UNIVERSITY OF WOLLONGONG AUSTRALIA

Australasian Accounting, Business and Finance Journal

Volume 12 | Issue 3 Article 4

Bank Risk, Capitalisation and Technical Efficiency in the Vietnamese Banking System

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Recommended Citation

Le, Tu DQ, Bank Risk, Capitalisation and Technical Efficiency in the Vietnamese Banking System, *Australasian Accounting, Business and Finance Journal*, 12(3), 2018, 41-61. doi:10.14453/aabfj.v12i3.4

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Abstract
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Keywords
Bank efficiency, capital ratios, bank risk, DEA-financial ratios, diversification, 3SLS

Bank Risk, Capitalisation and Technical Efficiency in the Vietnamese Banking System

Tu DQ Le[1]

This study investigates the interrelationships among bank efficiency, capital, and risk in Vietnamese banking between 2007 and 2011 by using the three-stage least squares in a simultaneous equations framework. The efficiency scores of individual banks are obtained from the Data Envelopment Analysis with the use of financial ratios. The average efficiency level of Vietnamese banks is relatively low, suggesting that there is a room for Vietnamese banks to further improve their efficiency so as to achieve world best practice. The findings also show a negative relationship between bank risk and capital, suggesting that credit risk and financial leverage are reinforcing each other. Furthermore, our findings also indicate that an improvement in bank efficiency precedes an increase in risk. In addition, the results suggest that more efficient and lower risk banks are associated with higher capital levels. Finally, the findings show that more-diversified banks tend to be higher risk-taking and have greater performance. Therefore, our findings have important implications for bank prudential supervision and underline the importance of increasing the minimum charter capital requirement in the future to support financial stability objectives.

JEL classification: C23, D24, E44, G21

Keywords: Bank efficiency, capital ratios, bank risk, DEA-financial ratios, diversification, 3SLS

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1. INTRODUCTION

Vietnam is a rising economic star and considered as a future dragon in the Asia-Pacific region with the average Gross Domestic Product (GDP) growth rate of 6.2% over the period 2006-2012 (WB 2016). Due to the relatively underdeveloped capital market[2], the Vietnamese banking system plays an essential role in the economy since it contributes 16% to 18% toward annual GDP (Stewart, Matousek & Nguyen 2016). Yet, it has long remained undercapitalised and higher level of non-performing loans (NPL).[3]

Along with other reforms, the State Bank of Vietnam (SBV) officially released the minimum charter capital requirements for commercial banks with the main objective of reducing risk and improving bank efficiency. Accordingly, all commercial banks must achieve at least VND 3,000 billion by the end of 2010 (The Vietnamese Government 2011). This requirement affects bank behaviour in different ways. For small banks, they seem to face greater difficulty in terms of raising their capital to meet the minimum charter capital requirement in the short time due to unfavourable conditions of the Vietnamese stock market. This, therefore, may induce them to seek high profits via over-branching or excessive risk-taking. For large banks, it is not hard for them to meet the minimum charter capital requirement because their higher capital was injected by the government. Under a moral hazard hypothesis, this free injection, however, may also affect adversely their management behaviour such as having less incentive to monitor costs or over-financing to state-owned enterprises that are poor management and have higher risk projects. In fact, the NPL ratio of the Vietnamese banking system significantly increased in the period 2007-2011 and reached the peak in 2008 (Vietcombank Securities Company 2011). This further raises a concern on whether this capital requirement should be really adequate for Vietnamese banks to reduce risk and improve efficiency.

Furthermore, the literature shows that capital and risk are related to the level of bank efficiency. Hughes and Mester (1998) demonstrate that more efficiency banks with the high quality of management may have greater flexibility of their financial leverage or overall risk profile, ceteris paribus. However, a less efficient bank with low capital tends to take higher risk under moral hazard considerations. As such, Vietnam offers a particularly interesting environment in which to investigate this critical issue.

It is surprising that only a few studies examining the links among risk, capitalisation and bank efficiency. The literature is dominated by studies from the US and Europe where larger markets and number of banks have facilitated economic modelling. The earlier studies suggest that efficiency and capital are relevant determinants of bank risk. Berger and DeYoung (1997) suggest that problem loans reduce cost efficiency and a reduction in cost efficiency precedes increases in problem loans, especially at highly leveraged banks in the US. Similarly, another study by Kwan and Eisenbeis (1997) using the US data conclude that poor-performing banks are prone to risk-taking than better-performing ones. Their findings also indicate that well-capitalized banks operate more efficiently than less-capitalized peers. These two studies demonstrate the potential existence of intertemporal relationships among risk, capital, and efficiency in banks.

[2] The stock market has been only serving a limited number of companies which are favoured by the government.
[3] According to the report of World Bank (2014), the level capitalisation of Vietnamese banking system is the lowest among ASEAN countries. In addition, the actual figure of NPL should be at least two digits, which was much higher than what was reported by the State Bank of Vietnam.

Several studies adopted the framework of Berger and DeYoung (1997) and Kwan and Eisenbeis (1997) for a European banking system. Williams (2004) shows that inefficient banks are associated with an increase in problem loans in a sample of European saving banks. This is in line with those of Berger and DeYoung (1997). Using the similar methodology in a panel data framework, Fiordelisi, Marques-Ibanez, and Molyneux (2011) indicate that lower bank efficiency leads to higher risk and increases in bank capital precede cost efficiency improvements. This finding is in line with those by Kwan and Eisenbeis (1997), suggesting that more efficient banks appear to be better capitalised and capital levels are also positively associated with efficiency levels. In contrast, Altunbas et al. (2007) demonstrate that inefficient banks appear to have more capital and take on less risky activities.

