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Capital Structure and Bank Profitability in Vietnam: A Quantile Regression Approach

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Abstract: We empirically investigate the impact of capital structure on bank profitability using a quantile regression method in the Vietnamese banking system during 2007–2019. Our results suggest that the nonlinear relationship between capitalization and bank profitability is only significant at the 90th quantile. This is the first study to conclude that the turning point of capital ratio increases throughout the profitability distribution. Our findings thus suggest that a continuous increase in bank capital requirements does not necessarily result in higher bank profitability.

Keywords: capital structure; bank profitability; Vietnam; quantile regression; nonlinearity

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1. Introduction

The financial crisis has reemphasized an essential role of bank capital since many large financial institutions went bankrupt or even were bailed out by the central banks and governments. The social cost of bank failures has justified and challenged the existence of regulatory capital requirements for banks. Higher capital levels allow them to absorb larger shocks and reduce the incentives of banks' shareholders to take-on excessive risk. Notably, the new Basel accords have proposed a more rigorous bank framework regarding capital requirements. One of the main motivations of such capital requirements is to promote social efficiency by preventing the instability of the financial system. Le (2020) also shows that greater capital adequacy to enhance the banks' financial soundness tends to weaken market discipline. However, such capital requirements may lead to trade-offs for the banking system. Banks often argue that higher capital requirements will jeopardize their performance if banks' cost of financing increases significantly due to more capital holding. These higher funding costs could lower their returns on equity (ROE) and have a disruptive effect on liquidity creation (Le 2019). Le (2018), Admati et al. (2014), and among others point out that greater risk—which may be associated with higher leverage—is often related to a greater expected return, especially during the recent global financial crisis. Therefore, the analysis of the ROE can be used to account for bank risk-taking.

Different views are held in the literature. In the case of a perfect market, the framework of Modigliani and Miller (1958) (hereafter denoted as M&M) makes irrelevant in terms of bank value and capital structure decisions.[1] Another view demonstrates the disciplinary role of debt on managers (Diamond and Rajan 2000). An increase in capital thus may relax the manager from this discipline and be detrimental for performance. Last, a third strand contends that capital reduces the moral hazard

1 Some studies have indeed shown that higher capital results in a reduction in equity risk premium, thereby suggesting that M&M framework partially apply to bank (Miles et al. 2013).

issue between debtholders and shareholders. Banks are seen as delegated monitors (Diamond 1984). Because costs incur when monitoring, this requires incentives for banks to monitor on behalf of their debtholders. Accordingly, higher levels of capital may encourage banks to monitor their borrowers closely because shareholders shall take a greater portion of asset payoffs and lose more in case of a bankruptcy. Thus, a positive effect of capital on bank performance may exist. An improvement in bank profitability, through higher margins, may come from either higher efficiency or greater market power. Our empirical strategy is to study the various determinants of bank profitability with the main focus on capital ratios. It is important to notice that the complete analysis of the channels through which the bank's profitability may vary may go beyond the scope of our study.

The discussion above indicates that the relationship between capital and bank performance is a matter of debate. Our study extends the earlier research by investigating the heterogeneity effect of capital on bank profitability using a quantile regression approach on a panel data of 30 Vietnamese banks from 2007 to 2019. We find that bank profitability as measured by returns on equity has an inverted U-shaped relationship with the bank capital ratio. Further, the turning point is more significant in highly-profitable banks than in less-profitable ones. Besides, the heterogeneous impacts of bank efficiency and diversification are also found.

To contribute to this debate, we examine how the bank capital ratio affect their ROE when considering both banks' business models and risk-taking behavior. From an accounting perspective, an increase in bank capital reduces the expected ROE, since the equal profit is divided by an increase in the equity amount. However, we pay more attention to the economic impact of bank capital on ROE apart from this accounting effect.

Our paper contributes to the existing literature in several ways. First, unlike prior studies, we investigate the relationship between capital and bank profitability using a quantile regression approach. In contrast to the traditional Ordinary Least Square (OLS) method, quantile regression can report the entire conditional distribution of bank profitability and allows us to evaluate how our main interest variables affect banks at each quantile of profitability's conditional distribution, where the lowest and the highest profitable banks are emphasized. It is often the case that characteristics of the banks that generate profits above or below the conditional mean are substantially different. Therefore, regulators and policy-makers need to understand what happens at both extremes of the profitable distribution, given a certain level of bank capital. Second, we use a comprehensive of 30 Vietnamese banks throughout 2007–2019 to study the Vietnamese banking system, while the existing literature focuses primarily on the US and Europe where larger markets and numbers of banks facilitate economic modeling. Throughout the evolution of the banking system, it is more interesting to examine the correlation between capital requirements and bank profitability when implementing the new capital regulation framework. Vietnam provides a unique opportunity to examine the effect of capital ratios on bank profitability because of its remarkable transformation.

Since entering the World Trade Organization in 2007, Vietnam boasts one of the fastest-growing economies in the world,[2] with an annual average growth rate of 6.2%. The Vietnamese banking system is the backbone of its economy due to the underdeveloped stock market (Le 2019). However, bank capitalization, solvency, and profitability are relatively below international standards. For example, the profitability of Vietnamese banks is lower than their regional counterparts while the level of bank capitalization in Vietnam was the lowest among regional countries. Even more worrisome is that the equity to asset ratio has fallen since 2008 (Le 2017a).

The Vietnamese banking system has witnessed major reforms regarding new capital regulation, corporate governance, and risk management (Le et al.). In particular, banks were required to achieve the minimum charter capital requirement of VND 3000 billion but this requirement may be further

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[2] Just behind China within Asia with an average of approximately 9% of Gross Domestic Product growth per year over the same period.

increased since this is still lower than what is suggested by the Basel III (Le 2019). An increased capital requirement however may generate a trade-off for the economy as discussed above. This further raises a concern about whether this capital requirement may improve bank profitability in Vietnam. To reach conclusions on the importance of these factors, we move to the empirical findings section where other potential determinants of bank profitability are also controlled for.

