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Article

How capital structure and bank liquidity affect bank performance: Evidence from the Bayesian approach

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GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

How capital structure and bank liquidity affect bank performance: Evidence from the Bayesian approach

Tran Thi Kim Oanh¹, Diep Van Nguyen², Hoi Vu Le³ and Khoa Dang Duong^{4*}

Abstract: This article analyzes the impact of capital structure and bank liquidity on the performance of commercial banks in Vietnam, a transition market in Asia. This research is unique because it is the first study to employ the Bayesian Estimation methods in banking studies. The data includes 463 annual bank-year observations from 37 commercial banks in Vietnam from 2003 to 2020. The Bayesian linear regressions indicate that a higher leverage ratio reduces ROA and ROE while positively empowering EPS. Our findings also document the positive impacts of bank funding liquidity on the performance of commercial banks in Vietnam. Our results are also robust even when employing the Generalized Least Squares estimations. While our results are consistent with the Pecking Order Theory and prior literature, they do not align with the trade-off theory. Finally, our study contributes implications for policymakers and bank managers to develop the banking system sustainably.

Subjects: Banking; Credit & Credit Institutions

Keywords: Bayesian regressions; capital structure; liquidity; commercial banks; generalized least squares

JEL Classification: C11; G21; G32

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1. Introduction

Banks play a substantial role in the financial system and the economy and are one of the conditions for long-term economic growth (Tran et al., 2022). Almaqtari et al. (2019) and Menicucci and Paolucci (2016) suggest that bank performance can be evaluated at the micro and macro levels. Specifically, competition negatively drives banking performance at the micro-level, so the fundamental goal is to gain profits, which is essential for a bank to grow sustainably. Commercial banks with lower costs are likely to gain a larger market share. Therefore, capital structure decisions play a crucial role in determining banking performance.

According to the State Bank of Vietnam, Vietnamese commercial banks plan to meet Basel II standards by 2023. However, only about 40% of banks have met the requirement. Thus, the minimum capital adequacy ratio (CAR) in Vietnam is 8%.¹ According to Basel II's standards, the National Financial Supervisory Commission of Vietnam predicts that banks must increase total equity by 1.8 to 2.0 times before meeting the minimum capital adequacy ratios regulation. In addition, the crises in several banks in Vietnam in recent years related to liquidity risks and capital structure management have brought much attention to policymakers, bank managers, and the people.² As a result, capital structure considerations will be the banking industry's primary issue. The capital structure relies on Trade-off Theory, suggesting that commercial banks archive safe capital structure as profitability costs. Siddik et al. (2017) and Sivalingam and Kengatharan (2018) document an inversed impact of capital structure on banking performance in Bangladesh and Sri Lanka.

The Vietnamese banking system continues to encounter several hurdles and difficulties (Khoe et al., 2022). The dominations of state-owned banks and credit quality and liquidity issues are critical challenges (Batten & Vo, 2016). Therefore, enhancing the business efficiency of banks is an essential requirement to motivate banks to enhance their competitiveness, increase market share, and be sustainable. While prior studies are conducted in developed and emerging countries, banking performance in transitional countries still needs to be explored.

Siddik et al. (2017) employ the Ordinary Least Square (OLS) method to analyze the negative impact of capital structure on bank performance. Almaqtari et al. (2019) apply the Generalized Method of Moments (GMM) to explain how leveraged capital structure affects ROA and ROE. Our work uses a Bayesian method to augment existing research for the following reasons. Although numerous research studies have been conducted on the linkage between capital structure and banking performance, the empirical results obtained using the classic panel estimating approach remain contentious (Andrade, 2019). Second, present research models are becoming increasingly complex, requiring more complex estimates. Nevertheless, the classical method based on asymptotic assumptions is faced with the problem of a small sample size. Therefore, implementing the Bayesian approach helps overcome the drawbacks of the linear estimation techniques because it does not require an asymptotic property, which can be problematic when applying the frequentist approach in small sample situations (McNeish, 2016; Miočević et al., 2017).

Additionally, the Bayesian estimator allows one to incorporate external information into the data using a prior distribution. Hespanhol et al. (2019) indicate that the added prior information improves the accuracy and reliability of the estimate. The credible intervals consider this; conversely, the confidence intervals depend exclusively on the data (Hespanhol et al., 2019). Thus, we use the Bayesian technique to estimate capital structure influence on the performance of Vietnamese banks. This research provides Vietnam's literature and policy discussions about commercial bank capital structure.

Capital structure and liquidity, and bank performance have a causal relationship. Banks must maintain appropriate amounts of cash, liquid assets, and potential credit lines to fulfill contingent liquidity demands to provide banking services to consumer funding for expansion. Lei and Song (2013) show that the better the quality of the bank's liquid assets, the higher the liquidity structure

and the lower the liquidity risk. Therefore, Lei and Song (2013) argue that higher liquidity allows commercials to enjoy credit growth, empowering bank performance. However, Arif and Anees (2012) conjecture that reducing liquidity causes banks to raise external capital with higher funding costs, reducing the bank's performance. Gropp and Heider (2010) report that highly levered banks have good reputations to efficiently raise capital from the public to extend their credit activities. As a result, capital structure certainly affects commercial bank performance.

Our empirical findings demonstrate the negative relationship between capital structure and ROA. Musah (2018) argued short-term debt ratio has a negative relationship with ROA. That means it has to repay the depositors on time while that debt has yet to make profits. However, our findings figure favorable impacts of the capital structure on ROE and EPS. The commercial bank uses higher leverage to amplify ROE and EPS. Therefore, a high bank's leverage ratio shows that the bank has a high debt-to-capital ratio. In addition, when a bank has higher leverage, it shows that it is operating efficiently and has obtained adequate capital to expand credit growth, empowering ROE and EPS. These results align with Al-Kayed et al. (2014) and Pecking Order Theory.

