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Optimal Capital Adequacy Ratios for Commercial Banks: Empirical Evidence from Vietnam

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Abstract

It is unavoidable for businesses, especially commercial banks, to compete with other firms and financial institutions in a globalized and internationalized world. Basel I, II, and III were developed by the Basel Committee on Banking Supervision with the primary purpose of supporting banks in dealing with potential risks and enhancing their ability to absorb losses. Basel II and III require the minimum capital adequacy ratio (CAR) of 8% and 10.5%, respectively. This paper estimates the optimal CAR of 26 commercial banks in Vietnam from 2016 to 2020 using the two-stage DEA method. According to the empirical findings, banks with ideal CARs exceeding 8% (as defined by Basel II) and 10.5 percent (as defined by Basel III) account for approximately 98 percent and 88 percent of all banks, respectively. Furthermore, 75.83 percent of all banks need to boost their existing CAR to achieve the optimal level of CAR as well as obtain the best performance. On average, the optimal CAR of state-owned banks is higher than other joint-stock banks, respectively 26 percent and 19 percent. Consequently, it is recommended for Vietnam commercial banks to reach optimal CAR and comply with the new policy set by Basel III with the purpose of approaching the efficient frontier.

Keywords: Capital Adequacy Ratio, BASEL II, BASEL III, Two-stage DEA, Banking System, Vietnam

JEL Classification Code: G21, D24, C43, C61

1. Introduction

The Basel Accord includes the management guidelines related to the banking system worldwide, which are built by the Basel Committee on Banking Supervision (BCBS). They guarantee that banks have the ability to reserve sufficient money to meet their financial demands and overcome financial troubles. Basel I was created in 1988 with the purpose of developing the steadiness of the monetary framework by setting the amount of minimum cash that international banks have to reserve. Banks with a major global presence must maintain a capital adequacy ratio (CAR) of at least 8% of assets to maintain sufficient cash reserves. Since the features of financial risk in the banking industry changed and became more sophisticated, Basel II was presented. Basel II took more risk into consideration by making normalized measures for operational, market, and credit risk. In Basel II, CAR was still kept at 8% and 2% was the minimum common equity to maintain. Nevertheless, the global financial crisis of 2008 uncovered the shortcomings of the worldwide monetary framework and prompted the setting of Basel III. In Basel III, both CAR and common equity increased to 10.5% and 4.5%, respectively.

The banking industry is growing in such a way that commercial banks are becoming more global. As a result, it is vital for financial authorities to preserve the stability of the banking system. Capital Adequacy Ratio (CAR) is also considered as a factor to measure the solvency of the bank, that is the capacity of the bank to exercise financial obligation in the short and long run. In addition, Park and Weber (2006), Besanko and Kanatas (1996), and Kahane (1977) stated that a high CAR assists the banks with scanning risky projects with their extraordinary capacity

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to fund their commitments. Supervisory agencies prefer to set a higher CAR to increase a bank's capacity in the face of several risks, such as market risk, operational risk, or market risk. Banks, on the other hand, pay a high price for taking on a large number of high-risk projects. Hughes (1999) mentioned that instead of using money to lend for profits, the banks must reserve the minimum amount of money as deposits. Thus, the bank does not profit from lending loans if the bank maintains a high level of capital. A bank's performance would suffer as a result of a too high CAR, whereas a bank's performance would also suffer as a result of a too low CAR; for example, when the economy declines, banks may suffer negative results. Thus, it is vital for the banking industry as well as specific banks to find out the optimal CAR.

In Vietnam, the State Bank of Vietnam published Circular No. 22/2019/TT-NHNN, in which the requirement for minimum CAR is 9 percent taking risk and information disclosure duties into account, effective from January 2020. Compared to the required CAR of 8 percent in the previous circular, the State Bank's decision to raise capital ratio requirement by 1 percent paves the way for the introduction of a new Basel III standard of 10.5 percent CAR in the Vietnamese banking industry.

Additionally, Nguyen et al. (2021) contributed to the topic "Optimal Capital Adequacy Ratio" by calculating the optimal CARs for commercial banks in Vietnam from 2010 to 2015. This study will contribute further by using the two-stage DEA method established by Chen et al. (2010) to estimate the optimal CAR from 2016 to 2020, discuss and compare them between state-owned banks and other joint-stock banks.

2. Literature Review

2.1. Relationship between Reserve Requirement and CAR

Capital Adequacy Ratio (CAR) is the ratio of a bank's capital to its risk-weighted assets. The capital adequacy ratio measures the ability of a bank to meet its obligations by comparing its capital to its assets. Regulatory authorities monitor this ratio to see if any banks are at risk of failure. The intent behind their monitoring is to protect the financial system from the negative effects of any bank failures, which includes protecting the funds of bank depositors. According to Fonseca and González (2010), the minimum capital requirement acts as a cushion for banks facing a number of risks, such as economic crisis or bankruptcy risk.

Previously, reserve requirement was considered fundamental to protect banks from facing numerous risks because it restricts the level of cash the banks can lend out. However, reserve requirement has gradually been replaced by CAR, which has the same purpose as reserve requirement and makes some arrangements for banks to manage risks. CAR has been used worldwide and becomes more important than the reserve requirement.

