Factors Influencing the Capital Adequacy Ratio : A Panel Regression Analysis for the Vietnamese Banking Sector

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Abstract

Currently, commercial banks are constantly implementing measures of capital adequacy to meet Basel standards. Commercial banks mainly issue bonds to increase their tier 2 capital and mobilize long-term capital for lending needs and capital adequacy. Therefore, this study aimed to determine the internal and macro factors affecting Vietnamese commercial banks' capital adequacy from 2007 – 2018. Applying the feasible generalized least squares (FGLS) estimator, our results showed that return on equity (ROE) and bank size (SIZE) had the significantly opposite impact on Vietnamese banks' capital adequacy. However, return on assets (ROA), customer deposits (DEP), credit risk (CR), and liquidity (LIQ) had similar direction effects and were statistically significant on banks' capital adequacy. For the macroeconomic factors, the inflation rate positively impacted the capital adequacy of Vietnamese commercial banks. Besides, our results revealed that Vietnamese commercial banks need to control internal factors and improve their performance to ensure capital adequacy according to Basel standards in globalization.

Keywords : **capital adequacy, Vietnamese commercial banks, credit risk, economic growth, inflation**

JEL Classification Codes : E42, E58, E52

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Bank administrators have always given the capital adequacy of commercial banks special attention in giving objectives, strategies, and implementation plans. In addition, organizations such as Banking Supervision Inspection Agency and the National Financial Supervisory Commission (NSC) always offer many mechanisms and policies to assess the banks' financial capacity, in which they emphasize the increase of equity capital to ensure the safety of Vietnam's financial system. According to the SBV-oriented roadmap, by the end of 2025, all banks will apply Basel II in accordance with the standard method. Also, state-owned commercial banks and some commercial banks completed Basel II's application according to the standard method and will try to apply Basel II with the advanced method. Basel II is the objective of Vietnam's banking industry development plan until 2025. Basel II's compulsory application is to gradually limit the business risks of banks and enhance the safety of the financial system. According to experts, Basel II's implementation also helps banks improve their reputation and supports regulators to expand credit growth and network.

From 2018 to 2019, Vietnamese commercial banks have constantly implemented safety standards to meet

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Basel II standards, but mostly through issuing bonds. For example, as of September 2019, Agribank had two times of bond issuance. The first one was VND 4,000 billion, and the second one was VND 5,000 billion. Also, VietinBank issued VND 10,000 billion; Asia Bank issued VND 2,500 billion to increase secondary capital, ensure capital safety, and mobilize long-term capital for the market demand for loans. Credit growth is the mean of the increase in the banks' profits. According to Basel II pillars, all banks now make capital safety regulations for their own credit institutions and comply with the State bank's capital safety regulations. The SBV had issued Circular No. 41/2016 / TT-NHNN providing a capital adequacy ratio for banks and foreign bank branches. Vietnamese commercial banks had four years to prepare for the implementation of Circular 41 before its effect from 1/1/2020. Particularly, the first 10 trial banks, including Vietcombank, VietinBank, BIDV, MB, Sacombank, Techcombank, ACB, VPBank, VIB, and MSB, were the target of SBV in the application of Circular 41 from the beginning of 2019. However, among 10 units, only Vietcombank complied with the earliest deadline and decided to apply Circular 41 by the end of November 2018.

It can be seen that increasing the capital adequacy ratio is not an easy requirement for commercial banks. Because, during the operation, the bank's capital adequacy ratio will be affected by many factors. Many studies also found internal and macro factors affecting commercial banks' capital adequacy ratio. Internal factors such as return on assets (ROA), financial leverage, and bank size were found to have a positive impact on commercial banks' capital adequacy ratios (Bateni et al., 2014; Dreca, 2013; Masood & Ansari, 2016; Olarewaju & Akande, 2016; Shukla, 2016). These studies suggested that credit risk, customer deposits ratio, liquidity, loan-to-assets ratio, and concentrated ownership had a statistically negative impact on capital adequacy in some countries such as Nigeria, Pakistan, and Indonesia (Olarewaju & Akande, 2016; Masood & Ansari, 2016; Mukhibad & Setiawan, 2020; Syed & Tripathi, 2020). Yahaya et al. (2016) studied the impact of banks' financial performance and macro factors, including macro variables including unemployment rate, inflation, real exchange rate, money supply, and gross domestic product (GDP), to banks' capital adequacy ratio in Japan. Similar results on the impact of macro factors on capital adequacy ratio were also found in Nagaraju (2014), Olarewaju and Akande (2016), Chandanani et al. (2017), and Syed and Tripathi (2020). Although many researchers have studied the impact of commercial banks' intrinsic and macro factors on capital adequacy, the majority of their studies focused on samples from developed countries such as the United States, Europe, Japan, and so on (Büyüksalvarci & Abdioglu, 2011; Gropp & Heider, 2010; Yahaya et al., 2016). There has been a minimal investigation into this topic in Vietnam and other developing countries. In fact, banking systems in Vietnam and other developing countries are expanding in size and becoming increasingly competitive.

