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Impact of the Subprime Crisis on Commercial Banks' Financial Performance

Summary: We investigated changes in the financial performance of representatives of the world's top 200 commercial banks after the global subprime financial crisis. Our empirical results show that following the subprime-crisis disclosure, all commercial banks exhibited worse performance in asset quality, profitability, liquidity, and growth index, accompanied by risk increases in asset adequacy, managerial ability, profitability, and growth index. Developed markets have suffered a greater negative influence than emerging markets, causing downward pressure on asset adequacy, asset quality, and profitability since the subprime crisis. Commercial banks within developed nations suffered more direct pronounced effects from the subprime crisis than did those in emerging markets. Our results prove that larger commercial banks, particularly those with larger capitalization, have the economies-of-scale advantage to resist the negative effects of economic downturns.

Key words: Subprime crisis, Financial performance, Commercial banks, CAMELS, Capitalization.

JEL: C23, G21, E02.

Although the percentage of subprime loans as part of the larger mortgage market was not high, these defaults caused the subprime crisis because financial institutions had devised innovative financial methods to sell opaquely structured products that combined mortgage-based securities (MBS) and collateralized debt obligations (CDO). On February 7, 2007, Europe's largest bank, HSBC Holdings, blamed soured U.S. subprime loans for its first-ever profit warning. On September 21, 2008, the Fed approved transforming the last two surviving U.S. investment banks, Goldman Sachs and Morgan Stanley, into commercial banks as their only means of survival in exchange for stable funding sources, a move that would subject them to more rigorous government supervision. Bloomberg indicated that by the fourth quarter of 2008, the global financial industry had been hit extremely hard by the subprime crisis, leading to a necessary capital injection of nearly US$750 billion in new funds, obtained from both shareholders and the market, to cover losses of US$850 billion and to survive this major financial crisis. To improve the capital structure weakened by the subprime crisis, capital within the global financial industry was increased by US$756.5 billion.

We analyze the effect of the subprime crisis on the financial performance of global commercial banks and examine certain variables of the CAMELS rating (i.e.

six financial dimensions: capital adequacy, asset quality, management performance, earnings, liquidity, and sensitivity) of the world's top 200 commercial banks to compare the main changes following the global subprime crisis. We also clarify which commercial banks in developed or emerging economies have suffered a greater negative influence from the subprime crisis, and explore whether bank size helps resist the negative effects from the financial crisis.

CAMELS is a rating system used for U.S. financial institutions after the National Credit Union Administration (NCUA) accepted the suggestion of the Federal Financial Institution Examination Council (FFIEC) in November 1979. The CAMELS rating system assesses the performance of financial institutions under six operational dimensions: capital adequacy, asset quality, management performance, earnings, liquidity, and sensitivity. The literature finds CAMELS financial ratios useful to measure bank performance. Robert Craig West (1985) found that capital adequacy, asset quality, profitability, and liquidity distinguish defaulting banks. Daniel Martin (1977) explained that certain CAMELS components can be used to predict banking crises: the ratio of capital/risk (C), the ratio of a bad debt/net profit (A), the ratio of expenses/sales revenue (M), and the ratio of profit/total sales (E). Frederick T. Furlong and Michael C. Keeley (1989) and Ronald E. Shrieves and Drew Dahl (1992) believed that a government that severely controls capital adequacy can effectively reduce bank operating risk and deposit insurance debt. Rebel A. Cole and Lawrence J. White (2012) empirically found that traditional proxies for CAMELS ratings significantly explain why commercial banks failed during the recent financial crisis.

