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Research article

The impacts of funding liquidity risk, liquidity risk and credit risk on risk-taking in banking: Evidence from an emerging market

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ABSTRACT

This study aims to investigate the impacts of funding liquidity risk, liquidity risk, and credit risk on risk-taking in banking by analyzing evidence from an emerging market. We utilize a sample of Vietnamese commercial banks for the 2010-2020 period to analyze these relationships. The fixed effects model and random effects model are used for panel data analysis in this study. Based on the Hausman test's result, the fixed effects model is preferred. We also test for the presence of the multicollinearity, heteroskedasticity and autocorrelation in the estimation of the model. The test results indicate that the multicollinearity is not an issue, but there is strong evidence for the presence of heteroskedasticity and autocorrelation problems in the research model. To overcome these problems and improve the estimation efficiency, we finally employ the fixed effects model incorporating Driscoll and Kraay standard errors. The final empirical results for the analysis are therefore based on this model. The results show that funding liquidity risk and credit risk have an impact on banks' risk-taking but in opposite directions. In particular, a significant and negative effect of funding liquidity risk on banks' risk-taking indicates that banks with lower funding liquidity risk are more likely to take greater risks, whereas credit risk has a substantial positive effect on banks' risk-taking, suggesting that an increase in credit risk leads to higher risk-taking activities of banks. Nevertheless, we do not find empirical statistical evidence to confirm the impact of liquidity risk on banks' risk-taking behavior in Vietnam. These results provide bank managers with more insights into the understanding of risk management in banks and offer several valuable implications for practitioners as well as policymakers.

Key words: Funding liquidity risk, Liquidity risk, Credit risk, Banks' risk-taking

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INTRODUCTION

Banks play an essential role in the financial system and country's economy. A healthy and solid banking system should promote economic activities and growth. In developing countries like Vietnam, along with the general trend of economic development, the banking industry is increasingly expanding in terms of scale and products, services and utilities for customers [1]. However, the expanded banking business is exposed to several risks such as credit risk, liquidity risk, operational risk, interest rate risk, etc. [2] The financial crisis of 2007–2009 has caught the attention of researchers and specialists to study about the importance of these factors to bank risk-taking. Among these, the risks that banks often face and can change the risk-taking behavior of banks are credit risk and liquidity risk because they are directly related to their operational activities [2].

Liquidity risk in banks is defined as the chance that banks are not able to perform their payment obligations when depositors unexpectedly withdraw their deposits [2,3]. It was found to be a major determinant to bank failures during and after the 2007–2009 financial crisis [4]. Moreover, funding liquidity risk refers to the possibility that banks fail to collect necessary amount of funds immediately [3]. It is a significant factor affecting banks' decisions to take risks which could negatively impact performance of the banking sector [5]. In addition, credit risk can be described as the potential that a bank borrower is incapable of repaying a loan, causing the risk of losing principal and interest, and moral hazard, and it could damage the stability of commercial banks [6].

These risks have led to some regulatory reforms on bank risk management. In 2010, the Basel Committee issued Basel III rules text, which demonstrated new liquidity standards. In addition, recently, credit risk management has also been a focus of Basel Committee, because bad credit risk management can diminish bank performance, reduce asset quality and raise non-performing loan and loan losses which contribute to financial distress [7]. However, despite the great attention from the Basel Committee and the wide theoretical suggestion about the management of liquidity,

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funding liquidity and credit risk, limited research has been conducted to give consistent conclusions [8].

There has been some research made globally about the connection between the three types of risks and overall bank risk-taking. Wagner [9] suggested that liquidity risk and banks' risk taking has an inverse relationship. The author found that higher asset liquidity encourages banks to engage in more risk-taking behaviors and thus bank instability increases. As higher liquidity yields lower risk by assisting the progress of assets liquidation in crisis situations, it reduces the severity of crises. Thus, banks can underrate the risk and take new risky actions. Similarly, funding liquidity risk has been shown to have negative influence on risk-taking. Acharya and Naqvi [10] found that funding liquidity risk has a negative impact on insolvency risk (a risk-taking measurement). This is explained as the higher deposits (a proxy for lower funding liquidity risk) help banks feel safe from bank run, so they have more confidence to take the risk of aggressive lending [5,11]. Dahir et al. [3] also confirmed that both funding liquidity risk and liquidity risk adversely affect risk-taking in the banking sector. These results are considered conflicting to the Basel III Accord's motivation to control risk of funding liquidity and liquidity [11]. Meanwhile, for credit risk, it has been suggested to have positive effect on bank risk-taking. Imbierowicz and Rauch [8] have discovered that credit risk increases banks' probability of default; Saleh and Afifa [12] witnessed that banks with higher level of risk-taking behavior tend to have greater amount of non-performing loans, diminishing bank stability. This is consistent with the incentive to lower credit risk by the authority.

