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MONETARY POLICY, BANK COMPETITIVENESS AND BANK RISK-TAKING: EMPIRICAL EVIDENCE FROM VIETNAM

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ABSTRACT

This study assesses the impact(s) of monetary policy and further influence of competitiveness on bank risk-taking of the Vietnamese commercial banks over the period of 2007–2016, an unstable period of the domestic monetary policy. The monetary policy is captured by a set of different variables including money supply, refinancing interest rate and treasury bill interest rate. Using the GMM methodology, the study finds that the monetary policy of Vietnam has a significant impact on bank risk-taking level, as measured by Z-score index. The empirical findings also indicate that bank risk-taking increases in the context of a loose monetary policy. In addition, the competitiveness of banks, presented by the Lerner index, is found as a determinant of bank risk-taking levels. By using interacting variables, the findings indicate that the impact of the competitiveness of banks outweighs that of monetary policy on bank risk-taking behaviour. It implies that the banks with high market power demonstrate less risk-taking behaviour even in a loose monetary policy environment. Besides that, liquidity, credit level and cost inefficiency could increase risk-taking behaviour of banks while bank size poses restrictions on bank risk-taking.

Keywords: bank, risk-taking, monetary policy, competitiveness, GMM, Vietnam

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INTRODUCTION

The stability of the banking sector plays an important role in ensuring that the country's economic goals are met, especially in developing countries. Therefore, the government generally steps in to consolidate the stability and improve the efficiency of the banking system through policies, in particular monetary policy. Similar to other developing countries, Vietnam has its banking sector working as the backbone of its economic system. Nevertheless, the erratic monetary policy, from loose policy to tight policy during the 2006–2012 period, had implications on the operation of the banking system in Vietnam. The expansionary monetary policy, which took effect during 2006–2007 and 2008–2009, significantly pushed domestic credit growth from about 25% to over 50%. The loose monetary policy, normally presented by an increase in money supply or decrease in interest rate, not only facilitated a boom in credit growth and non-controlling investments but also contributed to asset bubbles and bad debts. From 2007, bad debts soared as a consequence of high credit growth, while the risk management ability of banks was still weak. Bad debt rising rate reached over 51% during 2008–2011, twice the average credit growth rate in the same period. As a result, the government had to tighten the monetary policy, which in turn led to the fall of the financial market and the banking system in the following period (Refer to Appendix A).

Fundamentally, monetary policy affects the money and asset markets through the transmission mechanism, which involves influences on monetary and credit aggregation, market interest rates, asset prices and exchange rate. As a consequence, banks' operations are impacted and they respond to adapt to changes in monetary policy. In this mechanism, the respondency of financial institutions, which could be presented by commercial banks, receives a lot of attention both in theoretical and empirical research. Previous studies estimated that bank risk-taking is likely to be considerably affected by monetary policy (Gambacorta, 2009; Delis & Staikouras, 2011) in three ways: (1) Low interest rate is a motive for banks to seek more new investment products/projects; (2) Interest rate directly affects on the pricing evaluation process and the cash flows of projects, thus it can impact on the risk perception of banks' managers; and (3) banks usually set up financial targets in their balance sheet in order to balance with the interest's variation. Banks, therefore, could increase their risk-taking appetite to achieve the financial objectives on their balance sheets. Besides that, the competitiveness of banks is also considered a contributing factor in the transmission mechanism of monetary policy (Brissimis, Iosifidi, & Delis, 2014). A number of previous studies claimed that if the competitiveness of the banks is high, it could lead to lower risk-taking behaviour as compared to others with lower competitiveness irrespective of a loose monetary policy environment (Beck, De Jonghe, & Schepens, 2013;

Fu, Lin, & Molyneux, 2014). This difference reflects the ability to access other financial resources when the interest rate changes. Highly competitive banks, in this regard, do not need to search for and resort to risky investment projects.

Although the combined impact of monetary policy and competitiveness on bank risk-taking has been prolifically studied, this area has not been given sufficient focus and research in Vietnam. In addition, statistical results in Appendix A show that the expansionary monetary policy had been done by government, bad debt had an increasing trend in the following years. It gives a question whether or not the relationship between monetary policy and bank risk-taking behaviours. Some scarce prior studies mostly analysed only the impact of the competition on the sustainability of the banks and the relationship among competitiveness, monetary policy, and the credit growth of banks. Hence, this study aims to shed some light on the effect of monetary policy on bank risk-taking in Vietnam and to examine the additional role of competition in the relationship between monetary policy and bank risk-taking through the use and analysis of the database of 26 commercial banks in Vietnam from 2007 to 2016. In the context of continuous changes of monetary policy and apparent instability of banks in Vietnam, this study has specific implications. Firstly, few prior research, to our knowledge, has addressed the complex interaction between monetary policy, competition and risk-taking level of banks in the specific context of developing countries. Secondly, this study investigates the inter-relatedness between key variables of competition – market power, monetary policy and bank risk-taking to lend more support to the analysis. Thirdly, there are recommendations drawn from the results of the study which could be of use to policymakers as well as bank managers. As this study is conducted in a period of changeable monetary policies; it could be referred to when considering the impact of the Vietnamese government's policies in the future.