Regarding empirical studies in developing countries, especially in Asia-Pacific, mixed findings are also found. Tan and Floros (2013) indicate a negative relationship between bank risk and capitalisation and a positive relationship between risk and bank efficiency in China. Nguyen and Nghiem (2015) using the Indian data, however, show that a reduction in cost efficiency is followed by an increase in bank risk and a decrease in the capital ratio is followed by an increase in risk. In the context of the Vietnamese banking system, Nguyen, Nghiem and Roca (2016) suggest that earning asset diversification impacts risk, cost efficiency and bank capital negatively.

Our paper has several contributions to the literature as follows. First, prior studies show a lack of consistency in the relationships among bank risk, capitalisation and efficiency. This study revisits whether the four hypotheses with the mnemonics 'bad luck', 'bad management', 'skimping', and 'moral hazard' exists in the Vietnamese banking system. Along with different management behaviours of banks, this could be due to differences in the choice of variables, sample size, analysis periods and estimation methods in the first-stage analysis[4]. In order to mitigate this issue of input-output variables employed for frontier economic approaches, we use Data Envelopment Analysis with the use of standard financial ratios as outputs to estimate technical efficiency of banks. Second, while a number of studies are conducted in many countries, regions using different methods, the experience in emerging markets, especially Vietnam remains limited [Nguyen, Nghiem, and Roca (2016) may be one of the exceptions]. The experiences of other economies cannot be automatically applied to the banking system in underdeveloped economies because of the substantial differences in regulatory and economic environments and the level and quality of services associated with deposits and loans that exist in institutional reality. By providing the evidence in Vietnam, this will increase the external validity of the interrelationship between bank risk, capitalisation and efficiency in the Asia-Pacific region. This study focuses on the Vietnamese banking between 2007 and 2011 when there were significant changes in banks' capital ratios. Therefore, our study provides useful policy and managerial applications.

Our findings indicate that the technical efficiency level of Vietnamese banks is relatively low, suggesting that there is a room for Vietnamese banks to further improve efficiency so as to achieve world best practice. In addition, the findings show a positive impact of capital on bank efficiency, suggesting that banks with more capital operate more efficiently than those with less capital. Capital also impacts bank risk negatively. Together, the higher capital ratio could both improve bank performance and reduce bank credit risk. In addition, our results demonstrate that an improvement in banking efficiency precedes an increase in bank risk, supporting the skimping behaviour hypothesis. Furthermore, our findings indicate that in

[4] The choice of inputs and outputs is comprehensively discussed by several studies such as Berger and Humphrey (1997).

general bank risk impacts capitalisation negatively, thus supporting the moral hazard hypothesis. In other words, high risk-taking is combined with higher leverage. Lastly, the findings suggest that more-diversified banks tend to be higher risk-taking and also have greater performance. The results in subsamples also reinforce the main findings.

The remainder of the paper is organised as follows. Section 2 provides an overview of the Vietnamese banking system. Section 3 presents the methodology. Section 4 describes data used in this study. Section 5 discusses empirical findings while section 6 concludes.

2. OVERVIEW OF THE VIETNAMESE BANKING SYSTEM

During the past two decades, the banking system has transformed from one-tier to a two-tier system where the SBV acts as a true central bank, and commercial banking functions are transferred to state-owned commercial banks (SOCBs) and privately owned commercial banks (POCBs). Several reforms were also implemented with the objective of transforming banks into market-functioning and efficient institutions. The main focus of reforms has so far on the restructuring of SOCBs, which has long served as the lending arm of state-owned enterprises (SOEs). The rest of the banking system, approximately 50% of total bank assets (KPMG 2013) has a much-diversified structure. First, two policy banks have proven to be effective tools of the state in mobilising various resources, both domestically and internationally, to perform designated socio-political lending programs. Second, POCBs are generally the most market-oriented and primarily focus on serving consumers in particular regions. Their equity ownership is mainly distributed among private, foreign investors and state. Third, since Vietnam's entry into the World Trade Organization (WTO) in 2007, a number of foreign banks that have been operating in the market have led to fierce competition for deposits and loans. Two forms of foreign participation are greenfield investment and acquisitions of a minority share. In response, domestic banks should increase their competitiveness by utilising inputs and producing outputs efficiently or may have diversified away from their traditional business activities into new fee-based sources of revenue (Le 2017). Last, non-banking financial institutions (other credit institutions and investment banks and financial auxiliaries) also contribute to the amount of credit available in the financial system.

Recently, the SBV announced capitalisation and prudential ratios according to the Basel framework. Commercial banks are now required to meet the minimum charter capital requirement. This may have considerable implications for bank management in terms of enhancing bank efficiency and stability to survive in an increasingly competitive market. As being a critical role in the Vietnamese economy, the efficiency and behaviours of commercial banks are of interest to various stakeholders including policy-makers, industry participants, and academics.