The remainder of our study is organized as follows: Section 2 presents the literature review. Section 3 describes the data and methodology. Section 4 discusses empirical results and Section 5 concludes.

2. Literature Review

There is extensive theoretical literature on the relationship between capital and bank performance. Three views exist, leading to ambiguous conclusions. The first strand relies on the M&M framework, for which capital relative to assets does not affect the bank's value. The second assumes that too much capital will reduce banks' value. The last one however suggests that bank performance is positively associated with more capital. Along with these divergent theories, the empirical evidence of the relationship between capital and bank performance is ambiguous (Berger and Bouwman 2013). We discuss each theory and empirical studies in turn.

The M&M framework suggests that funding sources have no impact on asset cash flows. This means that a change in the mix of equity and debt does not affect firm value. The cost of equity is a function of asset risk and leverage and increases when equity financing decreases. This effect explains why the funding mix is neutral for firm value even though the cost of equity is superior to the cost of debt. Miller (1995) argues that nothing prevents the cost of capital from reducing when capital increases. It is noted that departures from M&M propositions (i.e., based on taxes and agency costs) do not systematically explain the different capital levels of firms across industries. The next two views depart from M&M proposition accurately, since they develop theories where capital levels may affect banks' asset cash flows differently.

The second view emphasizes that banks' value is negatively associated with higher levels of equity. This can be theoretically explained by the following reason. Based on their seminal work, Jensen and Meckling (1976) argue that more bank capital may induce agency costs. Besides, the literature in corporate finance on the disciplinary role of debt argues that managers can seek to avoid needing market discipline by building an equity cushion. In contrast, financing projects by debt encourages managers to make efficient decisions to regularly repay creditors (Hart and Moore 1995). Nonetheless, there is a difference between bank debt and corporate debt. A large portion is held by small insured depositors who have neither expertise nor the incentive to monitor banks (Dewatripont and Tirole 1994). This may limit the disciplinary role of debt, as proposed by the corporate finance literature.

Banks act as an intermediary in the economy by collecting funds from depositors and then lending them to borrowers. When a loan is given, a bank must monitor the borrowers and acquire loan payments as predetermined. This permits the bank to obtain private information from its borrowers, which helps the bank to evaluate their profitability more accurately. One may argue that this also may induce the bank to extract rents from its depositors by requiring a higher portion of the loan income. To maintain stable funding, the bank must make commitments to depositors by undertaking a fragile financial structure with a greater portion of liquid deposits. A fragile capital structure enhances the bank's ability to create more liquidity, since depositors have the right to cause a bank run when the bank is unable to raise financing (Diamond and Rajan 2000, 2001). This thus forces the bank to monitor the borrower. In this framework, increasing capital could result in a reduced loan value and a reduction in liquidity creation.

Capital requirements are also considered as a potential source of costs for banks, although regulatory capital aims at controlling bank risk-taking. Hellmann et al. (2000) demonstrate that higher capital requirements may have an indeterminate effect on bank behavior because they give incentives to invest in less risky portfolios but also may reduce banks' charter value. Therefore, this increases incentives to take on gambling behaviors. Indeed, several papers conclude that capital requirements tend to induce banks to switch from loans to low-yielding securities (Berger and Udell 1994; Thakor 1996). This shift may reduce bank profits. Moreover, several papers assert that a bank with an excessively high capital ratio is operating over-cautiously and ignoring opportunities to obtain profitable growth—thus, increasing opportunity costs of capital (Berger 1995b; Sharma et al. 2013). A recent study by Le and Ngo (2020) using cross-country data demonstrates that more capitalized banks tend to invest in risk assets, which in turn reduces their profits.

The third view, however, suggests a positive impact of capital on banks' value. This can be explained by two channels that are related to moral hazard behaviors, including the risk premium required by debtholders and monitoring efforts exerted by the bank (De Bandt et al. 2014). Due to the limited liability of shares, this minimizes the potential loss of equity holders but increases gains with risk-taking. Hence, this provides an incentive to take excessive risks at the expense of other stakeholders in the bank. Debtholders anticipate this behavior and require a premium to finance banks, thus debtors' market discipline forces banks to maintain a positive amount of capital (Calomiris and Kahn 1991). More capital may hinder a willingness of shareholders to take excessive risks. In contrast, debtholders require a lower premium in the case of better-capitalized banks. Consequently, higher capital requirements imply lower debt costs, thus ultimately increasing bank profitability. Under the second channel, higher capital internalizes potential losses derived from a lack of monitoring. Thus, banks are encouraged to monitor when the capital ratio increases. A study by Holmstrom and Tirole (1997) develops a model where the monitoring effort of the banks depends on its capital ratio. Later, a dynamic model proposed by Mehran and Thakor (2011) suggests that detaining capital is costly but the marginal cost differs across banks. Under a direct effect, higher payments extracted from borrowers because of the stronger monitoring effects imply higher margins for the bank. A direct effect comes from a supplementary incentive to monitoring because more capital increases the probability of survival, which improves future returns on the bank's investment. Berger and Bouwman (2013) indicate that a greater level of capital in the US small banks is associated with a higher probability of survival and greater market share both during financial crises and normal times. The same results are obtainable for large banks but only during financial crises episodes. Several empirical studies further report a positive relationship between capitalization and bank profitability (Berger 1995a; Goddard et al. 2004; Pervan et al. 2015; Saona 2016; Tan 2017). Others also suggest that banks with higher capital attract more loans and deposits, thus enhancing their performance (Calomiris and Mason 2003; Kim et al. 2005).