2.2. Risk Attitude of Banks Toward Minimum Capital Requirement

It is believed that the requirement for capital would increase the stability of the banking industry since it is considered as a discipline tool for measuring the behavior of banks in taking risks. To avoid the high cost of equity, instead of expanding the amount of money reserved, banks tend to increase their CAR by decreasing their risky projects. According to Chami and Cosimano (2010), banks are likely to hold more reserve capital than is required to avoid being forced to do so. In addition, Hyun and Rhee (2011) showed that when facing a bad economy or keeping a low level of long-term loans, banks tend to reduce the amount of risky assets instead of issuing non-cost equity.

According to Dewatripont (1994) and Blum (1999), banks with stricter CARs would not allocate their funds to risky projects with the purpose of decreasing risk. Furthermore, Furlong and Keeley (1989) and Dewatripont (1994) showed that regular ways to deal with regulated banks reduce risk-taking motivators since unregulated banks are willing to take higher risky assets to accomplish their aims. However, Kahane (1977), Koehn and Santomero (1980), and Kim and Santomero (1988) mentioned that a higher or lower capital adequacy ratio will give different results because it is based on the risk attitude of banks. It means that banks that are risk averse are not likely to take the risk to get high abnormal returns without being concerned about minimum capital requirement; whereas, banks that are risk-neutral or risk-seekers tend to allocate their funds to risky projects to maximize value. Therefore, it is not sure that tighter CAR can make banks riskier or safer in investment. Hence, CAR will affect banks differently.

2.3. Effect of Capital Adequacy Ratio on Efficiency and Profitability of Banks

Banks having a high CAR will be limited in the amount of deposits they can hold to reap the benefits of lending out. The benefits of lending funds are the primary source of bank income, hence the minimum capital ratio, according to Iloska (2014), can have a substantial impact on bank performance. According to (Shim, 2013), it can be

considered that stricter regulation can lead to the decrease in the performance of the banking industry. Additionally, Dao and Nguyen (2020a) mentioned that internal factor such as CAR has a negative effect on commercial banks profitability. They suggested that commercial banks in Vietnam should maintain adequate capital to avoid incurring costs and instead use it to invest in profitable ventures. However, Irawati et al. (2019) showed that the tighter regulation in Basel II has a positive correlation with banks' performance by decreasing the loans default in bad economic conditions. It is also suggested that implementing a new capital adequacy policy would improve bank governance, supporting commercial banks in reducing bad loans and improving income as well as efficiency (To & Le, 2020). Several conflicting views mentioned the link between CAR and the operational efficiency of banks. Thus, this study is helpful for the banking industry in Vietnam when investigating banks' operational performances and efficiency using CAR.

2.4. Empirical Findings in Vietnam

There are some papers concerning the capital adequacy ratio regulation of the banking industry in Vietnam in recent times. Dao and Nguyen (2020) investigated the relationship between CAR and bank operating efficiency, as well as the factors that influence these outcomes. This paper implied that it is better for banks to monitor the relevant variables with the purpose of preserving an appropriate CAR to approach the best performance. Nguyen (2020) used panel data regression analysis to demonstrate that the CAR of banks positively impacts banks' profitability while the other variables such as non-performing loans affect negatively. Furthermore, according to a study published in 2019 by Dan (2019), commercial banks in Vietnam do not implement Basel II requirements as quickly as their counterparts in other countries. Therefore, it is better to implement Basel II requirements only in specific banks rather than the entire banking industry. Dan (2019), Batten and Vo (2016), and Trang and Do (2019) demonstrated that the CAR of commercial banks is critical to preserve the profitability of banks. It is suggested that commercial banks in Vietnam should satisfy the required CAR to catch up with other nations in a globalized society, thus boosting banks' profitability.

Nguyen et al. (2021) calculated the optimal CARs of Vietnam commercial banks over the period of 6 years from 2010 to 2015. There are no other studies contributing further to the topic of optimal CAR in Vietnam. Therefore, this research is conducted to fill this gap by calculating the optimal CAR for commercial banks from 2016 to 2020 and discuss and analyze them further.

3. Methodology

3.1. Research Model

3.1.1. Single-Stage Data Envelopment Analysis

DEA (Data Envelopment Analysis) is known as an approach to evaluate a Decision-Making Unit (DMU) effi-ciency that employs linear programming techniques to enclose input observations and output observations closely (Boussofiane et al., 1991). By introducing weight limitations, DEA models might be further segmented in the aspect of constant returns to scale (CRS). According to Charnes et al. (1978), all DMUs would operate at the optimal level in DMU efficiency evaluation for CRS. After that, Charnes et al. (1978) established VRS - variable returns to scale which is an efficiency assessment approach in which DEA efficiency would be broken into efficiencies of technique and scale.