Our findings also document mixed impacts of bank liquidity, proxied by the loan-to-customer ratio (LIQ) and bank funding diversity (BFD), on banking performance. Although LIQ empowers the performance of commercial banks, maintaining diversified funding sources reduces Vietnamese commercial banks' performance. Our findings are consistent with Abbas et al. (2019), Ritz and Walther (2015), and Vo (2020).

Our study deviates from the prior literature as follows. First, we are the first to employ the Bayesian regression approach in banking studies in Vietnam, while prior studies employ traditional regression methods. The Bayesian regression approach helps us overcome asymptotic issues and optimizes the results in the small sample context. Secondly, we collect data on 37 Vietnamese commercial banks from 2003 to 2020. A long observation period enables us to fully consider the influence of capital structure on the performance of Vietnamese banks. Finally, we also perform a robustness test by comparing the results from Bayesian Regression with the Generalized Linear Model (GLM) estimations. Although the two methods generate similar results, the Bayesian estimates have advantages in small sample estimation (McNeish, 2016; Miočević et al., 2017). Therefore, our study generates robust results, even after employing the GLM method.

Our findings contribute several implications for bank managers and policymakers to develop the banking system sustainably. First, with a more diversified funding source, Vietnamese banks will be more active in various banking activities, improving their profitability and minimizing risk. However, to maintain a reasonable level of loan volume, they should also manage their capital requirements and operating costs. Second, since higher leverage allows banks to have more capital as a buffer against risky activities, they are motivated to increase their lending capacity. Therefore, credit risk management and a strong capital structure protect commercial banks from economic shocks. Third, bank managers must closely watch the macroeconomic factors affecting their business performance. Therefore, bank managers must update the latest macroeconomic forecasts to adjust their business models accordingly.

2. Literature reviews

2.1. Capital structure theories

The Modigliani-Miller theorem (M&M) states that a firm's capital structure does not affect firm value in a perfect market. However, the existence of a perfect market is doubtful in reality. Optimal capital structure minimizes the cost of capital and maximizes the firm's value. Myers and Majluf (1984) propose the Pecking Order Theory to explain the negative linkage between profitability and capital structure Kadek and Bagus (2019). The company will save on interest expenses and increase profits as it reduces the need for external debt. In addition, the Pecking Order Theory also shows a negative impact between liquidity and capital structure. More specifically, a company

with high cash flow or internal sources of financing is highly liquid, meaning it can meet long-term liabilities without using long-term financing.

Static Trade-off Theory investigates the optimal capital structure of firms. This capital structure is a trade-off between the marginal benefit from interest tax shields and interest expenses. Furthermore, capital structure optimizes firm performance when it balances benefits from tax shields with funding costs, meaning that both tax shields and interest costs must increase or decrease. In addition, Diamond and Rajan (2000) argue that a higher capital structure pressurizes the banks to earn a higher return to cover the funding costs. Secondly, achieving an optimal capital structure helps banks adapt to liquidity shocks or financial crises. Third, it improves the bank's ability to force repayment by the borrower. In short, Pecking Order and Trade-off Theories help explain the causality between capital structure, bank liquidity, and bank performance.

2.2. Capital structure and bank performance

Lotto and Papavassiliou (2019) states that banks are encouraged to have more equity in their capital structure to reduce risks and improve operational efficiency because the equity capital to total assets ratio represents the bank's capital structure and shows the ability of a bank to survive losses. Siddik et al. (2017), using data from 30 Bangladeshi banks from 2005 to 2014, showed that capital structure and three performance indicators, ROE, ROA, and EPS, have a negative relationship. These findings are supported by Yahya et al. (2017) report that bank managers should prioritize using their internal funding sources instead of relying mainly on external financing to maximize their performance. In addition, Almaqtari et al. (2019) conclude that a higher debt ratio reduces ROA in Indian banks, while this study finds that leverage does not impact the ROE. Khan et al. (2021) support this view, arguing that firms with positive earnings should use internal funding sources and debt to minimize information asymmetry. This view supports the pecking order theory. Therefore, profitability is negatively related to leverage. On the other hand, Frank and Goyal (2015) state that firms with positive pretax earnings should favor using higher leverage ratios to benefit from tax shields and support the trade-off theory that leverages and profits are positively related. However, papers related to the impact of capital structure on the performance of banks are still controversial (Khan et al., 2021). Therefore, the present paper proposes the following research hypothesis:

Hypothesis 1: There is a negative linkage between capital structure and bank performance in Vietnam.

2.3. Liquidity and bank performance

The relationship between liquidity and profitability still needs to be more conclusive. Lotto and Papavassiliou (2019) states that bank efficiency is commonly improved for banks that hold liquid assets, and banks strive to increase liquid assets, improving operating efficiency. On the one hand, Abbas et al. (2019) indicate that liquidity impacts bank profitability in developed Asian economies and the US banking sector. However, Arif and Anees (2012) and Siddik et al. (2017) show that liquidity adversely affected banking performance in developing economies between 2004 and 2014. Maintaining an excess liquidity position is costly and inefficient. However, Kajola et al. (2019) point out the positive influence of bank liquidity on the profitability of 10 banks in Nigeria from 2008 to 2017. Banks with higher liquidity regenerate high income because excess liquidity allows banks to extend credit activities that increase their profitability.

King (2013) argues that maintaining diversified funding sources reduces bank profitability, while Vo (2020) and Duong et al. (2022) document a positive relationship between funding diversity and profitability. Therefore, the diversity of the bank's capital has mixed effects on the profitability of commercial banks. Arif and Anees (2012), Siddik et al. (2017), and Kajola et al. (2019) focus on commercial banks in developing countries. However, no studies have examined commercial banks

in Vietnam yet. Moreover, in previous studies using multiple regression analysis (Arif & Anees, 2012; Kajola et al., 2019) and OLS by Siddik et al. (2017), the above methods are unsuitable for small samples.