We further verify whether the capital ratio has any impact on bank performance using quantile regression. This is the first attempt to investigate the relationship between capital and bank profitability in Vietnam. Therefore, this has important implications for Vietnamese authorities in terms of considering further higher capital requirements towards Basel III.

3. Data and Methodology

3.1. Data

Our sample covered the period 2007–2019 for 30 Vietnamese commercial banks on a consolidated basis which together accounted for more than 80% of total assets in the industry. Bank-specific information was mainly obtained from banks' financial statements according to Vietnamese accounting standards. The data for macroeconomic variables were collected from the World Bank. Foreign-owned banks, foreign bank affiliates, and joint-venture banks were excluded from the sample because these banks are somewhat limited in their ability to operate in the banking system. Therefore, an unbalanced panel date with 353 observations was obtained, as the banking system has witnessed several bank mergers and acquisitions.[3]

3.2. Methodology

The quantile regression approach as introduced by Koenker and Bassett (1978) is used by several banking studies in risk-taking behavior such as Klomp and Haan (2012) using cross-country data, Jiang et al. (2019) in China, and Pires et al. (2015) in the US and EU markets.

The τ-*th* quantile of the conditional distribution of Y_i given X_i is,

$$Q_\tau(Y_i|X_i) = X_i'\beta_\tau \ . \tag{1}$$

The parameter vector of the τ-*th* quantile of the conditional distribution is calculated by

$$\hat{\beta_\tau} = argmin \sum_{i=1}^{N} \rho_\tau\left(Y_i - X_i'\beta\right) \tag{2}$$

where the quantile loss function $\rho_\tau(.)$ is defined as

$$\rho_\tau(u) = \{^{(\tau-1)\mu \ for \ u<0}_{\tau u \ for \ u \geq 0} \ . \tag{3}$$

In Equation (2), the quantile regression method permits parameter heterogeneity with different values for $\boldsymbol{\tau}$ in the interval (0, 1). This enabled us to capture a complete picture of the correlation between the independent variable and the dependent variable. Moreover, this method is robust to outliers and extreme distributions, since the weight can be adjusted via the loss function. Alternatively, the quantile regression does not restrict itself to the standard error term assumption of OLS estimation (Jiang et al. 2019). It thus offers an advantage in bank profitability research where the profitability distribution is heavy-tailed.

Panel data is commonly used to account for unobserved heterogeneity. Following Koenker (2004), Canay (2011), and Kato et al. (2012), a panel quantile regression model with fixed effects was given,

$$Q_{Y_{i,t}}\left(\tau_j \middle| X_{it}, \alpha_i\right) = X_{it}'\beta\left(\tau_j\right) + \alpha_i \tag{4}$$

where $Q_{Y_{it}}(\tau_j|X_{it}, \alpha_i)$ is the τ_j quantile conditional quantile function, and α_i is the individual fixed effect. Koenker (2004) also suggests a penalized quantile regression estimator that can be used to overcome the potential issue of including many fixed effects, and the coefficients of conditional quantile function (4) are obtained as follows:

$$\left(\hat{\beta}\left(\tau_j, \lambda\right), \alpha_i(\lambda)\right) = argmin \sum_{j=1}^{J} \sum_{t=1}^{T} \sum_{i=1}^{N} \omega_j \rho_{\tau j}\left(Y_{it} - X_{it}'\beta\left(\tau_j\right) - \alpha_i\right) + \lambda \sum_{i=1}^{N} |\alpha_i| \tag{5}$$

where ρ_{τ_j} is the quantile loss function similar to Equation (3), ω_j is the relative weight is given to the *j-th* quantile, and λ is the tuning parameter that accounts for the degree of shrinkage of the penalty term. For example, if $\lambda = 0$, the penalty term disappears and the usual fixed effects are obtained. While λ is infinity, pooled quantile regression estimator was estimated as

$$\hat{\beta}(\tau) = argmin \sum_{i=1}^{N} \sum_{t=1}^{T} \rho_\tau\left(Y_{it} - X_{it}'\beta\right). \tag{6}$$

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[3] For further discussion, please see (Le 2017c).

The pooled quantile regression estimator is generally handy to estimate the time-invariant effects of interest that are related to the differentials of bank profitability at different quantile levels of the conditional distribution. Nevertheless, the estimator can be biased if α_i and X_{it} are not independent.

To avoid the intensive computation of Koenker's technique, we followed a consistent and asymptotically normal two-step estimator of estimating a panel quantile regression model with fixed effects as developed by Canay (2011). The first step was to calculate the fixed effects and utilize the estimated parameters to acquire the individual fixed effect variable $(\hat{\alpha_i})$. The second step was to construct a new dependent variable by subtracting the estimated individual fixed effect $\left(\hat{Y}_{it} = Y_{it} - \hat{\alpha}_i\right)$, and runs a standard quantile regression.

Therefore, we used quantile regression to examine whether a measure of bank capital has a heterogeneous effect on bank profitability. Our basic conditional quantile model is specified as follows:

$$Q_\tau(ROE_{it}|X_{it}) = \alpha_i + \beta_{1\tau}CAP_{i,t-1} + \gamma_\tau B_{it} + \theta_\tau M_t + \varepsilon_{\tau it} \quad (7)$$

where $Q_\tau(ROE_{it}|X_{it})$ is the τ-th quantile regression function. ROE_{it} is the profitability of bank i during year t.[4] CAP is the bank capital measured by the ratio of total equity to total assets. We used lagged value for our capitalization measures because a contemporaneous measure of capital is endogenous to bank profit. Non-distributed profits increase banks' capital reserves. We considered a one-year lag in our models for this reason. The lag between capital ratio decisions and their effect on banks' performance should be considered when using accounting data. Since capital structures change, the market value reacts immediately as investors may anticipate the effects of capital ratios. The use of accounting data allowed us to measure the actual enhancement in bank performance that usually takes time to realize.[5] To check whether the endogeneity issue may exist, the pairwise Granger-causality with up to three-year lags was performed. Table 1 shows that the lagged values of ROE never Granger-causes bank capitalization.