The findings indicate that loose monetary policy could push the risk-taking level of commercial banks. However, the banks with high market power are not willing to trade-off their stability, even in the loose monetary policy environment. In other words, banks with greater market power often focus more on general stability than on taking risks to gain profits. Bank characteristics have also been found to make significant impacts on bank risk-taking.

LITERATURE REVIEW

In prior studies on the transmission mechanism of monetary policy, the risk-taking channel is assumed to closely correlate with the credit growth channel (Keeley, 1990; Dell'Ariccia & Marquez, 2006). Through the credit channel, the monetary

policy could affect the credit approval process (the lending channel) and the needs of the customers (the balance sheet channel). The risk-taking channel can be seen as the combination between the lending channel and the balance sheet channel of the banks (Alpanda & Aysun, 2012). This channel provides a new outlook of the transmission mechanism of monetary policy; it also takes into consideration the relationship between the changes in the monetary policy represented by the interest rate and the risk-taking ability of individuals in the economy (Borio & Zhu, 2012).

Firstly, interest can affect the risk-awareness of individuals in the economy and the risk level of the adverse selection of customers (Gambacorta, 2009). Particularly, the risk-taking behaviour will increase as the interest rate goes down, and this leads to the changes in the behaviour of the lending bank (Borio & Zhu, 2012). Therefore, low-interest rate results in an increase in not only banks' debt but also the risk-taking level of the bank's managers. Low-interest rate is liable to motivate bank's managers to search for more investment projects in order to get more profits. This, however, can pose challenges to ensuring the financial stability of banks. Moreover, these potential projects may not be promising due to the psychological[1] and the institutional problems (Gambacorta, 2009). When a high nominal profit seems to be hard to capture in a low-interest rate environment, many bank managers could venture into risky projects to gain more profits. The monetary illusion could push bank's managers to try to find highest nominal profits that they used to achieve in the blossomed economy in the past. As such, bank's managers are willing to trade-off bank risks, in another word, they are willing to accept risk-taking incentives. Secondly, borrower's financial situation is based on borrower's net worth, which is defined as the sum of the value of liquid and marketable assets. Interest rate affects the pricing evaluation and the cash flow of the projects or assets. Therefore, it will also have an impact on the risk awareness of bank managers about borrower's balance sheet (Borio & Zhu, 2012). For instance, low interest will increase the net present value of projects' cash flow when discount rate decreases. Risk projects with negative net present value will become feasible; and firms will easily access financial resources thanks to the low cost of capital. Therefore, low interest rate could lead to the change(s) in risk-awareness of individuals. Estimates regarding project risk will also change as a consequence of low-interest rate, and they will actually be riskier in bank's portfolio. Thirdly, banks often set up financial goals, such as a targeted level of financial leverage or a capital adequacy ratio. When asset prices increase as a result of the expansionary monetary policy environment, the balance sheet of the banks will be better, and their market value will be improved. It implies that the leverage of banks – determined by the ratio of equity and total assets – will decrease. If the total assets increase while the banks do not adjust their equity

in a timely manner, the leverage will be negatively correlated with the total assets, and their liquidity will become better. However, banks usually want to minimise the excess high-cost capital to acquire their financial targets as well as their performance improving through accelerate financial leverage (Adrian & Shin, 2010). It implies that the banks will be able to expand their balance sheets after the monetary policy is loosened. Adrian and Shin (2008) found a strong correlation between loose monetary policy and the expansion of banks' balance sheets. In this study, the authors will give evidence to show that banks managed their leverage actively and aimed to keep a reasonable and appropriate financial leverage at a particular interest rate.

It can be seen that the transmission mechanism of monetary policy through the risk-taking channel and balance sheet channel can increase bank risk-taking when interest rate environment is relatively low; in comparison with current potential macroeconomic conditions. This phenomenon was found and confirmed by many previous studies (e.g. Keeley, 1990; Rajan, 2006). Therefore, this study expects that the monetary policy will have a significant impact on the bank risk-taking; for instance, when interest rate declines, risk-taking tendency of banks will be higher.

H1: The monetary policy has a significant positive impact on the bank risk-taking.