The DEA model in the one-stage method is solved by inserting a modest constraint that is greater than 0 on weights of input and output. Alternatively, the purpose of the DEA model was adjusted to include lower bound multiplication with input-output slacks. However, according to Ali and Seiford (1993), the single-stage technique might cause several issues. Using a low bound which is so small would result in undesirable mistakes. Due to this disadvantage, the two-stage model is established to become the favored solution technique in the DEA approach.

3.1.2. Two-stage Data Envelopment Analysis

The two-stage DEA method is employed in this research to find out the response for a number of research issues. DEA is a "black box" that contains a transformation structure that turns inputs into outputs. According to this viewpoint, the process is separated into multiple stages. In these stages, inputs and outputs serve dual purposes rather than play a distinct role. The results of one process might be the inputs of the following one. This type of outcome is considered an intermediate variable.

Using the breakdown of processes into sub-stages, Seiford and Zhu (1999) discovered that a bank process consists of two processes. The first stage involves assessing banks' performance, while the second stage involves determining cost-effectiveness. The first sub-process would use N inputs to result in D outputs. The second sub-process would use the D outputs of the first one to create M outputs.

The model is as follows:

$$\textbf{\textit{Max}}$$

$$\beta_j, \lambda_1, \ldots, \lambda_H, z'_1, \ldots, z'_D \qquad \beta_j$$

$$\sum_{h=1}^{H} \lambda_h \, \mathrm{x}_{\mathrm{nh}} \le \mathrm{x}_{\mathrm{nj}}, n = 1, 2, \ldots, N$$

$$\sum_{h=1}^{H} \delta_h y_{\mathrm{mh}} \ge \beta_j y_{mj}, m = 1, 2, \ldots, M$$

$$\sum_{h=1}^{H} \lambda_h \, \mathrm{z}_{\mathrm{dh}} \ge \mathrm{z}'_{\mathrm{dj}}, d = 1, 2, \ldots, D$$

$$\sum_{h=1}^{H} \delta_h z_{\mathrm{dh}} \le z'_{\mathrm{dj}}, d = 1, 2, \ldots, D$$

$$\lambda_h, \delta_h \ge 0, h = 1, 2, \ldots, H; \; z'_{\mathrm{dj}} \ge 0, d = 1, \ldots, D; \; \beta_j \text{ is free}$$

Where:

$x_{1j} \ldots x_{Nj}$: inputs of the first stage, $x_{1j} \ldots x_{Nj} \in R_+^{\mathrm{N}}$

$\mathrm{z}'_{1j} \ldots \mathrm{z}'_{\mathrm{Dj}}$: outputs of the first stage as well as inputs of the second stage, $\mathrm{z}'_{1j} \ldots \mathrm{z}'_{\mathrm{Dj}} \in \mathrm{R}_+^{\mathrm{D}}$

$y_{1j} \ldots y_{Mj}$: outputs of the second stage, $y_{1j} \ldots y_{Mj} \in R_+^{\mathrm{M}}$

N: number of inputs.

M: number of outputs.

D: number of intermediate variables.

H: number of commercial banks.

β_j: the reciprocal of overall efficiency.

We utilize this model to calculate the DMUs' efficiency since it takes the interaction of DMUs and production phases into consideration. Also, this model might be utilized to calculate the optimal intermediate products. It is useful for changing intermediate values to approach the efficiency frontier.

3.2. Description of Variables and Source of Data

The data set is gathered from 26 commercial banks in Vietnam over the period of 5 years from 2016 to 2020. The bank list is given in Appendix A. The variables include inputs (Fixed Assets, Employee Expense), intermediate variables (Deposits, Investments, Performing Loans), outputs (Interest Income, Non-interest Income) and are scaled by Equity Capital (see Table 1).

The first intermediate variable is CAR. Banker et al. (2010) and Berger (2013) stated that a bank with a larger CAR would have the capacity to face various types of risks, enhance the bank's ability to satisfy long-term loans, and bear crisis-related losses. However, a tighter CAR might produce a decline in the operational efficiency and cost-effectiveness of banks (Kahane, 1977; Besanko & Kanatas,1996; Park & Weber, 2006). Thus, it is reasonable while choosing CAR as an intermediate variable.

Deposit is the other intermediate factor. Personnel and equity of banks are utilized to boost the likelihood of consumers investing their cash in banks. That assists banks in financing their deposit amount to make profits (Sherman & Gold, 1985; Camanho & Dyson, 2006). Since the deposit is the primary source of revenue of banks, banks desire to attract money from depositors as much as possible (Yue, 1992; Weill, 2004; Ray, 2007; Valverde & Humphrey, 2007). Therefore, the deposit is likewise handled as the output of the first stage and the second process's input.

Investment and performing loans are two remaining intermediate variables. There is a link between investments, loans, and the cost-effectiveness of banks. Thus, it makes sense to use investment and loans as intermediate factors with dual purposes.