Given the debatable conclusions, the objectives of the research are to investigate the impacts of funding liquidity risk, liquidity risk, and credit risk on Vietnamese banks' risk-taking. This research is expected contribute to the existing literature in several ways. First, most research in Vietnam has focused on one risk at a time, for example My [13] studied about the effect of credit risk alone, or Ha & Phan [14] and Vo [15] particularly concentrated on funding liquidity risk. To the best of our knowledge, there is no prior attempt to examine the combined effects of all three mentioned risks on bank risk-taking in Vietnam. When analyzing the effects of multiple types of risks together, the levels of importance of each risk will be shown. Therefore, the study can provide insights into risk-taking behaviors of banks which cannot be clarified if only one risk is examined, and help bank managers focus on specific risks that have strong impact on the risk level taken by banks. Further, the incentive of exploring the relationships in Vietnam is that the country is in economic transition, and by using the new dataset, emerging economies will be further studied while developed countries have already been the main focus [3]. While banking industry in developed countries like the US and other European countries is at mature level, Vietnamese banking system's nature is different. There is severe competition among banks having small market shares whereas few top government-owned banks dominate the market. Further, the competition is not only among local banks but also with foreign-owned banks with aggressive expansion into Vietnamese market. In such competitive environment, the importance of bank risk management is emphasized. Appropriate risk management strategies and policies can help banks maintain good financial health and gain competitive advantages [15]. Thus, our empirical analysis of Vietnamese banks is expected to provide additional empirical evidence on the relationships between the three specific risks and bank risk-taking in developing countries as well as provide implications to help risk decision-making of bank managers and policy-making of the authority.

The rest of the article is structured as follows. First, the relevant literature is summarized, and the three main hypotheses are developed in Section 2. Section 3 contains methodology and data. Section 4 presents results and discussions. Finally, section 5 draws conclusion and implications.

LITERATURE REVIEW

Funding liquidity risk and banks' risk-taking

Funding liquidity refers to the ease with which banks can acquire funds, and funding liquidity risk is described as the banks' inability to raise funds immediately [3]. While banks acquire funding liquidity from several sources, funding liquidity risk is believed to be mainly related to deposits [3,14], as when there is a recession, depositors may pull out their deposits in an attempt to protect their investment [16]. Conventional banks produce illiquid loans that are backed by liquid deposits, creating funding liquidity on the right side of balance sheet [17]. Thus, funding liquidity risk arises from the liability side and is widely measured as the ratio of total deposits to total assets [3,5,10], in which when the deposit ratio is higher, bank will have less funding liquidity risk. Funding liquidity risk is believed to be a crucial determinant to bank risk-taking [5]. Banks' risk-taking is the banks' will to take risks in making organizational decisions. High risk-taking can lead to the bank being insolvent [18].

After the Global Financial Crisis and the issue of Basel III Accord in 2010, studies on the relation between funding liquidity risk and banks' risk-taking have been conducted at different regions. The popular school of thought is that funding liquidity risk adversely influences risk-taking. When examining the effects of the Basel III liquidity requirements for banks in 15 countries, King [19] argued that in order to raise funding liquidity, banks need to borrow more expensive long-term funds because of higher interest rates, thus lowering banks' profitability. Further, Acharya and Naqvi [10] also suggested that higher funding liquidity induces risk-taking behavior of banks. They reasoned that if banks have sufficient level of customer deposits, funding liquidity risk will be lower, so bank managers will misidentify risk and will be aggressively involved in risky behaviors, raising the amount of loan by lowering loan interest rate, and increasing asset price bubbles.

Collaborating with the prediction of Acharya and Naqvi [10], Khan et al. [5] using a dataset of US banks over the period of 1986–2014 concluded that banks with a higher deposit ratio, or a lower funding liquidity risk, take more risk – illustrated by greater liquidity creation, higher risk-weighted assets and weaker bank stability. While deposits can protect banks from operational risks, higher amount of funds encourage banks to be riskier by overlending, which is at the cost of deposit insurance. They believed funding liquidity risk is a critical determinant in analyzing risk-taking behavior of banks which adversely influences their stability. Furthermore, when examining 57 banks in BRICS countries over the period from 2006 to 2015, Dahir et al. [3] found a negative association between funding liquidity risk and bank risk-taking. Smaoui et al. [11] using the bank-level data in 18 Islamic countries over the period 2004-2016 also obtained the same results. Given the above discussion, it is logical for this hypothesis to be developed:

H1. Funding liquidity risk has a negative effect on banks' risk-taking.