3. METHODOLOGY

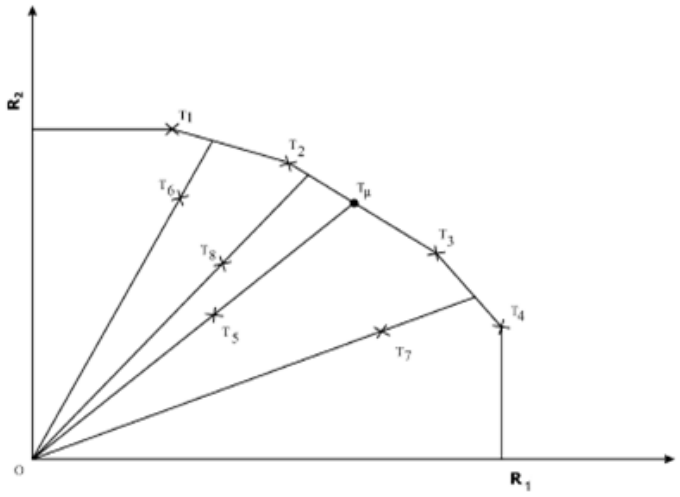
3.1 Efficiency Estimation

The literature suggests no consensus on the preferred method for determining the best practice frontier against which relative efficiency are measured. Two common approaches used to estimate bank efficiency include data envelopment analysis (DEA) and stochastic

frontier approach (SFA)[5]. DEA is selected in this study because it works well with small sample size (Evanoff & Israilevich 1991) and is less prone than SFA to specification error, thus is more flexible (Reinhard, Lovell & Thijssen 2000).

Let us now consider the problem diagrammatically. Assume that we have eight banks (T_1, T_2… T8). In order to simplify the problem, we consider two efficiency ratios: R_1 and R_2 as shown in Figure 1.

Figure 1 Diagrammatic presentation of the model



Source: Adapted from Halkos and Salamouris (2004)

The efficient frontier is created by four efficient banks: T_1, T_2, T_3, and T_4. Bank T_5 is considered as inefficient as it does not lie on the frontier. Point T_μ determines the optimal level of efficiency and is considered as the reference point, which is used for the measurement of the relative efficiency of bank T_5. The portion by which T_μ exceeds T_5 shows the size of inefficiency. The degree of efficiency for bank T_5 is found the ratio of the distances OT_5/OT_μ. This follows the model specification proposed by Halkos and Salamouris (2004). They suggest that inputs can be considered similar and equal for all banks as they operate in the same markets for money and services.

The N banks produce a vector of output R_i in the form of the financial ratios[6]. The matrix of outputs R_i $(i = 1,2,3, \dots, m)$ is known for each bank or a Decision Making Unit (DMU) n $(n = 1,2,3, \dots, N)$. The n variables to be estimated are a set of weights λ $(\lambda = \lambda_1, \lambda_2, \lambda_3, \dots, \lambda_k)^l$ placed on each of the banks in creating the efficiency frontier for the firm (l) and an efficiency measure θ^l. It is important to note that if a bank wishes to increase its score it would be best to focus on those outputs, with the highest weight as the efficiency score is most sensitive to those outputs.

Then the linear program for each bank can be formulated under the output-oriented model as follows:

$max\ \vartheta_l$

Subject to

[5] Berger and Humphrey (1997) provide a comprehensive discussion on economic frontier techniques.
[6] In our study, the values of ratios are non-negative. Thus the model is justified.

$$\sum_{n=1}^{N} \lambda_n R_{in} \geq \vartheta_l R_{il} \ (i = 1,2,3, \ldots., m)$$

$$\sum_{n=1}^{N} \lambda_n = 1 \qquad (1)$$

$$\vartheta_l \geq 0$$

$$\lambda_n \geq 0 \ (n = 1,2,3, \ldots., N)$$

The efficiency score for each DMU is given by $\theta_l^* = \frac{1}{\vartheta_l}$ and $0 \leq \theta_l^* \leq 1$. DMUs are considered as technically efficient if $\theta_l^* = 1$ and all slacks zero[7].

3.2 A simultaneous equations model

A two-stage framework is used in our study. In the first stage, the technical efficiency scores of banks are obtained using the DEA with the use of financial ratios as described above. In the second stage, a simultaneous equations model is used to examine the interrelationships between risk, capital, and efficiency. Several approaches are often used in the literature such as 2SLS (Kwan & Eisenbeis 1997), SUR (Altunbas et al. 2007) and Granger causality test (Berger & DeYoung 1997; Fiordelisi, Marques-Ibanez & Molyneux 2011; Williams 2004). Nguyen and Nghiem (2015) argue that results obtained from Granger causality are sensitive to model specification and the number of lags. In addition, Belsley (1988) suggested that 3SLS can be more efficient than 2SLS, a relative advantage that increases with the strength of the interrelations among the error terms. Therefore, the 3SLS estimator which combines 2SLS and SUR is adopted.

Following Altunbas et al. (2007), the ratio of loan loss reserves total assets (RISK) is used to measure bank risk derived from accounting information since data on non-performing loans are unavailable for most banks. Higher levels of reserves are suggestive of greater banking risk[8]. Bank capitalisation (CAP) is measured by the ratio of total equity to total assets while technical efficiency (TEFF) is obtained from the DEA with the use of financial ratios. Therefore, RISK, CAP, and TEFF represent the three endogenous variables in the simultaneous equation system, with two right-hand-side endogenous variables in each of the three equations. The model is completed by adding exogenous variables that have explanatory power for each of the above endogenous variables. The model is specified as follows:

$$CAP_{i,t} = \alpha_0 + \alpha_1 TEFF_{i,t} + \alpha_2 RISK_{i,t} + \alpha_3 ROAA_{i,t} + \alpha_4 LD_{i,t} + \varepsilon_{i,t} \qquad (2)$$

$$TEFF_{i,t} = \beta_0 + \beta_1 CAP_{i,t} + \beta_2 RISK_{i,t} + \beta_3 LA_{i,t} + \beta_4 SIZE_{i,t} + \beta_5 DIV_{i,t} + \delta_{i,t} \qquad (3)$$

$$RISK_{i,t} = \gamma_0 + \gamma_1 CAP_{i,t} + \gamma_2 TEFF_{i,t} + \gamma_3 LA_{i,t} + \gamma_4 DIV_{i,t} + \gamma_5 GDP_t + \gamma_6 INF_t + \omega_{i,t} \qquad (4)$$

[7] Note that if an efficiency score of 1 but a slack value is positive then the model has identified a point on the efficient frontier but still has excess on an output, which corresponds to the positive slack. This suggests that this DMU is not Pareto-efficient because its outputs cannot be expanded jointly; see Halkos and Salamouris (2004).