Furthermore, these countries must also address the capital adequacy ratio factors. Also, Vietnamese commercial banks have given too much credit to real estate and securities. Because of the volatility of the stock and real estate markets, these credits are very risky. This impacts bank profitability and capital, causing the capital adequacy ratio of Vietnamese commercial banks to fluctuate.

Besides, all previous studies used a p-value to test the hypotheses in terms of methods. Many scholars are currently criticizing this method (Briggs & Nguyen, 2019; Le et al., 2020). Therefore, in this study, we use the Bayesian model averaging (BMA) method, which is not based on p-value when assessing the impact of factors on the capital adequacy of Vietnamese commercial banks.

Due to the mentioned practical problems, this study is being carried out to examine the effects of internal and macro factors on capital adequacy in the Vietnamese commercial banking system. The objectives of this study are:

(i) Studying the multivariate relationship between intrinsic and macro factors and finding out the factors affecting Vietnamese commercial banks' capital adequacy.

(ii) What is the impact of factors on the capital adequacy of Vietnamese commercial banks ?

This study will show the factors influencing the capital adequacy ratio at Vietnamese commercial banks. These findings contribute empirical evidence to the theoretical framework on this topic in developing countries. Besides, we also propose the policy implications to ensure capital adequacy for Vietnamese commercial banks from the research results.

Theory Framework and Empirical Studies

Regulations on the Capital Adequacy of Commercial Banks Under Basel Accords

In the 80s of the last century, facing a decline in international banks' capital and an increase in global risks associated with countries with large debt ratios, a capital measurement system called the Basel Accords was born. The Basel Committee on Banking Supervision is one of the five important committees of the International Payment Bank. It was established as a Committee on banking safety supervision of G-10 countries at the end of 1974. This treaty was supplemented and completed to suit the reality. To implement safety supervision of banking activities under the Basel Committee, the capital adequacy ratio (CAR) is an economic indicator reflecting the relationship between equity capital and risk-adjusted assets of commercial banks. The CAR ratio is an important measure representing the operational safety of the bank.

To date, the Committee has issued the Basel Treaty, including :

- The Basel I Treaty on capital adequacy was issued in 1988 and implemented in 1992, providing a credit risk measurement framework with a minimum capital standard of 8%. Basel I's objective is to strengthen the entire international banking system's stability and establish a unified and equal international banking system to reduce unhealthy competition among international banks. Also, the risk-based capital ratio was developed by the Basel Committee on bank supervision with the aim of strengthening the international banking system. The initial target of these rules is international banks, but until now, these rules have been implemented in more than 100 countries.

- Basel II Treaty was established to overcome the limit of Basel I. In June 1999, the Basel Committee proposed a new measurement framework with three main pillars :

  - The first pillar, regarding the maintenance of compulsory capital;
  - The second pillar, related to banking policy-making;
  - The third pillar, regarding information disclosure according to market principles.

Basel II's first goal is to improve the quality and stability of the international banking system. The second goal is to create and maintain a level playing field for international banks. The third goal is to encourage the adoption of more stringent risk management practices. The first two goals of Basel II are the key goals of Basel I. The final goal is new, a sign of the gradual transition from the proportional-based regulatory to a regulation based more on internal metrics, practices, and models. According to Basel II, the CAR coefficient still kept the atomic number and changed the denominator compared with Basel I. The new risk-adjusted assets refer to credit risk in Basel I, while Basel II adds operational risk and market risk.

- In Basel III Treaty, the CAR coefficient is calculated according to Basel III compared to Basel II, although still required at 8%, but the ratio of high-quality capital is increased. The ratio of Tier 1 capital increased from 4% in Basel II to 6% in Basel III, and the equity ratio of shareholders is usually increased from 2% to 4%. Problematic "Yes" assets are excluded from equity as investments exceed the 15% limit on financial institutions.

In addition, Basel III also sets standards of liquidity for banks. This regulation requires the banks to hold highly liquid and high-quality assets to meet payment needs in difficult circumstances.

Legal Regulations for CAR Ratio in Vietnam

International operational safety standards were first studied and applied in Vietnam 11 years after Basel I was issued. In 1999, the first CAR was regulated in Vietnam according to Decision No. 297/1999/QD- NHNN of August 25, 1999, promulgating the regulation on prudential ratios in credit institutions' operations. Accordingly, the Decision stated that the capital adequacy ratio is at least 8%. Still, the calculation method is simple and does not fully reflect the contents of Basel I. SBV issued Circular No. 41/2016/TT-NHNN stipulating on capital adequacy ratio for banks. Foreign bank branches help Vietnamese commercial banks implement Basel Agreement. The SBV issued Circular 22/2019/TT-NHNN, dated November 15, 2019, regulating limit, capital adequacy ratio in the operation of banks, and foreign bank branches.

