (Wu, 1973; Hausman, 1978), we explore the endogeneity in the models.

Given that endogeneity poses a significant concern in this context arising from the lagged response of bank risk-taking to interest rate changes, macroeconomic conditions, and other bank-specific factors (Dang, 2020), as well as the endogenous nature of monetary policy itself (Delis &

Table 4. Regression results using SGMM

Items	Dependent variable (Z-score)					
L.Z-score	0.729***	0.792***	0.728***	0.789***	0.764***	0.793***
	(10.05)	(13.23)	(9.99)	(12.99)	(12.65)	(10.77)
Redis	−6.763***	−5.674**				
	(−2.71)	(−2.55)				
Refin · SIZE		1.952**				
		(2.06)				
Refin			−4.925***	−4.130**		
			(−2.72)	(−2.53)		
Refin · SIZE				1.466**		
				(2.02)		
Intbank					−4.660***	−2.880*
					(−3.20)	(−1.75)
Intbank · SIZE						1.716***
						(2.8)
SIZE	−0.0406**	−0.0653*	−0.0426**	−0.0674**	−0.0505***	−0.0817**
	(−2.30)	(−1.96)	(−2.37)	(−1.98)	(−2.74)	(−2.26)
CIR	−0.0836	−0.362	−0.0779	−0.386	−0.0857	−0.596*
	(−0.68)	(−0.93)	(−0.64)	(−0.99)	(−0.89)	(−1.66)
LAR	0.921***	0.862***	0.904***	0.868***	0.801***	1.001***
	(2.8)	(2.97)	(2.82)	(2.91)	(3.39)	(2.95)
LDR	−0.239	−0.197	−0.208	−0.197	−0.126	−0.214
	(−0.66)	(−1.21)	(−0.60)	(−1.20)	(−0.52)	(−1.21)
CAP	1.479	1.410**	1.431	1.385**	0.833	1.04
	(1.63)	(2.28)	(1.62)	(2.24)	(1.19)	(1.5)
CAR	0.075	−0.473	0.0634	−0.493	0.254	−0.323
	(0.09)	(−0.54)	(0.08)	(−0.56)	(0.29)	(−0.33)
NPLcover	0.00795	0.00871	0.0122	0.00833	0.0335	0.0225
	(0.28)	(0.34)	(0.43)	(0.32)	(1.6)	(0.97)
GDP	1.507**	1.675***	1.393**	1.613***	1.679***	1.610**
	(2.18)	(3.18)	(2.12)	(3.16)	(2.63)	(2.38)
INF	−2.310**	−0.683	−2.349**	−0.766	−2.694**	−1.036
	(−1.98)	(−0.58)	(−1.99)	(−0.63)	(−2.41)	(−0.71)
*AR*1	0.018	0.019	0.021	0.020	0.014	0.012
*AR*2	0.393	0.578	0.351	0.542	0.462	0.463
Hansen test	0.209	0.217	0.193	0.207	0.286	0.127
Number of instruments	20	22	20	22	20	22
Number of banks	24	24	24	24	24	24

Note: The table presents statistical significance at the 10%, 5%, and 1% one-, two-, and three-star levels, respectively. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

http://dx.doi.org/10.21511/imfi.23(3).2026.05

Kouretas, 2011; Chen et al., 2017) and considering the dynamic nature of the model (where lagged dependent variables are correlated with the error term), we employ the two-step system generalized method of moments (System GMM) as our preferred estimator (Arellano & Bover, 1995; Blundell & Bond, 1998). This approach effectively addresses simultaneity, dynamic endogeneity, and persistent unobserved heterogeneity.

All main regression results reported in the paper are therefore based on the System GMM (Table 4).