The descriptive statistics of inputs, intermediate products, and outputs are presented in Table 2. The intermediate variable of interest in the process is CAR. The mean value of the Capital Adequacy Ratio of 26 banks between 2016 and 2020 is 12.09. Interestingly, this figure is higher than both requirements under Basel II and III – 8% and 10.5%, respectively. SGB has the largest CAR during this period, with a CAR of 23.36 in both

Table 1: Variables and Data Source

	Variables	Data Source
Inputs	Fixed Assets	Financial Statement – Asset
	Employee Expense	Financial Statement – Cash Flows
Intermediate Products	CAR	Annual Report
	Deposits	Financial Statement – Liability
	Investments	Financial Statement – Asset
	Performing Loans	Financial Statement – Asset & Notes
Outputs	Interest Income	Financial Statement – Income Statement
	Non-interest Income	Financial Statement – Income Statement

2016 and 2017. Remarkably, the bank with the smallest CAR is SSB, with 7.85 percent in 2017, smaller than the requirement under Basel II and Basel III which are 8% and 10.5%, respectively.

4. Results and Discussion

This study uses the model developed by Chen et al. (2010) with R software to perform and run the model to obtain the empirical results. The optimal intermediate variables' descriptive statistics are presented in Table 2.

Over the period of 5 years from 2016 to 2020, the mean of optimal values of Deposits, Performing Loans, and Investment over Equity Capital, is 1406.3 percent, 1273.4 percent, 407.8 percent, respectively. The disparity between the actual and optimal value of Investment-to-Equity capital is 167% while between the actual and optimal value of ratios of Deposit over Equity and Performing loans over Equity is high, at 263 percent and 405 percent, respectively. It means that banks should strive to improve their performance by diversifying investment projects properly, attracting consumer deposits, and monitoring and handling non-performing loans to minimize the level of uncollectible loans.

The optimal CAR has a mean value of 20.06 percent. ACB has the maximum value of optimal CAR of 39.52 percent in 2016. It is clear that the optimal CAR of ACB is much larger than the capital requirement under Basel III which is 10.5 percent. The smallest optimal value of CAR belongs to MBB, at 2.11 percent.

As shown in Table 3, practically all banks have a CAR value that is higher than the capital requirement under Basel II (8 percent), which accounts for 97.5 percent of total capital. Nonetheless, if the Basel III capital requirement of 10.5 percent is applied, 87.5 percent of all banks' optimal CAR values are greater than 10.5 percent. We can say that 15 banks, including 3 banks with an optimal CAR of less than 8% and 12 banks with an optimal CAR of less than 10.5 percent, will not fulfill the new Basel III criteria. In these circumstances, a CAR of 10.5 percent is recommended.

We also define Excess CAR by subtracting the actual CAR from the optimal CAR (Table 4). We then discuss which banks should increase or decrease their current CAR to achieve the desired level by calculating the excess CAR. The detailed excess CAR of each bank is shown in Appendixes A, B, and C.

Table 4: Optimal CAR for Three Bank Groups

Optimal CAR Bank Groups	Number of Banks	Percentage of Total
< 8%	3	2.5%
8% < CAR < 10.5%	12	10%
> 10.5%	105	87.5%

Table 2: Variables' Descriptive Statistics

	Variables	Mean	Median	Standard Deviation	Minimum	Maximum
Inputs	Employee Expense	20%	20.52%	6.55%	5.22%	37.72%
	Fix Asset	17.29%	11.39%	2.12%	1.83%	116.55%
Intermediate Products	CAR	12.09	11.30	2.86	7.85	23.36
	Deposit	1143.30%	1115.30%	456.6%	400.30%	2846.40%
	Investment	240.37%	238.59%	109.99%	17.15%	618.57%
	Performing loans	868.20%	832.40%	343.16%	248.80%	2050.50%
Outputs	Interest Income	97.27%	96.26%	36.54%	4.40%	257.29%
	Non-Interest Income	13.15%	11.09%	7.77%	–1.33%	33.60%

Table 3: Optimal Intermediate Variables' Descriptive Statistic

	Mean	Median	Standard Deviation	Minimum	Maximum
Optimal CAR	20.06	20.29	8.42	2.11	39.52
Optimal Deposit	1406.3%	1293.7%	612.78%	248.1%	2851.2%
Optimal Investment	407.8%	362.2%	182.67%	151.7%	988%
Optimal Performing Loans	1273.4%	1265.9%	471.11%	500.9%	2325%

In Table 5, the number of banks that have an excess CAR smaller than 0 is approximately 19 percent of the total. Since the actual CAR exceeds the optimal CAR, it is necessary for these banks to lower their CAR to reach the desired CAR. On the other hand, almost 76 percent of 120 banks, or 91 banks should raise the actual CAR to achieve the desired CAR. The percentage of banks that have an excess CAR almost equal to 0 is 5%. It means that there are 6 banks with current CAR almost equivalent to the optimal CAR. In addition, in the case that banks desire to pursue the optimal CAR, they must satisfy the requirement CAR set by Basel II or Basel III.

Additionally, the State Bank of Vietnam published Circular No. 22/2019/TT-NHNN, which states that the requirement for CAR is 9 percent. Basel III has not been implemented yet; therefore, it is recommended that those banks whose optimal CAR is less than 9% should keep their level of actual capital at least 9 percent to comply with the policy of the State Bank in Vietnam.