Experimental Studies on the Capital Adequacy of Commercial Banks Under Basel Accords

Many studies have analyzed the determinants of commercial banks' capital safety, which have been studied in many economies and countries around the world. According to Büyüksalvarci and Abdioglu (2011), a study on the Turkish banking industry discovered the negative effect of the ratio of loans to total assets, return on equity, and leverage on capital adequacy ratio. Meanwhile, the ratio of liquidity and profit to total assets is determined to be positively statistically significant, while the size, deposit structure, payment ratio, and NIM did not significantly affect the capital adequacy ratio (CAR). Using OLS regression to study Bosnian banks, Dreca (2013) found that outstanding loans, ROA, deposits, bank size, ROE, and financial leverage significantly influenced the security ratio of capital, while the bad debt ratio and net profit margin had no significant impact. Bateni et al. (2014) studied internal factors affecting banks' capital adequacy ratio. The regression results showed that the capital adequacy ratio was positively affected by the variables of the ratio of loans to assets, return on equity, return on assets while being affected countered by the scale.

In addition to the studies that only consider the internal factors of the bank affecting the capital adequacy ratio, a number of other studies have also examined the impact of both internal and macroeconomic factors on the capital adequacy ratio. Gropp and Heider (2010) looked at both internal and macroeconomic factors and found that high return on equity was a key factor affecting large banks' capital adequacy in the United States and Europe. This finding is consistent with the assumptions of classification order theory. They discovered an astonishing consistency in sign, significance, and economic magnitude. Banks, like non-financial firms, appeared to have stable capital structures at different levels for each bank. The findings imply that capital requirements may only be of second-order importance for bank capital structures, and they confirm the robustness of current corporate finance findings in the holdout sample of banks. Allen and Powell (2013) used a combination of intrinsic and macro factors to show that profitability, bad debt, and GDP negatively affected leverage in banks. Yahaya et al. (2016) studied the impact of banks' financial performance and macro factors, including macro variables including unemployment rate, inflation, real exchange rate, money supply, and gross domestic product (GDP), to banks' capital adequacy ratio in Japan. For variables representing the banks' financial performance, total assets, ROE, and mobilization rates had a positive effect, while the variables of total deposits, total lending, and ROA had a negative effect on the capital adequacy ratio. All five macro variables had negative effects on the capital adequacy ratio of commercial banks.

Olarewaju and Akande (2016) found a positive relationship between ETA, ROA, and SIZE. Besides, there was an inverse linear relationship between ROA, CR, DEP, and LIQ, which is statistically significant for capital

adequacy among banks that accept deposits in Nigeria. However, macro variables like GDP and inflation were positive but not statistically significant with the level of capital adequacy among Nigerian banks.

Although many researchers have studied the impact of intrinsic and macro factors on banks' capital adequacy, the majority of the studies focused on samples from developed countries such as the United States, Europe, Japan, and so on (Büyüksalvarci & Abdioglu, 2011; Gropp & Heider, 2010; Yahaya et al., 2016). There has been a minimal investigation into this topic in Vietnam and other developing countries. In fact, banking systems in Vietnam and other developing countries are expanding in size and becoming increasingly competitive. Furthermore, these countries must also address the factors influencing the capital adequacy ratio. Also, Vietnamese commercial banks have given too much credit to real estate and securities. Because of the volatility of the stock and real estate markets, these credits are very risky. This impacts bank profitability and capital, causing the capital adequacy ratio of Vietnamese commercial banks to fluctuate.

Furthermore, previous studies used the frequency method to infer the influencing factors based on the *p*-value. However, several academics have recently opposed the usage of the *p*-value for hypothesis testing (Briggs & Nguyen, 2019 ; Le et al., 2020). As a result, the Bayesian technique is used in this study to infer the affecting factors. A key issue with estimating methods is that the regression coefficients also vary when the number of explanatory variables in the research model varies. Then, the conclusions regarding the impact of the explanatory factors on the dependent variable will change due to these regression coefficients. Therefore, this study uses the Bayesian model averaging (BMA) method to retest the regression coefficients to confirm the model's robustness and infer the conclusions.

The BMA method estimates a large number of models and infers the effect based on the probability of being present in the models of regression coefficients that correspond to the explanatory variables, rather than inferring the effect based on the regression coefficient and *p*-value.

Methodology and Data

Data

Our sample consists of 20 domestic commercial banks listed at the Ho Chi Minh Stock Exchange (HSX), Hanoi Stock Exchange (HNX), and Upcom stock exchanges. We collected the financial statements data of 20 Vietnamese joint-stock commercial banks by considering the 2007 – 2018 period. This period is selected based on the availability of financial reporting data of 20 Vietnamese joint-stock commercial banks.

The sources of the banks' financial statements were the websites: http://cophieu68.vn and http://vietstock.vn. We used secondary data collected from the audited financial statements of commercial banks to ensure the reliability of the data. The macroeconomic data were collected from sources: thomsonreuters.com and International Financial Statistics (IFS).

Description of the Variables in the Model

In this study, we used CAMELS analysis. This analysis is primarily based on financial factors, which are graded on a scale to determine the health of financial institutions. The first CAMELS factor is capital adequacy, which assesses whether commercial banks have enough capital to offset unexpected losses from credit risks, market risks, and operational risks. Due to the sample from the 2007 – 2018 period, we used the Basel I standard of capital adequacy. The reason is that at the time of the study, most Vietnamese banks had not met the capital adequacy standards under Basel II.