Empirical evidence with respect to whether competition enhances or reduces bank risk-taking is somewhat mixed and inconclusive. Previous studies have considered that the competitiveness of banks has exerted a considerable impact on their risk acceptance in addition to and amid the transmission mechanism of monetary policy (Brissimis et al., 2014). Some studies have implied that banks with stronger market power (higher competitive ability) could demonstrate more risk-taking tendency. Banks with high competitiveness easily get more future lending opportunities. Therefore, they are willing to venture to get more profits by offering customers with promoted interest rates on deposits. Thus, even in the context of decreasing interest rate in a loose monetary policy environment, market power can have still a significant effect on risk-taking behaviour of banks.

However, other studies on bank competition and risk-taking are sceptical about this conclusion. They suggested that banks with stronger market power often get more earnings than others. The premise is that high market power leads to a "quiet life",[2] a situation where these banks will not have the motivation to seek investment opportunities and forgo cost savings because they have already achieved high profits from the advantages of their superior market power. They will not exchange their existing prestige and stability for more risk profits, even in

a low-interest rate environment. Furthermore, Brissimis et al. (2014) determined that market power is an internal factor influencing banks' reaction in terms of lending and risk-taking to monetary policy impulses. The marginal cost of loan activities is considerably affected by changes in domestic monetary policy, which determines the interest rate banks must pay to access sources of finance. Thus, a change in interest rates can change the marginal cost and lending interest rate of the credit activities. As a result, in more competitive environments, there is greater pressure on maintaining profits, which makes banks take on more risks, resulting in higher fragility (Sanjukta & Rudra, 2016). However, in the non-competitive market, the lending interest rate is considered less sensitive to the changes in the marginal cost of the loan activities (Khan, Scheule, & Wu, 2017). Since banks with market power have easier access to alternative sources of finance, and they are inclined to hold their current situations and be willing with their "quiet life"; a change in central bank rates will cause less impact on their marginal cost (Brissimis et al., 2014). Thus, this study assumes that banks with high market power will have less risk-taking acceptance, even in a low-interest rate environment; or in other words, competitiveness has a negative and adverse impact on the relationship between the monetary policy and the risk-taking behaviour of banks.

H2: The competitiveness of banks has a negative and adverse impact on the relationship between the monetary policy and the bank risk-taking.

METHODOLOGY

To examine the impact of monetary policy, competitiveness on the bank risk-taking, this study uses the database from Vietnamese commercial banks from 2007 to 2016, which is collected by FiinPro.[3] It should be noted that this study excludes the commercial banks which do not disclose sufficient data on bank financial statements during the period of research. Moreover, this study excludes the banks which are acquired or controlled under special terms by the State Bank of Vietnam, and banks which were merged and consolidated in the past. The final sample consists of 26 commercial banks, including one commercial bank with 100% state capital, three state-owned commercial banks and 22 private commercial banks. After the data selection process, the sample comprises 238 entries for 26 banks.

This study uses the model previously applied by Baselga-Pascual, Trujillo-Ponce and Cardone-Riportella (2015), Lapteacru (2017), and Paligorova and Santos (2017). The relationship between the competitiveness of banks, the

existing monetary policy and the banks' risk-taking level is illustrated by the following equation:

$$\begin{aligned} Risk_{it} = \; & \beta_0 + \beta_1 * Risk_{it-1} + \beta_2 * Liquid_{it} + \beta_3 * Loans_{it} \\ & + \beta_4 * Deposit_{it} + \beta_5 * Size_{it} + \beta_6 * Cost_{it} \\ & + \beta_7 * Lerner_{it} + \beta_8 * Monetarypolicy_{it} \\ & + \beta_9 * Lerner_{it} * Monetarypolicy_{it} + \varepsilon_{it} \end{aligned} \quad (1)$$

In this Equation (1), *Risk* represents the bank risk-taking, calculated by *Z-score*, according to Turk Ariss (2010) and Beck et al. (2013). The justification for using *Z-score* is to highlight the relationship between a bank's capital and the volatility of its returns, which reflects how much variability in returns could be absorbed by a bank's capital without putting the bank into insolvency. *Z-score* is the natural logarithm of the index which is calculated by the following equation:

$$Z\text{-}score = \frac{ROA + {}^{E}\!/_{TA}}{\sigma ROA}$$

ROA is the after-tax profit on the total assets; *E/TA* reflects the leverage of the banks calculated by the ratio of equity to total assets of the bank; and is the standard deviation of *ROA*. From the above *Z-score* formula, it can be seen that an increase in *Z-score* value may result from an increase in *ROA* or bank capital, or a decrease in the volatility of standard deviation of *ROA*. The assumption is that in the scenario where bank's capital level falls to zero, it becomes insolvent. It could therefore be implied that bank risk will be lower when the *Z-score* value increases and vice versa (Berger, Klapper, & Turk-Ariss, 2009; Beck et al., 2013).

