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The Determinants of Banks' Capital Structure in Cambodia: Empirical Evidence from A Highly Dollarized Economy

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Abstract

In Cambodia, one of the world's highest dollarized economies, commercial banks are exposed to high systemic risk, since the lender of last resort function of the central bank is severely restricted. Although many studies including IMF (2018) Country Report 18/369 worry about the high systemic risk of the banking industry, there has been no empirical research examining how fully it is recognized by Cambodian banks.

This paper is the first empirical study to examine whether the capital structure of Cambodian commercial banks legitimately reflects risk factors in the market. In this paper, following Romdhane (2012), and Allen et al. (2013) investigating the capital structure of banks in developing countries, we conducted a regression analysis of banks' capital to asset ratios by using panel data on 12 major commercial banks during the 2011-2017 period. According to the estimation results, (1) the capital structure of Cambodian commercial banks can be explained rationally by the standardized corporate financing theory, and (2) banks aggressively expanding their business activities tend to recklessly neglect credit and liquidity risk. Our analysis suggests that Cambodian banks need to be aware of the systemic risk caused by dollarization and be more risk-conscious in their business activities.

1. Introduction

In developed countries since the 1990s, when financial deregulation began in earnest, the view that the capital structure of the banking industry, like the capital structure of normal companies, is endogenously determined has become persuasive. According to Kiuchi (2018), there are two approaches to studying the capital structure of banks: the "corporate finance approach," which is based on representative corporate finance theories based on the Modigliani and Miller theorem, such as the pecking order theory, and trade-off theory, and the "banking theory approach," which emphasizes the unique characteristics of banking, such as deposit currency. Empirical research up until now has focused on developed countries, which have prioritized financial deregulation and offer plentiful data sets, but the research that takes the "banking theory approach" as its analytical framework has been relatively uncommon, with the majority of studies being based on the "corporate finance approach" (Flannery et al., 2008; Gropp et al., 2010). In recent years, however, such research has also been conducted in developing countries, with Romdhane (2012), Ukaegbu and Oino (2013), and Allen et al. (2013) examining the validity of general corporate finance theory relative to the capital structure of commercial banks in Tunisia, Kenya, and Southeast Asia, respectively.

Regarding the banking industry in Cambodia, an emerging market with significant economic growth, the research on determinants of capital structure has garnered considerable attention, particularly from a policy standpoint. In Cambodia, where the dollarization of the financial economy has proceeded considerably, banks must obtain flexible relief financing in dollars to avoid systemic risk when the problem of insufficient liquidity arises. However, the National Bank of Cambodia is unable to provide limitless relief financing denominated in dollars, and in this sense is unable to function adequately as the lender of last resort. Consequently, Cambodia's banks, in order to maintain operational health, must adopt capital structures while paying considerable attention to systemic risk. With respect to this point, elucidating the determinant factors of capital structure (i.e., how Cambodian banks actually determine their capital structures) is of immense significance.

Several pioneering studies have demonstrated the economic efficiency of and degree of competition among Cambodian commercial banks. For example, Okuda and Aiba (2014) used data envelopment analysis (DEA) to estimate changes in technical efficiency and all-factor productivity for

major Cambodian financial institutions from 2006–2011. In addition, Okuda et al. (2019) estimated the Boone index of the Cambodian banking industry and examined the degree of market competition and trend changes using data from 2010 to 2017. These analyses indicated that Cambodian commercial banks maintain excess capital significantly above equity ratio restrictions and have remarkably high liquidity-asset ratios. This factor significantly negatively affects their financial intermediation efficiency, creating differences in the market behavior of foreign and local banks. These facts imply that the determination of the capital structure of Cambodian commercial banks occurs autonomously for endogenous reasons.

Based on the situation described above, this study examines the determinants of the capital structure of Cambodian banks. Following a "corporate finance approach," this study also uses annual data on Cambodian commercial banks obtained from the website of the National Bank of Cambodia (hereinafter abbreviated as "NBC") to estimate the determining factors of the capital ratios (the ratio of capital to total assets) of individual Cambodian banks.

According to this study's provisional analysis results, (1) while the ratio of lending to deposits has a positive effect, the scale of operations and the ratio of non-performing loans have a negative effect on the capital structure of Cambodian commercial banks; (2) the influence of the scale of operations, growth opportunities, and the ratio of lending to deposits are aligned with previous research, but the signs for profitability and operational risk were the reciprocal of those found in previous research. This indicates that, despite the restrictions on the function of the central bank as a lender of last resort in a dollarized economy, Cambodian commercial banks may not be paying full attention to risk. Therefore, as part of Cambodian banking policy, it may be necessary to pay greater attention to ensuring sound banking administration.

The structure of this paper is as follows. In Section 2, a simple explanation of the characteristics of the Cambodian banking industry is provided. In Section 3, a theory of bank capital structure developed based on corporate finance structure theory is introduced. In Section 4, the analysis methods are explained. Section 5 presents a regression analysis of the determinants of the capital structure of Cambodian commercial banks, using annual data from 2011 to 2017. Finally, Section 6 summarizes and concludes the paper.

2. Characteristics of the Cambodian Banking Industry

In Cambodia, in 1996, on the legal basis of the Law on the Organization and Conduct of the National Bank of Cambodia, the NBC assumed the functions of issuing currency, formulating and implementing financial policy, managing currency exchanges, and supervising financial institutions (Nomura Research Institute, 2015). Cambodian financial institutions are categorized into three types: banking institutes, microfinance institutes (MFIs), and other financial or "covered" institutes. Banking institutes include 39 commercial banks and 15 specialized banks (as of the end of December 2017). Furthermore, commercial banks can be categorized by ownership structure as shown in Table 1.