Dependent Variable

The dependent variable is the capital adequacy of commercial banks. According to Olarewaju and Akande (2016), capital adequacy is calculated as follows :

↳ Capital Adequacy *(ETA)* = $\frac{\text{Total value of equity}}{\text{Total assets}}$

Independent Variables

We used secondary data from annual reports and audited financial statements of joint-stock commercial banks listed at the stock exchange for internal variables. Ho Chi Minh City (HSX), Hanoi Stock Exchange (HNX), and on the stock exchange (OTC) for unlisted banks. The sample was taken from 20 banks operating continuously from 2007 – 2018. These internal variables will be calculated and processed as follows :

↳ Bank size (*SIZE*): Taking the logarithm of total assets.

↳ The return on assets *(ROA)* = $\frac{\text{Profit before tax}}{\text{Total assets}}$

↳ The return on equity *(ROE)* = $\frac{\text{Profit before tax}}{\text{Total equity}}$

↳ Credit risk *(CR)* = $\frac{\text{Outstanding bad debts}}{\text{Total outstanding credit}}$

The outstanding bad debt includes the total debt balance in groups 3, 4, and 5.

↳ Deposit proportion *(DEP)* = $\frac{\text{Total deposit}}{\text{Total assets}}$

↳ Liquidity *(LIQ)* = $\frac{\text{Total outstanding credit}}{\text{Total deposit}}$

For macro variables, we followed the study of Olarewaju and Akande (2016) and took the following data :

↳ Economic growth *(GDP)* : Vietnam's real GDP data is taken from nominal GDP adjusted for the CPI (taken 2010 as the base year).

↳ Inflation *(INF)* : The inflation data is also calculated from the CPI Index, with 2010 taken as the base year.

From the viewpoints of capital adequacy related to the Treaties of Basel I, Basel II, and empirical studies discussed in this paper, we examine eight factors affecting capital adequacy of Vietnamese commercial banks as follows: bank size, ROA, ROE, deposit structure, liquidity, credit risk, inflation, and economic growth and the expected sign of these variables are described in Table 1.

Table 1. ***Description and the Expected Sign of Variables***

Variables	Notation	Calculation	Expected Sign	Data Sources
		Dependent Variable		
Capital Adequacy	*ETA*	Total value of equity / Total assets		http://www.cophieu68.vn/ và http://vietstock.vn/
		Independent Variables		
Bank Size	*SIZE*	Taking the logarithm of total assets	–	http://www.cophieu68.vn/ và http://vietstock.vn/
Return on Assets	*ROA*	Profit before tax / Total assets	+	http://www.cophieu68.vn/ và http://vietstock.vn/
Return on Equity	*ROE*	Profit before tax / Total equity	–	http://www.cophieu68.vn/ và http://vietstock.vn/
Credit Risk	*CR*	Outstanding bad debts / Total outstanding credit	(–) or no impacts	http://www.cophieu68.vn/ và http://vietstock.vn/
Deposit Proportion	*DEP*	Total deposit / Total assets	+	http://www.cophieu68.vn/ và http://vietstock.vn/
Liquidity	*LIQ*	Total outstanding credit / Total deposit	(+) or no impacts	http://www.cophieu68.vn/ và http://vietstock.vn/
Economic Growth	*GDP*	Taking nominal GDP adjusted by CPI with the base year 2010	(–) or no impacts	web thomsonreuters.com
Inflation	*INF*	Taking an increase of consumer price index (CPI) with the base year 2010	No impacts	International Financial Statistics (IFS)

Research Model

The research model of factors affecting capital adequacy of Vietnamese commercial banks in terms of internal and macroeconomic factors is shown in equation (1).

$$ETA_{i,t} = \beta_0 + \beta_1 \times SIZE_{i,t} + \beta_2 \times ROA_{i,t} + \beta_3 \times ROE_{i,t} + \beta_4 \times CR_{i,t} + \beta_5 \times DEP_{i,t} + \beta_6 \times LIQ_{i,t} + \beta_7 \times GDP_t + \beta_8 \times INF_t + u_{i,t} \quad (1)$$

where,

i: indicates bank i,
t: indicates year t,
$u_{i,t}$: residuals of the regression model.

Panel data analysis methods are used in our study, including Pooled OLS regression, fixed effect model (FEM), random effects model (REM), and FGLS regression. We also conducted the Hausman test (1978) to choose between FEM and REM.

Simultaneously, we tested the VIF to check multicollinearity between variables and also used the Wooldridge test and modified Wald test to test for heteroscedasticity and autocorrelation. If heteroskedasticity appears, we overcome it with FGLS.