Hypothesis 2: Liquidity positively affects the performance of Vietnamese banks.

3. Model and methodology

3.1. Data

Our first sample data includes 38 Vietnamese banks. However, to minimize missing data, we excluded from the data one state-owned bank that is not a joint stock commercial bank. Finally, our data include 37 Vietnamese joint-stock commercial banks from January 2003 to December 2020, including banks before mergers (M&A). Therefore, the total number of Vietnamese banks in our data is higher than those listed on the State Bank of Vietnam. In our data, there are three banks with state ownership over 60% (8.1% of the total number of banks) and 34 banks with private ownership (accounting for 91.9% of the total number of banks). We take the data from Fiinpro and manually collect the remaining data from banks' annual financial reports. Moreover, we ensure that our data sample is consistent by cross-checking the secondary and primary data. In addition, we collect the Vietnamese macroeconomic variables from the World Development Indicators dataset for the sampling period. We eliminate observations with insufficient data and winsorize our variables at 5 and 95 percentiles to mitigate extreme value issues. We also follow Tran et al. (2022) to exclude observations with insufficient information to calculate the required variables. Our final is a balanced panel with 463 annual bank-year observations.

3.2. Methodology

We use Bayesian linear regressions to examine the influence of capital structure on commercial banks' performance in Vietnam. One of the main advantages of the Bayesian method is the ability to integrate prior information. Bayesian methods estimate the likelihood that hypothesized effects occur. The Bayesian analysis quantifies the confidence level in the related hypothesis being accurate based on observational data. Bayesian methods will also allow the prior distribution to integrate existing knowledge about the hypothesized effects of the procedure. Bayesian analyses also move from the null hypothesis significance test's dichotomous "effect or no effect" evaluation.

On the other hand, Bayesian methods estimate the distribution of effects. These posterior distributions give specific information about the size of the impact and its uncertainty. Bayesian approaches have several other fascinating properties. For example, Bayesian regression allows us to combine past information about a parameter and form a prior distribution for future analysis. When we have new observations, the previous posterior distribution is used as the prior distribution. All inferences follow the logic of Bayes' theorem. Second, Bayesian statistics provide interpretations that are more intuitive and consistent with theory. Instead of asking whether capital structure affects bank performance (thus rejecting an alternative as inappropriate), Bayesian statistics provide the probability that capital structure impacts bank performance. Third, Bayesian regression performs better than frequency school regression models when working with small sample sizes. This method provides precise and data-driven conditional inferences independent of asymptotic approximations. Small sample inference proceeds similarly to when one has a large sample. Thus, meaningful Bayesian estimates are possible if credible priors are available (McNeish, 2016; Miočević et al., 2017). Fourth, the Bayesian method is based on something other than asymptotic theory; therefore, this method can help with multicollinearity problems (My et al., 2022). Thus, researchers can include the number of independent variables with which they are correlated in the regression model. Fifth, Bayesian methods can handle complex models and data structures (Kruschke & Liddell, 2018; Kruschke et al., 2012). Finally, Bayesian

analysis helps the researcher assess the endogenous phenomena' extent. The Bayesian method provides a complete distribution of the correlation between the endogenous suspect variable and the random error. To evaluate the quantitative impact of endogeneity on regression outcomes, a Bayesian researcher compares the distribution of the parameter of interest obtained from simple regression with the distribution obtained from the model with instrument variable (Block et al., 2014).

Following the Bayesian viewpoint, we construct a Bayesian linear regression model base on probability distribution, where y is obtained from the probability distribution and has the following form:

$$y \sim N(\beta^T X, \sigma^2 I)$$

Here, y is described by mean and variance. The mean is the transpose of the predictor matrix multiplied by the weight matrix, and variance (σ^2) is the square of the standard deviation multiplied by the Identity matrix. Bayesian linear regression built on the Bayesian theorem has the following form:

$$P(\beta|y, X) = P(\beta|X) * P(y|\beta, X) / P(y|X)$$

Here, $(\beta | y, X)$ is the posterior probability, $p(\beta | X)$ is the prior probability, $P(y | \beta, X)$ is the likelihood probability, and $P(y | X)$ is a normalizing factor.

The Bayesian theorem is often simplified to posterior \propto prior \times likelihood.

Lemoine (2019) advises using the conjugate prior distribution, namely the normal distribution for the mean and the inverse gamma distribution for the variance. The a priori distribution is written as $\beta \sim (0, 1)$; $\sigma^2 \sim (1/100, 1/100)$. Second, we utilize the Markov chain Monte Carlo (MCMC) strategy with a Gibbs sampling to produce the following distribution. Finally, to ensure robust Bayesian analysis, MCMC must converge (Roy, 2020).

3.3. Models construction

To investigate the impact of capital structure on the performance of Vietnamese commercial banks, we construct three linear regression models.