Table 1. Pairwise Granger-causality tests.

Number of Lags	1		2		3	
Null hypothesis	F-Statistic	Probability	F-Statistic	Probability	F-Statistic	Probability
ROE does not Granger-cause CAP	0.067	0.797	0.098	0.907	0.45	0.717
CAP does not Granger-cause ROE	11.07	0.001	4.734	0.009	2.641	0.049

We also included the quadratic term of the capital ratio ($CAP2_{t-1}$) in the model to examine whether an inverted U-shaped relationship between bank capital and profitability may exist. We also used a one-year lag for this variable.

B_{it} is a set of bank-specific control variables. $EQGR$ is a dummy variable that takes a value of 1 when equity is increased between two periods, 0 otherwise is used to control for the equity accounting effect. This dummy was included to consider the economic effect of the capital measure apart from the accounting effect. More importantly, this dummy variable is also generally used to account for the subgroup with an absolute increase in capital (that is different from the variation in capital ratios), since a negative accounting effect may cause the same economic effect of the change in capital ratios but a

4 Following (Le et al. 2019), we also used $RAR_{ROE} = \frac{ROE_{it}}{\sigma_{ROE_i}}$ where σ_{ROE_i} is the standard deviation of ROE over the examined period as an alternative measure of bank profitability for robustness checks. Similar results were also obtained, although they are not reported here due to the length restriction.

5 Note that accounting data presents an advantage over market data when examining the causal relationship between capitals ratios and bank profitability. More specifically, over-valued stocks may induce banks to raise equity. This means that an increase in market value would be associated with higher capital ratios but without causality stemming from capital (Baker and Wurgler 2002). By utilizing accounting data, this potential over-valuation bias could be avoided.

reduced ROE on average for this subgroup. This variable was expected to be negatively related to our measures of bank profitability. A one-year lag of this variable was used since the contemporaneous variable is endogenous, i.e., benefits raise capital reserves, and thus simultaneously increase equity growth. *CIR*, the cost to income ratio, was used to control for bank efficiency. Greater efficiency was associated with reduced production costs by employing superior management or more advanced production technologies. This then allows banks to lower their pricing charged, which results in increased sales and greater market shares, thus triggering higher profitability. *LLP*, as measured by the ratio of loan loss provisions to total loans, was used to control for the credit risk (Le 2017b). Several studies show that greater credit risk is associated with a reduction in bank profitability (Athanasoglou et al. 2008; Dietrich and Wanzenried 2014). In contrast, Figlewski et al. (2012) indicate that a greater level of risky assets is related to higher profitability because banks need to compensate for their higher risk of default. *LOAN*, the ratio of total loans to total assets, was used to control for the effect of lending specialization. Several studies show a positive impact of loans on bank profitability (Ben Naceur and Goaied 2008; Saona 2016). However, Demirgüç-Kunt and Huizinga (1999) and Duca and McLaughlin (1990) show opposite findings and suggest that if a large credit portfolio includes high-risk loans causing lower returns and financial losses, then bank profits will deteriorate. *LATA*, the ratio of liquid assets to total assets, is used to control for liquidity risk. Several studies conclude banks that hold more liquid assets tend to have a lower profit (Sharma et al. 2013). Given the low return relative to other assets, more funds invested in cash or cash equivalents may reduce liquidity premiums in the net interest margin. However, an increase in the relative liquid assets holdings of banks may reduce its probability of default—thus, improving bank profits (Bordeleau and Graham 2010; Bourke 1989). To measure bank functional diversification (*DIV*), we used the ratio of non-interest income to total net income. Several studies reveal that diversification affects bank performance positively because it constitutes an additional source of revenues (Cybo-Ottone and Murgia 2000; Lepetit et al. 2008). The costs, however, may outweigh the gains of diversification (Berger et al. 2010).

M_t is a set of time-varying macroeconomic control variables. The Herfindahl-Hirschman index (*HHI*) as measured by the sum of the squared market shares of each bank's assets for a given year, is used to control for the effects of market concentration[6] (García-Herrero et al. 2009).[7] Accordingly, *HHI* is just greater than 0 for a perfectly competitive market and equals to the value of 1 in the case of a monopoly. The structure-conduct-performance hypothesis posits that banks with market power earn higher profits by colluding to charge high fees on their products and/or services while offering lower deposit rates (Dietrich and Wanzenried 2014; Saona 2016). Several studies, however, show opposite findings (Bolarinwa and Obembe 2017; Mirzaei et al. 2013).[8] *GDP*, the annual Gross Domestic Product growth rate, was used to control for the effects of economic growth (Ben Naceur and Goaied 2008). Some research shows that economic growth affects bank profitability negatively (Tan and Floros 2012) or does not have any impact (Sharma et al. 2013). However, an increase in demand for banks' financial products and services during cyclical upswings of the economy improves their profitability (Athanasoglou et al. 2008; Demirgüç-Kunt and Huizinga 1999; Dietrich and Wanzenried 2014). *INF*, the annual inflation rate, was used to control for the effects of inflation. A greater inflation rate will result in higher interest rates on loans, thus generating greater bank profitability. On the other hand, a higher inflation rate affects the borrowers' budgets, which threatens their liquidity and limits their ability to pay debts. An increase in interest rates thus may increase the risk of loan repayment (Pervan et al. 2015).