[8] Borio (2003) suggested that banks build more provision in good times and run them down in the case of unfavourable economic conditions and an increase in loans defaults. As such banks with higher levels of reserves could be considered as a lower risk. However, Altunbas et al. (2007) argued that banks with higher levels of reserves have an expectation of higher future risk, thus, are riskier.

Berger and DeYoung (1997) indicated four types of managerial hypothesis underlying the interrelationships among bank risk, capital and operating efficiency that include: bad management, bad luck, moral hazard and skimping.

As per the bad management hypothesis, banks with poor management may fail to control operating costs or monitor borrowers, thus resulting in higher risk. Also, less efficient banks tend to be more prone to risk-taking due to a lower value of their charter capitals. According to the skimping costs hypothesis, banks tend to skimp on operating costs by reducing credit monitoring, collateral valuing and marketing activities to achieve short-run economic efficiency. These activities, however, would deteriorate loan quality which ultimately leads to higher risk. In addition, inefficient banks are subject to more regulatory scrutiny. Thus they are required to hold higher capital ratios (Kwan & Eisenbeis 1997).

The bad luck hypothesis argues that banks are required to expend additional managerial efforts, additional resources/inputs to address credit risk caused by external events such as financial shocks. As a result, this reduces banks' efficiency. On the other hand, the costs of managing credit risk may be reduced with the level of risk exposure due to credit screening.

The conventional view suggests that managerial quality banks with more capital and less leverage are likely to be more efficient than those with less capital (Kwan & Eisenbeis 1997). CAP, therefore, is positively associated with TEFF. Furthermore, the moral hazard hypothesis postulates poorly capitalised banks that face risks due to a reduced capital ratio have incentives to take risky portfolios. Consequently, a negative impact of the CAP on RISK is expected.

Following prior studies such as Fu, Lin, and Molyneux (2015) and Nguyen and Nghiem (2015), we use bank profitability (ROAA) and bank intermediation (LD) as control variables for CAP (equation 2). ROAA, the ratio of profit before tax to average total assets, is included to control for bank's profitability. The charter value hypothesis suggests that a profitable bank may improve capital ratios, all else being equal, to protect its charter value (Keeley 1990). As per the pecking order theory of finance, increasing extra capital may be costly. It thus may be easier to accumulate capital via higher retained earnings. LD, the ratio of gross loans to total deposits, is included to control for the effects of bank intermediation. Accordingly, banks with the higher level of intermediation of deposit to loans could obtain greater earning – thus, resulting in higher level of capital.

We also use lending specialization (LA), bank size (SIZE) and bank diversification (DIV), as control variables for TEFF (equation 3). LA, the ratio of gross loans to total assets, is included to control for lending specialization. Accordingly, a greater loan-to-asset ratio may suggest higher market power in loan markets. The efficient structure hypothesis demonstrates that market power in loan markets may be a consequence of efficient operations. Because of the ability to control their operations more productively, relatively efficient banks may have lower production costs, which allow them to offer more reasonable loan terms and thus gaining larger market shares over their inefficient competitors. LA thus is expected to have a positive effect on TEFF (Isik & Hassan 2003; Nguyen & Nghiem 2015). SIZE, the natural logarithm of total assets, is included to control for bank size. Due to economies of scale, SIZE is expected to have a positive impact on TEFF (Andries 2011; Drake 2001). DIV, the ratio of off-balance sheet items to total assets, is included to control for bank diversification towards off-balance sheet activities. According to the conglomeration hypothesis, diversified banks can leverage managerial skills and abilities across products and services (Iskandar-Datta & McLaughlin 2005) and gain economies of scope through spreading fixed costs over

multiple products (Drucker & Puri 2009). Diversification thus has a positive impact on bank efficiency. The increased income generated from diversification, however, would be offset by the costs for non-lending products (Nguyen & Nghiem 2015). Diversification, therefore, impacts bank efficiency negatively.

Furthermore, we use excessive lending (LA), bank diversification (DIV), economic growth (GDP) and inflation (INF) as control variables for RISK (equation 4). LA, the ratio of gross loans to total assets, is used to control for excessive lending. Banks may intend to seize new lending opportunities, expand to new geographic markets or increase market share with existing products and markets (Rossi, Schwaiger & Winkler 2009). Under this presumption that new loans are advanced to borrowers who were previously rejected, perhaps too little collateral relative to their credit quality, excessive lending may increase bank risk. DIV, the ratio of off-balance sheet activities to total assets, is used to control for the effects of bank diversification. Conventional wisdom in banking suggests that diversification could reduce bank risk. In contrast, Berger, Hasan and Zhou (2010) emphasise that aggressive diversification strategies may lead to increased risk-taking. Similarly, Acharya, Hasan and Saunders (2006) demonstrate that diseconomies of scope arise through weakened monitoring incentives and a poorer quality loan portfolio when a risky bank expands into additional industries and sectors. This is also due to the issue of agency costs (Deng & Elyasiani 2008). For that reason, diversification impacts on bank risk positively. GDP, the economic growth rate, is used to control for the economic condition that influence banks' investment opportunity and therefore bank risk-taking behavior. INF, the inflation rate, is used to control for the effects of inflation.