From Equation (1), monetary policy is presented by a set of variables such as the refinancing interest rate (*rate*), the M2 money supply (*m2*), the treasury bill interest rate (*tbill*). Normally, a loose monetary policy is presented by an increase in money supply or a decrease in interest rate (e.g. refinancing interest rate or treasury bill interest rate); and conversely, a tight policy is signified by a decrease in money supply or an increase in interest rate. These variables have been used extensively in many prior studies on monetary policy. The loose monetary policy, as used in the study's hypothesis, can trigger banks to implement the inherently risky investment projects to increase their profits, so banks will be more willing to accept risks.

In Equation (1), the competitiveness is captured by the Lerner index. The Lerner index (commonly-known as the price-cost margin) is a popular measure of market power in the banking market. It is defined as the difference between output prices and marginal costs (relative to prices), and higher values of

the Lerner index implies greater market power of bank. According to Demirgüç-Kunt and Huizinga (2010), the Lerner index is calculated based on the difference between the output price (*P*), calculated by the ratio of total revenue to total assets, and the marginal cost (*MC*); a subtraction which is then divided by the output price.

$$Lerner = \frac{P - MC}{P}$$

With reference to Berger et al. (2009) and Turk Ariss (2010), this study estimates marginal cost through the following translog cost function:

$$\begin{aligned} Cost_{it} = {} & \beta_0 + \beta_1 * lnQ + \frac{\beta_2}{2} * lnQ^2 + \sum_{k=1}^{2} \gamma k * W_k \\ & + \sum_{k=1}^{2} \theta_k * lnQ^2 * W_k + \sum_{k=1}^{2} \sum_{j=1}^{2} W_k * W_j + \delta_1 \\ & * Trend + \delta_2 * Trend^2 + \delta_3 * Trend * lnQ \\ & + \sum_{k=1}^{2} \varphi_k * Trend * W_k + e \end{aligned} \tag{2}$$

As presented in the above formula, bank cost (*Cost*) is a function of output. The physical capital, the human capital and financial capital are three input prices, in which financial capital is calculated by the interest expenses on the total deposits (*w1*), the physical capital is denoted by operating expenses on the total assets (*w2*), and the human capital is calculated by staff salaries on the total assets (*w3*). The output products (*lnQ*) is presented by the total assets of the bank. *Trend* shows movements in the cost function over time (technical changes). The study scales the cost of input (*w1*) and (*w2*) by (*w3*) to control heteroskedasticity. After estimating the Equation (2) by the OLS estimation method, the marginal costs (*MC*) are then computed as:

$$MC = \frac{Cost}{Q}\left(\beta_1 + \beta_2 * \ln Q + \sum_{k=1}^{2} \theta_k * W_k * \delta_3 * Trend\right)$$

Besides that, the study considers that risk-taking level is also affected by the characteristics of a bank. Thus, a set of control variables is added to account for bank risk-taking. These features, including liquidity of bank (*Liquid*), outstanding loan rate (*Loans*), bank deposit proportion (*Deposit*), bank size (*Size*), Operating expenses (*Cost*), are used in a large number of previous studies (Refer to Appendix B). We emphasize that equity-to-asset ratio (*Equity*) and net profit on total assets (*ROA*) are not considered as control variables in our model because the (*Z-score*) (dependent variable) is calculated based on these two indices. They, therefore, cause spurious regression.

Liquidity of bank (*Liquid*) is measured by the ratio of a liquid asset to total asset. An improvement in a bank's liquidity implies the adequacy of capital to cover the banks' operations (Borio & Zhu, 2012). As regards the relationship between a bank's liquidity and its risk-taking, it is argued that the excess holding of liquid assets will generate a considerable expense to the banks. This may drive banks to seek more high-profit investments with high risks, and therefore shows that banks are accepting more risk-taking behaviour (Acharya & Naqvi, 2012). Bank deposit (*Deposit*) is presented by a deposit which is measured by the ratio of total customer deposits to total assets. According to Acharya and Naqvi (2012), excess deposits will make bank managers more tolerant to risk.

Bank size (*Size*), which is measured by the natural logarithm of total assets, is one of the critical factors to determine bank risk-taking. However, the impact of bank size on risk-taking behaviour has not been confirmed. Supporting views point to the "too big to fail" theory to stipulate that bank size has a positive relationship on bank risk-taking. According to "too big to fail" theory, these banks have acknowledged that they will get government support if they have any potential bankruptcy risk. Hence, they become more adventurous in their activities. By contrast, many researchers have based on a view of diversification to emphasise that bank size could negatively influence risk-taking behaviour of banks. In other words, large banks will diversify their portfolio, incomes and loans; so they will have less risk than smaller banks. This study assumes that bank size has a negative relationship with bank risk-taking.