Liquidity risk and banks' risk-taking

According to Basel Committee on Banking Supervision (2009), liquidity is banks' ability to meet the needs of using available capital for business activities at any time such as payment of customers' cash requirements and supply advance types of financial loans. Conversely, liquidity risk is the banks' inability to meet obligations at all times, or, the inability to finance cash on a regular basis [3]. This is different to funding liquidity risk as funding liquidity risk relates to the inability to raise funds.

Vodova [20] argued that when banks have liquidity shortage, there can be solvency crisis because of the significant loss of value resulting from converting illiquid assets into liquid assets on short notice. On the other hand, despite the emphasis on the importance of liquidity, Basel Committee on Banking Supervisions (2000) stated that over dependence on the securitization and assets sale in order to increase liquidity creates doubts about the true capability of a bank to match cashflows obtained from sale of assets with funding need. In addition, holding a large amount of liquid assets bears associated costs [21]. Holding too much funds may negatively affect profitability due to the low returns of liquid assets [22]. This aligns with the trade-off theory implying that objectives of liquidity and profitability cannot be accomplished together. There is opportunity cost for a bank either choosing to be liquid or profitable, and banks want to be profitable cannot be liquid or vice versa [23]. Thus, if a bank desires to maximize profit but is forced to hold high level of liquidity, it may try to take part in risky projects to offset the opportunity cost resulting from liquidity requirements. The authors suggested that there should be effective management practices that balance liquidity and profitability by ensuring that banks do not suffer excessive or insufficient level of liquidity as the two diminish banks' stability.

Nevertheless, the empirical literature about the impact of liquidity risk on banks' risk-taking lacks consensus. Several studies in developed economies have reported that the percentage of loans to total assets (a proxy of liquidity risk) is positively associated with bank issues, rising bad debt and risk of insolvency as a consequence of long-term bank mismanagement [24]. Investigating five EU member states, Festic et al. [25] found that loan growth can negatively affect banking performance and non-performing loan dynamics, because of the overheating of these economies at that time. However, the context of developing countries is different to developed countries. Studying BRICS countries, Dahir et al. [3] observed that lower loan-to-asset ratio leads to higher risk of insolvency. When a relatively large bank channels too low level of loan into the public compared to its size, it means that its involvement in market activities is low. This can cause the bank to make more risky decisions since it needs enough interests from loans to create profitability for its large size, or when there are too much bank activities in market, it may cease to further take any new risky action. Profitability has been found to increase as the proportion of loans to asset increases because higher loan means more interest revenue [26].

Because profitability and stability are interdependent, bank stability should rise too [3].

Based on the paper of Dahir et al. [3] in emerging economies which are similar to Vietnamese context, the following hypothesis is formed:

H2. Liquidity risk has a negative effect on banks' risk-taking.

Credit risk and banks' risk-taking

Credit risk is described as the risk that a bank loan will not be returned in full or in part on maturity [27]. It is considered as the most critical risk that banks face and if it is not handled appropriately, banks are at great risk of bankruptcy [28]. Internally, for the majority of banks, loans are the most common and obvious source of credit risk [29], in which the direct impact of non-performing loans is one of the primary causes of bank failure [12].

Non-performing loan is the amount of bad debt that cannot be collected. Borio et al. [30] showed that during recession, non-performing loan rises as a result of financial distress of enterprises and households. When the economy grows, companies demand more loans and are able to repay them easily, but as the economy is in bad conditions, they face higher difficulty in repaying debts. Ozili [31] argued that credit risk reflects the quality of bank loan portfolios, and when lending quality is not good, there would be more non-performing loans and greater loan loss provisions, consequently leading to lower bank profitability and putting the bank in risky position in terms of solvency.