4. DATA

In our analysis, only Vietnamese commercial banks between 2007 and 2011are considered. Foreign banks and joint-venture banks are excluded from our analysis as they were much more restricted in bank entry and banking activities. Due to the data sample must be homogeneous when using DEA for assessing efficiency, this exclusion ensures maximum feasible comparability among banks. After accounting for missing data, we obtain an unbalanced panel data in which these banks accounted for more than 80% of total assets in the banking industry. The data were collected from the balance sheets and profit and loss accounts of the banks under consideration.

A variety of financial ratios are used for this evaluation with each ratio to provide indications for technical efficiency of a bank. Following Halkos and Salamouris (2004), we initially considered five common financial ratios as outputs that include: return difference of interest-bearing assets (RDIBA)[9]; the ratio of profits before tax to average total equity (ROAE); efficiency ratio[10] (EFF); net interest margin[11] (NIM); the ratio of profits before tax to average total assets (ROAA). For reasons of convenience with the other indices as described in Figure 1, EFF is used in our analysis as 1/EFF. ROAE, NIM, and ROAA are three main measures of

[9] This is measured by the difference between the interest receivable and similar income-to-the average interest-bearing assets ratio and the interest payable and similar charges-to-the average interest-bearing liabilities ratio. The larger RDIBA is, the more efficient the management of the bank's capital is.

[10] This is measured by the ratio of the operational expenses to total net income. The smaller EFF is the more efficient the bank is because the percentage of the bank's income generated is sufficient to cover its operating expenses.

[11] The ratio of the net income to average total assets

bank profitability in the literature. Following the suggestion of Halkos and Salamouris (2004), ROAA should be excluded from our analysis because ROAA is highly correlated with EFF and NIM with using a correlation of about 0.7 as a cut off as presented in Table 1.[12]Therefore, four financial ratios used as outputs in DEA include RDIBA, ROAE, EFF, and NIM. Given our unbalanced panel data, a set of 1x4 inputs and outputs is used in our study which is consistent with DEA literature. Dyson et al. (2001) suggest that sample size should be at least three times larger than the sum of inputs and outputs to discriminate between the units.

Table 1 Correlation matrix between financial ratios used in DEA

	RDIBA	ROAE	EFF[a]	NIM	ROAA
RDIBA	1				
ROAE	0.134	1			
EFF[a]	0.198	0.287	1		
NIM	0.399	0.194	0.380	1	
ROAA	0.287	0.297	0.784	0.704	1

Note: [a] the data of EFF was transformed.

Descriptive statistics of variables used in this study are presented in Table 2.

Table 2 Descriptive statistics of variables used in this study

Variables	2011	2010	2009	2008	2007
Number of banks		33	37		
37				33	27
Financial ratios used for efficiency estimation					
RDIBA	4.573[b]	3.622	3.404	2.895	3.085
	(2.610)[c]	(2.336)	(1.789)	(1.491)	(1.138)
ROAE	15.745	16.772	16.749	13.846	22.695
	(8.662)	(8.003)	(8.148)	(9.871)	(12.421)
EFF[a]	0.022	0.025	0.025	0.022	0.031
	(0.005)	(0.007)	(0.007)	(0.009)	(0.011)
NIM	3.539	2.813	3.204	2.940	3.169
	(1.410)	(0.936)	(1.342)	(1.615)	(1.613)

[12] This rule may vary depending on the study of the discipline.

Variables used for assessing the interrelationships between bank risk, capital, and efficiency

RISK	0.715	0.657	0.621	0.617	0.488
	(0.578)	(0.525)	(0.539)	(0.632)	(0.630)
CAP	11.490	11.954	13.764	15.038	12.878
	(6.837)	(6.927)	(11.920)	(9.770)	(8.613)
LA	46.242	47.853	55.177	54.196	52.246
	(15.479)	(13.811)	(17.291)	(13.981)	(13.683)
LD	102.878	95.772	108.667	100.553	125.261
	(38.697)	(22.523)	(52.854)	(30.751)	(71.969)
DIV	7.963	7.218	6.915	7.530	10.651
	(10.847)	(10.022)	(8.895)	(10.546)	(15.403)
SIZE	17.962	17.683	17.176	16.880	16.888
	(1.108)	(1.132)	(1.305)	(1.364)	(1.359)
ROAA	1.679	1.776	2.070	1.637	2.587
	(0.965)	(0.971)	(1.111)	(1.381)	(1.519)
GDP	6.240	6.423	5.398	5.662	7.130
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
INF	21.261	12.074	6.216	22.673	9.630
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes*:* [a] the data of EFF was transformed; [b,c] mean and standard deviation value of the variable, respectively

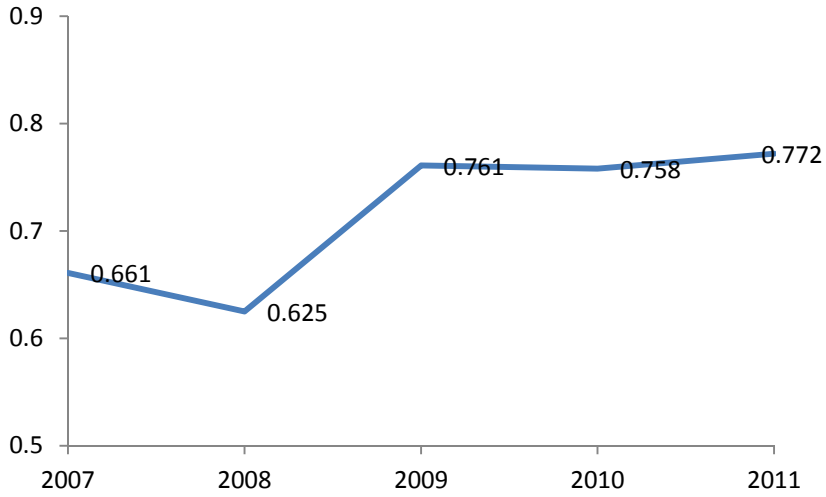
5. RESULTS

5.1 Technical efficiency of the Vietnamese banking system, 2007 - 2011

As mentioned above, the financial ratios are treated as output variables, while a dummy-input (equals to 1) is set for all banks in the sample. Figure 2 shows the technical efficiency level of the Vietnamese banking system between 2007 and 2011[13].