To reach the optimal CAR, there are some ways for banks to increase their actual CAR. To begin with, the capital adequacy ratio (CAR) is a measure of how much capital a bank has available, reported as a percentage of a bank's risk-weighted credit exposures. Two types of capital are measured: tier-1 capital, which can absorb losses without a bank being required to cease trading, and tier-2 capital, which can absorb losses in the event of a winding-up and so provides a lesser degree of protection to depositors. One way to raise Tier 1 which is the core capital is holding gains of shareholders or issuing shares to them instead. The other way could be paying stock dividends, or the sale of treasury securities, so on. The issuance of long-term bonds could be a feasible choice for Tier 2. Or it could be through accumulating dividends, which means that asking current owners for contributing equity without share dilution. In addition, in the case that these solutions can not be applied efficiently, banks could seek to boost capital from abroad and decrease the percentage of state ownership in the banks. This option could assist banks to relieve the strain on the budget of the government. Furthermore, the reduction in state-owned capital would force banks to be more cautious in overseeing and utilizing their resources of money in managing operations, making decisions, and providing products to customers. As a result, these banks' performance and efficiency would be enhanced.

Next, we will discuss the optimal CAR and actual CAR of state-owned banks and other joint-stock banks in Vietnam. Table 6 shows that the average values of optimal CAR for two types of banks and all banks are above the Basel II and III capital requirements. The difference between the mean actual CAR of banks with state-owned capital greater than 50% and their mean optimal CAR is around 15%. And when compared to one of the banks with a state-owned capital below 50% and all banks, which are approximately 7% and 8%, respectively, this figure is nearly twofold.

There are some reasons why the mean value of optimal CAR of state-owned banks is higher than other banks. First, optimal CARs of state-owned banks would be higher than other joint-stock banks to ensure the safety and efficiency of the banking system because 40% of the overall market share for lending and deposit is contributed by state-owned banks in Vietnam. Besides, Nguyen (2020) stated that in comparison to other banks, banks with state capital above 50% receive greater benefits from the government; therefore, they can easily and quickly manage liquidity

Table 5: Excess CAR in Three Bank Groups

	2016	2017	2018	2019	2020	All	% of All
Excess CAR < 0	6	6	4	4	3	23	19.17%
Excess CAR ≈ 0	2	2	1	1	0	6	5%
Excess CAR > 0	18	18	21	21	13	91	75.83%

Table 6: Average Optimal, Actual, and Excess CAR of State-owned Banks, Non-State-owned Banks, and All Banks

	Optimal CAR (Mean)	Actual CAR (Mean)	Excess CAR (Mean)
State-owned banks (state ownership > 50%)	25.89	10.56	15.33
Other joint-stock banks (state ownership < 50%)	19.231	12.31	6.92
All banks	20.06	12.09	7.97

shortages by acquiring capital or refinancing from the State Bank.

However, in fact, the mean value of actual CAR of state-owned banks is quite low compared to other banks. First, it is more difficult for state-owned banks to boost capital ratios based on investment from foreign investors compared to the other banks. Second, because state-owned banks depend on the state budget, which is currently in deficit, they lack the state's investments in recent years. Finally, state-owned banks have recently experienced a loss in performance as well as an increase in bad debts, in addition to setting high uncollectible loan provisions. Therefore, these reasons lead to a higher drop in actual CAR of state-owned banks compared to other banks.

Finally, a better understanding of the connection between CAR and other factors could be gained through calculating and analyzing the excess CAR's distribution (Table 7).

As the mean of employee expense to owner's equity ratio is compared across the four classifications, the fourth category has the greatest value. The mean of other variables, such as fixed assets, non-interest income, and interest income, is similarly highest in the fourth group. It could be inferred that as the third quartile is less than the excess CAR, the mean of these variables is the highest. It means that if banks modify the difference between optimal and actual CARs to be higher than the third quartile, the mean of these variables will be the highest. Similarly, the optimal CAR is higher in banks with high values of employee expense, fixed assets, and incomes. When the values of these variables are high, banks are regarded to be riskier in terms of providing services and managing; hence, banks must have a higher capital reserve ratio to ensure their safety in the face of economic fluctuations or extreme crises.

5. Conclusion

In general, with the continuous expansion of the economy as well as the banking system and financial market in Vietnam, it is essential for all Vietnam commercial banks to integrate with the global financial system. To manage and enhance the growth of commercial banks in Vietnam as well as other nations around the world, there are always a plethora of global norms to comply with. Basel Committee on Banking Supervision set a CAR of 8% in Basel I and II and then enhanced to the new stricter requirement of 10.5% in Basel III.

The two-stage DEA model proposed by Chen et al. (2010) is used in this study to measure the optimal CAR and other optimal intermediate variables such as loans, investments, or deposits. In this research, the information of 26 commercial banks in Vietnam is collected and analyzed over the period of 5 years from 2016 to 2020. It is shown in empirical findings that 97.5% of all DMUs have an optimal CAR of higher than 8 percent, which is the capital requirement set by Basel II. Moreover, the figure for DMUs that have an optimal CAR of higher than 10.5 percent is approximately 88 percent. Besides, almost 76 percent of 120 banks or 91 banks should raise the actual CAR to achieve the desired frontier efficiency. It means that it is feasible for commercial banks in Vietnam to meet the new Basel III CAR requirements to achieve the best results. State-owned banks, in particular, with the state capital of more than 50%, have a higher average optimum CAR and a lower actual CAR than the mean values of all banks, including other joint-stock banks. Thus, state-owned banks should focus on minimizing the difference between their optimal and actual values to maximize their performance as well as implement the new requirements.