As shown in Table 1, there are three types of Cambodian commercial banks: (1) local banks, (2) local subsidiaries controlled by foreign banks, and (3) foreign bank branches. Foreign capital has moved into the Cambodian banking industry, and as of the end of December 2017, 27 of the 39 commercial banks were 100% foreign banks. Additionally, foreign shareholders controlled 50% or more of five of the local banks. At the same point in time, foreign banks (not including local banks controlled by foreign shareholders) accounted for 55.41% of the total assets in the Cambodian banking industry.

The characteristics of Cambodian banks are, firstly, that the scale of assets held by individual banks is comparatively small, but rapid gains have been made in the increase in total assets, credit, and deposits supported by recent favorable economic conditions and political stability. The number of banks and bank branches in the Cambodian banking industry increased yearly from 2011 to 2017, but the total balance of assets in the Cambodian banking industry was, as before, still small. In the 2000s, the political situation in Cambodia stabilized, and Cambodia's annual GDP growth rate, excluding 2009 when it was negatively impacted by the financial crisis, stayed at a high level of 6% or above. Given these favorable political and economic conditions, the Cambodian financial sector has rapidly expanded, and the commercial banks at its core have continued to experience rapid growth.

Table 1. Categories of Cambodian commercial banks

Entering the 2010s, the balance of total assets, credit, and deposits in the Cambodian banking industry, as shown in Figures 1 and 2, continued to grow at a rate of 20% or more, and the ratio of the balance of total assets to GDP also continued to increase. The balance of total assets in 2017 increased by 20.1% compared to the previous year, an increase of 115.6 trillion riel, reaching a ratio of 142.0% in comparison to GDP.

Figure 1. The annual growth rate in total asset balance, credit balance, and deposit balance

Figure 2. The ratio of total asset balance, credit balance, and deposit balance to GDP

The second characteristic is that major operational indicators such as equity ratios, non-performing loan ratios, return on equity (ROE), return on asset (ROA), and so on, are largely favorable. The equity ratio, as shown in Figure 3, began to increase and reached 21.9% in 2017 after decreasing up until 2015, considerably exceeding the minimum standard of 8% set by Basel regulations. The non-performing loan ratio, after decreasing until 2015, gradually increased to 2.4%, still a low level in comparison to neighboring ASEAN nations. ROE and ROA, which reflect profitability, are in an upward trend but fell significantly in 2017. Regarding the cause of this fall, Takeyama (2019) identifies that in 2017, the NBC set the upper limit for interest rates for riel-denominated loans by microfinance institutes to 18%. This change precipitated a contraction in commercial bank profit margins, which compete with microfinance institutes.

Figure 3. Operating indicators for commercial banks

The third characteristic of the operation of Cambodian commercial banks is the remarkably high ratio of dollar-denominated transactions in both capital procurement and deployment. According to the NBC (2018), in 2017, 83% of broadly defined liquidity (M2) in Cambodia comprised deposits denominated in foreign currency. Furthermore, financial institutions such as commercial banks and microfinance institutes conduct most of their investment and loan activities in dollars, with 90% or more of credit balances being denominated in dollars. In recent years, dependence on foreign

borrowing for capital procurement has increased, with nearly all of these funds being denominated in dollars (Okuda, 2019).

This dollarization of banking has become a major destabilizing factor for Cambodian banking. As the dollarization of the economy has increased considerably, when the problem of insufficient liquidity arises, banks must obtain flexible relief financing in dollars to avoid systemic risk. However, the National Bank of Cambodia is unable to provide limitless relief financing denominated in dollars, preventing it from functioning adequately as the lender of last resort. As such, Cambodia's commercial banks must secure the health of their own operations through their own efforts. In fact, all commercial banks maintain excess capital significantly above necessary levels and, on the asset side, maintain large reserves of liquid assets through NBC deposits, foreign deposits, and so on.

3. Previous research

3.1 Theories of bank capital structure

Methods of studying the capital structure of banks can be largely categorized into two approaches: the "corporate finance approach" and the "banking theory approach" (Kiuchi, 2018). The "corporate finance approach" asserts that corporate finance structure theories such as pecking order theory and trade-off theory can be applied to the study of the capital structures of banks. This approach, for banks with assets below a certain size, regards deposits as liabilities and, in order to maximize the bank's value, searches for the optimal combination of capital structures. In contrast, the "banking theory approach," in contradiction to the notion that asymmetries of information have an effect on the capital procurement behaviors of banks, argues that the capital structures of banks, unlike those of normal corporations, are determined by a bank's unique characteristics. The "banking theory approach" argues that bank deposits are not equivalent to the debts of normal corporations and that the optimal capital structure of a given bank should be determined by the comprehensive effect of the assets and liabilities on its balance sheet. In this study, I conduct a regression analysis based on the "corporate finance approach," as substantial previous research has been conducted using this approach, including examples of studies in developing countries.

3.2 Research on the capital structure of banks in developed countries

Up until the 1970s, the general understanding was that, as financial activities were placed under strong financial regulations, the capital structures of banks were fundamentally exogenously determined by these regulations. However, with increasing financial deregulation, in particular following the implementation of Basel I in 1992,[1] a stronger understanding of the capital structure of banks as being endogenously determined appeared, and theoretical and empirical research on the determining factors of the capital structures of banks was widely conducted in various developed countries.

According to Wong et al. (2005), Hong Kong's banks maintain a capital adequacy ratio (CAR) that far exceeds regulatory requirements. To investigate this phenomenon, the authors conducted an analysis of the determining factors of the capital adequacy ratio of Hong Kong banks using two approaches: a qualitative and quantitative analysis. The qualitative analysis was based on the results of a survey of the banks' opinions regarding determinants of the preferred level of capital (that is, the range of the amount of capital that the bank would like to maintain) and the determinants of the actual level of capital. The qualitative analysis used panel data from banks established in Hong Kong and estimated variables that could affect CAR using an econometric model. According to the authors' analysis, the banks' internal factors, such as the bank's risk level, the influence of the business cycle, the agency problem, the bank's business strategy, and the opportunity cost of capital, as well as market and government regulations, affect the capital adequacy ratio of the Hong Kong banking industry.