[13] The results of technical efficiency score of each bank over the examined period cannot be presented due to length restrictions but are available upon request.

Figure 2: Technical efficiency of Vietnamese banks, 2007-2011



The average technical efficiency score of banks over the five-year period is 0.72. This value fits within the range of the scores found in other overseas studies but is lower than the world mean efficiency. As indicated by Berger and Humphrey (1997), the mean efficiency score is in the range of 0.55 (UK) to 0.95 (France). This suggests that there is a room for Vietnamese banks to further improve efficiency so as to achieve world best practice (i.e., banks can increase outputs produced by 28%).

Furthermore, this appears as a significant reduction in bank efficiency in 2008. However, there is a slight improvement in technical efficiency in 2009 and remains levelled off between 2010 and 2011,[14] suggesting that the Vietnamese banking system is less affected by the GFC. This recovery could be explained by the fact that banks gained benefits from the government's stimulus packages. A large amount of money was injected into the economy by the government through commercial banks channel. This enables banks to increase lending from this cheap fund, thus may improve bank efficiency.

5.2 Management behaviours

Table 3 presents the correlation matrix of the various variables that are used in this study. For the convenience, we focus on the interpretation of the correlation between CAP, TEFF, and RISK. At first glance, there is a positive relationship between TEFF and CAP and a negative relationship between RISK and CAP. The correlations of other control variables in three equations as above are also reported. As can be seen in Table 3, there are no high correlations between explanatory variables in a single equation. However, the intertemporal relationships among CAP, TEFF and RISK can be only addressed by using a simultaneous equations model as presented in the following section.

The simultaneous equations system is fitted by pooled time-series cross-section observations using the 3SLS estimation.

[14] Since our data is unbalanced, and particularly because the purpose of this study is to investigate the interrelationship between bank efficiency, capitalisation, and risk, we have not focused on the productivity change over time for the Vietnamese banking system. Nonetheless, this is well beyond the scope of our study, thus leaving this for future research.

Table 3 Correlation matrix of key variables

	CAP	TEFF	RISK	ROAA	LD	LA	SIZE	DIV	GDP	INF
CAP	1.000									
TEFF	0.187**	1.000								
	(2.440)									
RISK	-0.258***	0.103	1.000							
	(-3.431)	(1.326)								
ROAA	0.603***	0.629	-0.180	1.000						
	(9.710)	(10.399)	(-2.345)							
LD	0.529***	0.086	0.006	0.429	1.000					
	(8.018)	(1.112)	(0.081)	(6.106)						
LA	0.122	-0.044	0.494***	0.103	0.447	1.000				
	(1.573)	(-0.567)	(7.291)	(1.334)	(6.427)					
SIZE	-0.733	0.104	0.522	-0.437	-0.431	-0.02	1.000			
	(-13.833)	(1.338)	(7.868)	(-6.243)	(-6.136)	(-0.255)				
DIV	-0.262	0.138*	0.402***	-0.028	-0.255	0.024	0.436	1.000		
	(-3.480)	(1.789)	(5.646)	(-0.360)	(-3.381)	(0.310)	(6.218)			
GDP	-0.082	-0.035	-0.049	0.133	0.091	-0.121	0.042	0.092	1.000	
	(-1.053)	(-0.443)	(-0.636)	(1.724)	(1.180)	(-1.565)	(0.537)	(1.189)		
INF	0.009	-0.111	0.055	-0.189	-0.093	-0.082	0.066	-0.007	-0.055	1.000
	(0.117)	(-1.431)	(0.707)	(-2.476)	(-1.197)	(-1.057)	(0.845)	(-0.090)	(-0.709)	

Notes: CAP, the ratio of total equity to total assets; TEFF, technical efficiency scores of banks; RISK, the ratio of loan loss reserves to total assets; ROAA, the ratio of profit before tax to the average total asset; LD, the ratio of gross loans to total deposits, LA, the ratio of gross loans to total assets, SIZE, the natural logarithm of total assets; DIV, the ratio of off-balance sheet items to total assets; GDP, the economic growth rate; INF, the inflation rate. *t*-statistics are shown in parentheses, **, *** Significant at 5, 1 percent levels, respectively.

Table 4 Determinants of bank capitalisation

	CAP
TEFF	-35.644***(-4.718)
RISK	-3.585**(-2.337)
ROAA	7.310***(7.244)
LD	0.022*(1.602)
Constant	24.561***(5.808)
Adjusted R^2	0.275
Number of observations	167

Notes: CAP, the ratio of total equity to total assets; TEFF, technical efficiency scores of banks as obtained from DEA; RISK, the ratio of loan loss reserves to total assets, ROAA, the ratio of profit before tax to the average total assets; LD, the ratio of gross loans to total deposits. The table contains the results estimated using a simultaneous equations model with the 3SLS estimator. CAP, TEFF, and RISK represent the three endogenous variables in the simultaneous equations system. *t*-statistics are shown in parentheses, *, **, *** Significant at 10, 5, 1 per cent levels, respectively.