Banks could boost their CAR in a variety of methods including raising Tier 1 capital or Tier 2 capital. Core capital (Tier 1) consists of some methods such as holding gains of shareholders or issuing shares to them, paying stock dividends, sale of treasury securities, so on, while supplemental capital (Tier 2) includes the issuance of long-term bonds or the reduction of state-owned capital in bank structures.

We have two recommendations in this research. Firstly, those banks whose optimal CAR is below actual CAR and optimal CAR is less than 9% should keep their level of actual capital at least 9 percent to comply with the Circular No.

Table 7: Excess CAR's Distribution

	Excess CARs			
	<1st Quartile	1st–2nd Quartile	2nd–3rd Quartile	>3rd Quartile
Employee Expense	11.21%	15.96%	21.3%	26.3%
Fix Asset	4.09%	7.83%	14.82%	20.63%
Interest Income	55.74%	79.87%	102.54%	120.03%
Non-Interest Income	4.09%	7.83%	14.82%	20.63%
	Q1 = 0.12	Q2 = 8.15	Q3 = 14.56	

22/2019/TT-NHNN of the State Bank in Vietnam. Secondly, it is vital for commercial banks in Vietnam to strive for the optimal CARs that meet the minimum capital requirement set by Basel II and III to assist them in improving their profitability and efficiency, complying with rules, and enhancing globalization.

References

Ali, A. I., & Seiford, L. M. (1993). Computational accuracy and infinitesimals in data envelopment analysis. *INFOR: Information Systems and Operational Research*, *31*(4), 290–297. https://doi.org/10.1080/03155986.1993.11732232

Banker, R. D., Chang, H., & Lee, S. Y. (2010). Differential impact of Korean banking system reforms on bank productivity. *Journal of Banking and Finance*, *34*(7), 1450–1460. https://doi.org/10.1016/j.jbankfin.2010.02.023

Batten, J. A., & Vo, X. V. (2016). Bank risk shifting and diversification in an emerging market. *Risk Management*, *18*(4), 217–235. https://doi.org/10.1057/s41283-016-0008-2

Berger, B. (2013). The profit-structure relationship in banking tests of market-power and efficient-structure hypotheses. *Journal of Money, Credit and Banking*, *27*(2), 404–431. https://doi.org/10.2307/2077876

Besanko, D., & Kanatas, G. (1996). The regulation of bank capital: Do capital standards promote bank safety? *Journal of Financial Intermediation*, *5*(2), 160–183. https://doi.org/10.1006/jfin.1996.0009

Blum, J. (1999). Do capital adequacy requirements reduce risks in banking? *Journal of Banking and Finance*, *23*(5), 755–771. https://doi.org/10.1016/S0378-4266(98)00113-7

Boussofiane, A., Dyson, R. G., & Thanassoulis, E. (1991). Applied data envelopment analysis. *European Journal of Operational Research*, *52*(1), 1–15. https://doi.org/10.1016/0377-2217(91)90331-O

Camanho, A. S., & Dyson, R. G. (2006). Data envelopment analysis and Malmquist indices for measuring group performance. *Journal of Productivity Analysis*, *26*(1), 35–49. https://doi.org/10.1007/s11123-006-0004-8

Chami, R., & Cosimano, T. F. (2010). Monetary policy with a touch of Basel. *Journal of Economics and Business*, *62*(3), 161–175. https://doi.org/10.1016/j.jeconbus.2009.12.001

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision-making units. *European Journal of Operational Research*, *2*(6), 429–444. https://doi.org/10.1016/0377-2217(78)90138-8

Chen, Y., Cook, W. D., & Zhu, J. (2010). Deriving the DEA frontier for two-stage processes. *European Journal of Operational Research*, *202*(1), 138–142. https://doi.org/10.1016/j.ejor.2009.05.012

Dang, V. D. (2019). Should Vietnamese banks need more equity? Evidence on risk-return trade-off in dynamic models of banking. *Journal of Risk and Financial Management*, *12*(2), 84. https://doi.org/10.3390/jrfm12020084

Dao, B. T. T., & Nguyen, D. P. (2020a). Determinants of profitability in commercial banks in Vietnam, Malaysia, and Thailand. *Journal of Asian Finance, Economics, and Business*, *7*(4), 133–143. https://doi.org/10.13106/jafeb.2020.vol7.no4.133

Dao, B. T. T., & Nguyen, K. A. (2020b). Bank capital adequacy ratio and bank performance in Vietnam: A simultaneous equations framework. *Journal of Asian Finance, Economics, and Business*, *7*(6), 39–46. https://doi.org/10.13106/jafeb.2020.vol7.no6.039