In Brewer et al. (2008), estimates were conducted using panel data from 78 private banks in 12 developed countries, such as the US, the UK, Japan, and so on, from 1992 to 2005. Their results indicated that it was necessary to comprehensively consider the effect of the macroeconomic environment, government policy and regulations, and factors peculiar to the banks themselves in analyzing the determining factors of capital ratios at these banks. According to Kleff and Weber (2008), it is characteristic of most banks in Germany to have small capital adequacy ratios, indicating that

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[1] In 1998, the Basel Committee on Banking Supervision (BCBS) published international standards (Basel I) regarding minimum necessary capital adequacy regulations and so on for banks. Subsequently, in 2004 and 2017, these standards were revised for Basel II and Basel III.

banking regulations may have stronger effects on banks with insufficient capital than on banks with plentiful levels of capital. Furthermore, as it is easier for banks to refinance in capital markets in relation to how large they are, larger banks may have smaller capital adequacy ratios. Moreover, their analysis showed that portfolio risk and profitability had a positive effect on capital adequacy ratios.

In Gropp and Heider (2009), the capital structures of banks were examined based on a theory in the empirical literature related to the capital structures of non-financial corporations. The sample included commercial banks and bank holding companies in 16 countries (the US and 15 members of the EU) from 1991 to 2004. The authors, in order to reduce bias, conducted estimates primarily for large-scale banks listed on stock exchanges. In the authors' analysis, a fixed effect model was adopted and, as with the results from the literature concerning the capital structures of non-financial corporations, the scale of assets, profitability, risk, and other factors had a significant effect on the capital structures of banks in the US and EU. In contrast, it was also shown that factors such as deposit insurance and capital regulations had relatively small effects.

Graf (2011) conducted estimates primarily on the relationship between leverage ratios and profitability and risk in the banking industries in the US and Europe using data from 1994 to 2008. The author, after controlling for variables such as the size of the bank, the capital regulations, and employees' education costs, analyzed the effect on the capital structures of the banks using profitability and risk as the main variables. According to the author's analysis, the banks' operators adjusted leverage ratios faster than non-financial enterprises, and as with previous research, the profitability of the banks had a negative relationship with leverage ratios. However, as a result of estimating default costs as a proxy variable for the bank's risk, the author indicated a positive relationship between a bank's risk and its leverage ratio in the European banking industry, a finding that contradicts the results of existing research. At the same time, in the US banking industry, a correlation was indicated between a bank's risk and its leverage ratio, although this relationship was not found to be statistically significant.

3.3 Studies on the capital structure of banks in developing countries

Romhdane (2012), using data from 18 commercial banks from 2002 to 2008 as a sample,

examined whether factors for determining the capital adequacy ratio of banks in Tunisia were the same as those from previous research in developed countries. According to the analysis, the bank's cost of shareholder equity, fixed term deposit ratio, and scale of assets had a negative effect on capital adequacy ratios, while variables such as risk, interest rate margin, liquidity of deposits, and loan deposit rate had a positive effect.

Allen et al. (2013), using data from 1999 to 2008, investigated the determinants of the capital structure of banks in Thailand, Malaysia, and Japan. The point of differentiation in this research was that, although most research on capital structures has focused on banks' internal variables, this study included variables on market-based risk in addition to internal variables. Variables such as default and value-at-risk (VaR), which express market-base risk, were considered. Book leverage and market leverage were both used as explanatory variables, and it was concluded that, in comparison to Japan and Malaysia, where markets have developed, the capital structure of banks in Thailand reflected market-based risk factors only slightly.

Ukaegbu and Oino (2013) used data from the annual reports of 19 banks from 2001 to 2009 to analyze the determining factors of the leverage ratios of Kenyan banks. According to the analysis results, factors such as the size of a bank's assets, its profit ratio, risk, growth opportunities, capital regulations, and macroeconomic environment affected the leverage ratios of Kenyan banks. In addition, large banks tended to have high leverage ratios, and as with corporations (non-financial corporations), it was indicated that banks have stable capital structures at levels peculiar to each individual bank. The estimation results align with the predictions of the pecking order theory, but inconsistences with the trade-off theory can also be seen.

4. Method of empirical analysis

4.1 Estimation formula

Previous studies on bank capital structures in developed and developing countries can be largely divided into two categories based on whether they use capital or leverage ratio as the explanatory variable. In addition, explanatory variables that affect bank capital structures can be categorized into internal and external factors. Endogenous factors, that is, factors controlled by the bank itself, include

asset size, profitability, risk, growth opportunities, loan-deposit rate, cost of equity, dividends, deposit liquidity, tangible asset ratio, and so on. Exogenous variables, that is, factors that the bank itself cannot control, include macroeconomic environment, capital regulations, and so on. In this study, while referencing Romdhane (2012) and Ukaegbu and Oino (2013), the capital ratio was used as the explanatory variable, and the following estimation formula was established for the determinant factors of the capital structures of Cambodian banks.

$$Y_{it} = \alpha + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 X_{5it} + \beta_6 X_{6it} + \beta_7 X_{7it} + U_{it} \qquad (1)$$

Here, i denotes the individual bank and t denotes the observation year. The explanatory variable Y_{it} expresses capital structure as the ratio of capital to total assets. The explanatory variables X_{jit} ($j = 1, 2, \ldots, 7$) were calculated as shown in Figure 2, with the stock variables in the NBC data used in this study being on a book-value basis. X_{1it} is the proportion of total assets made up of profit before taxes, which reflects the bank's profitability. X_{2it} is a variable that denotes the number of bank employees, and to adjust for scale, the natural log of total assets is taken for this variable. X_{3it} is an index that measures the macroeconomic environment of the bank's location country, for which Cambodia's real GDP growth rate is used. X_{4it} is the proportion of assets comprising non-performing loans and denotes direct risk to the bank. X_{5it} is the bank's growth opportunities and measures the bank's future growth prospects using the annual growth rate of each bank's loans. X_{6it} is the loan-deposit rate, an indicator that examines how much procured capital is allocated to loans. X_{7it} denotes the proportion of total assets comprising current central bank accounts.