Recent studies have subsequently found the effect of banking performance during the subprime crisis. Đorđe Đukić and Mališa Đukić (2009) explored the effects of financial crisis on interest rates in the banking industry in Serbia. Following the subprime financial crisis, banks are not prepared to lend on the interbank money market because of their lack of confidence, leading to continued market failure. Martin Knaup and Wolf Wagner (2012) measured credit-risk indicators (CRIs) for 150 of the largest U.S. bank holding companies and found that CRIs can forecast bank failures and share price performances during a subprime crisis. Justin Y. Jin, Kiridaran Kanagaretnam, and Gerald J. Lobo (2011) investigated the ability of the measured accounting and audit-quality variables in the pre-crisis period to predict bank failure during the financial crisis. Their results identified six and 10 predictors of bank failure for the troubled sample and the larger full sample of banks, respectively. Andreas Dietrich and Gabrielle Wanzenried (2011) showed that profitability determinants of commercial banks during the recent financial crisis include bank-specific characteristics and industry-specific and macroeconomic factors. Emilia Peni and Sami Vahamaa (2012) and Vincent Aebi, Gabriele Sabato, and Markus Schmid (2012) examined whether banks with stronger corporate governance mechanisms are associated with enhanced performance during the financial crisis. Their results indicated that banks with good governance exhibited higher stock returns and mitigated the adverse influence on bank credibility during the crisis. Albert S. Kyle (2012) empirically found that small banks that failed during the financial crisis tended to have a high concentration of loans financing commercial real estate, whereas large banks

failed during the financial crisis because of investment in pool subprime mortgages. The empirical results obtained by Andrea Beltratti and Rene M. Stulz (2012) and Rudiger Fahlenbrach, Robert Prilmeier, and Stulz (2012) and showed that banks that have more leverage rely more on short-term funding, and banks with greater growth are more likely to perform poorly in the financial crisis.

The global financial industry is in tatters because of the subprime crisis, which has also ended the investment banking era in the United States. However, the last two remaining investment banks, Goldman Sachs and Morgan Stanley, elected to continue their operations as commercial banks, suggesting that the commercial bank business model is more resistant to the crisis effect than that of investment banks. Because these larger troubled banks that were rescued during the subprime crisis, previously operating as investment banks, were merged, taken over, or transformed into commercial banks, we do not consider them in our samples. We focus on the crisis influence on the financial performance of the world's top 200 commercial banks in areas such as capital adequacy, asset quality, management capacity, profitability, liquidity, and growth during the post-subprime financial crisis period.

Graciela L. Kaminsky, Carmen M. Reinhart, and Carlos A. Vegh (2003) noted that when international financial crises occur, developed countries tend to act as a conduit, passing the effects onto developing countries. Sandeep A. Patel and Asani Sarkar (1998) indicated that in nine crises occurring between 1970 and 1997, those occurring in developed nations became less severe over time, in both the extent of price declines and duration, whereas this was not the case in emerging stock markets. David E. Palmer (2000) reported that claims by U.S. banks on emerging-market counterparties declined between 1997 and 1999 because U.S. banks either suffered losses on claims or actively reduced their exposure in such regions. Kee-Hong Bae, G. Andrew Karolyi, and Stulz (2003) asserted that emerging markets are more vulnerable to the effects of international financial crises than are developed markets. Yoonbai Kim and Yung-Hsiang Ying (2007) argued that a market opening in an emerging financial market serves only to accelerate the effect of a financial crisis. However, the asset impairment associated with subprime and related credit losses suffered by the financial sectors of developed nations in North America and Europe accounted for approximately 96% of all global losses from the subprime debacle. Therefore, whether these empirical studies have successfully identified if the financial sector of developed countries or emerging economies are more seriously affected by the subprime crisis is questionable.

Richard R. Rivard and Christopher R. Thomas (1997) suggested that banks may increase their operating safety when they have a larger scale, higher market growth, and more branches. Obeua S. Persons (1999) identified several factors (i.e. scale, profitability, capital, assets, management quality, and overseas debt) that may influence the level of bank-operating success, and found a negative relationship when comparing return on assets, deposit rates, and scale to possible bank defaults. Yang Li (2003) indicated that when banks are faced with a significant financial event, larger bank capitalization leads to greater bank-owned capital; thus, such banks have greater resources to reduce irrecoverable loans. Ahmet Faruk Aysan and Sanli Pinar Ceyhan (2008) verified this finding in their report of a positive relationship between bank capi-