Credit risk, proxied by non-performing loan ratio, is often discussed through the view of agency theory [18,32]. The agent works for the principal, but if there is a conflict of interest between them, their initial objective when the relationship forms may not be accomplished [33]. From the agency theory, the conflict of interest may occur in the case of banks' lending with bad credit [32]. The first moral hazard problem is managerial compensation-seeking, which is the conflict between the bank manager (the agent) and the shareholders (the principal). To increase their compensation, the bank manager can increase loan to customers for the purpose of gaining better compensation, by investing in pet projects, loosening lending requirements, or through poor supervising of loan, leading to higher non-performing loan [18,32]. The second one is the conflict between the group of bank shareholders and bank managers (the agent) and depositors (or creditor, the principal). Shareholders, through their managers, may want to make riskier loans than the depositors expected, because ultimately the risk will be on the creditors [32]. If the risky project is successful, all of the benefits will go to the stockholders, because creditors' interest revenue is fixed at the low-risk rate. However, if the project is unsuccessful, the creditor will have to share in the losses. In addition, adverse selection could generate the increasing of non-performing loan. Managers and shareholders misidentify credible borrowers, which leads to banks having more bad credit instead of return [18].

Aligning with the above perspective, credit risk, or non-performing loan, has been found to have positive effect on bank risk-taking. Examining international and national banks in Nigeria, Atoi [34] confirmed the moral hazard hypothesis is supported, meaning higher non-performing loan ratio increases risky lending, diminishes loan quality and damages financial stability. Aggarwal and Jacques [35], while studying the impacts of Federal Deposit Insurance Corporation Improvement Act capital requirements on U.S. banks' risk, argued that the decrease in asset quality is equivalent to a higher degree of risk, meaning credit risk is positively associated with default risk. In Asian countries, the positive relationship between non-performing loan and banks' risk-taking has been confirmed by studies of Yuwonoputro and Syaichu [18] in Indonesia; and Zhang et al. [32] in China. The following hypothesis is established based on the above argument:

H3. Credit risk has a positive effect on banks' risk-taking.

METHODOLOGY AND DATA

Empirical model

To test the three hypotheses of this study, we employ the following model:

$$RISK_{i,t} = \beta_0 + \beta_1 FLR_{i,t} + \beta_2 LR_{i,t} + \beta_3 CR_{i,t} + \phi X_{i,t} + \sum_{k=1}^{4} \gamma_k Control_{i,t} + \varepsilon_{i,t} \quad (1)$$

Where subscripts i denotes the individual bank, t denotes the time, and ε_{it} is the error term. *RISK* is the dependent variable of the model and represents the overall banks' risk-taking. FLR is banks' funding liquidity risk, LR is banks' liquidity risk, and CR is banks' credit risk. $X_{i,t}$ represents a set of control variables which capture bank-specific and country-specific effects, including banks' size (SIZE), leverage (LEV), efficiency (EFF), inflation rate (INF), and real GDP growth rate (GDP).

We use the Z-score to measure a bank's probability of insolvency, which is extensively employed in

the empirical banking literature[3,36]. The Z-score is computed as follows: Z-score = (ROA+EA)/ (ROA), where ROA is returns on asset, EA = Equity/Total assets, and (ROA) is standard deviation of ROA. A high value of Z-score characterizes the low probability of a bank's financial distress, indicating the low-level bank failure and insolvency risk. Thus, a higher Z-score implies higher bank stability and thus lower bank risk-taking, and vice versa. Because the Z-score is heavily skewed, we take its natural logarithm form as a construct of overall bank risk[36]. In addition, to make the interpretation of the signs of coefficients comparable, following a similar approach as in study of Mihet[37], we use an inverse form of Z-score natural logarithm and from now on denote this measure as the "Z-index". Hence, a rise in the Z-index indicates the greater probability of bank default.

Regarding the main explanatory variables of interest, following the previous studies, we employ different measures for different types of risks. First, as a proxy for funding liquidity risk, we use the total deposits to total assets ratio[3,14]. This proxy is an inverse measure of funding liquidity risk that relates to the inability of bank to raise funds. Thus, a higher value of this ratio corresponds to a lower funding liquidity risk. Unlike funding liquidity risk, the liquidity risk relates to the banks' inability to efficiently meet short-term financial obligations without incurring major losses and is measured by loans-to-assets ratio[13,20]. This ratio represents what proportion of the bank's assets is tied up in loans that are illiquid assets. The greater this ratio, the less liquid the bank is and therefore the higher the liquidity risk. The last one is credit risk which is defined as the possibility of a bank borrower or counterparty failing to meet the repayment obligations and is captured by the ratio of non-performing loans (NPL) to total loans[3,21,38]. This measure provides information on the quality of a bank's loan portfolio. A greater value of this ratio implies the higher level of credit risk.