The results of the determinants of bank capitalisation are indicated in Table 4. The coefficient of TEFF is significant and negative, suggesting that banks often respond to a decline in operating efficiency by raising capital as a precautionary step. RISK[15] is significantly and negatively related to CAP – thus, the moral hazard hypothesis may exist. This result is in line with findings of Fiordelisi, Marques-Ibanez and Molyneux (2011) in European banking. Brewer, Jackson and Moser (1996) argue that when deposit insurance premiums are not risk-sensitive, managers invest in high-risk assets at discounted rates while simultaneously extending financial leverage to improve returns. In other words, moral hazard bank behaviour is indicative of high risk-taking which is combined with higher leverage. ROAA is positively and significantly associated with CAP, confirming that profitability leads to higher capital. This finding is in line with those of Kwan and Eisenbeis (1997) in the US banking system. Lastly, the coefficient of LD is significant and positive, implying that banks with the higher level of intermediation of deposit to loans could generate higher earnings, which ultimately leads to greater bank capital.

The results of determinants of bank efficiency are presented in the following table. As can be seen in Table 5, the coefficient of CAP is positive and significant, suggesting that banks with more capital operate more efficiently than those with less capital. This supports the view that moral hazard incentives are reduced as bank capital increases because more-capitalised banks are more likely to cut costs than less-capitalised counterparts.

[15] We also use Z-score as a proxy for bank risk. The coefficient of Z-score is statistically not significant in all models although the table of results cannot be presented due to the space restrictions. Nonetheless, the results are available upon request.

Table 5 The determinants of bank efficiency

	TEFF
CAP	0.031**(2.343)
RISK	-2.774***(-3.380)
LA	0.049***(3.171)
SIZE	0.710***(3.564)
DIV	0.029***(3.167)
Constant	-13.010***(-3.380)
Adjusted R^2	-33.186
No. of Obs	167

Notes: CAP, the ratio of total equity to total assets; TEFF, technical efficiency scores of banks; RISK, the ratio of loan loss reserves to total assets; LA, the ratio of gross loans to total assets; SIZE, the natural logarithm of total assets; DIV, the ratio of off-balance sheet items to total assets. The table contains the results estimated using a simultaneous equations model with the 3SLS estimator. CAP, TEFF, and RISK represent the three endogenous variables in the simultaneous equations system. *t*-statistics are shown in parentheses, **, *** Significant at 5, 1 percent levels, respectively.

RISK is negatively and significantly related to TEFF, thus supporting the bad luck hypothesis. According to this hypothesis, external events (the global financial crisis) precipitate an increase in risk for the banks (perhaps, loan defaults). Banks have to purchase the additional inputs necessary to administer these problem credits. This finding somewhat conflicts with those of Stewart, Matousek and Nguyen (2016) who found no relationship between bank risk and efficiency in Vietnam. In their paper, an ordinary least square estimation is not a robust method since it ignores the correlation of error term across equations. In addition, LA is positively and significantly associated with TEFF, suggesting that banks with higher loans-to-assets ratio tend to have greater technical efficiency levels. This also emphasizes that bank loans seem to be more highly valued than alternative bank outputs (investment and securities) in Vietnam. The finding is in line with those of Kwan and Eisenbeis (1997) in the US and Nguyen and Nghiem (2015) in India. Furthermore, SIZE is found to have a positive impact on TEFF, suggesting that larger banks are more efficient than smaller counterparts. This finding is comparable to those of Minh, Long and Hung (2013) and Stewart, Matousek and Nguyen (2016) in Vietnam. This can be explained by two main following reasons. Large banks should pay less for their inputs if it relates to market power. Also, there may be by increasing returns to scale through the allocation of fixed costs over a higher volume of services or from efficiency gains from a specialised workforce (Hauner 2005). In addition, DIV is significantly and positively related to TEFF, suggesting that diversification towards OBS activities is able to improve bank efficiency. This supports earlier findings of Sufian (2009) in Malaysia, Jeon and Miller (2005) in Korea. This can be explained by the following reasons. First, diversified banks can leverage managerial skills and abilities across products and services (Iskandar-Datta & McLaughlin 2005) and gain economies of scope by spreading fixed costs over multiple products (Drucker & Puri 2009). Second, they can provide more services to customers who demand multiple products and are willing to pay for extra convenience, thus increasing their income (Berger, Hasan & Zhou 2010).

The results of determinants of bank risk are shown in Table 6. CAP is found to have a negative impact on bank risk, suggesting that banks with relatively more capital (less leverage) tend to have less credit risk. The coefficient of TEFF is significant and positive, suggesting that supervisory authorities may allow efficient banks (with high-quality management) a greater flexibility in terms of their capital leverage – thus, more investing in risky assets. This is in line with the findings of Hughes and Mester (1998) who found that

higher risk is positively associated with more efficient banks.

Table 6 The determinants of bank risk

	RISK
CAP	-0.037***(-7.483)
TEFF	0.605**(2.474)
LA	0.021***(9.494)
DIV	0.011***(3.754)
GDP	0.095**(2.453)
INF	0.002(0.637)
Constant	-1.104***(-3.194)
Adjusted R^2	0.347
No. of Obs	167

Notes: CAP, the ratio of total equity to total assets; TEFF, technical efficiency score of banks; RISK, the ratio of loan loss reserves to total assets; LA, the ratio of gross loans to total assets; DIV, the ratio of off-balance sheet items to total assets; GDP, the economic growth rate; INF, the inflation rate. The table contains the results estimated using a simultaneous equations model with the 3SLS estimator. CAP, TEFF, and RISK represent the three endogenous variables in the simultaneous equations system. *t*-statistics are shown in parentheses, **, *** Significant at 5, 1 percent levels, respectively.