talization and financial performance. Nicholas Apergis and Effrosyni Alevizopoulou (2011) analyzed banking-system efficiency in eight European countries. Their results showed that risk factors and variable size should be considered when examining banking-sector efficiency. The empirical results by Jose Eduardo Gomez-Gonzalez and Nicholas M. Kiefer (2009) and Fadzlan Sufian and Muzafar Shah Habibullah (2010) also showed that capitalization negatively and significantly explains bank failure during a financial crisis. Jakob de Haan and Tigran Poghosyan (2012b) examined whether bank earnings volatility depends on bank size. By controlling for management quality, leverage, and diversification, including the recent financial crisis period, their results showed that bank size reduces return volatility. These studies consistently show that the bank scale of a bank, especially its capitalization, is positively correlated to its performance, particularly when a financial crisis occurs. However, following the subprime-crisis disclosure, the largest commercial banks in the United States, including Citibank, Bank of America, and Wells Fargo, all reported unprecedented huge quarterly losses. This suggests that large capitalization and total asset levels are not necessarily helpful to banks in weathering the subprime crisis.

Hence, our contribution is as follows. First, in contrast to existing studies that focused on bank performance following the financial crisis, we used the simple Z- and F-tests and the efficient panel-data model to analyze what elements of overall financial performance described in the CAMELS rating for the world's top 200 commercial banks are significantly and negatively affected by the global subprime crisis. Second, the advantage of using the Z- and F-tests and the panel data model might be that Z- and F-tests examine the different changes in bank performance for average level and risk in the pre- and post-crisis periods. The panel data model addresses the simultaneous existence of cross-sectional and time-series data, thereby producing an efficient estimation. We separately examined whether bank size measured by capitalization and total assets and level of market maturity are significant factors in combating the negative effects of the subprime crisis on the financial performance of commercial banks. In contrast to the methodology and sample by Patel and Sarkar (1998), Palmer (2000), and Bae, Karolyi, and Stulz (2003), who investigated market maturity on bank performance from the financial-crisis perspective, we used simple and efficient methods to determine whether the negative effects on overall financial performance of the world's top 200 commercial banks, attributable to the global financial crisis, were significantly greater for banks located in more mature markets. Differing from the analysis by Gomez-Gonzales and Kiefer (2009) and Sufian and Habibullah (2010) on the influence of bank size in bank performance resulting from the financial crisis in specific regions, we used multiple methods to examine whether the negative effects on bank financial performance from the global financial crisis were significantly smaller for large-scale banks. Our study has important implications for financial authorities and bank supervisors in making managing decisions when facing a global financial crisis. Figure 1 shows a framework of the subprime-crisis effect on the financial performance of commercial banks.

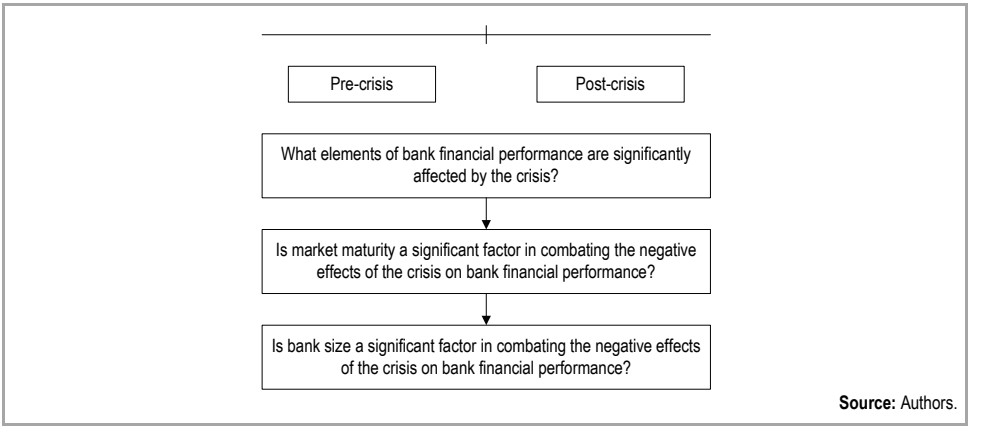

Figure 1 Framework of the Subprime-Crisis Effect on Commercial-Bank Financial Performance

The remainder of this paper is organized as follows. Section 1 provides a description of the study sample, variable measurements, and research design, followed by a discussion in Section 2 of the empirical results. Finally, Section 3 presents the conclusion and a summary of the managerial implications.