In estimation formula (1), as an endogeneity problem is produced by the simultaneous determination of variables, the estimate was conducted using a 2-stage least squares method using estimated values in which the explanatory variable was regressed on the relevant variable's single period lag value and the GDP growth rate. Moreover, to compare the estimation results for reference purposes, estimates using the single period lag values for the explanatory variable were also conducted (see Supplementary Table 1).

4.2 Establishing hypotheses

Based on the previous research introduced in Section 3, the following hypotheses were established regarding the relationship between the capital ratio Y_{it} and each explanatory variable X_{jit} (j=1, 2, …, 7).

Hypothesis 1: Higher levels of profitability have opposing positive and negative effects on capital ratios. DeAngelo and Masulis (1980) could not establish a relationship between profitability and capital ratios for the capital structures of companies. That is, based on the pecking order theory, as raising capital through debt has greater costs than internal capital, companies with low profitability are predicted to maintain relatively low levels of debt. In contrast, based on the trade-off theory, as highly profitable companies tend to pursue greater profits due to a "tax avoidance effect," they maintain relatively large amounts of debt. As such, as profitability increases, the capital ratio drops.

Ukaegbu and Oino (2013), who examined the capital structures of banks in developing countries, found that banks with high profitability have greater reserves of internal capital and that, before raising capital through debt, they will first do so by means of internal capital. Further, to prevent the dilution of the controlling rights of banks with high profitability, these banks maintain as few debts as possible. As such, as profitability increases, leverage ratios may decrease.

Hypothesis 2: The size of assets has a negative effect on capital ratios. According to Ukaegbu and Oino (2013), as a bank increases in size, it becomes more difficult to go bankrupt. Moreover, capital markets tend to have greater confidence in very large-scale banks. This is because such banks are understood to have more diversified operations, higher profitability, and a better ability to pay interest on debts. In addition, as depositors have greater confidence in very large-scale banks, such banks tend to be able to accept deposits at low-interest rates. As such, as banks become larger, based on both the trade-off theory and pecking order theory, they may have more debt and a lower capital ratio.

Hypothesis 3: A reduction in the GDP growth rate has a positive effect on capital ratios. According to Wong et al. (2005), during recessions, repayments and reserves are more likely to increase, and as a protective measure, the bank will attempt to maintain more capital. Furthermore, to gain access to capital markets, the bank will need to increase the capital it holds to maintain its rating.

For these reasons, the capital ratio may increase as the GDP growth rate decreases.

Hypothesis 4: The risk of bankruptcy has a positive relationship to capital ratios. The analysis in Romdhane (2012) shows that banks with high levels of risk need to hold more capital to provide a buffer against losses. As a result, as the risk of bankruptcy increases, the capital ratio may increase.

Hypothesis 5: Increases in growth opportunities have a negative effect on the capital ratio. According to Ukaegbu and Oino (2013), the more growth increases the more a bank's demand for investment capital increases, raising the need for short-term and long-term debt. As such, as growth opportunities for a bank expand, its capital ratio may decrease.

Hypothesis 6: An increase in the loan-deposit ratio has a positive effect on capital ratios. According to Romdhane (2012), the loan-deposit ratio is an indicator of the extent to which procured capital is being used for loans. Higher loan-deposit ratios result in greater profitability but increase the risk borne by a bank in which available liquidity may be insufficient. To avoid risk, the bank must hold more capital, increasing the capital ratio as a result. For the above reasons, if banks take risk into consideration, the capital ratio may rise as the loan-deposit ratio rises.

Hypothesis 7: An increase in the central bank current account ratio has a negative effect on capital ratios. One of the characteristics of Cambodian banks is that the ratio of dollar-denominated deposits is larger than for other countries. Although there is a limit to the function of the NBC as a lender of last resort due to significant dollarization in Cambodia, so long as the NBC's balance sheet is not harmed, dollar-denominated deposits in the NBC function as self-protective measures against systemic risk for individual banks.[2] Accordingly, the risk for banks with large central bank deposit ratios decreases, which may increase the debt held in comparison to other banks and lower the capital ratio.

4.3 Data

The data used in this study was obtained from the various financial tables of each bank listed on the NBC homepage and from the "Economic and Monetary Statistics." The sources for each variable,

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[2] In typical economies in which a country's own currency is used, the core of the financial system is maintained by a high degree of confidence in a central bank that has the ability to issue currency, making deposits held by the central bank considerably more secure than other assets.

as shown in Table 2, are from a sample that covers the seven years from 2011 to 2017. Further, the subjects of this analysis were the top 12 commercial banks by asset size and exclude foreign bank branches with different operational characteristics. The reasons for choosing the top 12 banks are that (1) continuous data for the seven years from 2011 to 2017 can be used; (2) these commercial banks roughly represent 64.7% of the total asset balance of Cambodian commercial banks; and (3) small banks with fewer assets have less stable operations, which may damage the reliability of the estimate results.