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6 We are aware that there are alternative indicators of market concentration such as Lerner index or the Rosse-Panzar. However, these non-structure measures have some major limitations, as discussed in Dietrich and Wanzenried (2014)'s study.

7 We also use HHI-D in terms of deposits to provide the robust checks. Similar results were obtained, although they cannot be presented here for brevity.

8 For further discussion on this matter, please see (Le 2017a).

Following prior studies, five quantiles $\tau = \{0.1,\ 0.25, 0.5, 0.75, 0.9\}$ were reported to investigate the covariate effect across the conditional distribution of bank profitability.

The descriptive statistics of variables used in our regressions are presented in Table 2. As can be seen, the distribution of *ROE* at the 10th and the 90th quantiles is approximately 1% and 18.6%, respectively. This indicates that bank profitability measured by *ROE* varies a lot from lower quantiles to higher quantiles. A histogram of *ROE* is presented in Figure 1. The distribution of profitability is skewed and has a heavy right tail. Such a fact further reinforces the necessity of a quantile approach.[9] Also, Table 3 presents the correlation matrix among explanatory variables and shows that multicollinearity among them should be less of a concern.

Table 2. Descriptive statistics of the variables used.

Variables	Mean	S.D	Min	Q(10)	Median	Q(90)	Max
ROE	0.088	0.08	−0.045	0.01	0.081	0. 186	0.362
CAP_{t-1}	0.143	0.173	0.034	0.054	0.09	0.219	1.03
$EQGR_{t-1}$	0.703	0.457	0	0	1	1	1
CIR	0.095	0.029	0.032	0.009	0.095	0.022	0.257
LLP	0.006	0.005	−0.005	0.002	0.004	0.013	0.044
LOAN	0.894	0.072	0.191	0.826	0.913	0.945	0.97
LATA	0.488	0.215	0.108	0.244	0.448	0.782	1.38
DIV	0.248	0.082	0.066	0.145	0.246	0.35	0.595
HHI	0.092	0.025	0.076	0.08	0.083	0.124	0.17
GDP	0.063	0.085	0.05	0.053	0.063	0.07	0.084
INF	0.078	0.058	0.063	0.027	0.06	0.185	0.198

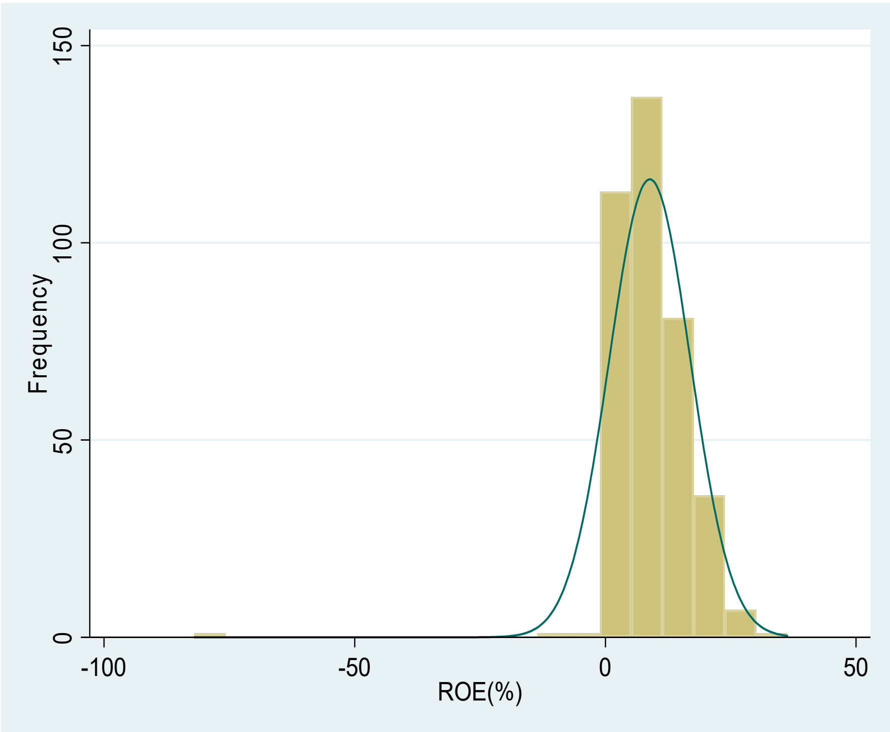

Figure 1. Histogram for *ROE*. This figure presents the histogram and normal density for *ROE*.

9 Although the standard conditional mean method could be appropriate to model average risk, it cannot offer an accurate description of the risk spread (Pires et al. 2015).

Table 3. Correlation matrix of variables used.

	ROE	CAP_{t-1}	$EQGR_{t-1}$	CIR	LLP	LOAN	LATA	DIV	HHI	GDP	INF
ROE	1										
CAP_{t-1}	0.140	1									
$EQGR_{t-1}$	−0.039	−0.052	1								
CIR	−0.259	0.024	−0.051	1							
LLP	0.101	0.004	0.017	0.155	1						
LOAN	0.147	−0.334	−0.012	−0.129	0.045	1					
LATA	0.006	0.098	0.006	−0.180	−0.335	−0.235	1				
DIV	0.363	0.121	−0.017	0.391	0.459	−0.118	−0.073	1			
HHI	0.122	0.104	0.007	−0.119	−0.137	−0.349	0.194	−0.027	1		
GDP	0.106	−0.079	0.000	0.152	0.084	0.147	−0.184	0.168	−0.004	1	
INF	0.090	0.152	−0.008	−0.443	−0.196	−0.335	0.392	−0.273	0.459	−0.195	1

4. Findings

4.1. Conditional Mean Regressions

One of the serious disadvantages of OLS regression is to under- or over-estimate the effects in heterogeneous distributions (Cade and Noon 2003). Hence, we first reported the results of the relationship between the capital ratio and ROE using pooled and fixed effects OLS regression estimates as benchmarks. For different specifications of the model, the data indicated in Table 4 show that the specific impact of bank capital is slightly different but the signs of estimates are all the same. In other words, better-capitalized banks are associated with higher profitability.