Loans, measured by the ratio of the total loans to the total assets, could be seen as an important factor in generating more profits for the bank. However, the correlation between loans and bank risk-taking is not consistent; and it also largely depends on the level of risk involving in the investments or projects which a bank finances. Besides that, operating cost (*Cost*), captured by operating cost and total assets, reflects the efficiency of bank operation. Banks demonstrating high operating cost imply low profitability; hence their bank managers will be pushed to seek more investments or projects with higher risk. In other words, high operating costs will probably lead banks to hazardous situations (Boyd & Prescott, 1986; Agoraki, Delis, & Pasiouras, 2011).

To examine the model, the study uses a GMM-sys method (Generalise Momentum Method) for two main reasons: (1) The GMM can overcome endogenous, heteroskedasticity and autocorrection problems. As mentioned above, *Z-score* and independent variables, such as liquidity, loans or bank size, may have correlations; and it could cause endogenous problems or heteroskedasticity. GMM is a suitable method to deal with these problems. (2) The two-step system GMM estimation method gives better results than the other separate two-step

systems (Blundell & Bond, 1998). The study assumes that all variables in the Equation (1) are endogenous variables and use a lag of endogenous variables as instrumental variables based on the suggestion of Roodman (2009).

DATA AND DESCRIPTIVE STATISTIC

Firstly, Table 1 shows the mean, standard deviation, minimum, median and maximum value of variables. Based on the given statistics, it could be seen that the mean of the *Z-score* value is 3.555, which implies that the bank risk-taking in the research sample is not high. However, based on the standard deviation and the minimum value, there are significant differences in risk-taking appetite among banks. Specifically, Tien Phong Commercial Joint Stock Bank (TBP) had the lowest *Z-score* in the sample in 2011 (0.919), while Saigon Hanoi Commercial Joint Stock Bank (SHB) had the highest *Z-score* in the whole sample (5.921). As we take into account the competition context of the entire period, the lowest Lerner index was 0.0000, while the highest was 0.8878 (Lien Viet Post Bank). The mean of the overall sample amounts to 0.3056, and the standard deviation is 0.2059. According to Fu et al. (2014), the average Lerner index in Vietnam was lower than that in China (0.3914) or Singapore (0.3316). This shows that competition among commercial banks was quite fierce during the research period. Variables representing Vietnam's monetary policy show instability during this period, such as the change in refinancing interest rate, which fluctuated between −6 and 6, or the change in treasury bill interest rate, which ranged from −0.0409 to 0.0798. Among the characteristics of the bank, the total assets of commercial banks in Vietnam fluctuated significantly, the highest being VND1,006.65 trillion (34.5454 – Joint Stock Commercial Bank for Investment and Development of Vietnam), the lowest being VND2.20 trillion (28.4199 – Kien Long Bank). Similarly, the ratio of liquid assets to total assets was also high, ranging from 7.94% to 81.60% and average at 38.68%. Loan ratio fluctuated from 11.38% to 84.48%, while deposit ratio spreading from 22.68% to 89.22% with an average at 60.98%.

Table 2 shows the matrix of correlation among the variables used in the study. Bank deposit and loans had a positive correlation with bank risk-taking at 1% significance level, while bank liquidity, size, operational cost and the Lerner index show negative correlations with bank risk-taking at 1% significant level. Moreover, the absolute value of the correlation coefficients indicates that there might exist a multicollinearity problem in the model (indicated by high correlation coefficients). Therefore, this study uses GMM estimation method to effectively deal with possible problems generated by the model, such as multicollinearity, autocorrelation, heteroskedasticity, and endogenous problem.

Table 1
Descriptive statistics

Variables	Medium	Standard deviation	Smallest value	Median	Biggest value	Number of observations
Z-score	3.5552	0.8583	0.9191	3.6167	5.9212	238
Liquid	0.3868	0.1323	0.0794	0.3941	0.8160	238
Loans	0.5216	0.1419	0.1138	0.5381	0.8448	238
Depo	0.6098	0.1352	0.2268	0.6221	0.8922	238
Size	31.9016	1.2794	28.4199	31.9570	34.5454	238
Cost	0.5001	0.1687	0.0000	0.4796	1.9077	238
Lerner	0.3056	0.2059	0.0000	0.2558	0.8878	238
Δ*rate*	−0.0378	3.2206	−6.0000	0.0000	6.0000	238
Δ*m2*	0.2115	0.0705	0.1128	0.2109	0.3995	238
Δ*tbill*	−0.0012	0.0338	−0.0409	−0.0081	0.0798	238

RESULTS AND DISCUSSION

The main findings are presented in Table 3. Based on the test results of the GMM estimation method, it can be seen that the *p*-values of AR(2) test and Sargan test are insignificant. It indicates that GMM method is appropriately used, and estimation results are reliable and unbiased. The Arellano–Bond test for autocorrelation has a null hypothesis of no autocorrelation and is applied to the residuals. The test for AR(1) process in first differences usually rejects the null hypothesis, whereas the test for AR(2) in first differences is more important because it will detect autocorrelation in the levels (Roodman, 2009). The results of AR(2) tests in our models indicate that there are not autocorrelation problems. The Sargan test has a null hypothesis of "the instruments as a group are exogenous". Therefore, the high *p*-value of the Sargan statistic cannot disprove the null hypothesis. In other words, instrumental variables are valid in the study.