We follow Al-Qudah and Jaradat (2013), Vo (2020), Ozili (2015), and Anbar and Alper (2011) to construct a model (1) to examine the impact of capital structure and liquidity on bank performance

$$Performance_{i,t} = \alpha + \beta \times TDTA_{i,t} + \gamma \times LIQ_{i,t} + \delta \times Control_{i,t} + \varepsilon_{i,t} \quad (1)$$

Following Wu et al. (2007), we add macroeconomic factors such as the economic growth rate (RGDP) and annual money supply M2 growth rate (M2GR) to the baseline model. Model 2 examines the impact of capital structure and liquidity on bank performance after controlling for macroeconomic factors:

$$Performance_{i,t} = \alpha + \beta \times TDTA_{i,t} + \gamma \times LIQ_{i,t} + \delta \times Control_{i,t} + \varphi \times Macro_{i,t} + \varepsilon_{i,t} \quad (2)$$

Finally, we follow Elnahass et al. (2021) to add COVID-19 as a dummy variable in model 2. Model 3 examines whether COVID-19 affects the impacts of capital structure and liquidity on bank performance. We construct a model (3) as follows:

$$Performance_{i,t} = \alpha + \beta \times TDTA_{i,t} + \gamma \times LIQ_{i,t} + \delta \times Control_{i,t} + \varphi \times Macro_{i,t} + \xi \times Covid - 19_{i,t} + \varepsilon_{i,t} \quad (3)$$

Individual bank and time dimension indices are represented by i and t , respectively. Additionally, *performance* is measured by ROA, ROE, and EPS. *TDTA* was measured with the capital structure, and the bank's liquidity index measures *LIQ*. *Control* includes control variables such as political connection (POC), bank funding diversity (BFD), loan growth (LGR), and bank size (LogSIZE). *Macro* is measured by economic growth rate (RGDP) and annual money supply M2 growth rate (M2GR). The details of variable definitions are shown in Appendix A.

We use three proxies widely in most related empirical studies to measure banking performance. The first proxy is the ROA because it reflects using assets to generate profit. We follow Almaqtari et al. (2019), Sivalingam and Kengatharan (2018), Yahya et al. (2017), Siddik et al. (2017), and Menicucci and Paolucci (2016) to employ ROA as a proxy for banking performance. We also follow Almaqtari et al. (2019), Sivalingam and Kengatharan (2018), Yahya et al. (2017), Siddik et al. (2017), and Menicucci and Paolucci (2016) to employ ROE to estimate how managers utilize capital to generate profitability in commercial banks.

We use EPS as the third proxy to measure a bank's performance. Siddik et al. (2017) hint that EPS is a fundamental bank efficiency ratio. Onay and Ozsoz (2013) argue that government involvement can increase ROE through tax regulations, leading to inconsistent results. Therefore, we use EPS to examine commercial banks' performance to overcome the possible impacts of government interventions.

In the first model, we estimate the impact of capital structure and liquidity on the performance of commercial banks after controlling for bank characteristics. We follow Yahya et al. (2017), Siddik et al. (2017), and Almaqtari et al. (2019) to estimate the capital structure by the total debt-to-assets ratio (TDTA). King (2013) reports that diversifying funding sources is expensive and erodes bank income, whereas Vo (2020) asserts that diversification increases bank profitability. In addition, Siddik et al. (2017) indicate the adverse impact of liquidity on bank performance. Consequently, we add bank funding diversity (BFD) and liquidity (LIQ) to model 1 to investigate the effects of capital structure and liquidity on commercial banks' performance.

To test the impact of political connections on the profitability of commercial banks, we follow Khoa et al. (2022), Hung et al. (2017), Rehman et al. (2016), and Micco et al. (2007) to fill up the political connection (POC) variable to our econometric model. Micco et al. (2007) argue that political connections negatively influence bank performance. However, Hung et al. (2017) showed a positive relationship between political connections and profitability. Prior literature documents mixed impacts of political connections on profitability, so we add the political connection variable (POC) to model 1 to clarify POC's effect on Vietnamese banks' performance.

We follow Ozili (2015), Menicucci and Paolucci (2016) to add Loan Growth Ratio (LGR) as a control variable into Model 1. Ozili (2015) indicates an inverse relationship between LGR on profitability, while Menicucci and Paolucci (2016) report a positive effect on bank performance.

Finally, based on previous studies (see: Anbar & Alper, 2011; Menicucci & Paolucci, 2016), we add bank size (LogSIZE) as a control variable in model 1.

$$Performance_{i,t} = \alpha + \beta \times TDTA_{i,t} + \gamma \times LIQ_{i,t} + \delta \times Control_{i,t} + \varepsilon_{i,t} \quad (4)$$

In the second model, we examine the impact of macroeconomic indicators on the profitability of commercial banks. Al-Qudah and Jaradat (2013), and Wu et al. (2007) assert that macroeconomic factors affect bank performance because they impact customer demand for banking services and

products. Hence, we follow Wu et al. (2007) to construct model 2 to examine how capital structure, liquidity, and macroeconomic factors affect the performance of commercial banks after controlling for macroeconomic factors.

$$Performance_{i,t} = \alpha + \beta \times TDTA_{i,t} + \gamma \times LIQ_{i,t} + \delta \times Control_{i,t} + \varphi \times Macro_{i,t} + \varepsilon_{i,t} \quad (5)$$

Finally, Li et al. (2021) and Elnahass et al. (2021) document the negative impacts of the COVID-19 pandemic on bank performance. Therefore, we construct model 3 to examine how capital structure, liquidity, and macroeconomic factors affect the performance of commercial banks before and during the COVID-19 pandemic.

$$Performance_{i,t} = \alpha + \beta \times TDTA_{i,t} + \gamma \times LIQ_{i,t} + \delta \times Control_{i,t} + \varphi \times Macro_{i,t} + \xi \times Covid - 19_{i,t} + \varepsilon_{i,t}$$

4. Results and discussion

4.1. Descriptive statistics

Table 1 offers the statistical description of the main variables in this study. The average ROA of the banking sector is 1.05%, indicating that banks generate an average net income of 1.05% from their total assets. The maximum and minimum ROA for the sample is 5.57% and negative −5.99%, with a standard deviation of 0.89%. Furthermore, the average value of ROA in Vietnam is the lowest compared to 1.17% in India (Almaqtari et al., 2019) and 1.48% in Bangladesh (Siddik et al., 2017). Similarly, the average ROE is 10.63%, and the standard deviation is 8.09%. Our descriptive statistics of ROE and ROA are similar to Le and Nguyen (2020) and Vo (2020). Table 1 also reports that the mean EPS is 1,332.0 with a standard deviation of 1,134.4. In other words, Vietnamese banks generate an average of VND 1,332.0, which is approximately \$0.058 per share. This finding is consistent with Nguyen et al. (2020).