Table 4. Capital structure and bank profitability (ROE): OLS and fixed-effects models.

	Pooled OLS		Fixed Effects	
CAP_{t-1}	7.439 *** (2.307)	7.364 *** (2.310)	6.753 *** (2.412)	6.218 *** (2.412)
$CAP2_{t-1}$		−1.22 (1.45)		−3.63 ** (1.71)
$EQGR_{t-1}$	−0.096 (0.12)	−0.534 ** (0.717)	−0.376 (0.712)	−0.303 (0.709)
CIR	−137.964 (15.584)	−141.088 *** (15.798)	−165.919 *** (17.224)	−172.497 *** (17.408)
LLP	−198.928 *** (75.874)	−196.856 *** (76.203)	−250.026 *** (81.534)	−247.635 *** (81.091)
LOAN	28.511 ** (6.563)	28.326 *** (6.591)	19.807 *** (7.375)	17.138 *** (7.441)
LATA	−2.478 (2.15)	−2.569 (2.167)	−2.93 (2.522)	−2.635 (2.512)
DIV	57.601 *** (5.719)	57.906 *** (5.792)	48.575 *** (6.552)	46.619 *** (6.515)
HHI	76.096 ** (30.484)	75.268 ** (30.402)	71.435 ** (29.851)	66.080 ** (29.793)
GDP	0.830 * (5.096)	0.917 * (0.516)	1.097 ** (0.503)	1.414 ** (0.522)

Table 4. *Cont.*

	Pooled OLS		Fixed Effects	
INF	0.064 *** (0.081)	0.052 (0.081)	−0.06 (0.085)	−0.105 (0.087)
Constant	−28.217 (8.209)	−28.051 (8.224)	−15.282 (9.137)	−13.220 (9.138)
No. Obs	353	353	353	353
R−square	0.348	0.353	0.361	0.370

Notes: This table presents pooled OLS and panel OLS with fixed effects. Robust standard errors clustered at the bank level are reported in parentheses. *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

4.2. *Quantile Regression Analysis*

Although these two above methods can provide a good estimation of the average profitability level, neither of them can capture the whole distribution of conditional bank profitability. Thus, quantile regression was used to address the heterogeneity effect of capitalization on bank profitability along with the quantile distribution. For the ease of exposition, we only focused on interpreting our main interest variables.

Table 5 displays baseline results of panel quantile regression analysis in which five quantiles of the conditional distribution of *ROE* (the 10th, 25th, 50th, 75th, and 90th quartiles) are indicated. All estimate coefficients are significant and their signs are similar to those obtained by the conditional mean approach. More specifically, the coefficients of *CAP* are significant and positive, suggesting that an increase in capital level tends to improve ROE. This thus supports a positive view where more capital increases the monitoring effort of the banks, and thus the pay-offs it collects.

We contend that higher capital may cause a decrease in marginal returns, and thus a positive relationship between capital ratios and bank profitability in Vietnam may not hold beyond a certain threshold. Therefore, the quadratic term of the capital ratio was used to capture the U-shaped feature of nonlinearity between capital and bank profitability.[10] Table 6 shows that the coefficients of *CAP2* are statistically significant in the higher quantiles (i.e., the 90^{th} quartile), but not in the lower quantiles. This suggests that the inverted-U shaped relationship is only significant around the 90th quantile of the distribution. To provide further insights into the non-linear relationship between capital ratio and bank profitability, we needed to estimate the turning points. It should be noted that evidence would support the inverted U-shaped relationship at the τ quantile if $\beta_{1\tau} > 0$ and $\beta_{2\tau} < 0$ where $\beta_{1\tau}$ and $\beta_{2\tau}$ denote the coefficients of linear and quadratic terms of *CAP* at the τ quantile, respectively. The turning point level of bank capital was calculated as $CAP^*_\tau = -\frac{\beta_{1\tau}}{2\beta_{2\tau}}$. We found that the turning point obtained from a quantile regression (1.01) is greater than those obtained from fixed effects OLS regression (0.86).

Our findings indicate that the influence of capitalization on bank profitability is heterogeneous across profitability conditional distributions. However, it is necessary to test whether or not these differences are statistically significant. We used inter-quantile regressions to check for slope equality across quantiles (Koenker and Bassett 1978). Following Jiang et al. (2019) among others, we ran the inter-quantile regressions for a range of inter-quantile regressions. For brevity, we only present the result between upper quantiles (the 90th) and the lower quantiles (the 10th a), i.e., $Q(90/10) = Q_{0.90}(y) - Q_{0.10}(y)$. Table 7 shows that the coefficients are not significantly different. These findings demonstrate that there is little evidence of heterogeneity in the effect of capitalization on bank profitability, although the effect is different across the conditional distribution of bank profitability.

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[10] Another strand in the literature argues the relationship between risk-taking and capital ratios has an inverted U-shape. See notably (Jiang et al. 2019).

Table 5. Baseline results for ROE: quantile regressions.