Table 2
Correlation matrix

	Z-score	*Liquid*	*Loans*	*Depo*	*Size*	*Cost*	*Lerner*	*Δrate*	*Δm2*	*Δtbill*
Z-score	1.0000									
Liquid	−0.4785	1.0000								
Loans	0.4018	−0.9178	1.0000							
Depo	0.0582	−0.4940	0.5315	1.0000						
Size	−0.1909	−0.1148	0.1825	0.4234	1.0000					
Cost	−0.2507	−0.0111	−0.0857	0.1171	−0.0164	1.0000				
Lerner	−0.0324	0.0114	0.1922	0.1956	0.5899	−0.5250	1.0000			
Δrate	0.1558	0.0870	−0.0762	−0.2479	−0.0816	−0.1182	0.0170	1.0000		
Δm2	0.1340	0.0240	0.0445	−0.1087	−0.2413	−0.3090	0.1956	−0.3285	1.0000	
Δtbill	0.2213	0.0645	−0.0466	−0.1681	−0.1723	−0.1204	−0.0253	0.7255	−0.1105	1.0000

Table 3
Estimated results of Equation (1)

Z-score	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Z-score (−1)	0.6063***	0.6200***	0.6659***	0.6927***	0.7513***	0.6868***
	(14.04)	(16.42)	(10.27)	(22.57)	(24.83)	(28.35)
Liquid	−3.6735***	−2.9739***	−4.0306***	−2.8761***	−2.9431***	−2.3354***
	(−4.00)	(−4.24)	(−3.22)	(−3.49)	(−4.23)	(−3.62)
Loans	−2.4967***	−2.2045***	−2.4712**	−1.8947***	−1.6517**	−1.5605**
	(−3.34)	(−2.67)	(−1.98)	(−2.59)	(−1.97)	(−2.33)
Depo	0.5516	0.6389	−0.2319	−0.0334	0.0046	0.2605
	(1.48)	(1.34)	(−0.78)	(−0.20)	(0.02)	(1.16)
Size	0.0468*	0.1005**	0.1072*	0.0732**	0.1059***	0.1259***
	(1.72)	(2.14)	(1.74)	(2.31)	(2.64)	(3.66)
Cost	−1.6331***	−1.4775***	−1.1439***	−1.2276***	−0.9197***	−1.1458***
	(−8.24)	(−5.12)	(−8.93)	(−6.79)	(−10.60)	(−6.51)
Lerner	−0.6043***	−0.8747***	−0.8997**	−1.4975*	−0.8113***	−0.8056***
	(−3.56)	(−2.76)	(−2.19)	(−1.87)	(−2.74)	(−2.90)
Δ*rate*	0.0292***	0.0488***				
	(5.79)	(8.07)				
Δ*m2*			−1.1770***	−4.2596***		
			(−2.95)	(−4.52)		
Δ*tbill*					4.0780***	10.1017***
					(11.17)	(14.87)
Δ*rate*Lerner*		−0.0735**				
		(−2.46)				
Δ*m2*Lerner*				6.9929**		
				(2.23)		
Δ*tbill*Lerner*						−19.9441***
						(−7.41)
Coefficient	3.2041**	0.9746	1.7547	2.1519	0.1083	−0.6209
	(2.30)	(0.58)	(0.61)	(1.62)	(0.06)	(−0.5)
AR(1)	0.0090	0.0110	0.002	0.007	0.003	0.0030
AR(2)	0.3910	0.8220	0.415	0.805	0.606	0.5350
Sargan	0.4890	0.5140	0.137	0.145	0.581	0.7720

Notes: Model (1) to (6) estimates the relationship between monetary policy, bank competitiveness and interaction of them on bank risk-taking. *, ** and *** indicates significance level at 10%, 5% and 1% respectively.