Besides using the above frequency methods, we also used the BMA method to determine the factors affecting the capital adequacy ratio of Vietnamese commercial banks. The BMA method can be described by considering a linear regression model with constant γ_0 and k explanatory variables $x_1, x_2, ..., x_k$, as shown in equation (2):

$$y = \gamma_0 + \gamma_1 x_1 + \gamma_2 x_2 + ... + \gamma_k x_k + \varepsilon \quad (2)$$

With k regressors, we will have 2^k combinations of the explanatory variables on the right. Each combination will create a new model denoted as T_j with $j = 1, 2, 3, ..., 2^k$. At this point, a model space has been built, the posterior probability of any regression coefficient γ_i with data set D, is determined as follows:

$$P(\gamma_i \mid D) = \sum_{j:\gamma_i \in M_j} P(\gamma_i \mid T_j) \times P(T_j \mid D) \quad (3)$$

where $P(T_j \mid D)$ is the posterior probability of any model T_j with data set D, calculated by the formula:

$$P(T_j \mid D) = \frac{P(D \mid T_j) \times P(T_j)}{\sum_{j=1}^{2^k} P(D \mid T_j) \times P(T_j)} \quad (4)$$

where,

$$P(D \mid T_j) = \int P(D \mid \gamma^j, T_j) \times P(\gamma^j \mid T_j)\, d\gamma^j \quad (5)$$

γ^j is the vector of estimated parameters of the model T_j, $P(\gamma^j \mid T_j)$ is a prior probability assigned to the parameters of the model T_j. $P(\gamma^j \mid T_j)$ is a prior probability of the model T_j. The posterior mean and the posterior standard deviation of any regression coefficient γ_i are calculated according to the following formula:

$$E[(\gamma_i \mid D] = \sum_{j=1}^{2^k} \hat{\gamma}_i P(T_j \mid D) \quad (6)$$

$$\delta[\gamma_i \mid D] = \sqrt{VAR[\gamma_i \mid D]} = \sqrt{\sum_{j=1}^{2^k} (VAR[\gamma_i \mid D] + \hat{\gamma}_i^2) \times P(T_j \mid D) - E[\gamma_i \mid D]^2} \quad (7)$$

Thus, to apply the BMA method, it is necessary to determine a prior probability $P(T_j)$ of the model T_j, and $P(\gamma^j \mid T_j)$ is a prior probability assigned to the parameters of the model T_j.

According to Zeugner (2011), a popular choice for a prior probability $P(T_j)$ is a uniform probability distribution since each model is equally likely. In this study, we use a uniform probability distribution for a prior probability $P(T_j)$, so:

$$P(T_j) = \frac{1}{2^k} \quad (8)$$

Unlike the choice of a prior probability $P(T_j)$ a prior probability $P(\gamma^j \mid T_j)$ depends heavily on the information that the researcher has about the probability distribution of the parameters γ^j. In the Bayesian linear regression model, one form of a prior probability distribution of the parameters commonly used by researchers is the

Zellner's g (the default type of information a priori). A prior probability distribution g proposed by Zellner (1986) is based on the data, so it does not violate the law of conditional probability.

Empirical Analysis and Results

Descriptive Statistics and Variables of Pearson Correlation

The results of descriptive statistics are presented in Table 2. Specifically, the average Tier 1 capital adequacy ratio for banks is 10.2%, showing that equity financing over risky assets of commercial banks accounts for about 10.4%. Vietnamese inflation highly fluctuates from 3.6% to 18.7%. Similarly, Vietnamese banks' performance is potential, with return on equity reaching a mean value of 13%. The Vietnamese banking system's liquidity and deposit proportion are rather high, with mean values of 87% and 66%, respectively. In addition, the credit risk is still in the safety threshold, with a low mean value of 1.3%.

Variables of Pearson Correlation

Table 3 shows that the pair-correlation between variables is rather high, in which SIZE and GDP have a strongly

Table 2. *Descriptive Statistical Results*

Variable	Obs	Mean	Std.Dev	Min	Max
ETA	240	0.102205	0.0939277	0.0303	1
INF	240	8.011574	4.507983	3.54	18.6792
GDP	240	2.48×10^{15}	5.92×10^{14}	1.68×10^{15}	3.49×10^{15}
ROA	240	0.0126204	0.0175783	0.0002	0.1946
ROE	240	0.1298992	0.088318	0.0011	0.4625
SIZE	240	7.975669	0.5477822	6.4768	9.1183
LIQ	240	0.8700783	0.2037047	0.3633	1.5716
DEP	240	0.664375	0.4752632	0.2268	6.1398
CR	240	0.012955	0.0058749	0.0014	0.0385

Table 3. *Correlation Analysis*

	ETA	*SIZE*	*ROA*	*ROE*	*CR*	*DEP*	*LIQ*	*GDP*	*INF*
ETA	1.0000								
SIZE	–0.5059	1.0000							
ROA	0.8558	–0.2631	1.0000						
ROE	–0.0757	0.2147	0.3703	1.0000					
CR	–0.0564	0.3454	–0.0136	0.0044	1.0000				
DEP	0.8143	–0.1277	0.8418	0.0252	0.0538	1.0000			
LIQ	0.0231	–0.1478	0.0259	0.1475	–0.2452	–0.2167	1.0000		
GDP	–0.2409	0.5043	–0.2707	–0.2784	0.0781	0.0122	–0.1910	1.0000	
INF	0.2222	–0.3527	0.2210	0.1994	0.0054	0.0052	0.1736	–0.7028	1.0000

negative correlation with ETA, but the correlation coefficient of ROE and CR are weaker. The remaining variables have a strong positive correlation with ETA.

Regression Results of Factors Affecting Capital Adequacy Ratio of Vietnamese Commercial Banks

(1) Regression Results of Intrinsic and Macro Factors Affecting Capital Adequacy Ratio of Vietnamese Commercial Banks

Our study uses panel data, including the Pooled OLS, FEM, and REM regression models according to Olarewaju and Akande (2016).