1. Data and Methodology

1.1 Data Range and Sample Analysis

In late 2006, the U.S. housing market slowed after 2 years of increases in official interest rates. On August 10, 2006, Central banks pumped billions of dollars into banking systems in a concerted effort to avert a credit crisis. On February 7, 2007, Europe's largest bank, HSBC Holdings, blamed subprime loans for its profit warning. We therefore followed Francis A. Longstaff (2010) to divide the timeline at the beginning of 2007, the onset of the subprime crisis, into the pre-crisis period and the crisis period. We referenced the world's top 200 commercial banks based on their size, measured by total assets in a 2007 issue of *The Banker* magazine, which listed the top 1,000 world banks, and the data were obtained from the Bank Scope[1] database. The study periods were collected from fiscal financial reports in the 3 years before (2004-2006) and the 3 years after (2007-2009) the subprime crisis to analyze changes in financial performance.

After the selection, the results of summary statistics in Appendix 2 Table 2 show 148 commercial banks in our sample. These include 103 banks in developed countries, constituting 70%, and 45 banks in developing countries, constituting 30%. The average capitalization of commercial banks in developed countries is significantly lower than that in developing countries, but the average total assets of commercial banks in developed countries are significantly higher than those in developing countries. The standard deviations for both capitalization and total assets of commercial

[1] **Bank Scope Database.** 2011. Bureau van Dijk. http://www.bvdinfo.com/Products/Company-Information/International/Bankscope.

banks in developed countries are significantly lower than those in developing countries. The results of summary statistics suggest that a possible cause of our empirical results, which shows that commercial banks in developed markets experienced a greater negative influence than did those in emerging markets during the subprime crisis, may be due to their significantly lower capitalization. This is consistent with the results by Gomez-Gonzales and Kiefer (2009) and Sufian and Habibullah (2010) that bank capitalization is positively correlated to their performance. However, the significantly higher total assets of commercial banks in developed countries may result from their higher levels of debt and risky assets.

1.2 Variable Measurement

1.2.1 Measures of Financial Performance Indicators

This study adopted the U.S. financial auditing system's CAMELS rating method of the U.S. financial auditing system to measure financial performance variables. We omitted CAMELS' the sixth category, S for sensitivity to market risk, because this study focused on commercial banks. The measure of each CAMELS variable is as follows.

(1) Capital Adequacy

The capital adequacy ratio represents the ability of a bank to manage its liabilities or potential risks. The most common indicators include the capital adequacy ratio and equity ratio. A high ratio indicates that banks are more stable and implies a higher degree of safety for business operations. The New Basel Accord, the current generally accepted monitoring standard published by the Bank for International Settlements (BIS), calls for a minimum total capital adequacy ratio of 8%. The definitions of equity ratio and capital adequacy ratio are as follows:

$$\text{Equity ratio } (y_1) = \text{Total equity/Total assets},$$

$$\text{Capital adequacy ratio } (y_2) = \text{Capital/Risky asset}.$$

(2) Asset Quality

Loan quality can be used to measure bank-asset quality (e.g. overdue loan ratio, uncollected interest ratio, and the coverage ratio of uncollectible accounts). A high coverage ratio of uncollectible accounts indicates a bank's good loan quality. The coverage-ratio measure of uncollectible accounts is as follows:

$$\text{Coverage ratio of uncollectible accounts } (y_3) = \text{Deposits for uncollectible accounts/Total amount of overdue loans}.$$

(3) Managerial Capability

We used the operating-cost ratio and fixed-asset turnover ratio to measure the level of bank management efficiency, using the operating-cost ratio to measure cost-control ability and fixed-asset turnover ratio to measure substantial asset management ability. The measure of the operating cost ratio and fixed asset turnover ratio are as follows:

Operating cost ratio (y_4) = Operating cost/Operating revenue,

Fixed asset turnover ratio (y_5) = Operating revenue/Average of fixed assets.