Furthermore, LA is significantly and positively associated with RISK, suggesting that excessively lending may increase risk faced by banks. In fact, the accelerating pace of lending between 2007 and 2011, especially advancing to non-deposit sources, potentially exposed the Vietnamese banking sector to higher liquidity risk. This result is comparable to those of Amador, Gómez-González and Pabón (2013), demonstrating that significant credit expansions do not generate corresponding increases in bank safety margins. The coefficient of DIV is significant and positive, implying that aggressive diversification strategies may have resulted in increased risk-taking. This is in line with those of Deng and Elyasiani (2008) and Le (2017), indicating that diversification benefits are offset by increased bank risk. In addition, GDP is significantly and positively related to RISK, suggesting that Vietnamese banks tend to pursue a massive lending and investment opportunities during the expansion of the economy – thus, they may face greater risk. INF is found to have no impact on bank risk.

5.3 Robustness Check

We further examine whether the interrelationship between risk, capitalisation and technical efficiency differ between small and large banks as presented in the following tables. Following

Berger and Bouwman (2009) and Le (forthcoming), large and small banks are defined as those with total assets greater and less than the median value, respectively.

Table 7 The relationships between risk, capital and efficiency for large banks

	CAP	TEFF	RISK
TEFF	-14.840***(-2.633)		0.285(0.570)
RISK	-0.748(-1.101)	-0.397(-1.535)	
CAP		0.039(1.532)	-0.123***(-4.405)
Constant	12.366***(3.852)	-4.114***(-3.564)	-0.680(-0.968)
Adjusted R^2	0.298	-1.363	0.341
No. of Obs	83	83	83

Notes: CAP, the ratio of total equity to total assets; TEFF, technical efficiency scores of banks; RISK is the ratio of loan loss reserves to total assets. The table contains the results estimated using a simultaneous equations model with the 3SLS estimator. CAP, TEFF, and RISK represent the three endogenous variables in the simultaneous equation system. The same set of control variables is used as above, but the coefficients of these variables are not presented due to space constraints. Large banks are classified as those with total assets greater than the median value. *t*-statistics are shown in parentheses, *** Significant at 1 percent levels, respectively.

Table 8 The relationships between risk, capital and efficiency for small banks

	CAP	TEFF	RISK
TEFF	-17.079(-1.485)		0.963***(5.748)
RISK	-8.954*(-1.916)	0.744(1.156)	
CAP		0.029**(2.103)	-0.024***(-6.658)
Constant	18.334***(2.970)	-0.892(-0.214)	-0.513**(-2.151)
Adjusted R^2	0.221	-0.868	-0.005
No. of Obs	84	84	84

Notes: CAP, the ratio of total equity to total assets; TEFF, technical efficiency scores of banks; RISK is the ratio of loan loss reserves to total assets. The table contains the results estimated using a simultaneous equations model with the 3SLS estimator. CAP, TEFF, and RISK represent the three endogenous variables in the simultaneous equation system. The same set of control variables is used as above, but the coefficients of these variables are not presented due to space constraints. Small banks are classified as those with total assets less than the median value. *t*-statistics are shown in parentheses, *,**, *** Significant at 10, 5, 1 percent levels, respectively.

Tables 7-8 show that CAP is found to have a positive impact on TEFF. Also, CAP is negatively associated with RISK regardless of bank sizes. Consequently, firms with more capital operate more efficiently and have the lower risk. In addition, TEFF is negatively related to CAP and has a positive impact on RISK. This confirms that Vietnamese banks tend to skimp on operating costs by reducing credit monitoring and collateral valuing in order to achieve efficiency in the short run. Vietnamese banks, however, would be exposed to greater credit risk in the long run. Last, RISK is significantly and negatively related to CAP for the case of small banks, supporting the moral hazard hypothesis. Nonetheless, these findings confirm our main findings as discussed above.

6. CONCLUSIONS

This study investigates the links among bank risk, capitalisation and technical efficiency in Vietnamese banking between 2007 and 2011 using the 3SLS estimation in a simultaneous equations model. The efficiency level of Vietnamese banking system as derived from DEA with the use of financial ratios appears to be relatively low, suggesting that there is a room for banks to further improve efficiency so as to achieve world best practice.

Our main findings indicate that banks with more capital operate more efficiently than those with less capital, indicating the level of capitalisation is a good proxy for performance. Capital also appears to have a negative impact on bank risk, implying that a higher capital ratio could not only improve bank efficiency but also reduce bank credit risk. Therefore, our findings strongly support the view of SBV that an increase in the minimum charter capital requirement would be beneficial for Vietnamese banks. In fact, the current minimum requirement on bank capital adequacy in Vietnam is much lower than what is suggested in BASEL III.

At the same time, technical efficiency is related to bank risk-taking. Our findings indicated that an improvement in banking efficiency precedes an increase in bank risk, supporting the skimping behaviour. This suggests that supervisors must pay special attention to the bank's internal credit control procedures (i.e. loan monitoring and review, collateral valuing). More importantly, our findings demonstrate the negative impact of bank risk on capitalisation. This implies that moral hazard bank behaviour is indicative of high risk-taking is combined with higher leverage. In addition, our findings also show that more-diversified banks tend to be higher risk-taking and have better performance. Our main findings still hold in subsamples.

It is worth to mention that each of these results has a relatively small impact on banks on average but may have a substantial effect on individual banks that are most subject to bad luck, bad management, skimping and/or moral hazard.

While this study examines only one emerging market and a limited period of study, it suggests the need for future research in other emerging nations that have similar banking structure for the robustness of our main findings. Perhaps, alternative techniques (bootstrap DEA as suggested by Simar and Wilson (1998, 2000) or SFA) could be used to estimate the technical efficiency of banks.

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