Table 4 shows the impact of macroeconomic and internal variables affecting commercial banks' capital adequacy by three regression methods. However, the selection test results between the suitable models show that the FEM method is the most suitable; so, the regression results are discussed only under the FEM model.

↳ ***For the Internal Factors of Commercial Banks*** : The size of assets of commercial banks has a negative impact and statistical significance of 1% on capital safety of Vietnamese commercial banks, showing that when the size of the total assets increases by 1%, the capital adequacy of commercial banks will reduce by about 0.0655% in accordance with Dreca (2013).

The ROA variable has a positive and statistically significant effect of 1%. When the rate of return on total assets

Table 4. ***Regression Results of Factors Affecting Banks' Capital Adequacy***

Independent Variables	Pooled OLS	FEM	REM
SIZE	**–0.0300*** **	**–0.0655*** **	**–0.0325*** **
(*p*-value)	**0.000**	**0.000**	**0.000**
ROA	**4.9432*** **	**5.0035*** **	**4.8302*** **
(*p*-value)	**0.000**	**0.000**	**0.000**
ROE	**–0.4136*** **	**–0.4649*** **	**–0.4287*** **
(*p*-value)	**0.000**	**0.000**	**0.000**
CR	0.3894	0.0536	0.1644
(*p*-value)	0.192	0.869	0.595
DEP	0.0059	–0.0076	0.0081
(*p*-value)	0.531	0.482	0.394
LIQ	**0.0186** **	0.0083	**0.0178***
(*p*-value)	**0.035**	0.465	**0.068**
GDP	4.23×10^{-18}	1.98×10^{-17}**	4.37×10^{-18}
(*p*-value)	0.331	**0.002**	0.328
INF	**0.0009***	**0.0011** **	0.0010**
(*p*-value)	**0.056**	**0.011**	**0.026**
Intercept	0.2899	0.5609	**0.3145**
R^2	0.9372	0.9001	0.9361

Note. * significant at 10% level; ** significant at 5% level; ***significant at 1% level.

increases by 1%, commercial banks' capital adequacy will also increase to 5.0035%, in accordance with Olarewaju and Akande (2016). However, the ROE variable has the opposite effect and is statistically significant at 1%, consistent with the findings of Olarewaju and Akande (2016).

The impact of credit risk (CR) and liquidity (LIQ) have a positive and non-significant impact on the capital adequacy of commercial banks, in accordance with the study of Büyüksalvarci and Abdioglu (2011). In contrast, the deposit ratio (DEP) has the opposite effect, but it is not statistically significant to commercial banks' capital adequacy.

↳ ***For Macroeconomic Factors*** : The research results show that the macroeconomic variables have an impact on the capital adequacy of Vietnamese commercial banks, namely :

The GDP variable has a positive direction and a statistical significance of 5%. This shows that when real GDP increases, the capital adequacy of commercial banks will be improved, as opposed to the findings obtained by Yahaya et al. (2016), Allen and Powell (2013), and Olarewaju and Akande (2016). The inflation rate (INF) variable has a positive effect, and it is statistically significant at 5%. This shows that when inflation in the Vietnamese economy increases by 1%, commercial banks' capital adequacy will also be improved by 0.0011%.

(2) Results of Testing the Most Appropriate Regression Model

We conducted the *F*-test to select the most appropriate regression model between Pooled OLS model and the fixed effects model (FEM). Also, we implemented the Breusch – Pagan Lagrange test multiplier to select the Pooled OLS model and the random effects (REM) model and Hausman test to consider the more appropriate FEM or REM model.

↳ **H01 :** There is no difference between the banks in the sample (there is no difference between the Pooled OLS model and the FEM).

According to Table 5, with a 10% significance level, the *F*-test results in the choice between the Pooled OLS model and the fixed effects model (FEM), which shows the rejection of the H01. It means that the FEM is better than the Pooled OLS model.

↳ **H02 :** There are no potential errors in the sample data (there is no difference in errors between the Pooled OLS model and the REM model).

With a 10% significance level, the chi-square statistic test results in choosing between the Pooled OLS model and the random effects model (REM) and show the rejection of the H02. It means that the REM is better than the Pooled OLS model.

↳ **H03 :** There is no correlation of slope coefficient and independent variables in the regression model (there is no significant difference between the FEM and the REM).

Table 5. ***The Results of the Model with ETA as a Dependent Variable***

Selection	Test	Statistical value	*p*-value	Decided
Pooled OLS and FEM	*F* - test	*F* - statistic: 4.42	Prob > *F* = 0.0000	FEM
Pooled OLS and REM	Breusch – Pagan Lagrange	$Chi^2(01) = 19.23$	Prob> $Chi^2 = 0.0000$	REM
FEM and REM	Hausman	$Chi^2 (08) = 27.15$	Prob > $Chi^2 = 0.0007$	FEM

With a 10% significance level, the results of the Hausman test show the rejection of the H03. It means that the FEM is better than the REM.

The Stability of the Model

According to the test results depicted in Table 5, the FEM is the most suitable model. Therefore, we continue to perform the Modified Wald test for heteroskedasticity and the Wooldridge test for autocorrelation.