Dewatripont, T. (1994). A theory of debt and equity: Diversity of securities and manager-shareholder congruence. *The Quarterly Journal of Economics*, *109*(4), 1027-1054. https://doi.org/10.2307/2118355

Fonseca, A. R., & González, F. (2010). How bank capital buffers vary across countries: The influence of cost of deposits, market power, and bank regulation. *Journal of Banking and Finance*, *34*(4), 892–902. https://doi.org/10.1016/j.jbankfin.2009.09.020

Furlong, F. T., & Keeley, M. C. (1989). Capital regulation and rank risk-taking. *Journal of Banking and Finance*, *13*(1977), 883–891. https://doi.org/10.1016/0378-4266(89)90008-3

Hughes, J. P. (1999). Incorporating risk into the analysis of production. *Atlantic Economic Journal*, *27*(1), 1–23. https://doi.org/10.1007/BF02299174

Hyun, J. S., & Rhee, B. K. (2011). Bank capital regulation and credit supply. *Journal of Banking and Finance*, *35*(2), 323–330. https://doi.org/10.1016/j.jbankfin.2010.08.018

Iloska, N. (2014). An analysis of bank profitability in Macedonia. *Journal of Applied Economics and Business*, *2*(1), 31–50. http://www.aebjournal.org/articles/0201/020102.pdf

Irawati, N., Maksum, A., Sadalia, I., & Muda, I. (2019). Financial performance of Indonesian banking industry: the role of good corporate governance, capital adequacy ratio, non-performing loan, and size. *International Journal of Scientific and Technology Research*, *8*(4), 22–26. https://www.ijstr.org/final-print/apr2019

Kahane, Y. (1977). Capital adequacy and the regulation of financial intermediaries. *Journal of Banking and Finance*, *1*(2), 207–218. https://doi.org/10.1016/0378-4266(77)90007-3

Kim, D., & Santomero, A. M. (1988). Risk in banking and capital regulation. *The Journal of Finance*, *43*(5), 1219. https://doi.org/10.2307/2328216

Koehn, K., Michael, S., & Anthony, M. (1980). Regulation of bank capital and portfolio risk. *The Journal of Finance*, *35*(5), 1235–1244. https://doi.org/10.1111/j.1540-6261.1980.tb02206.x

Nguyen, P. A., Tran, B. Le, & Simioni, M. (2021). Optimal capital adequacy ratio: An investigation of Vietnamese commercial banks using two-stage DEA. *Cogent Business and Management*, *8*(1). https://doi.org/10.1080/23311975.2020.1870796

Nguyen, T. H. (2020). Impact of bank capital adequacy on bank profitability under Basel II Accord: Evidence from Vietnam. *Journal of Economic Development*, *45*(1), 31–46. http://jed.or.kr/full-text/45-1/2.pdf

Park, K. H., & Weber, W. L. (2006). A note on efficiency and productivity growth in the Korean Banking Industry, 1992-2002. *Journal of Banking and Finance*, *30*(8), 2371–2386. https://doi.org/10.1016/j.jbankfin.2005.09.013

Ray, S. C. (2007). Are some Indian banks too large? An examination of size efficiency in Indian banking. *Journal of Productivity Analysis*, *27*(1), 41–56. https://doi.org/10.1007/s11123-006-0022-6

Seiford, L. M., & Zhu, J. (1999). Profitability and marketability of the top 55 U.S. commercial banks. *Management Science*, *45*(9), 1270–1288. https://doi.org/10.1287/mnsc.45.9.1270

Sherman, H. D., & Gold, F. (1985). Bank branch operating efficiency: Evaluation with data envelopment analysis. *Journal of Banking and Finance*, *9*(2), 297–315. https://doi.org/10.1016/0378-4266(85)90025-1

Shim, J. (2013). Bank capital buffer and portfolio risk: The influence of business cycle and revenue diversification. *Journal of Banking and Finance*, *37*(3), 761–772. https://doi.org/10.1016/j.jbankfin.2012.10.002

To, T. H., & Le, P. T. (2020). An analysis of Vietnamese bank productivity change in the time of restructuring. *Journal of Asian Finance, Economics, and Business*, *7*(11), 779–788. https://doi.org/10.13106/jafeb.2020.vol7.no11.779

Trang, V. K., & Do, H. (2019). Impact of capital on profitability of banks: evidence from Vietnamese commercial banks. *Journal of Economics and Business*, *2*(2). https://doi.org/10.31014/aior.1992.02.02.94

Valverde, V., & Humphrey, H. (2007). Opening the black box: Finding the source of cost inefficiency. *Journal of Productivity Analysis*, *27*(3), 209–220. https://doi.org/10.1007/s11123-007-0034-x

Weill, L. (2004). Quaternary codes and biphase sequences from Z8-codes. *Problemy Peredachi Informatsii*, *40*(2), 50–62. https://doi.org/10.1023/B

Yue, P. (1992). Data envelopment analysis and commercial bank performance: A primer with applications to Missouri banks. *Review*, *74*(1), 31–45. https://doi.org/10.20955/r.74.31-45