Table 4 presents the empirical results of the bank risk-taking measure using the Z-score. In models without a moderator, the interest rates, as denoted by Redis, Refin, and Intbank, have a significantly negative impact on the bank's Z-score. Higher Redis, Refin, and Intbank are associated with lower Z-scores, indicating the bank's risk-taking is higher. More details show that a 1% point increase in Redis, Refin, and Intbank is associated with a 6.763, 4.925, and 4.660 unit decrease in Z-score, respectively, or, in other words, a 6.763, 4.925, and 4.660 unit increase in the level of a bank's risk-taking. The study's findings align with Dang (2020) but contradict Chen et al. (2017). To clarify, Chen et al. (2017) posit a negative correlation between interest rates and bank risk-taking in emerging economies, consistent with the standard risk-taking channel (Borio & Zhu, 2012): expansionary monetary policy (lower interest rates) encourages banks to lend more aggressively with lax standards, thereby increasing default risk and lowering Z-scores.

In contrast, evidence from Dang (2020) and from our study, both examining Vietnam's banking industry, shows that increases in interest rates (i.e., contractionary monetary policy) tend to amplify banks' risk-taking, reflected in lower Z-scores. This outcome is the opposite of the risk-taking channel (Borio & Zhu, 2012), but aligns with the credit view of Bernanke and Gertler (1995), which suggests that higher interest rates raise borrowers' financing costs, increase the likelihood of default, and force banks to allocate more resources to loan-loss provisions. These provisions erode profitability and diminish equity buffers, weakening overall bank stability and encouraging greater risk-taking. This dynamic was especially evident in Vietnam in early 2011, when lofty interest rates triggered significant borrower distress, a surge in non-performing loans and a subsequent large-scale engagement by banks in "evergreening". Hence, in Vietnam, when rates are high, banks tend to take on additional risks not to boost returns, but to obscure problematic loans and prevent their non-performing loan ratios from breaching regulatory thresholds. Therefore, our findings support *Hypothesis 1: Interest rates are positively associated with bank risk-taking*, such that higher interest rates are linked to greater risk-taking in the Vietnamese context. Among the interest rate measures examined, the rediscount rate (Redis) has the strongest impact, followed by the refinancing (Refin) and interbank (Inter) rates.

In the meantime, Size has also been shown to correlate negatively with the bank's Z-score, suggesting that larger banks are associated with lower Z-scores and higher risk-taking. To clarify, a primary mechanism is revenue diversification. Driven by increasing competition and regulatory pressures, banks, particularly larger ones, shift from traditional interest income toward non-interest revenue streams (e.g., fees from investment banking, foreign exchange, bancassurance, and market-based activities). While diversification can offer scale economies and reduce risk in some contexts, empirical evidence shows it often fails to lower total risk for larger banks because of exposure to volatile non-interest activities, which are more sensitive to market fluctuations and economic cycles (De Nicoló, 2000; Stiroh, 2004). This, therefore, underpins *Hypothesis 2: Size is positively associated with bank risk-taking.*

Turning to the moderating effect of size, our empirical results reveal that size alleviates the adverse effect of the interest rates, encompassing all three interest rate indicators, on the bank's Z-score. In other words, this suggests that banks of different sizes respond differently to changes in interest rates, with the risk-taking behaviors of larger banks being less affected than those of smaller banks. To clarify, this finding is reflected in the Vietnamese banking context, where, during periods of high interest rates, small banks with more flexible organizational structures and closer information ties with borrowers are more inclined to engage in evergreening and less prone to withdrawing from risky borrowers. Moreover, larger banks tend to be more resilient than smaller ones, as they typically have diversified credit portfolios, advanced technology, and cheap funding sources, thanks to their extensive networks and well-established brands, enabling them to hedge and manage interest rate risk effectively. In contrast, smaller banks tend to rely more on traditional lending, making them more vulnerable to interest rate hikes. This thus underpins *Hypothesis 3: Size of banks moderates the effect of interest rates on bank risk-taking.*

Next, to calculate the conditional marginal effect of E_Index on bank performance at different levels of bank size, we note that because the interaction model employs mean-centered variables, the marginal effect is:

$$\partial Perf / \partial E\_Index = \beta 1 + \beta 3 \cdot SIZE\_c, \qquad (3)$$

where $SIZE\_c$ – SIZE – Mean denotes the mean-centered bank size. The marginal effect is evaluated at the 25th, 50th (median), and 75th percentiles of SIZE, as well as at the mean.