In line with the previous literature, we also consider control variables that can affect bank risk-taking. To control for bank-specific effects such as bank leverage, we include the ratio of total debts to total assets into the model (as for example in[13]). We also control for the size and efficiency of the banks. Bank's size is calculated as the natural logarithm of the bank's total assets[2,3], and the bank efficiency ratio is measured by operating expenses divided by total income[2,13], a measure of a bank's ability to turn its expenses into revenue. The lower this ratio, the more operationally efficient the bank will be. Finally, in order to control for country-specific effects, we also incorporate the real GDP growth rate (GDP) as well as the inflation rate (INF) into the model (as in[2,3]). Details on measurement of the variables are summarized in Table 1.

Research data and estimation method

To shed light on the impact of funding liquidity risk, liquidity risk, and credit risk on banks' risk-taking behaviors, we use a dataset of Vietnamese commercial banks for the period 2010–2020. Data are extracted from published audited financial statements of banks, which were validated by external auditors. The sample excludes banks with five-year intermittent data. The final sample includes 31 commercial banks (both listed and unlisted), which form a panel data of 320 bank-year observations. Meanwhile, the macroeconomic data (GDP, INF) are collected from the World Development Indicators.

Consistent with the existing literature, we use fixed (FEM) and random effects models (REM) for panel data analysis. The FEM allows for heterogeneity or individuality among banks by letting each bank have its own (fixed) intercept value, while REM assumes that the intercepts of individual banks are randomly distributed. To determine the most appropriate regression model, we apply the well-known Hausman test. In addition, we also test for the presence of the multicollinearity, heteroskedasticity and autocorrelation by using VIF (variance inflation factor), modified Wald and Wooldridge tests respectively. If there is the presence of heteroscedasticity and/or autocorrelation problems in the preferred model, the method of Driscoll-Kraay[39] will be used for correcting standard errors to generate consistent parameter estimates.

RESULTS AND DISCUSSIONS

Descriptive statistics and correlation matrix

Table 2 reports summary statistics for the variables employed in this research. The results indicate that the average score of Z-index is 0.318 with standard deviation 0.058, ranging from a low of 0.153 to a high of 0.479. Funding liquidity risk, liquidity risk and credit risk are the main explanatory variables. The funding liquidity risk has an average value of 64.6%, and ranges from 29.2% to 89.3% with standard deviation 0.125. The range of liquidity risk is from 0.191 and 0.788, with an average value of 0.548 and a standard deviation of 0.123, meaning that Vietnamese commercial banks used about 54.8% of their assets dedicated to lending activities. Finally, the mean value of credit risk (NPL ratio) in the sample is 2.2% with standard deviation 1.4%, ranging from 0.01% to 11.4%. This implies that many Vietnamese banks are still

Table 1: Definition of Variables

Variable	Measure
Dependent variable (RISK):	
Insolvency Risk (Z-index)	The inverse of natural logarithm of the Z-score, with Z-score = (ROA + EA)/ (ROA)
Explanatory variables:	
Funding liquidity risk (FLR)	Total deposits/Total assets
Liquidity risk (LR)	Total loans/Total assets
Credit risk (CR)	Non-performing loans (NPL)/Total loans
Bank Size (SIZE)	The natural logarithm of total assets
Leverage (LEV)	Total debts/Total assets
Efficiency (EFF)	Operating expenses/Total income
GDP growth rate (GDP)	Real annual GDP growth rate
Inflation rate (INF)	CPI annual inflation rate

Table 2: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Z-index	320	0.318	0.058	0.153	0.479
FLR	320	0.646	0.125	0.292	0.893
LR	320	0.548	0.123	0.191	0.788
CR	320	0.022	0.014	0.0001	0.114
SIZE	320	18.469	1.126	15.923	21.140
LEV	320	0.907	0.041	0.745	0.974
EFF	320	0.543	0.148	0.225	1.115
GDP	320	0.060	0.011	0.029	0.071
INF	320	0.057	0.047	0.006	0.187

Table 3: Correlation matrix and VIF

Variables	Z-index	FLR	LR	CR	SIZE	LEV	EFF	GDP	INF	VIF
Z-index	1.000									1.07
FLR	0.113*	1.000								2.25
LR	0.127*	0.583*	1.000							1.81
CR	-0.082	-0.114*	-0.125*	1.000						1.19
SIZE	0.079	0.316*	0.283*	-0.262*	1.000					2.60
LEV	0.157*	0.283*	0.069	-0.241*	0.657*	1.000				2.34
EFF	-0.087	0.214*	-0.162*	0.185*	-0.262*	0.123*	1.000			1.70
GDP	0.032	-0.049	-0.005	-0.087	-0.058	0.056	0.006	1.000		1.04
INF	-0.104*	-0.548*	-0.341*	0.236*	-0.245*	-0.263*	-0.222*	-0.048	1.000	1.59

* Shows significance at the 0.1 level

faced with high levels of NPL ratio which exceed the 3% threshold set by the State Bank of Vietnam.