TDTA has a mean value of 0.9137, with a standard deviation of 0.0321. Furthermore, Vietnam's TDTA is the highest compared to 0.0434 in India and 0.8704 in Bangladesh (Almaqtari et al., 2019; Siddik et al., 2017). The banking business uses savings deposits as the primary source of funding. This finding aligns with Le and Nguyen (2020). The average bank funding diversity (BFD) is 0.5589, concordant with Vo (2020). The average annual loan growth rate (LGR) is 43.50%, suggesting that Vietnam has significant credit growth during the sample period. Our findings align with Le and Nguyen (2020). The average bank liquidity (LIQ) value is 0.9351 and is lower than in India and Bangladesh (Almaqtari et al., 2019; Siddik et al., 2017). The average annual real GDP growth rate (RGDP) is 6.14 percent, and the average annual Vietnam M2 money supply growth (M2GR) is

Table 1. Summary statistics

Variables	Obs	Mean	Standard deviation	Min	Max
ROA	463	0.0105	0.0089	−0.0599	0.0557
ROE	463	0.1063	0.0809	−0.5633	0.4449
EPS	463	0.1332	0.1134	−0.4572	0.6691
TDTA	463	0.9137	0.0321	0.8340	0.9546
BFD	463	0.5589	0.1003	0.1876	0.7546
LGR	463	0.4350	0.9553	−0.4157	11.3173
LogSIZE	463	31.7379	1.5414	26.0908	34.9553
LIQ	463	0.9351	0.4054	0.3719	7.2959
RGDP	463	0.0614	0.0104	0.0291	0.0755
M2GR	463	0.2314	0.1055	0.0440	0.4610

Table 2. Summary statistics for the political connection variable (POC)

	With Connection	Without Connection	With and without Connection ³	Total
Numbers of Banks	18	11	8	37
Percent	50	29	21	100

23.14 percent for macroeconomic scenario factors. Table 1 also includes descriptive statistics for the other control variables.

In addition, Table 2 provides the number of banks with and without political connections.

4.2. Pearson correlation matrix

Table 3 reports the Pearson correlation matrix between independent variables. The correlation between variables is less than 0.5, except for the correlation between LogSIZE and TDTA. Therefore, we run VIF to check whether our sample has multicollinearity issues. The mean VIF is less than 5, implying no multicollinearity problem (Tran et al., 2022).

4.3. MCMC diagnostics

When performing Bayesian regression, diagnosing the convergence of MCMCs is necessary. The diagnosis was based on the adequate sample size (ESS) and the Gelman-Rubin diagnostic (GR diagnostic) of Gelman et al. (2013). ESS of a parameter sampled from an MCMC is the number of effectively independent withdrawals from the posterior distribution. GR diagnostic by Gelman et al. (2013) is the most common method to evaluate the convergence of MCMC.

We perform the MCMC diagnostics for three models. The results in Table 4 show that the ESS of posterior estimates is based on at least 26,500 independent observations for each coefficient and the coefficient efficiency ratio. The number (coefficient) is more significant than 0.01. Furthermore, the GR diagnostic of Gelman et al. (2013) is all less than 1.1. With the Gibbs sampling procedure, the acceptance rate is 1.0000, indicating that the Bayesian regression has met the acceptance rate. As a result of the initial tests, MCMC has converged, indicating that Bayesian linear regression is stable.

We also perform similar MCMC diagnostics for ROE and EPS, alternative proxies of commercial banks' performance. Tables 5 and 6 show that the most negligible efficiency is 0.9619, and the Gelman—Rubin statistics R_c are all less than 1.1. Therefore, the Bayesian inference is stable and reliable.

4.4. Posterior simulation and discussion

Table 7 reports that capital structure (TDTA) reduces the ROA and ROE of Vietnamese commercial banks. Musah (2018) argued that the short-term debt ratio negatively affects ROA and ROE. If the bank uses short-term customer deposits for investment, its ROA and ROE are reduced because it has to repay the depositors on time while that debt has yet to make a profit. This result aligns with Almaqtari et al. (2019), Sivalingam and Kengatharan (2018), Siddik et al. (2017), Yahya et al. (2017), and Al-Qudah and Jaradat (2013). However, TDTA has positive impacts on EPS. This result aligns with Al-Kayed et al. (2014) because they recommend that the commercial bank uses higher leverage to amplify the EPS. That means a high bank's leverage ratio shows that the bank has a high debt-to-capital ratio. In addition, when a bank has much debt, it implies that it operates efficiently and obtains much capital to expand lending activities, empowering EPS.

Overall, our findings support hypothesis 1 and are consistent with the Pecking Order Theory but inconsistent with the Trade-off Theory theory. Banks are financial intermediaries, so their main

Table 3. Bayesian correlation matrix

	TDTA	BFD	LGR	LogSIZE	LIQ	POC	RGDP	M2GR	VIF
TDTA	—								2.05
BFD	-0.322*** [2.181e+10]	—							1.21
LGR	-0.144 [9.094]	0.197*** [889.509]	—						1.10
LogSIZE	0.661*** [3.197e+59]	-0.316*** [7.573e+9]	-0.278*** [1.840e+7]	—					1.97
LIQ	-0.294*** [2.086e+8]	0.089 [0.390]	0.103 [0.760]	-0.266*** [3.329e+6]	—				1.14
POC	0.011 [0.058]	0.009 [0.058]	-0.049 [0.101]	0.151 [16.002]	-0.017 [0.061]	—			1.10
RGDP	0.000 [0.057]	0.062 [0.144]	0.132 [3.961]	-0.201*** [1312.826]	0.071 [0.196]	.025[.065] [0.065]	—		1.67
M2GR	0.146 [8.443]	-0.038 [0.081]	-0.270*** [2.147e+6]	0.275*** [3.776e+6]	-0.183*** [140.348]	.033[.075] [0.075]	-319***[3.011e+9] [3.011e+9]	—	1.52

Note: Bayes factors (BF) in brackets, * BF₁₀ > 10, ** BF₁₀ > 30, *** BF₁₀ > 100.