Table 5 shows that a 1 percentage point increase in interest rates is associated with negative changes in Z-scores across all sizes, but the magnitude of the effect increases with bank size (e.g., Redis: -7.22 at the 25th percentile to -3.96 at the 75th percentile). This indicates stronger stabilizing effects (higher Z-score gains or greater risk reduction) for larger banks, suggesting their risk-taking behavior is less sensitive to interest rate hikes. Evidence from Refin and Intbank comes to the same conclusion. For example, at the 25th value of Size, the effect of Refin on a bank's Z-score is –5.29, which further increases to –2.844 when Size rises to the 75th percentile.

Regarding bank determinant variables, the study identifies a consistently significant positive relationship between the loan-to-asset ratio (LAR) and the Z-score across all models. Meanwhile, with respect to macroeconomic factors, the empirical results reveal a significant positive relationship between GDP growth and the Z-score across all estimations, indicating that higher economic growth is associated with reduced bank risk-taking. This finding is consistent with those of Chen et al. (2017) and Djatche (2019), but contradicts Dang (2020). Our understanding is that robust economic growth stimulates local business activity, thereby enhancing firms' revenues and financial health, improving their repayment capacity and reducing default risk. From a banking perspective, increased business activity also translates into greater demand for credit and financial services, boosting bank performance and strengthening their Z-scores, ultimately reducing risk.

3.3. Robustness check

This section presents a robustness check to determine whether the above findings hold when an alternative variable is used to proxy for the bank's size. More specifically, the study replaces the bank's total assets with total loans and total deposits, as these constitute the largest shares of the bank's total assets and total liabilities, respectively.

Based on the results in Tables 6 and 7, we find that most of the study's main findings persist. All three interest rate indicators are significantly and negatively correlated with the Z-score. Meanwhile, total loans and total deposits, which represent the bank's size, are also shown to significantly correlate with the bank's Z-score and to moderate the nexus between the interest rates and bank risk-taking.

Table 5. Change in a bank's Z-score as a result of a one percentage point increase in interest rates

Size level	Redis (with Coef. –5.674)		Refin (with coef. –4.130)		Intbank (with coef. –2.880)	
	Size_c	Marginal effect on Z–score	Size_c	Marginal effect on Z–score	Size_c	Marginal effect on Z–score
Mean value	0	–5.674	0	–4.13	0	–2.88
25th percentile	–0.792	–7.22	–0.792	–5.291	–0.792	–4.239
50th percentile	–0.080	–5.830	–0.080	–4.247	–0.080	–3.017
75th percentile	0.877	–3.962	0.877	–2.844	0.877	–1.375

Note: Changes in banks' Z-score are calculated as (Level of Size ×α1)+α2 where α2 is a coefficient on the interest rate indicator, and α1 is the coefficient on the interaction term between size and the interest rate indicator.