(4) Earnings

Bank earnings were measured by its Return on Equity (ROE) and Return on Assets (ROA). Larger indicators mean higher bank profitability. ROE measures the rate of return on ownership interest of common stock owners and a firm's efficiency at generating profits from every unit of shareholder equity at any given period of time. ROA represents how profitable company assets are in generating revenue. A high ROA means that a bank has good operational performance. The ROE and ROA measures are as follows:

ROA (y_6) = Net income/Average total assets,

ROE (y_7) = Net income/Average total equity.

(5) Liquidity

Current ratio (CR) represents bank-asset liquidity, and abundant assets or cash reserves represent bank capacity to manage a short-term bank run. Therefore, CR can be used to measure the bank-safety level. The CR function is as follows:

Current ratio (y_8) = Current asset/Current liability.

(6) Growth Index

We adopted the first five measures of the CAMELS system and a growth-index measure to assess commercial bank operating performance. The growth index is as follows:

Sales revenue growth rate (y_9) =
(Current sales revenue – Previous sales revenue)/Previous sales revenue.

1.2.2 The Subprime Crisis and Moderating Variables

(1) The Subprime Crisis (D_S)

We used the beginning of the subprime financial crisis (early 2007) as a starting point. Within the test and estimates of the panel data model of the entire sample, whether the subprime crisis occurred was set as a dummy variable, D_S; if the sample period was later than January 2007, then $D_S = 1$; otherwise, $D_S = 0$.

(2) Market Maturity (D_{ma})

Palmer (2000) and Bae, Karolyi, and Stulz (2003) showed that when an international financial crisis occurs, emerging-market counterparties are more vulnerable than those of developed countries. Thus, based on the potential differences in market maturity, we divided the sample markets into developed and emerging markets to explore whether the subprime crisis had different effects on the risks and levels of bank financial performance within markets of differing maturity levels. This approach also enabled us to examine whether, in the crisis aftermath, the negative effects on the

financial performance variables were greater for emerging markets than for developed markets. In the panel data model test and analysis of the estimates in this study, the market maturity level was set as a dummy variable, D_{ma}; if the sample bank was located in a developed market, then $D_{ma} = 1$; otherwise, $D_{ma} = 0$.

(3) Capitalization (s_1)

Higher bank capitalization indicates a larger amount of available bank-owned capital for use, thereby providing the bank with better control over its operational risks. Li (2003), Gomez-Gonzalez and Kiefer (2009), and Sufian and Habibullah (2010) proposed that bank capitalization positively correlates with bank performance, particularly when a financial crisis occurs. Because different effects of the subprime crisis on the financial performance variables of commercial banks may have been attributable to different capitalization levels, we designated bank capitalization to explore whether greater capitalization enabled a bank to endure a relatively smaller negative effect on its financial performance variables during the subprime crisis. In the statistical analysis, we also divided the bank samples into the greater 1/5 and the smaller 1/5 groups by capitalization to explore whether banks with greater capitalization successfully reduced the effect of the subprime credit crisis.

(4) Total assets (s_2)

Larger total assets of a bank indicate a greater force that the bank can generate when faced with strong market competition. Because the differences in total assets of commercial banks after the subprime crisis may result from diverse effects on their financial performance variables, we designated bank total assets to determine whether greater total assets resulted in smaller negative effects on the financial performance variables. All bank samples in the statistical analysis were again divided by total assets into greater 1/5 and smaller 1/5 groups to determine whether greater total assets were successful in reducing the effect of the subprime credit crisis.