Table 3 reports the correlation matrix and VIF for all variables of interest. In particular, we note that funding liquidity risk and liquidity risk are significantly associated with banks' risk-taking (measured by Z-index), but the association between credit risk and banks' risk-taking is small (-0.082) and insignificant. The results also show that all correlation coefficients are less than 0.80. Furthermore, the maximum VIF score is 2.60 (for Size variable) which is less than a popular VIF threshold of 10. Therefore, the problem of potential multicollinearity among the predictors in our model is modest and should not be a concern.

Results and discussions

Table 4 presents the findings of the relationship between explanatory variables and banks' risk-taking, using the panel data estimation methods. Based on the Hausman test's result, the FEM is preferred in this study. Moreover, the Modified Wald test result with p-value of less than 1% indicates the presence of heteroskedasticity in the model. Similarly, the Woodridge test value is 109.3 with p-value of less than 1%, suggesting the presence of autocorrelation problem in the error term of the model. To overcome these problems and improve the estimation efficiency, we employ the FEM incorporating Driscoll and Kraay standard errors. The final results for the analysis are therefore based on this model.

The results show that the relationship between funding liquidity risk (i.e., deposit ratio, an inverse measure of funding liquidity risk) and Z-index is positive at the 5% significance level (beta of 0.0126), indicating that the higher risk-taking is driven by lower funding liquidity risk. Thus, hypothesis H1 is supported. This finding is in line with the discussed foreign studies such as [3,5,11], in which banks with less funding liquidity risk have more motives to invest in high-risk assets, and supports the bank theory of loan established by Acharya and Naqvi [10] suggesting that excessive deposits make bank executives overconfident, lower loan standards, increase risky loans, and create a threat for the banks' potential crisis. This theory also builds on an assumption that larger deposits protect banks from run risk. This result is believed to be appropriate in Vietnamese context. Since several cases of banks suffer from severe shortage of funding liquidity, the banking industry restructuring measures and new requirements have been gradually implemented more strictly, thereby the amount of funds coming from customer deposits of banks in Vietnam has been raised [40]. However, the redundancy of these funds can also be a problem. The more funds are held, the more likely banks are to respond well to funding liquidity risk; nevertheless, an excessive amount of funds without being invested will have an adverse impact on banks' profitability. Thus, in order to utilize the high level of funds to enhance profitability, bank managers can decide to lend more risky loan which in turn diminishes banks' stability.

Regarding the relation between liquidity risk and banks' risk-taking, the negative coefficient (beta of -0.004) reveals that a bank with low liquidity risk seems to be associated with more risk-taking behaviors, which is consistent with our expectation. However, this result is statistically insignificant, thereby rejecting our hypothesis H2. In other words, we cannot make any conclusion about the effect of the liquidity risk on banks' risk-taking activities with the data in the study period. This finding is consistent with prior studies in other developing countries (see [41,42]). The insignificant impact is also consistent with the empirical study of the South Asian commercial banks by Nisar et al. [43], which showed insignificant relation between liquidity risk and banks' risk-taking (or bank stability) in eight South Asian countries.

In terms of credit risk, it is found to have positive effect to bank risk-taking at the significance of 5% (beta of 0.0599). This result confirms hypothesis H3, and it is consistent with the results of prior studies (see [18,32,34,35]). It also further confirms the view of agency theory that a rise in non-performing loan ratio raises riskier lending, thus resulting in a worsening of credit quality and financial system instability [18,32,34]. Compared to the two types of liquidity risk, credit risk has contributed the most to the overall bank risk-taking in Vietnam, which contradicts with the results of Ghenimi et al. [2] who found that the effect of liquidity risk is much stronger than that of credit risk on banks' stability in MENA region. In Vietnam, the current legislative and regulatory framework about credit, although has been improved, but is still incomplete and sometimes confusing; risk management system is still limited; and dealing with non-performing loan is still problematic [38]. The risk of bad credit can come from several sources, such as credit policy, complicated processes of handling bad credit, internal systems such as fraud and profiteering activities from bank executives, or external actors like deceptive behaviors from borrowers [38]. Since the global financial crisis, bad debt has indeed become a central problem in the Vietnamese banking system due to the aggressive credit growth and information asymmetries [44]. Although non-performing loan ratio has