Table 4. MCMC diagnostics for the models (ROA)						
Models	Model 1		Model 2		Model 3	
Independent variables	Efficiency	GR diagnostic	Efficiency	GR diagnostic	Efficiency	GR diagnostic
TDTA	1.0000	1.0000	1.0000	1.0000	0.9929	1.0001
BFD	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
LGR	0.9934	1.0002	1.0000	1.0000	1.0000	1.0000
LogSIZE	1.0000	1.0000	0.9819	1.0000	0.9872	1.0000
LIQ	0.9901	1.0000	1.0000	1.0001	1.0000	1.0000
POC	1.0000	1.0000	1.0000	1.0000	0.9934	1.0002
RGDP	—	—	0.9856	1.0000	1.0000	1.0000
M2GR	—	—	1.0000	1.0000	1.0000	1.0000
COVID19	—	—	—	—	0.9716	1.0000
_cons	1.0000	1.0001	0.9833	1.0000	0.9907	1.0001
var	0.9631	1.0002	0.9507	1.0000	0.9729	1.0000

Table 5. MCMC diagnostics for the models (ROE)						
Models	Model 1		Model 2		Model 3	
Independent variables	Efficiency	GR diagnostic	Efficiency	GR diagnostic	Efficiency	GR diagnostic
TDTA	1.0000	1.0000	0.9748	1.0000	1.0000	1.0001
BFD	1.0000	1.0001	0.9820	1.0000	1.0000	1.0000
LGR	1.0000	1.0000	0.9897	1.0000	1.0000	1.0000
LogSIZE	1.0000	1.0000	0.9883	1.0001	1.0000	1.0001
LIQ	1.0000	1.0000	0.9882	1.0000	1.0000	1.0001
POC	0.9752	1.0000	1.0000	1.0000	0.9843	1.0002
RGDP	—	—	0.9860	1.0000	1.0000	1.0001
M2GR	—	—	1.0000	1.0001	1.0000	1.0000
COVID19	—	—	—	—	1.0000	1.0000
_cons	1.0000	1.0000	0.9888	1.0001	1.0000	1.0001
var	0.9614	1.0001	0.9809	1.0000	0.9836	1.0001

Table 6. MCMC diagnostics for the models (EPS)						
Models	Model 1		Model 2		Model 3	
Independent variables	Efficiency	GR diagnostic	Efficiency	GR diagnostic	Efficiency	GR diagnostic
TDTA	1.0000	1.0000	0.9851	1.0000	1.0000	1.0001
BFD	1.0000	1.0000	1.0000	1.0000	1.0000	1.0001
LGR	1.0000	1.0001	1.0000	1.0000	1.0000	1.0000
LogSIZE	0.9619	1.0001	1.0000	1.0000	1.0000	1.0000
LIQ	1.0000	1.0001	1.0000	1.0000	1.0000	1.0000
POC	0.9927	1.0001	1.0000	1.0001	0.9868	1.0000
RGDP	—	—	0.9773	1.0000	1.0000	1.0002
M2GR	—	—	1.0000	1.0001	1.0000	1.0000
COVID19	—	—	—	—	1.0000	1.0001
_cons	1.0000	1.0001	1.0000	1.0001	0.9954	1.0000
var	0.9917	1.0000	0.9900	1.0000	1.0000	1.0001

business is to take deposits which are their primary liability. However, if banks do not have an efficient capital structure and capital management strategy, they will face risks of reducing income. In addition, Vietnam is transitioning from a centralized economy into a market economy, so the information asymmetry between companies and investors is relatively significant. Thus, companies prioritize using internal capital rather than debt to avoid bringing negative signals to the market (Khan et al., 2021). Moreover, Vietnamese banks have low ROA, so they also limit the use of external sources because the tax shield is relatively weak (Khan et al., 2021). Thus, our findings support the pecking order theory. On the other hand, equity is the foundation for banks to expand their business, including increasing credit growth and diversifying their operations networks to generate more income (Suu et al., 2020). Therefore, when implementing plans to increase capital, banks must ensure an appropriate proportion in the capital structure. Therefore, the more banks use external capital, the lower the performance of commercial banks in Vietnam.

Table 7 also demonstrates the positive impact of bank liquidity, proxied by bank funding diversity and liquidity (LIQ), on the profitability of commercial banks in Vietnam. The probability of ROE and ROA is more significant than 99.3%, implying stable and apparent impacts of BFD and LIQ on profitability. Otherwise, when banks increase their loan-to-customer ratio (LIQ), they generate additional profits from credit activities. Moreover, diversification of financing sources aids in the maintenance of steady operations, the reduction of costs, and the improvement of operational efficiency. These results are consistent with Abbas et al. (2019), Ritz and Walther (2015), and Vo (2020), and they also support hypothesis 2.

Table 7 also reports the impact of other control variables on banking performance. Specifically, the size of the bank has a strong positive effect on banking performance as measured by ROA, ROE, and EPS. This result is conformable to the economies of scale theory. In addition, larger banks have diversified services and products that capture consumer demand, so they have higher revenues than smaller banks. Our findings are suitable to those of Siddik et al. (2017), Menicucci and Paolucci (2016), and Anbar and Alper (2011).