1.3 Research Design

Because the descriptive statistical Z-test and F-test, based on normal distribution, are fitted with a large sample, we first used Z- and F-tests separately to perform the original investigation because of a larger sample number over 30 in this study. We did not use multiple regression in the original analysis because Z- and F-tests jointly examine whether significant differences exist in bank performance changes of the average level and risk in the pre- and post-crisis periods. The panel-data model also addresses the simultaneous data structure of cross-sections and time series. However, multiple regression ignores the difference in cross-sectional or time-series data, thereby producing an inefficient estimation.

We used this procedure to determine whether the subprime crisis caused any significant deterioration in the average financial performance levels of commercial banks, or in any significant rise in their level of financial risk. We used the Z-test to examine whether the subprime crisis caused any significant deterioration in the average financial performance levels of commercial banks, and used the F-test to ex-

amine whether the crisis caused any significant rise in their financial-risk level. The sampling covers the 2004-2009 annual financial reports of the world's top 200 commercial banks. Based on the panel-data description, the sample contains a relatively large cross-section and a relatively short time series. We treated the time effect in this study as a static-state change, assuming that the time-span samples are in a static state, and therefore, remain unchanged. The advantage of this model is that it simultaneously addresses the coexistence of cross-sectional and time-series data and generates efficient estimates, essentially because it considers the differences between cross-sectional data. Thus, in addition to adopting descriptive statistical test analysis, we adopted the fixed and random effects of the panel data model to estimate a regression model constructed to analyze the different effects of the subprime crisis on the financial performance of commercial banks.

1.3.1 Panel Data Model: Fixed Effects

The fixed effects focus on the allowance between financial-performance differences by using a fixed intercept for each of the different cross-sectional structures. If we assume that the dummy variable for a bank is either 1 or 0, then D_i, which is the dummy variable for bank *i*, can be expressed as:

$$D_1 = \begin{cases} 1, i-1 \\ 0, otherwise \end{cases} \quad D_2 = \begin{cases} 1, i-2 \\ 0, otherwise \end{cases} \quad \cdots \quad D_N = \begin{cases} 1, i-N \\ 0, otherwise \end{cases} . \tag{1}$$

The regression of total samples can be expressed as:[1]

$$Y_{it} = \sum_{j=1}^{N} \beta_{0j} D_j + \beta_1 D_s + \beta_2 D_{ma} + \beta_3 s_1 + \beta_4 s_2 + \varepsilon_{it} . \tag{2}$$

The dummy variables are expressed as follows: if $j = i$, then $D_j = 1$; otherwise $D_j = 0$.[2]

To further investigate the crisis effect, De Haan and Poghosyan (2012a, 2012b) analyzed whether the financial crisis, bank size, and bank concentration affect bank earnings volatility. Based on a similar research design by De Haan and Poghosyan (2012a, 2012b), few explanatory variables should be included in this study. The regression of the post-subprime crisis is as follows:

$$Y_{it} = \sum_{j=1}^{N} \beta_{0j} D_j + \beta_1 D_{ma} + \beta_2 s_1 + \beta_3 s_2 + \varepsilon_{it} . \tag{3}$$

[1] Where i = bank 1, 2,…,N; t = year 1, 2,…,T; $Y_{it} = [y_{1it}, y_{2it} \ldots y_{9it}]$ refers to the values of the various financial performance variables for bank i in year t; and D_j is the fixed intercept, which indicates that the cross-sectional data each have a different structure.

[2] ε_{it} is the error term $\varepsilon_{it} \sim iid\ (0, \sigma_{\varepsilon}^2)$; and the definitions of D_s, D_{ma}, s_1 and s_2 are as previously described in the variable measurements.

The definitions of D_j, D_{ma}, s_1, and s_2 are as described in the variable measurements. Because the fixed effects account for both cross-sectional and time-series data, the increased covariance caused by individual-bank differences is eliminated, thereby increasing estimation-result efficiency.