According to Table 6, the *p*-value of the Modified Wald test is 0.0000, less than 5%, which shows the problems of heteroskedasticity in the model. Also, the *p*-value of the Wooldridge test is 0.0004, less than 5%, which shows the problem of autocorrelation in the model. The multicollinear test results for the independent variables of the research model are as follows.

According to Table 7, the largest VIF index is 10.49 (the average of VIF is 3.93), and greater than 5 belongs to the ROA and DEP variables. Therefore, we can confirm that the model has the multicollinearity phenomenon. Due to the appearance of multicollinearity and heteroskedasticity in the FEM model, we use the Feasible Generalized Least Squares (FGLS) model.

According to Table 8, the results show that the seven variables in the group of eight research variables have a high impact and statistical significance on Vietnamese commercial banks' capital adequacy.

Internal variables of banks such as ROA, DEP, and LIQ have the same directional impact. They are statistically significant at 1%, while CR has only 5% statistical significance to commercial banks' capital adequacy. These results are in agreement with some studies such as Büyüksalvarci and Abdioglu (2011) but in contrast to the studies of Yahaya et al. (2016) and Olarewaju and Akande (2016). Therefore, these results are in line with the expected sign of the hypothesis. In contrast, the variables SIZE and ROE have opposite effects and are statistically significant at 1%, consistent with the hypothesis's expected sign.

Table 6. *Test Results of Variance Change and Autocorrelation*

Test	Results
Modified Wald test for groupwise heteroskedasticity in the fixed effect regression model	Chi^2 (20) = 1944.62
	Prob > Chi^2 = 0.0000
Wooldridge test for autocorrelation in panel data	*F* (1, 19) = 18.170
	Prob > *F* = 0.0004

Table 7. *VIF of Independence Variables*

Variables	VIF	1/VIF
ROA	10.49	0.095293
DEP	8.38	0.119362
GDP	2.76	0.362744
ROE	2.74	0.364345
SIZE	2.45	0.407869
INF	2.01	0.497141
LIQ	1.34	0.747323
CR	1.27	0.784399
Mean VIF	**3.93**	

Table 8. ***Regression Results of Factors Affecting Capital Adequacy of Banks Under the FGLS Model***

Variables	Coefficient	*p*-value
SIZE	–0.02903***	0.000
ROA	4.40516***	0.000
ROE	–0.35252***	0.000
CR	0.47090**	0.030
DEP	0.02339***	0.002
LIQ	0.02564***	0.000
GDP	2.68×10^{-18}	0.324
INF	0.00067***	0.000
Intercept	0.26515	0.000

Note. * significant at 10% level; ** significant at 5% level; ***significant at 1% level.

Table 9. ***Regression Results of Factors Affecting Capital Adequacy of Banks Under the BMA Method***

Variables	PIP	Post Mean	Post *SD*
ROA	1	5.097301	0.126984
SIZE	1	–0.02804	0.003653
ROE	1	–0.42207	0.022585
INF	0.28024	0.000215	0.000408
LIQ	0.27816	0.004321	0.0082
CR	0.11008	0.037294	0.146431
DEP	0.06408	-6.30×10^{-5}	0.002455
GDP	0.06004	2.83×10^{-20}	1.14×10^{-18}
Mean no. regressors		3.7926	
Draws		25000	
Burnins		2500	
Model space		256	
No. Obs.		240	
Model Prior		uniform	
g-Prior		UIP	

The regression results show that six internal factors have a statistically significant impact on the capital adequacy of Vietnamese commercial banks, such as SIZE, ROA, ROE, CR, DEP, and LIQ. Among the two macroeconomic factors, only the inflation rate significantly affects commercial banks' capital adequacy in Vietnam. However, GDP does not affect and be suitable with hypothesis expected sign and opposite with hypothesis expected sign. This result has achieved the research objective of the study. The results also show that Vietnamese commercial banks' capital adequacy level will be significantly affected by internal rather than macro factors.

After estimating the models by frequency method, we use the Bayesian model averaging (BMA) analysis to retest the regression coefficients to ensure the robustness of the model and the conclusions. The results of model estimation by the BMA method are presented in Table 9.

Table 9 shows the results of model estimation by the BMA method, including PIP value, post mean value, and post *SD* value corresponding to each variable in the model. The first column, PIP, represents the sum of the posterior model probabilities of the models with the presence of the corresponding explanatory variable. The second column, post mean, represents the posterior mean of the regression coefficients for all models (including models where this coefficient is zero). The third column, post *SD*, represents the posterior standard deviation of the regression coefficient. The study has estimated 256 models, with the average number of independent variables in each model being 3.79. The estimated results show the following :

With the ROA variable, the post mean of the regression coefficient corresponding to the ROA variable is 5.097301. Besides, the PIP corresponding to the ROA variable has a value of 1, indicating that ROA occurs in all models. This result confirms the positive impact of ROA on the capital adequacy ratio of Vietnamese commercial banks and is similar to the results of the frequency method.