http://dx.doi.org/10.21511/imfi.23(3).2026.05

Table 6. Robustness check using total loans to replace total assets

Items	Dependent variable (Z-score)					
L.Z–score	0.729***	0.789***	0.728***	0.788***	0.765***	0.775***
	(10.1)	(13.28)	(10.04)	(13.04)	(12.83)	(9.05)
Redis	−6.772***	−5.748***				
	(−2.70)	(−2.59)				
Redis · SIZE		1.666*				
		(1.82)				
Refin			−4.932***	−4.196***		
			(−2.71)	(−2.59)		
Refin · SIZE				1.346*		
				(1.94)		
Intbank					−4.664***	−3.335*
					(−3.20)	(−1.72)
Intbank · SIZE						0.974*
						(1.84)
SIZE	−0.0417**	−0.0663**	−0.0438**	−0.0683**	−0.0520***	−0.0951**
	(−2.33)	(−2.00)	(−2.40)	(−2.09)	(−2.74)	(−2.35)
CIR	−0.0876	−0.359	−0.082	−0.384	−0.0908	−0.684*
	(−0.71)	(−0.93)	(−0.66)	(−1.02)	(−0.92)	(−1.94)
LAR	0.997***	0.983***	0.984***	0.994***	0.897***	1.197***
	(3.05)	(3.07)	(3.06)	(3.05)	(3.55)	(3.04)
LDR	−0.239	−0.199	−0.208	−0.198	−0.126	−0.244
	(−0.66)	(−1.20)	(−0.60)	(−1.21)	(−0.52)	(−1.29)
CAP	1.477	1.427**	1.43	1.388**	0.835	0.826
	(1.63)	(2.32)	(1.62)	(2.3)	(1.2)	(1.2)
CAR	0.0601	−0.497	0.0468	−0.493	0.23	−0.186
	(0.08)	(−0.57)	(0.06)	(−0.56)	(0.26)	(−0.18)
NPLcover	0.00814	0.00839	0.0124	0.00873	0.0337	0.0258
	(0.28)	(0.32)	(0.44)	(0.33)	(1.61)	(0.96)
GDP	1.510**	1.694***	1.396**	1.634***	1.684***	1.753**
	(2.18)	(3.19)	(2.12)	(3.19)	(2.64)	(2.38)
INF	−2.300**	−0.691	−2.341**	−0.781	−2.686**	−0.723
	(−1.98)	(−0.58)	(−1.99)	(−0.65)	(−2.41)	(−0.48)
*AR*1	0.017	0.019	0.021	0.019	0.013	0.011
*AR*2	0.391	0.597	0.341	0.555	0.462	0.375
Hansen test	0.209	0.221	0.200	0.216	0.288	0.103
Number of instruments	20	22	20	22	20	22
Number of banks	24	24	24	24	24	24

Note: The table presents statistical significance at the 10%, 5%, and 1% one-, two-, and three-star levels, respectively. *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 7. Robustness check using total deposits to replace total assets

Items	Dependent variable (Z-score)					
L.Z–score	0.727***	0.788***	0.726***	0.787***	0.762***	0.774***
	(10.08)	(13.07)	(10.02)	(12.81)	(12.63)	(8.91)
Redis	−6.765***	−5.666**				
	(−2.73)	(−2.53)				
Redis · SIZE		1.723*				
		(1.85)				
Refin			−4.925***	−4.123**		
			(−2.73)	(−2.53)		
Refin · SIZE				1.380**		
				(1.98)		