Table 4: Regression results

	Dependent variable: Z-index		
	REM	FEM	FEM (Driscoll-Kraay)
FLR	0.0121*	0.0126**	0.0126**
	(1.92)	(2.09)	(2.98)
LR	-0.00221	-0.00417	-0.00417
	(-0.35)	(-0.67)	(-0.77)
CR	0.0575*	0.0599*	0.0599**
	(1.65)	(1.80)	(2.82)
SIZE	-0.00142	-0.00077	-0.00077
	(-1.10)	(-0.59)	(-0.48)
LEV	0.373***	0.374***	0.374***
	(19.84)	(20.67)	(7.46)
EFF	0.0150***	0.0165***	0.0165**
	(3.33)	(3.81)	(2.98)
GDP	0.00723	0.0109	0.0109
	(0.20)	(0.31)	(0.30)
INF	0.0224*	0.0259**	0.0259**
	(1.70)	(2.03)	(2.78)
Constant	-0.285***	-0.298***	-0.298***
	(-13.74)	(-14.63)	(-11.44)
	320	320	320
Hausman ($\chi 2$)		34.63***	
Modified Wald		5928.80***	
Wooldridge		109.304***	

*** p<0.01, ** p<0.05, * p<0.1

decreased thanks to the efforts of State Bank of Vietnam in NPL resolution through the establishment of the Vietnam Asset Management Company, the scale of non-performing loan has not changed much and many banks are still struggling under the burden of bad debts [13,44]. Therefore, a rising level of bad debts or non-performing loans results in higher loan loss provisions, eroding the profitability as well as stability of banks in Vietnam.

With respect to the effect of control variables, bank size has no significant effect on banks' risk-taking, which is similar to the results of other studies (see [13,38,41]). Macroeconomic variable GDP growth rate also shows an insignificant influence on dependent variable, conforming to the results of Dahir et al. [3] and Nisar et al. [43]. However, positive and significant coefficient of inflation rate supports the typical view that increasing inflation can lead to higher banks' risk-taking as well as lower profitability of businesses, especially when the ascent of inflation is not expected and incorporated in prices [43]. This is also consistent with the work of Mahat and Dahir [42]. Additionally, efficiency has a positive impact on banks' risk-taking, suggesting that banks with low cost efficiency are more exposed to risks [15]. Finally, positive influence of leverage on bank risk confirms the wide perception that banks with higher leverages are exposed to greater risk of bankruptcy.

CONCLUSION AND IMPLICATIONS

This study aims to explore the relationships among funding liquidity risk, liquidity risk, credit risk and

banks' risk-taking using a sample of 31 commercial banks in Vietnam for the period 2010-2020. Based on the testing results, we finally employ the FEM with Driscoll and Kraay standard errors to account for the problems of heteroskedastic and autocorrelation. The results indicate that the influence of liquidity risk on banks' risk-taking is relatively limited (beta of -0.004) and insignificant. However, the negative impact of funding liquidity risk on banks' risk-taking is statistically significant at 5% level, implying that banks facing less funding liquidity risk are more likely to take greater risks. The results also reveal that the banks' risk-taking has a positive association with credit risk, suggesting that the increase in credit risk translates into higher probability of bank default risk. These findings are congruent with the existing literature in showing the importance of funding liquidity risk, liquidity risk and credit risk in understanding of banks' risk-taking behaviors, especially in the context of emerging economies like Vietnam.

The findings of this study provide some implications and some rooms for future research. First, from the negative relation between funding liquidity risk and banks' risk-taking, it is recommended that banks should avoid excessive increase of deposits to maintain stability. Since funding liquidity has a strong impact on the insolvency risk of Vietnamese banks, banks need to maintain reasonable amount of funding liquidity in case of sudden capital needs, but concurrently high funding liquidity will adversely affect the overall stability as it might induce bank executives to take on more risk. Moreover, to create funding liquidity, banks should consider raising funds from different sources rather than deposits only. In addition, risk-taking behaviors of bank managers should be controlled when the deposits change. Although when there is low risk of funding liquidity, the capital should not be used recklessly. Banking regulatory framework should be carefully reviewed to ensure discipline and appropriately control growth of deposit ratio. Second, because of the positive impact of credit risk to bank risk-taking, banks should put more emphasis on regulating the credit release and management to lower non-performing loan ratio. Credit risk prevention should be raised, better monitoring processes for loans should be implied, and reviewing loan quality after disbursing should be emphasized. Further, regulators should consider non-performing loan ratio as an effective indicator for identifying potential moral hazard problems in banks and establishing transparent policy goals, to monitor banks closely to avoid profiteering activities from banks' loan officers. However, banks can increase lending with caution, as long as they are able to keep the non-performing loan low and improve loan quality. Third, for the inconclusive result of the linear impact of liquidity risk on banks' risk-taking, there may be curvilinear relationship between liquidity risk and banks' risk-taking, meaning there may be a threshold in the relationship. Therefore, further research is required.