With the SIZE variable, the post mean of the regression coefficient corresponding to the SIZE variable is –0.02804. In addition, the PIP corresponding to the SIZE variable has a value of 1, indicating that SIZE occurs in all models. This result confirms the negative impact of SIZE on the capital adequacy ratio of Vietnamese commercial banks and is similar to the results of the frequency method.

With the ROE variable, the post mean of the regression coefficient corresponding to the ROE variable is –0.42207. Besides, the PIP corresponding to the ROE variable has a value of 1, indicating that ROE occurs in all models. This result confirms the negative impact of ROE on the capital adequacy ratio of Vietnamese commercial banks and is similar to the results of the frequency method.

Regression coefficients of the remaining variables, including INF, LIQ, CR, DEP, GDP, all have PIP values less than 0.5, showing that the regression coefficients of these variables are zero in most of the models. Thus, these variables have little impact on the capital adequacy ratio of Vietnamese commercial banks.

Conclusion

This study has analyzed two research objectives: examining the multivariate relationship between intrinsic factors and macro factors of 20 Vietnamese commercial banks in the 2007 – 2018 period, and assessing the impact of these factors on the capital adequacy of Vietnamese commercial banks. The research results show that :

The internal variables : ROA, DEP, and LIQ have the same directional impact and statistical significance at 1%, while CR has only 5% statistical significance to capital adequacy of commercial banks. These results are in line with the findings of Büyüksalvarci and Abdioglu (2011) but in contrast to the studies of Yahaya et al. (2016) and Olarewaju and Akande (2016). In contrast, the SIZE and ROE variables have an opposite and statistically significant effect of 1%, consistent with the findings of Olarewaju and Akande (2016) and Yahaya et al. (2016).

With regard to the macroeconomic variables, the study has shown that only the inflation rate positively and significantly affects commercial banks' capital adequacy in Vietnam. However, GDP does not affect, as opposed to the findings of Olarewaju and Akande (2016) and Yahaya et al. (2016).

Theoretical Implications

This study has added more evidence about factors affecting the capital adequacy ratio of Vietnamese commercial banks. More specifically, this evidence is obtained from a developing country, Vietnam. Besides, this study uses the Bayesian model averaging (BMA) method to retest the regression coefficients to confirm the model's robustness and infer conclusions. The BMA method estimates many models and infers the effect based on the probability of being present in the models of regression coefficients that correspond to the explanatory variables,

rather than inferring the effect based on the regression coefficient and *p*-value. The results of the model estimation by the BMA method are similar to the frequency method. Therefore, conclusions about factors affecting the capital adequacy ratio of Vietnamese commercial banks are reliable. Finally, by applying the BMA method, this study opens a new research direction for applying test methods without using the *p*-value.

Policy Implications

From the research results, we propose the policy implications to ensure capital adequacy for Vietnamese commercial banks, which are as follows :

Firstly, bank size has a negative impact on the banks' capital adequacy ratio. Therefore, banks need to maintain appropriate size, and increase in size through increased credit activities should be controlled. Secondly, banks need to use financial leverage and capital to meet credit growth effectively so that there is a balance between debt and equity. Thirdly, banks must consider keeping their capital adequacy ratio appropriately by increasing or decreasing their profits. Bank managers should not consider carefully pursuing a policy of increasing profits by investing in a risky asset portfolio, thereby reducing the banks' safety. However, the application of the above governance policies depends on the actual market situation. If the market is in a growth cycle, the banks can open a risky appetite to seek profits and accept a lower capital adequacy level.

Besides, commercial banks need to have a forecast system of macroeconomic fluctuations, especially the forecast of inflation and GDP of the economy, to develop appropriate strategies adapting to economic fluctuations and ensure the safety level in banking activities.

Finally, for policy managers, particularly the State Bank of Vietnam, the commercial banking system in developing countries has a particularly important role in developing the economy, especially in moving capital flows in the economy. Therefore, policy managers' decisions will affect the operation of commercial banks and significantly affect the macroeconomic situation of the economy. In planning credit policies, controlling credit, and commercial banks' operational risks, state management agencies need to consider and balance the macro objectives with commercial banks' performance. Therefore, these decisions will greatly impact almost all actors in the Vietnamese economy, especially the commercial banks' system. So, they need to ensure the implementation of macroeconomic goals and ensure credit growth with safety in the commercial banking system's operations.

Limitations of the Study and Scope for Further Research

Firstly, although the study collected data with a sample of 20 Vietnamese commercial banks over a relatively long period from 2007 – 2018, the research sample is not large enough. This limits the conclusions drawn from the estimation results and affects the reliability of the test. Further studies need to improve the data collection process, thereby improving the data's quality and quantity. Second, except for the variables analyzed in the models shown above, the capital adequacy ratio of Vietnamese commercial banks is theoretically influenced by other variables. Therefore, further studies need to be based on specific research objectives to add other variables.

Authors' Contribution

Linh Thi Thuy Tran conceived the idea, wrote the theoretical framework, and did the empirical analysis. Dr. Tran and Dr. Pham developed the quantitative methodology to undertake the empirical study. Dr. An Ha Thi Pham collected the data and did the numerical computations using STATA 16.0. Dr. Tran and Dr. Pham wrote the research results. The conclusion and implications were written by Dr. Tran.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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