Appendix A: Bank List

	Security Code	**Bank's Name**
1	ABB	An Binh Commercial Joint Stock Bank
2	ACB	A Chau Commercial Join stock bank
3	BAB	Bac A Commercial Joint Stock Bank
4	BID	JSC Bank For Investment And Development Of Vietnam
5	CTG	Vietnam Joint Stock Commercial Bank for Industry and Trade - VietinBank
6	EIB	Vietnam Commercial Joint Stock Export Import Bank - EximBank
7	HDB	Ho Chi Minh City Development Joint Stock Commercial Bank
8	KLB	Kien Long Commercial Joint Stock Bank
9	MBB	Military Commercial Joint Stock Bank
10	MSB	Vietnam Maritime Commercial Joint Stock Bank
11	NAB	Nam A Commercial Joint Stock Bank
12	NVB	National Citizen Commercial Joint Stock Bank
13	OCB	Orient Commercial Joint Stock Bank
14	PGB	Petrolimex Group Commercial Joint Stock Bank
15	SGB	Saigon Bank For Industry And Trade
16	SCB	Saigon Commercial Joint Stock Bank
17	SSB	Southeast Asia Commercial Joint Stock Bank
18	SHB	Saigon Hanoi Commercial Joint Stock Bank
19	STB	Sai Gon Thuong Tin Commercial Joint Stock Bank
20	TCB	Vietnam Technological and Commercial Joint Stock Bank
21	TPB	Tien Phong Commercial Joint Stock Bank
22	VCB	Bank for Foreign Trade of Vietnam

Appendix A: (Continued)

	Security Code	Bank's Name
23	VIB	Vietnam International Commercial Joint Stock Bank
24	VietAbank	Vietnam Asia Commercial Joint Stock Bank
25	BVB	Viet Capital Commercial Joint Stock Bank
26	VPB	Vietnam Prosperity Joint Stock Commercial Bank

Appendix B: Optimal CAR

	2016	2017	2018	2019	2020
ABB	27.01	21.55	28.11	26.38	
ACB	39.52	27.06	35.95	33.00	28.54
BAB	12.96	11.4	15.95	22.59	
BID	37.31	26.92	33.86	25.29	32.86
CTG	26.39	21.67	26.37	22.67	24.62
EIB	21.77	15.66	21.13	19.25	18.59
HDB	36.37	23.56	30.03	10.72	20.56
KLB	2.10	23.65	28.48	31.40	35.70
MBB	11.85	11.60	25.47	21.13	20.47
MSB	12.60	11.52	8.78	9.89	9.93
NAB	28.00	18.61	25.70	25.26	24.11
NVB	37.20	31.98	37.12	25.73	
OCB	24.27	18.72	21.42	16.52	12.08
PGB	13.14	9.48	15.37	13.35	
SGB	15.15	11.78	14.37	14.96	
SCB	9.02	10.08	9.69	8.35	
SSB	23.11	20.19	22.51	19.64	21.12
SHB	25.85	20.38	25.15	25.35	
STB	34.73	28.35	35.65	37.93	
TCB	21.98	14.20	9.16	9.41	9.22
TPB	10.20	14.98	5.85	15.85	
VCB	24.83	22.28	23.98	20.51	18.67
VIB	15.97	16.00	7.32	12.08	12.59
VietABank	13.78	11.29	14.45	10.89	12.25
BVB	17.35	13.34	12.32	10.85	
VPB	14.59	12.07	20.44	19.49	17.21

Appendix C: Excess CAR

	2016	2017	2018	2019	2020
ABB	11.91	8.15	15.31	15.29	
ACB	26.33	19.03	24.86	22.10	17.48
BAB	0.00	0.00	4.81	12.37	
BID	28.32	16.02	22.96	14.40	21.96
CTG	16.00	11.28	15.98	12.27	14.22
EIB	4.66	–0.32	6.09	5.44	6.79
HDB	23.87	10.07	17.94	–0.48	8.47
KLB	–14.24	7.88	11.86	17.98	23.66
MBB	–0.65	–0.40	14.57	10.45	10.05
MSB	–3.88	–2.29	–3.39	–1.56	–0.67
NAB	16.82	5.99	14.55	15.61	15.13
NVB	26.27	22.71	27.55	16.06	
OCB	15.94	10.17	9.39	3.48	–2.45
PGB	–4.89	–5.43	0.82	0.16	
SCB	–8.20	–11.58	–7.79	–3.43	
SSB	0.00	0.00	0.00	0.00	
SGB	13.97	12.34	9.91	2.92	9.02
SHB	12.85	9.09	13.37	13.35	
STB	23.92	17.05	23.78	26.41	
TCB	8.88	4.80	–5.44	–6.08	–6.87
TPB	0.21	4.98	–4.39	5.16	
VCB	13.71	10.66	11.84	11.17	9.12
VIB	2.72	2.93	–2.68	2.39	2.47
VietABank	–1.98	1.05	4.37	1.15	3.86
BVB	4.18	2.28	1.56	2.32	
VPB	1.40	–2.52	8.14	8.39	5.41