Firstly, monetary policy, represented by a quantitative change in refinancing interest rates, monetary supply or treasury bill interest rates, has impacts on bank risk-taking at a statistically significant rate of 1% in all equations. In particular, the sensitivity of the refinancing interest rates as well as treasury bill interest rates has a positive relationship with the *Z-score* index. In other words, the increase in refinancing or treasury bill interest rates, generally known as typical consequences of a tight monetary policy, will lead to a corresponding increase in *Z-score* value, with the coefficients of 0.0292 and 4.0780 respectively. Meanwhile, the expansion of M2 monetary supply, which can be understood as an indicator of a loose monetary policy, has a negative impact on the *Z-score* index of −1.1770 at significant 1%. These findings arrive at the same implication: the government loosening monetary policy will increase bank risk-taking (and conversely, tightening monetary policy will decrease risk-taking) . The findings bear a similarity to those in prior empirical studies such as Gambacorta (2009) and Delis and Staikouras (2011).

Secondly, the Lerner index shows an adverse effect on the *Z-score* at statistically significant 1% or 10% in all equations. In other words, a decrease in Lerner index will increase the *Z-score* value. As a representation of bank competitiveness, the result shows that banks with high competitive power will not venture into potential risks. This finding is consistent with previous results from Uhde and Heimeshoff (2009) and Schaeck and Cihák (2013). However, specific figures on the interactions between monetary policy and competitiveness of banks show surprising elements. The Δ*rate* and Δ*tbill* coefficients are 0.0488 and 10.1017, while Δ*rate*Lerner* and Δ*tbill*Lerner* coefficients are −0.0735 and −19.9441 respectively at 1% significant level. It suggests that the competitiveness of banks can override the impact of the monetary policy on bank risk-taking. The results are robust when further estimations with monetary supply variable (Δ*m2*) are conducted. The Δ*m2* coefficient is −4.2596, while Δ*m2*Lerner* coefficients are 6.9929 at 1% significant level. Since negative changes in refinancing interest rate or treasury bill interest rate as well as positive changes in money supply are also synonymous with loose monetary policy, such changes will lead to an increase in the *Z-score* value with a sufficiently high Lerner index (it is found to range from 0.5 to 0.6 in our sample, and it is higher than median Lerner index at 0.25). It means that the banks with high market power are not willing to increase their risk-taking levels when the government loosens the monetary policy. In these cases, the impact of competitiveness outweighs the impact of monetary policy on bank risk-taking. The banks with high competitiveness may impose the higher price (deposit interest rate or lending interest rate) than average marginal

cost (Demirgüç-Kunt & Huizinga, 2010). Such banks, therefore, will not have the motivation to engage in any high-risk investment projects, even in a low-interest rate environment (Beck et al., 2013; Fu et al., 2014).

Thirdly, bank characteristics have been found to be determinants towards bank risk-taking. In more details, the liquidity of banks has a negative impact on the *Z-score* of 1% in all equations. A possible explanation is that holding many liquid assets will lead to a situation in which banks must accept a lower profit margin than lending (Delis & Staikouras, 2011). Those banks, therefore, have to seek other investment opportunities with higher potential risks to achieve their target profits. As a consequence, the banks will undertake more risk-taking behaviour. Similarly, loan also shows a negative relationship with *Z-score* at 1% statistical significance in all equations. When the credit level goes up, it reduces the *Z-score* value; in other words, bank risk-taking will increase. It is relevant to the no-good situation, in which banks will have to face more bad debts as well as payback ability in the long term when they raise lending activities (Trujillo-Ponce, 2012). Operating cost has been found to have a negative relation with *Z-score* at 1% significance level. This result indicates that a considerable increase in operating costs implies inefficiency in cost management. Bank executives, under the pressure of delivering results and attaining goals, will compensate the losses caused by the rising operating expenses through seeking high-profit investments with potential risk. To some extent, efficiency in cost management also reflects the quality of credit activities as well as risk level of the bank (Louzis, Vouldis, & Metaxas, 2012; Baselga-Pascual et al., 2015). Therefore, the banks with high operating expenses are considered high risk. This result supports the findings of Uhde and Heimeshoff (2009), Delis and Staikouras (2011) and Baselga-Pascual et al. (2015).

By contrast, bank size has been found to make a positive effect on the *Z-score* at 10% significant level. Larger banks often have fewer activities of taking risks than smaller banks. This is probably related to the ability/capability of diversification in their activities (Salas & Saurina, 2002). In addition, it can be seen that large banks are in a better position to access financial resources, and can deal with liquidity shortage better (Konishi & Yasuda, 2004). Meanwhile, there is no proof to show that deposit has an impact on bank risk-taking in all empirical equations. Finally, bank risk-taking depends on the prior risk-taking behaviour of banks in earlier periods because the coefficient of the lagged of *Z-score* is a positive relationship with *Z-score* at 1% significant.