Table 7 (cont.). Robustness check using total deposits to replace total assets

Items	Dependent variable (Z-score)					
Intbank					−4.738***	−3.263*
					(−3.10)	(−1.68)
Intbank · SIZE						0.999*
						(1.92)
SIZE	−0.0443***	−0.0664**	−0.0461***	−0.0686**	−0.0536***	−0.0956**
	(−2.66)	(−2.01)	(−2.71)	(−2.11)	(−2.96)	(−2.40)
CIR	−0.0929	−0.365	−0.0857	−0.391	−0.0938	−0.694**
	(−0.70)	(−0.94)	(−0.65)	(−1.03)	(−0.92)	(−1.99)
LAR	1.001***	0.986***	0.988***	0.997***	0.911***	1.197***
	(3.08)	(3.05)	(3.07)	(3.02)	(3.47)	(3.01)
LDR	−0.278	−0.274	−0.249	−0.275	−0.191	−0.347*
	(−0.79)	(−1.48)	(−0.74)	(−1.50)	(−0.73)	(−1.65)
CAP	1.49	1.430**	1.449	1.392**	0.906	0.82
	(1.64)	(2.32)	(1.62)	(2.3)	(1.28)	(1.21)
CAR	0.0279	−0.5	0.0136	−0.5	0.176	−0.174
	(0.03)	(−0.56)	(0.02)	(−0.56)	(0.2)	(−0.17)
NPLcover	0.00944	0.00823	0.0137	0.00849	0.0344	0.0254
	(0.33)	(0.31)	(0.48)	(0.32)	(1.63)	(0.94)
GDP	1.512**	1.679***	1.398**	1.616***	1.724**	1.738**
	(2.21)	(3.16)	(2.14)	(3.14)	(2.53)	(2.34)
INF	−2.301*	−0.646	−2.340*	−0.737	−2.683**	−0.689
	(−1.94)	(−0.53)	(−1.96)	(−0.61)	(−2.36)	(−0.45)
*AR*1	0.018	0.019	0.021	0.019	0.014	0.011
*AR*2	0.390	0.595	0.340	0.556	0.453	0.372
Hansen test	0.206	0.217	0.197	0.212	0.285	0.103
Number of instruments	20	22	20	22	20	22
Number of banks	24	24	24	24	24	24

Note: The table presents statistical significance at the 10%, 5%, and 1% one-, two-, and three-star levels, respectively. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

CONCLUSION AND IMPLICATION

In this paper, we primarily examine the nexus between interest rates and bank risk-taking, with a particular emphasis on how bank size moderates this relationship. Empirical results reveal that higher interest rates, especially the rediscount rate, significantly increase risk-taking among Vietnamese banks. Furthermore, larger banks take on greater baseline risk by heavily pursuing unstable non-interest revenue. Yet, bank size significantly moderates this effect, with larger banks showing much greater resilience and lower risk sensitivity compared to smaller ones. The results suggest that Vietnamese regulators should adjust their regulatory policies conservatively based on bank size, specifically by closely monitoring the non-interest income risks of large banks while helping smaller banks build resilience against interest rate shocks.

The primary theoretical contribution of this study lies in extending the traditional risk-taking channel theory by proving that higher, rather than lower, interest rates can increase bank risk in a transitional economy like Vietnam. Furthermore, our study contributes to the literature on firm characteristics by highlighting bank size and risk. While the conventional view suggests larger banks are safer, they carry higher underlying risk because they push heavily into non-interest activities. Methodologically, this study moves beyond the direct effects of bank size to examine its moderating role. Besides, using recent data from a frontier market allows us to observe exactly how these banks adapt to real-world macroeconomic shocks.

http://dx.doi.org/10.21511/imfi.23(3).2026.05

Translating these empirical findings into practice, our study outlines critical strategies for both internal bank governance and macroeconomic regulatory oversight. First, from a practical management perspective, considering the significant influence of bank size on bank risk-taking, institutions are encouraged to develop size-specific stress testing frameworks to evaluate how interest rate fluctuations might impact their risk profile; for instance, various funding scenarios beyond traditional deposit bases should be formulated to ensure that banks can absorb and operate safely under the fluctuation of interest rates. Second, regarding internal governance for larger banks, while they successfully buffer interest rate shocks, their management must carefully manage their expansion into non-interest activities to ensure that unstable revenue streams from these services do not threaten the bank's core financial health. Third, for smaller banks, executive management needs to enforce stricter internal controls over loan restructuring when interest rates increase. This is crucial to stop managers from using evergreening to hide rising bad debts. Fourth, given the significant impact of interest rates on bank risk-taking, policymakers must be mindful of the implications of any monetary policy measures. For example, an increase in interest rates through contractionary policy should be carefully considered, as it increases banks' risk-taking behaviors. Finally, to ensure system safety, regulators should introduce more effective macroprudential tools, such as the minimum capital adequacy ratio (CAR) or the liquidity coverage ratio, tailored to different bank sizes to enhance banks' resilience to interest rate shocks. This is particularly important for Vietnam's young banking sector, especially in the post-COVID era, when the local economy is expected to continue facing uncertainties and challenges.