Table 2. Data sources

Table 3 summarizes the characteristics of the top 12 banks. One of the characteristics shown in the table is a high level of foreign capital penetration. Among the top 12 banks, seven are foreign banks and the remaining five have foreign shareholders who hold a considerable share of the equity. Capital from Canada, South Korea, and other developed countries, as well as from neighboring countries such as Vietnam and Thailand, has permeated Cambodia. Another characteristic is that considerable differences exist between the banks in terms of size. The first and second banks by asset size are Acleda Bank Plc. and Canadia Bank Plc., which together make up approximately one-third of the Cambodian banking industry, placing the Cambodian banking market in a state of oligopoly.

Table 3. Characteristics of the top 12 commercial banks

Table 4 summarizes the descriptive statistics for each variable. The average value of the explanatory variable for capital ratio, Y_{it}, is 17.38, a relatively high value in comparison to such ratios in other countries. The high value of this ratio indicates that Cambodian commercial banks have low lending ratios in comparison to the amount of capital they hold, indicating that they face a relatively low level of latent risk. The minimum and maximum values for the explanatory variable X_{1it} are -4.77% and 4.2%, respectively, and the average value is 1.7%. This is extremely close to the ROA value for the overall Cambodian banking industry shown in Figure 3. The recent decrease in profitability is

thought to be due to the limiting restrictions on riel-denominated loan interest rates introduced by the NBC. The difference between the maximum and minimum values (4.10 and 1.83, respectively) for the operational scale variable X_{2it} is large, despite being natural log values. The domestic economic environment was favorable in Cambodia from 2011 to 2017, with the real GDP growth rate, X_{3it}, around 7%. The average value of risk, X_{4it}, varied greatly depending on the bank, from 0.00% at minimum to 14.00% at maximum. The maximum and minimum growth opportunities, X_{5it}, were -25.3% and 97.4%, respectively, indicating a considerable gap in growth potential between banks. The average loan deposit ratio, X_{6it}, is at 90.8%, a high level in comparison to developed countries, indicating that banks are shouldering high levels of risk despite the fact that Cambodia's economic and financial activity is robust. Finally, the central bank current account ratio, X_{7it}, is generally at a high level, but differences between banks were highly scattered from as low as 6.28% to as high as 67.6%. Correlation coefficients between each set of explanatory variables were low, as shown in Table 5, with the exception of correlations between two sets of pairs: X_{1it} and X_{2it} as well as X_{1it} and X_{4it}.[3]

Table 4. Fundamental statistics (2011-2017)

Table 5. Correlation matrix (2011-2017)

5. Estimated results

Table 6 summarizes estimate results using pooled ordinary least squared (OLS) model, a fixed-effect model, and a random-effect model.[4] Judging from the result of a Lagrange multiplier test and Hausman test, the fixed-effect model was selected from the three estimate results[5] for which the

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[3] According to Bowerman and O'Connel (1990), if the value of the economic variance inflation factor (VIF) exceeds 10, it indicates a high degree of multiple collinearity. The VIF value for each explanatory variable is smaller than 10.

[4] To compare two SLS estimate results, estimates with a single period lag were conducted for each explanatory variable in this study. The results are summarized in Supplementary Table 1. The characteristics of these estimate results are similar to those in Table 6.

[5] Initially, to compare the OLS regression model and the random-effect model, a BP Lagrange multiplier test was conducted. The results showed a p value of 0, so the null hypothesis of the OLS regression model was rejected and the random-effect model was understood to be superior. Furthermore, to compare the fixed-effect and random-effect models, a Hausman test was conducted. The test results showed a p value of 0, so the null hypothesis of no correlation between the individual effect α_i and the explanatory variable X_{it} was rejected and the fixed-effect model was adopted. This implies that each individual bank i has a fixed effect α_i and that this individual effect α_i is correlated with an explanatory variable X_{it}.

following observation results were obtained for the seven explanatory variables.

Table 6. Estimated results (2SLS)

First, a negative correlation was seen between profitability and capital ratio, but it was not sufficiently statistically significant. This result may indicate that the "tax reduction effect" for banks identified by DeAngel and Masulis (1980) is applicable to the Cambodian banking industry. The behavior of banks with high profitability in pursuing profits from a "tax reduction effect" perspective does support the trade-off theory. In addition, this result may indicate that the capital procurement activities observed in Cambodian banks do not fully support the pecking order theory. When procuring capital, banks with low profitability tend to use internal capital, which has lower costs than debt, but as banks with relatively high profitability have healthy capital structures, they may increase the amount of debt they hold to obtain greater profits and not encounter serious problems despite bearing a certain degree of repayment obligations. Banks with low profitability act in accordance with the pecking order theory, but banks with high profitability do not do so.

Second, as predicted, a negative relationship was observed between operational scale and capital ratio, with sufficient statistical significance. This negative correlation was observed in the pooled OLS, fixed-effect, and random-effect models, and was statistically significant even in the random-effect model. This result is consistent with the results of Ukaegbu and Oino (2013). It is also true that as Cambodian banks increase in size, the range of their operations diversifies, their profitability increases, and their risk of bankruptcy decreases as they become increasingly trusted by capital markets and depositors. As such, large-scale banks can more easily procure funds by issuing debt. As above, following the predictions of the pecking order theory and trade-off theory, a bank's asset size has a negative effect on its capital ratio. If it chooses to issue stock when procuring funds, the information costs caused by over or undervaluation of its existing assets due to information asymmetries will also increase, making it preferable even from a pecking order theory standpoint to procure capital through the issuance of debt.

Third, as in Wong et al. (2005), a negative correlation was observed between the GDP growth

rate and capital ratios, and statistical significance was observed under a fixed effect model. From 2011 to 2017, the Cambodian economic climate was favorable and the real GDP growth rate was around 7% with only minor annual fluctuations. As a result, because the accumulation of capital in preparation for the recession was thought to be unnecessary and access to capital markets could be easily secured, there was no particular need to increase capital ratios. Conversely, it may have been difficult to accumulate sufficient capital quickly enough to catch up with the rapid expansion of assets under the favorable macroeconomic climate.