CONCLUSION

This study assesses the impact of monetary policy on bank risk-taking and the influence of competitive ability within this relationship of the Vietnamese commercial banks from 2007 to 2016. With the GMM methodology, the study found that the monetary policy has a significant impact on the bank risk-taking, captured by *Z-score*. The empirical findings show that bank risk-taking increases when the government conducts loose monetary policy and the converse way is also true. Besides that, the competitiveness of banks is found as a key factor in bank risk-taking levels. Banks with high market power, presented by the Lerner index, have less risk-taking behaviour, even in a loose monetary policy environment. Using interacting variables, the findings indicate that the impact of bank competitiveness outweighs the impact of monetary policy on bank risk-taking. In addition, bank characteristics have an influence on bank risk-taking in different ways. While liquidity, credit level and cost inefficiency could increase risk-taking behaviour of banks, bank size has a negative impact on bank risk-taking.

The study is conducted in a period of changing monetary policies from 2007 to 2016; hence it has certain implications for bank managers and policymakers. Firstly, managers could control their bank's risks through controlling vulnerable bank characteristics mentioned in the study. Secondly, the government should consider how a change in monetary policy could alleviate or aggravate the vulnerability of the banking system, as well as consequently increasing bad debts in the future.

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NOTES

1. For example, investors may ignore the fact that nominal interest rates may decline to compensate for lower inflation (Gambacorta, 2009).
2. A term is given by Hicks (1935).
3. An associate company of Nikkei Inc. and QUICK Corp., is known a leading financial and business information corporation in Vietnam, website: http://stoxplus.com

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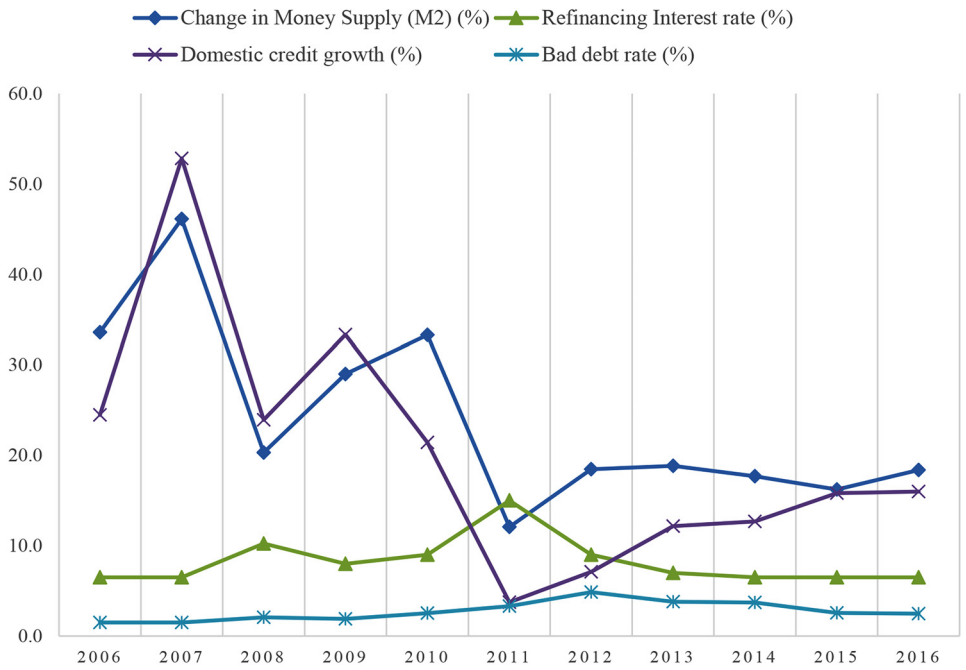
APPENDIX A

Monetary Policy and Domestic Credit Growth



(*Source*: World Bank and National Financial Supervisory Commission of Vietnam)

APPENDIX B

Variables Measurement Methods

Variable name	Symbol/Abbreviation	Measurement method
Dependent variable		
Bank risk-taking	*Z-score*	The natural logarithm of the index: (After-tax profit on the total assets + equity on total assets)/Standard deviation of after-tax profit on the total assets
Independent variables		
Monetary policy		
Change in refinancing interest rate	Δrate	The difference between interest rates in year t and year $t - 1$
Change in money supply (M2)	Δm2	The difference between M2 money supply in year t and year $t - 1$
Change in treasury interest rate	Δtbill	The difference between government bond yields in year t and year $t - 1$
Bank characteristics		
Bank liquidity	Liquid	Liquid assets on the total assets
Bank lending	Loans	Outstanding loans on the total assets
Bank deposit	Depo	The customer's deposits on the total assets
Bank size	Size	The natural logarithm of the total assets
Bank operating cost	Cost	The operating expenses on the total assets
Bank competitiveness	Lerner	Authors estimate from Equation (2)