While this study provides robust empirical evidence and novel insights into the risk-taking behaviors of Vietnamese banks, we acknowledge certain limitations that suggest directions for future research. First, the scope of this study is confined to Vietnam's specific transitional economy. Although this context offers valuable results for frontier markets, future research could expand this scope by conducting cross-country analyses across ASEAN or other emerging markets to validate the consistency of the size-risk relationship and interest rate impact. Second, regarding moderating mechanisms, our study primarily focuses on the role of bank size. The transmission of monetary policy shocks could also be shaped by other institutional characteristics. Thus, future studies are encouraged to investigate additional moderating variables, such as ownership structure, capital buffers, or the degree of digital transformation, to provide a more comprehensive picture of bank behaviors.

AUTHOR CONTRIBUTIONS

Conceptualization: Huy Lam Tan Ngo.
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Formal analysis: Huy Lam Tan Ngo, Linh Thuy Do Tran.
Investigation: Huy Lam Tan Ngo.
Validation: Huy Lam Tan Ngo.
Visualization: Linh Thuy Do Tran.
Writing – original draft: Huy Lam Tan Ngo, Linh Thuy Do Tran.
Writing – review & editing: Huy Lam Tan Ngo, Linh Thuy Do Tran.

ACKNOWLEDGMENT

The authors are thankful to the Internal Grant Agency of FaME TBU in Zlín, no. IGA/FaME/2026/016 for financial support to carry out this research.

DATA ACCESS STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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APPENDIX A

Table A1. List of banks

No.	Bank	Full Name	Type
1	ACB	Asia Commercial Joint Stock Bank	Private bank
2	Agribank	Vietnam Bank for Agriculture and Rural Development	State-owned bank
3	Bac A	Bac A Commercial Joint Stock Bank	Private bank
4	Ban Viet	Viet Capital Commercial Joint Stock Bank	Private bank
5	BIDV	Joint Stock Commercial Bank for Investment and Development of Vietnam	State-owned bank
6	Eximbank	Vietnam Export Import Commercial Joint Stock Bank	Private bank
7	HD Bank	Ho Chi Minh City Development Joint Stock Commercial Bank	Private bank
8	Kien Long	Kien Long Commercial Joint Stock Bank	Private bank
9	LP Bank	Fortune Vietnam Joint Stock Commercial Bank	Private bank
10	MB Bank	Military Commercial Joint Stock Bank	Private bank
11	MS Bank	Vietnam Maritime Commercial Joint Stock Bank	Private bank
12	Nam A	Nam A Commercial Joint Stock Bank	Private bank
13	OCB	Orient Commercial Joint Stock Bank	Private bank
14	Sacombank	Saigon Thuong Tin Commercial Joint Stock Bank	Private bank
15	SEA Bank	Southeast Asia Commercial Joint Stock Bank	Private bank
16	SHB	Saigon – Hanoi Commercial Joint Stock Bank	Private bank
17	Saigon Bank	Saigon Bank for Industry and Trade	Private bank
18	Techcom	Vietnam Technological and Commercial Joint Stock Bank	Private bank
19	TP Bank	Tien Phong Commercial Joint Stock Bank	Private bank
20	VCB	Joint Stock Commercial Bank for Foreign Trade of Vietnam	State-owned bank
21	VIB	Vietnam International Commercial Joint Stock Bank	Private bank
22	Vietinbank	Vietnam Joint Stock Commercial Bank for Industry and Trade	State-owned bank
23	VP Bank	Vietnam Prosperity Joint Stock Commercial Bank	Private bank
24	Viet A	Vietnam Asia Commercial Joint Stock Bank	Private bank