Fourth, in a reversal of expectations, a negative relationship was observed between credit risk and capital ratios, which was statistically significant under a fixed effect model. This result contradicts the results of Romdhane (2012) and the general results of corporate finance research. According to standardized corporate finance research, banks with high levels of risk must hold larger amounts of capital to provide a buffer against losses; thus, higher levels of bank risk create lower leverage ratios. As an interpretation of the effects observed in this study, Cambodian banks may be unaware of the risk of bankruptcy due to overdependence on debt, or, even if they are aware of the risk of bankruptcy, may think that the profit brought on by the "tax reduction effect" of debt will considerably exceed the losses caused by the risk of bankruptcy. In either case, this result suggests an operational problem in Cambodian commercial banking.

Fifth, as predicted, a negative relationship was observed between growth opportunities and capital ratios, although this relationship was only statistically significant in the pooled OLS model. This result is consistent with the results of Ukaegbu and Oino (2013). As growth opportunities increase, internal reserves are insufficient to fulfill the demand for funds for increased investment, so more external funds are often procured through debt.

Sixth, as predicted, a positive relationship was observed between the loan-deposit ratio and capital ratio, and its statistical significance was confirmed in all models. This result is consistent with the results of Romdhane (2012). As a bank's risk increases in relation to its loan-deposit ratio, the capital ratio increases such as is optimal for the bank.

Seventh, a negative relationship was observed between the central bank deposit ratio and the capital ratio under the pooled OLS model, with sufficient statistical significance. However, in the other

models, such a relationship was not confirmed. Generally, because deposits in central banks are highly secure, banks with significant central bank deposits have lower risk and a higher optimal debt ratio, typically resulting in a lower capital ratio. However, the estimated results appear to suggest that, in Cambodia, central bank deposits do not necessarily have the effect of reducing individual bank risk.

6. Summary and conclusion

This study estimated the determinants of capital structure in the Cambodian banking industry, which has experienced rapid growth in recent years, based on previous research in developing and developed countries using a "corporate finance approach." As part of the estimation process, data listed on the NBC homepage was reviewed, and panel data from the seven years from 2011 to 2017 from the top 12 commercial banks in terms of asset size was used.

In comparing the analysis results to those of previous research in developing and developed countries, the "corporate finance approach" largely functioned well, and many aspects of the capital structure of Cambodian commercial banks were explainable without contradiction using corporate finance theory. Determining factors that both aligned with theoretical predictions and were highly statistically significant were (1) profitability, a proxy variable for operational stability and degree of confidence in markets, and (2) loan-deposit ratio, which is a proxy variable for liquidity risk. Furthermore, determining factors that matched theoretical predictions but were not sufficiently statistically significant were (3) ROA, which is a proxy variable for high profitability or plentiful internal funds; (4) real GDP growth rate, a proxy variable for a favorable macroeconomic environment; and (5) asset size increase rate, a proxy variable for significant bank growth opportunities.

In contrast, a factor that had high statistical significance and effects that contradicted theoretical predictions was (6) non-performing loan ratio, a proxy variable for credit risk. Cambodian banks may be unaware of the risk of bankruptcy due to overdependence on debt, or maybe overemphasize the "tax reduction effects" of debt even though they are aware of bankruptcy risk. Additionally, the effects of (7) central bank deposit ratio, a proxy variable for liquid assets, could not be confirmed to act as predicted by theory. This fact indicates the possibility that central bank deposits are being used simply as idle capital that is stored away and are not necessarily effectively functioning as part of the bank's

asset portfolio. These estimate results must be carefully interpreted; however, they do indicate problems with the operation of Cambodian commercial banks.

Finally, it is important to note a few limitations to this study. (1) The estimation period in this study is from 2011 to 2017, and the subjects of the estimates are limited to the top 12 commercial banks by asset size. To completely understand the determinants of the capital structure of Cambodian banks, the sample size will need to be increased. (2) According to Takeyama (2019), the amount of non-performing loans held by Cambodian banks may be underestimated; thus, a more appropriate proxy variable for risk should be found. (3) Although dollarization is severe in Cambodia, variables that express dollarization, such as the amount of loans denominated in foreign currency, were not considered. This was due to the availability of data in this study. The limitations discussed here represent challenges to be resolved in future research.

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Figure 1. The annual growth rate in total assets, credits, and deposits
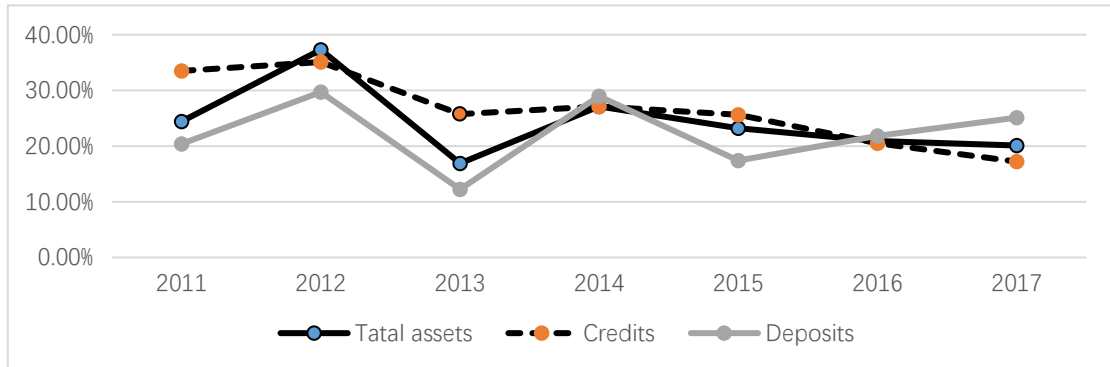
(Source) Authors' calculation using the database from the National Bank of Cambodia (NBC) homepage.