Quantiles	0.1	0.25	0.5	0.75	0.9
CAP_{t-1}	7.917 *** (2.734)	8.126 *** (2.318)	9.464 *** (2.02)	6.610 ** (2.481)	6.274 ** (2.593)
$EQGR_{t-1}$	−0.442 (0.901)	0.013 (0.764)	0.317 (0.665)	−0.158 (0.817)	−1.086 (0.854)
CIR	−35.324 ** (17.832)	−5087.192 (15.12)	−62.908 *** (13.172)	−89.769 *** (16.186)	−110.601 *** (16.91)
LLP	−8.007 (87.763)	−240.198 *** (74.445)	−314.002 ** (64.856)	−357.837 *** (79.669)	−213.088 ** (83.257)
LOAN	25.651 *** (7.438)	35.409 *** (6.307)	44.412 *** (5.494)	44.220 *** (6.749)	40.305 *** (7.053)
LATA	1.718 (2.329)	0.499 (1.975)	−1.884 (1.72)	−1.207 (2.113)	−0.111 (2.208)
DIV	31.056 *** (6.422)	54.462 *** (5.446)	65.154 *** (4.744)	80.077 *** (5.828)	91.121 *** (6.09)
HHI	19.81 (38.912)	7.168 *** (32.994)	10.432 (28.744)	10.546 (35.31)	94.700 ** (36.9)
GDP	0.239 (0.649)	0.235 *** (0.55)	−0.244 (0.479)	−11.329 (0.588)	0.588 (0.615)
INF	0.274 *** (0.098)	0.326 *** (0.083)	0.349 *** (0.072)	0.395 *** (0.089)	0.412 *** (0.093)
Constant	−30.726 (9.503)	−36.493 (8.051)	−41.634 (7.02)	−40.203 (8.624)	−46.489 (9.012)
No. Obs	353	353	353	353	353
Pseudo R^2	0.126	0.258	0.335	0.383	0.435

Note: This table presents pooled quantile regression for the 10th, 25th, 50th, 75th, and 90th quantiles. The dependent variable is ROE. Standard errors are in parentheses. **, and *** denote statistical significance at 5%, and 1%, respectively.

Table 6. The U-shaped relationship between capital ratio and ROE.

Quantiles	0.1	0.25	0.5	0.75	0.9
CAP_{t-1}	6.648 *** (2.419)	8.491 *** (2.200)	8.728 *** (2.059)	5.789 ** (2.304)	7.339 ** (2.914)
$CAP2_{t-1}$	3.50 (1.42)	1.79 (1.30)	4.97 (1.21)	−2.11 (1.36)	−3.62 ** (1.72)
$EQGR_{t-1}$	−0.564 (0.796)	−0.104 (0.724)	0.136 (0.678)	−0.048 (0.758)	−1.081 (0.960)
CIR	−31.872 ** (15.883)	−56.689 *** (14.448)	−59.409 *** (13.522)	−97.779 *** (15.129)	−114.772 *** (19.138)
LLP	32.221 (77.887)	−267.268 *** (70.848)	−330.735 *** (66.309)	−274.399 *** (74.190)	−222.182 ** (93.844)
LOAN	22.338 *** (6.661)	33.801 *** (6.059)	44.573 *** (5.671)	440.770 *** (6.345)	40.793 *** (8.026)
LATA	2.579 (2.076)	0.016 (1.889)	−1.738 (1.768)	−0.486 (1.978)	−0.825 (2.502)
DIV	29.024 *** (5.775)	54.319 *** (5.253)	64.801 *** (4.916)	−0.486 (1.978)	−0.825 (2.502)

Table 6. *Cont.*

Quantiles	0.1	0.25	0.5	0.75	0.9
HHI	5.418 (34.407)	−11.765 (31.298)	10.433 (29.293)	8.971 (32.774)	91.967 ** (41.457)
GDP	0.376 (0.577)	0.423 (0.525)	−0.307 (0.491)	0.350 (0.550)	0.532 (0.696)
INF	0.288 *** (0.087)	0.329 *** (0.079)	0.361 *** (0.074)	0.353 *** (0.082)	0.416 *** (0.104)
Constant	−27.628 (8.495)	−35.694 (7.727)	−41.619 (7.232)	−39.504 (8.092)	−46.207 (10.236)
No. Obs	353	353	353	353	353
Pseudo R^2	0.140	0.265	0.336	0.389	0.449

Note: This table presents pooled quantile regression for the 10th, 25th, 50th, 75th, and 90th quantiles. The dependent variable is ROE. Standard errors are in parentheses. **, and *** denote statistical significance at 5%, and 1%, respectively.

Table 7. The result of inter-quantile regression.

Inter-Quantile	Q(90/10)
CAP_{t-1}	0.851 (3.97)
$CAP2_{t-1}$	−0.000 *** (0.000)
$EQGR_{t-1}$	−0.517 (1.001)
CIR	−82.899 ** (41.561)
LLP	−189.961 (129.86)
LOAN	18.455 (12.724)
LATA	−3.405 (3.524)
DIV	64.629 *** (14.171)
HHI	86.548 (77.332)
GDP	0.155 (0.831)
INF	0.128 (0.199)
Constant	−18.579 (17.085)
No. Obs	353

Notes: This table shows the difference in quantile regression estimates for an inter-quantile regression: *Q(90/10)* = $Q_{0.90}(y) - Q_{0.10}(y)$. The bootstrapped cluster standard errors (in parentheses) were obtained with 50 bootstrap replications. **, and *** denote statistical significance at 5%, and 1%, respectively.

Tables 5 and 6 also indicate that *CIR* is generally negatively and significantly associated with ROE, suggesting that less efficient banks tend to have lower profitability. Besides, a positive relationship between *DIV* and ROE implies that more-diversified banks tend to have greater performance. This is comparable with the findings of Le (2018) in Vietnam. Table 7 further confirms the heterogeneity in the impacts of bank efficiency and diversification on bank profitability.