Credit growth also positively affects ROA, ROE, and EPS because bank lending activities generate additional profits for commercial banks. Implementing the BASEL II accord requires commercial banks to operate sustainably by tightening credit quality. Therefore, banks reduce the provisions for non-performing loans, so this cost-saving becomes an additional profit for commercial banks. This result aligns with Menicucci and Paolucci (2016).

Finally, Table 7 indicates a positive linkage between political connections and ROA and EPS while a negative linkage between the ROE of commercial banks in Vietnam. In Vietnam, the most prominent commercial banks used to be state ownership banks, which played a leading role in the stability of the banking industry and the banking system. Hung et al. (2017) indicate that politically connected banks quickly access new sources of information and monetary policies. Moreover, state-owned banks have easy access to refinancing loans from the state bank of Vietnam at preferential interest rates. Thus, politically connected banks have more government incentives and assurance, so they tend to have competitive advantages against non-connected banks. Our results are consistent with Hung et al. (2017) and inconsistent with Micco et al. (2007).

This section examines the impacts of macroeconomic indicators on banking performance in Vietnam. Table 7 suggests that the RGDP variable positively affects ROA, ROE, and EPS. Wu et al. (2007) suggest that clients have enough money to save and use other banking services during periods of economic growth. Furthermore, economic development allows banks to provide additional banking services and allows commercial banks to earn noninterest revenue, increasing their performance gradually. This finding is conformable to Wu et al. (2007) and Sufian and Habibullah (2009).

Table 7. The impacts of capital structure and bank liquidity on the performance of commercial banks

Models	ROA		ROE		EPS	
Independent variables	Mean	Probability of mean	Mean	Probability of mean	Mean	Probability of mean
TDTA	−0.0584	1.0000*	−0.3759	0.9932*	0.1926	0.5774**
	[−0.0774;		[−0.6741;		[−1.8020;	
	−0.0396]		−0.0786]		2.1610]	
BFD	0.0105	0.9836**	0.1169	0.9978**	0.1276	0.5524**
	[0.0008;		[0.0378;		[−1.8649;	
	0.0204]		0.1960]		2.0833]	
LGR	0.001	0.9735**	0.0546	0.9979**	0.0974	0.5401**
	[0.0000;		[0.0176;		[−1.8646;	
	0.0020]		0.0915]		2.0624]	
LogSIZE	0.0190	0.9164**	1.1782	1.0000**	0.7148	0.7629**
	[−0.0081;		[0.9119;		[−1.2359;	
	0.0464]		1.4430]		2.6765]	
LIQ	0.0006	0.7028**	0.1174	1.0000**	0.2065	0.5817**
	[−0.0017;		[0.0739;		[−1.7556;	
	0.0029]		0.1607]		2.1540]	
POC	0.001	0.8523**	−0.0115	0.9481*	0.139	0.5526**
	[−0.0009;		[−0.0254;		[−1.8290;	
	0.0030]		0.0024]		2.0877]	
RGDP	0.1489	0.9785**	1.2132	0.8912**	0.0052	0.5038**
	[0.0048;		[0.2806;		[−1.9682;	
	0.2923]		2.1692]		1.9583]	
M2GR	−0.0191	0.9999*	−0.0774	0.9583*	0.0512	0.5218**
	[−0.0287;		[−0.1649;		[−1.9059;	
	−0.0094]		0.0102]		1.9909]	
COVID19	−0.0041	0.5047*	−0.0178	0.9308*	−0.0006	0.5002*
	[−1.9678;		[−0.1214;		[−1.9646;	
	1.9582]		0.0354]		1.9474]	
_cons	−0.0156	0.6374*	−3.8131	1.0000*	0.2043	0.5806**
	[−0.1023;		[−4.5961;		[−1.7795;	
	0.0701]		−3.0269]		2.1881]	
var	0.0001	—	0.0027	—	2,891,902	—
	[0.0001;		[0.0023;		[2,536,297;	
	0.0001]		0.0032]		3,291,556]	

Notes: *, ** is probability of mean < 0, and > 0, respectively; 95%-credible interval in brackets.

On the other hand, Table 7 reports that the M2 money supply growth rate (M2GR) negatively impacts ROA and ROE, while M2GR positively impacts EPS. According to the quantity theory of money, a higher supply of money increases the inflation rate in the economy. Commercial banks must increase the savings interest rate to prevent customers from using other investment channels. Commercial banks may lose the cheapest funding sources for lending activities if depositors have alternative investments. Therefore, they must pay additional costs to raise capital from other sources, decreasing their profitability. Our results are concordant with Sufian and Habibullah (2009).

Table 8. The impacts of capital structure and bank liquidity on the performance of commercial banks

Models	ROA		ROE		EPS	
	Coefficient	P> z	Coefficient	P> z	Coefficient	P> z
TDTA	−0.0833***	0.0000	−0.3969***	0.0010	−0.7215***	0.0000
BFD	0.0077***	0.0060	0.0555**	0.0690	0.0463	0.2380
LGR	0.0054***	0.0000	0.0335**	0.0290	0.0319	0.1060
LogSIZE	0.0938***	0.0000	1.1999***	0.0000	1.9546***	0.0000
LIQ	0.0077***	0.0000	0.1010***	0.0000	0.1183***	0.0000
POC	−0.0013***	0.0070	−0.0204***	0.0000	−0.0273***	0.0000
RGDP	0.0012**	0.0190	0.0649**	0.0145	0.0803***	0.0030
M2GR	−0.0063**	0.0300	−0.0707**	0.0390	−0.0745*	0.0920
COVID19	−0.0019**	0.0200	−0.0116	0.2050	−0.0252**	0.0210
_cons	−0.2530***	0.0000	−3.7939***	0.0000	−6.1271***	0.0000
Firm fixed effect	Yes		Yes		Yes	
Prob > chi2	0.0000		0.0000		0.0000	
Obs	463		463		463	