Figure 2. The ratio of total assets, credits, and deposits to GDP
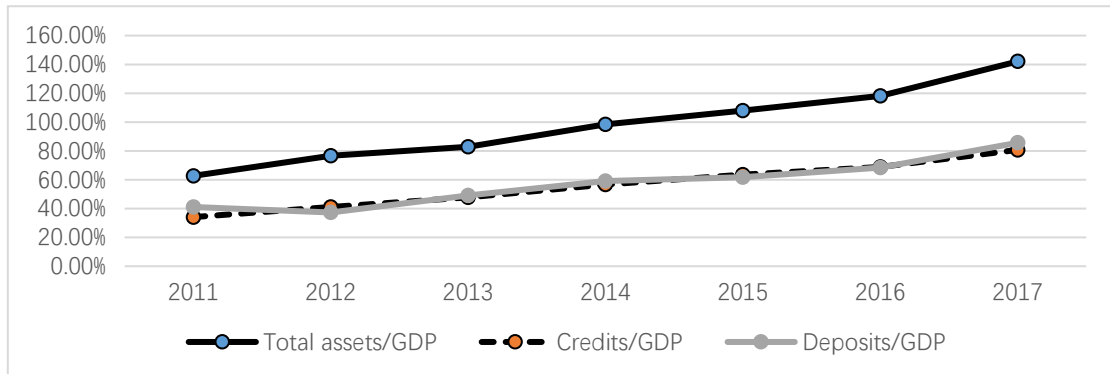
(Source) Authors' calculation using the database from the National Bank of Cambodia (NBC) homepage.

Figure 3. Various operating indicators for banks

(Source) Authors' calculation using the data in Takeyama (2019)

Table 1. Categories of Cambodian commercial banks

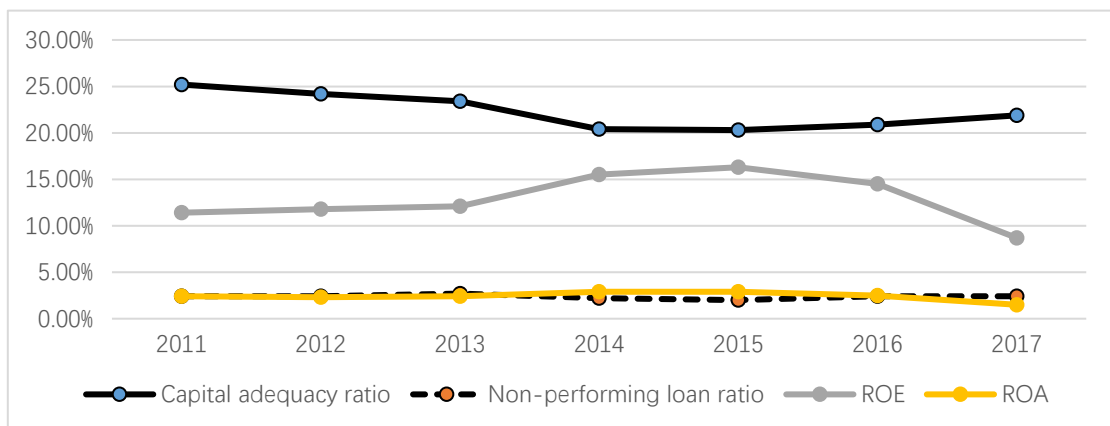|	2011	2012	2013	2014	2015	2016	2017
（1） Local banks－local majority ownership							
No. of banks	6	6	6	7	7	7	7
No. of locations	286	298	310	354	375	383	395
（2）Local banks－foreign majority ownership							
No. of banks	6	6	5	6	5	5	5
No. of locations	38	40	33	47	54	225	244
（3）Foreign subsidiary banks							
No. of banks	11	11	14	12	14	14	15
No. of locations	83	97	128	119	142	150	157
（4）Foreign branch banks							
No. of banks	5	9	10	11	10	11	12
No. of locations	7	13	16	21	22	25	31
Total							
No. of banks	28	32	35	36	36	37	39
No. of locations	414	448	487	541	593	783	827

(Source) The database of the National Bank of Cambodia (NBC) homepage.

Table 2. Variables and data source

Variables	Calculation formulas	Source
Y_{it}: Capital Ratio	Equity/ Total Assets	（1）
X_{1it}: Profitability	Profit & Loss Before Tax/ Total Assets	（1）（2）
X_{2it}:Size	Log of Total Assets	（1）
X_{3it}: Macroeconomic Environment	Real GDP Growth Rate	（3）
X_{4it}: Risk	Non-performing Loans/ Loans	（2）（4）
X_{5it}: Growth Opportunities	Annual Growth in Loans	（1）
X_{6it}: Loan-Deposit Rate	Loans/ Deposits	（1）
X_{7it}:The Ratio of Deposits with NBC	Deposits with NBC/Total Assets	（1）

(Notes) Data sources indicate (1) Comparative Statement of Condition, (2) Profit and Loss Statement, (3) Economic and Monetary Statistics, and (4) Loans and Non-Performing Loans, from the database of National Bank of Cambodia homepage.