4.3. Robust Checks

To provide robust checks, several regressions were run. Following Dietrich and Wanzenried (2014), we first used returns on assets (*ROA*) as an alternative measure of bank profitability.[11] The *ROE* is simply calculated as the product of *ROA* and the ratio of total assets to equity. Therefore, a negative accounting effect should be not expected with the ROA, and the variable *(EQGR)* was excluded from our model. For the sake of brevity, we only report our main interest variables as shown in Tables 8–10. The findings show a positive impact of capital ratio on bank capital and the U-shaped relationship between them in higher quantiles (i.e., 50th, 75th, and 90th). However, we do not find any evidence of heterogeneity in the effect of bank capitalization on ROA. Therefore, our main findings as above were confirmed.

Table 8. Baseline results for ROA: quantile regressions.

Quantiles	0.1	0.25	0.5	0.75	0.9
CAP_{t-1}	0.008 (0.005)	0.005 (0.004)	0.016 *** (0.004)	0.032 *** (0.006)	0.035 *** (0.009)
Constant	−0.014 (0.005)	−0.009 (0.004)	−0.011 (0.005)	−0.021 (0.006)	−0.026 (0.009)
No. Obs	353	353	353	353	353
Pseudo R^2	0.173	0.229	0.257	0.303	0.323

Note: This table presents pooled quantile regression for the 10th, 25th, 50th, 75th, and 90th quantiles. The dependent variable is ROA. The same set of variables in Equation (7) is used although they are not reported here due to the length constraints. Standard errors are in parentheses. *** denotes statistical significance at 1%.

Table 9. The U-shaped relationship between capital ratio and ROA.

Quantiles	0.1	0.25	0.5	0.75	0.9
CAP_{t-1}	0.021 (0.014)	0.017 (0.010)	0.041 *** (0.010)	0.050 *** (0.014)	0.0744 *** (0.018)
$CAP2_{t-1}$	−0.013 (0.022)	−0.015 (0.016)	−0.047 *** (0.016)	−0.059 *** (0.021)	−0.094 *** (0.028)
Constant	−0.016 (0.007)	−0.012 (0.005)	−0.015 (0.005)	−0.024 (0.007)	−0.021 (0.009)
No. Obs	353	353	353	353	353
Pseudo R^2	0.175	0.223	0.263	0.309	0.334

Note: this table presents pooled quantile regression for the 10th, 25th, 50th, 75th, and 90th quantiles. The dependent variable is ROA. The same set of variables in Equation (7) was used, although they are not reported here due to the length constraints. Standard errors are in parentheses. *** denotes statistical significance at 1%.

It may be a concern that our study of the relationship between bank capital and profitability may suffer from potential endogeneity. To overcome the potential issues of omitted variables and reverse causality among variables that may cause parameter estimates become biased and inconsistent, we re-estimated the model in a two-step system generalized method of moments (GMM) framework for both ROA and ROE. The data shown in Table 11 confirms our above findings.

[11] We thank an anonymous referee for their suggestion.

Table 10. The result for ROA: inter-quantile regression.

Inter-Quantiles	Q(90/10)	Q(75/25)
CAP_{t-1}	0.052 *	0.033 *
	(0.031)	(0.017)
$CAP2_{t-1}$	−0.081	−0.043
	(0.063)	(0.039)
Constant	−0.005	−0.011
	(0.010)	(0.007)
No. Obs	353	353

Notes: This table shows the difference in quantile regression estimates for an inter-quantile regression: $Q(90/10) = Q_{0.90}(y) - Q_{0.10}(y)$. The same set of variables in Equation (7) was used, although they are not reported here due to the length constraints. The bootstrapped cluster standard errors (in parentheses) were obtained with 50 bootstrap replications. * denotes statistical significance at 10%.

Table 11. The relationship between the capital ratio and bank profitability using system GMM.

	ROA		ROE	
π_{t-1}	0.276 ***	0.235 ***	0.371 ***	0.616 ***
	(0.053)	(0.020)	(0.077)	(0.102)
$CAP_{t\text{-}1}$	0.045 ***	0.048 ***	0.308 ***	0.333
	(0.009)	(0.009)	(0.101)	(0.581)
$CAP2_{t\text{-}1}$		−0.043 ***		−1.937
		(0.012)		(0.402)
$EQGR_{t\text{-}1}$			−0.087 ***	−0.107 **
			(0.027)	(0.036)
Constant	−0.051	−0.019	−0.393	−0.410
	(0.009)	(0.005)	(0.109)	(0.167)
No. of Obs	353	353	353	353
No of Groups	30	30	30	30
AR1 (p-value)	0.060	0.055	0.094	0.050
AR2 (p-value)	0.137	0.118	0.333	0.721
Hansen test (p-value)	0.344	0.225	0.691	0.689

Notes: This table presents a two-step GMM estimator to control for potential endogeneity between capitalization and bank profitability. The same set of variables in Equation (7) was used, although they are not reported here due to the length constraints. Robust standard errors are reported in parentheses. **, and *** denote statistical significance at 5%, and 1%, respectively.

5. Conclusions

This paper brings new evidence of the effect of bank capitalization on bank profitability in Vietnam. Our study contributes to the debate on the effect of capital requirements where no consensus emerges from prior literature. We find unambiguous support of a positive effect of an increase in the capital on banks' ROE. However, our results indicate that an inverted U-shaped relationship between capitalization and banks' ROE is only significant at the 90th quantile. We do find very little evidence of the heterogeneity of sensitivity to capitalization across banks with different profitability levels. Nonetheless, this may suggest that banks may not be encouraged to improve their capital requirements as much as possible, since exceeding a turning point may reduce banks' profitability. For this reason, the adoption of increasing capital requirements towards the Basel framework is carefully considered by Vietnamese banks and should be taken step-by-step.

The study may suffer some following limitations. Future research may consider the use of capital adequacy as an alternative measure of bank capital ratios to verify our main findings. Furthermore, our study only examines one country within a limited period, implying that future research needs to investigate this link in other emerging markets that have an analogous banking structure for robust checks.

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