Notes: ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

This section examines the effects of the COVID-19 pandemic on Vietnamese banking performance. Table 7 suggests that the pandemic adversely affects bank performance. During the COVID-19 pandemic, the government imposed social distancing and lockdown policies, which created a stagnant economy. Moreover, workers have lower incomes because their factories are closed during the lockdown. Businesses are exposed to higher default risks because they cannot continue manufacturing or providing services during the COVID-19 pandemic. Elnahass et al. (2021) also state that banks encounter additional credit risks due to liquidity issues in servicing debts during the pandemic. As a result, commercial banks have to increase the loan loss provisions, significantly dampening their profits. These results are compatible with Li et al. (2021) and Elnahass et al. (2021).

4.5. Robustness test by the generalized least squares (GLS) estimations

Table 8 provides a robustness test between Bayesian estimation and generalized least squares (GLS). The robustness test results suggest that the impacts of liquidity and capital structure on bank performance are similar to Bayesian regressions, and the main results are robust. McNeish (2016) and Miočević et al. (2017) argue that Bayesian estimation can eliminate the small sample problem, which provides more reliable results. Therefore, Bayesian regressions have advantages over the GLS in estimating bank performance, especially during the pandemic.

5. Conclusions

As the banking sector plays an irreplaceable role in the financial system, our research adds to the body of knowledge by demonstrating the impact of capital structure and liquidity on bank performance in Vietnam. We use a Bayesian estimator to study a sample of 37 commercial banks from January 2003 to December 2020, whereas previous literature used traditional regression methodologies.

Our empirical findings show that higher debt in capital structure reduces ROA and ROE. On the contrary, our results suggest a positive linkage between capital structure on EPS. Moreover, our findings indicate a positive linkage between the political connection and the performance of

commercial banks in Vietnam. In addition, our study reports that commercial banks with higher liquidity can improve profitability. Finally, our findings support the Pecking Order Theory, the economies of scale theory, and prior literature.

Our study provides the following implications for policymakers and bank managers. Firstly, our study suggests that commercial banks should diversify funding sources to adapt to unusual incidents preventing financial crises quickly because maintaining the diversified funding sources increase bank performance. Secondly, our research also shows that the capital structure management of banks needs to be flexible and suitable for management purposes in each period. There can be no universally perfect capital structure in this regard. This comes from the study results showing that debt can positively affect one output factor but negatively affect another. Therefore, bank managers can be flexible in capital management depending on the goals of each period. Finally, the political connection is also an extraordinary suggestion for bank managers and policymakers. In addition, policymakers can issue policies to encourage banks to diversify funding, such as stipulating a ratio and providing a roadmap for all banks (similar capital adequacy ratio-CAR)

Although our study contributes evidence by applying Bayesian estimations in banking studies, it has the following limitations. First, our data sample only reflects the Vietnamese context. Therefore, our findings may be different from emerging and developed markets. Future studies complement this topic with data from various countries in Asia to see the impact of capital structure on bank performance in the following periods.

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Data availability statement

The [Excel File] data used to support the findings of this study are available from the corresponding author upon request.

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Notes

1. According to Circular No. 41/2016/TT-NHNN dated December 30, 2016, of the State Bank of Vietnam.
2. Crises leading to bank withdrawal incidents in 2003, 2014, and especially 2022.
3. Banks have changed in the position of CEO or chairman during the study period who is a member of the Communist Party of Vietnam or not.

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Appendix A: Variable definitions

Variables	Symbol	Definition
Dependent variables		
Return on asset	ROA	Net profit/Average Total Assets.
Return on equity	ROE	Net profit (after taxes)/Average Total Equity.
Earnings per share	EPS	We follow Siddik et al. (2017) to estimate EPS as the ratio of Net income divided by the total number of outstanding shares.
Independent variables		
Total debt to total asset	TDTA	Following Al-Qudah and Jaradat (2013), the TDTA is Total debt over Total asset
Bank Funding Diversity	BFD	We use the formula of Vo (2020): $BFD = 1 - \left[\left(\frac{EQU}{Fund} \right)^2 + \left(\frac{GOV}{Fund} \right)^2 + \left(\frac{JBD}{Fund} \right)^2 + \left(\frac{CD}{Fund} \right)^2 + \left(\frac{DER}{Fund} \right)^2 + \left(\frac{LTF}{Fund} \right)^2 + \left(\frac{OTH}{Fund} \right)^2 \right]$
Loans Growth	LGR	According to Ozili (2015), LGR is calculated using the following formula: (Total Bank's Loan in year t - Total Bank's Loan in year $t-1$) / (Total Bank's Loan in year $t-1$)
Size of the Bank	LogSIZE	Following Anbar and Alper (2011), the size of the bank is the Natural logarithm of total assets.
Liquidity	LIQ	Following Al-Qudah and Jaradat (2013), the LIQ variable is calculated as Total loan debt divided by Total customer deposits.
Political Connection	POC	Following Rehman et al. (2016) and Duong et al. (2022), POC is the dummy variable with a value of 1 if the CEO or chairman is a member of the Communist Party of Vietnam and 0 otherwise. According to The constitution of the Socialist Republic of Viet Nam, section 04, The Communist Party of Vietnam is the only ruling party in Vietnam.
Economic Growth	RGDP	The annual growth rate of real GDP (Khan et al. (2017))
Money Supply Growth Rate	M2GR	M2 yearly growth rate (Hameed, 2010)
COVID-19 pandemic	COVID19	The dummy variable takes the value of 1 if the year 2020 and 0 otherwise.