Table 3. Characteristics of the top 12 commercial banks

Commercial bank (Market share)	Category	Characteristics
Acleda Bank Plc. (18.1%)	Local bank	Initially established as an NGO. Investments from Japanese companies active abroad, such as SMBC, ORIX, and so on.
Canadia Bank Plc. (15.6%)	Local bank	Established with a joint investment from Cambodians living in Canada and the NBC. Privatized in 1998. 100% Cambodian capital.
Cambodian Public Bank Plc. (7.4%)	Foreign subsidiary	A subsidiary of the Malaysian Public Bank Berhad.
Advanced Bank of Asia Ltd. (5.8%)	Foreign subsidiary	A subsidiary of the Canadian National Bank of Canada.
ANZ Royal Bank (Cambodia) Ltd. (3.6%)	Foreign subsidiary	Established with a joint investment from the Australian ANZ and the Cambodian company, Royal Group.
Foreign Trade Bank of Cambodia (3.5%)	Local bank	Originally government-run, privatized in 2009. ING and individuals hold 90%; the Cambodian Ministry of Economy and Finance holds 10%.
CIMB Bank Plc. (2.4%)	Foreign subsidiary	A subsidiary of the Malaysian bank, CIMB Group.
Phnom Penh Commercial Bank (2.2%)	Foreign subsidiary	Jointly established with capital from Korean banks such as Jeonbuk Bank, Apro Financial Co. Ltd, B Woori Capital Co., Ltd., and so on.
Union Commercial Bank Plc. (1.8%)	Foreign subsidiary	A subsidiary of the Taiwanese bank, E.SUN Bank.
Vattanac Bank (1.7%)	Local bank	Established with a joint investment from individual investors, such as OKNHA SAM ANG, etc.
Bank for Investment and Development of Cambodia Plc. (1.6%)	Local bank	The local company IDCC, which is under the umbrella of the Vietnamese Investment Development Bank, is the largest shareholder.
Cambodian Commercial Bank Ltd. (0.9%)	Foreign subsidiary	A subsidiary of the Thai Siam Commercial Bank.

(Source) Summarized by the authors using the database of the National Bank of Cambodia (NBC) homepage.

Table 4. Summary Statistics (2011-2017)

Variable	Obs	Mean	Std. Dev.	Min	Max
Cr	84	17.38	5.89	10.15	39.79
Pro	84	1.77	1.52	-4.77	4.20
Size	84	2.65	0.56	1.83	4.10
GDP	84	7.10	0.17	6.90	7.40
Risk	84	2.01	2.67	0.00	14.00
Grow	84	25.75	24.33	-25.28	97.42
LDR	84	90.80	56.04	26.25	288.00
NBC	84	22.14	11.32	6.28	67.6

Table 5. Correlation Matrix

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Pro	1.000						
(2) Size	0.467***	1.000					
(3)GDP	0.122	-0.103	1.000				
(4) Risk	-0.290***	0.157	-0.092	1.000			
(5) Grow	0.136	-0.081	0.153	-0.421***	1.000		
(6) LDR	-0.172	0.050	-0.037	0.371***	0.110	1.000	
(7) NBC	-0.243**	-0.105	-0.094	-0.065	-0.020	-0.082	1.000

Table 6. Estimated results (2SLS)

	Pooled OLS	Fixed effect	Random effect
Pro Profitability (-), internal funds (+)	0.371	-0.715	-0.358
	0.684	0.506	0.672
Size Stability of operations/market confidence (-)	-2.572*	-15.082***	-3.957*
	1.373	3.172	2.037
GDP Favorable macroeconomic environment (-)	-0.656	-4.269*	-0.517
	3.261	2.248	2.573
Risk Non-performing asset ratio (Credit risk) (+)	-0.539*	-0.624**	-0.188
	0.301	0.291	0.340
Grow Growth opportunities (Capital requirements) (-)	-0.063**	-0.014	-0.017
	0.028	0.020	0.026
LDR Loan-deposit ratio (Liquidity risk) (+)	0.027**	0.209***	0.065***
	0.012	0.035	0.022
NBC Central bank deposit ratio (Liquid assets) (-)	-0.095*	0.004	-0.058
	0.048	0.027	0.036
_cons	29.940	71.559***	27.935
	23.899	22.774	20.792
Obs.	72	72	72
R^2	0.2525	0.6609	0.4940

Instrumented: Pro, Size, LDR

Instruments: GDP, Risk, Grow, z1, z2, z3

(Note 1) Standard errors are in parenthesis

(Note 2) *** *p<0.01, ** p<0.05, * p<0.1*

(Note 3) z1=Pro(t-1)+GDP/GDP(t-1), z2=Size(t-1)+GDP/GDP(t-1),
        z3=LDR(t-1)+GDP/GDP(t-1)

Supplementary Table 1. Estimated results (Single period lag model: 2012-2017)

	Pooled OLS	Fixed effect	Random effect
Pro Profitability (-), internal funds (+)	0.	-0.824**	-0.332
	0.898	0.358	0.474
Size Stability of operations/market confidence (-)	-3.528	-14.311***	-6.888***
	2.297	2.122	1.861
GDP Favorable macroeconomic environment (-)	-2.966	-3.401*	-2.741
	3.241	1.971	2.699
Risk Non-performing asset ratio (Credit risk) (+)	-0.836*	-0.711***	-0.428
	0.412	0.232	0.298
Grow Growth opportunities (Capital requirements) (-)	-0.067*	-0.051***	-0.045*
	0.036	0.018	0.025
LDR Loan-deposit ratio (Liquidity risk) (+)	0.036	0.188***	0.082***
	0.027	0.020	0.018
NBC Central bank deposit ratio (Liquid assets) (-)	-0.105**	-0.015	-0.064
	0.037	0.030	0.042
_cons	50.041*	66.897***	51.625**
	26.591	17.129	20.967
Obs.	72	72	72
R^2	0.2826	0.7105	0.6261

(Note 1) Standard errors are in parenthesis

(Note 2) *** $p<0.01$, ** $p<0.05$, * $p<0.1$