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LIST OF ABBREVIATIONS

REM: Random effects model
FEM: Fixed effects model
NPL: Non-performing loans
BRICS: Brazil, Russia, India, China and South Africa
VIF: Variance inflation factor

CONFLICT OF INTEREST DECLARATION

The authors have declared that no competing interests exist.

AUTHOR CONTRIBUTION

Pham Tien Minh conceived, designed the research, and analyzed the data;
Truong Bao Thach contributed to the literature review, discussions and implications;
Bui Huy Hai Bich collected and processed the data and contributed with the methodology;
Pham Tien Minh, Truong Bao Thach and Bui Huy Hai Bich wrote the paper.

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Bài nghiên cứu

Tác động của rủi ro thanh khoản vốn, rủi ro thanh khoản và rủi ro tín dụng đến mức độ chấp nhận rủi ro trong ngân hàng: minh chứng từ một thị trường mới nổi

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TÓM TẮT

Nghiên cứu này nhằm mục đích kiểm tra các tác động của rủi ro thanh khoản vốn, rủi ro thanh khoản, và rủi ro tín dụng đến mức độ chấp nhận rủi ro trong ngân hàng thông qua phân tích các minh chứng từ một thị trường mới nổi. Chúng tôi sử dụng mẫu nghiên cứu là các ngân hàng thương mại Việt Nam trong giai đoạn 2010-2020 để phân tích các mối quan hệ này. Mô hình tác động cố định và mô hình tác động ngẫu nhiên được sử dụng để phân tích dữ liệu bảng trong nghiên cứu này. Dựa trên kết quả của kiểm định Hausman, mô hình tác động cố định được ưu tiên chọn. Chúng tôi cũng kiểm tra sự hiện diện của đa cộng tuyến, phương sai thay đổi và tự tương quan trong ước lượng mô hình. Kết quả kiểm định chỉ ra rằng đa cộng tuyến không phải là vấn đề, nhưng có bằng chứng chắc chắn về sự hiện diện của các vấn đề phương sai thay đổi và tự tương quan trong mô hình nghiên cứu. Để khắc phục những vấn đề này và nâng cao hiệu quả ước lượng, cuối cùng chúng tôi sử dụng mô hình tác động cố định kết hợp với sai số chuẩn của Driscoll và Kraay. Do đó, kết quả thực nghiệm cuối cùng cho phân tích được dựa trên mô hình này. Kết quả cho thấy rủi ro thanh khoản vốn và rủi ro tín dụng có tác động đến mức độ chấp nhận rủi ro của ngân hàng, nhưng theo các hướng trái ngược nhau. Cụ thể, tác động âm và có ý nghĩa của rủi ro thanh khoản vốn cho thấy các ngân hàng có rủi ro thanh khoản vốn thấp có nhiều khả năng để chấp nhận rủi ro cao hơn, trong khi rủi ro tín dụng có tác động dương lớn đến việc chấp nhận rủi ro của ngân hàng, cho thấy sự gia tăng rủi ro tín dụng dẫn đến các hoạt động chấp nhận rủi ro cao hơn của các ngân hàng. Tuy nhiên, chúng tôi không tìm thấy bằng chứng thống kê thực nghiệm để khẳng định tác động của rủi ro thanh khoản đến hành vi chấp nhận rủi ro của các ngân hàng tại Việt Nam. Những kết quả này cung cấp cho các nhà quản lý ngân hàng những hiểu biết sâu sắc hơn về quản trị rủi ro trong ngân hàng, và đưa ra một số hàm ý giá trị cho các nhà thực hành cũng như các nhà hoạch định chính sách.

Từ khoá: Rủi ro thanh khoản vốn, Rủi ro thanh khoản, Rủi ro tín dụng, Mức độ chấp nhận rủi ro của ngân hàng

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