1.3.2 Panel Data Model: Random Effects

Random effects focus on the relationship with the study sample as a whole[3]; thus, the samples are randomly selected, as opposed to using the entire population. The total-sample regression (a function of the random effect) can be expressed as[4]:

$$\begin{aligned} Y_{it} &= \beta_{0j} + \beta_1 D_s + \beta_2 D_{ma} + \beta_3 s_1 + \beta_4 s_2 \\ &= \overline{\beta}_0 + \beta_1 D_s + \beta_2 D_{ma} + \beta_3 s_1 + \beta_4 s_2 + \mu_i + \varepsilon_{it} \end{aligned} \quad (4)$$

If this is represented with random variables, then $\beta_{0j} = \overline{\beta}_0 + \mu_j$, which indicates that the difference occurs randomly, and the expectation value of β_{0j} is $\overline{\beta}_0$.[5] The regression of the post-subprime crisis is as follows:

$$\begin{aligned} Y_{it} &= \beta_{0j} + \beta_1 D_{ma} + \beta_2 s_1 + \beta_3 s_2 \\ &= \overline{\beta}_0 + \beta_1 D_{ma} + \beta_2 s_1 + \beta_3 s_2 + \mu_i + \varepsilon_{it} \end{aligned} \quad (5)$$

1.3.3 Panel Data Model: Hausman Test

The Hausman test (Yair Mundlak 1978) is the most commonly used method for evaluating fixed and random effects.[6] If μ_i, (D_s), D_{ma} , s_1, and s_2 are statistically correlated, then the fixed-effects estimation is consistent and efficient, whereas the random-effects estimation is inconsistent, and the fixed-effects model should be adopted.[7] Conversely, if μ_i, (D_s), D_{ma}, s_1, and s_2 are statistically uncorrelated, then the random-effects estimation is consistent and efficient, whereas the fixed-effects estimation is consistent but inefficient, and the random-effects model should be

[3] This allows for differences in financial performance between banks, and assumes a high similarity within the population as a whole, and that the intercept of the structural differences in financial performance (i.e. the intercept of each regression of financial performance) is random and does not change over time.

[4] Where i = bank 1, 2,…,N; and t = year 1, 2,…,T; the intercept, β_{0j}, represents the different structure of each of the cross-sections.

[5] μ_i is the error item of the intercept. $E(\mu_i) = 0, Var(\mu_i) = \sigma_\mu^2; E(\mu_i \varepsilon_{it}) = 0, E(\mu_i \mu_j) = 0, if \quad i \neq j$, which shows the different intercepts for a sample bank i; ε_{it} is the error term.

[6] Mundlak (1978) argued that the random effect ($\mu_i + \delta_{it}$) should be examined to determine whether any correlation exists between μ_i and independent variables (D_s), D_{ma}, s_1 and s_2.

[7] If μ_i is correlated with (D_s), D_{ma}, s_1, and s_2, then bias and inconsistency is introduced into the regression estimation of the random effects.

adopted.[8] We therefore use the Hausman test to examine whether μ_i, (D_s), D_{ma}, s_1, and s_2 are statistically correlated. Under the null hypotheses, H_0, the random effects model is used. Under H_1, the fixed-effects model is used.[9]

2. Empirical Results

2.1 Descriptive Statistical Test

2.1.1 Entire Sample

Under the alternative hypothesis H_1 for the descriptive statistical test, we assumed that the anticipated large-value variables (i.e. equity ratio, capital adequacy ratio, coverage ratio of uncollectible accounts, fixed-asset turnover ratio, ROA, ROE, current ratio, and sales growth rate) should have a significantly smaller value after the crisis. Similarly, we supposed that the anticipated small-value variable (i.e. operating cost ratio) should have a significantly larger value following the crisis. Alternatively, under the null hypothesis H_0, we proposed a contrary circumstance, compared with the alternative hypothesis H_1. The result in Table 2 clearly shows that following the subprime crisis disclosure, the coverage ratio of uncollectible accounts, ROA, ROE, and the current ratio and growth rate of commercial banks were all significantly reduced. Table 2 also shows that the variances in equity ratio, operating cost ratio, fixed-asset turnover ratio, ROA, ROE, and growth rate are significantly increased in the post-subprime crisis period. These results indicate that the subprime crisis had significant negative effects on asset quality, profitability, liquidity, and the growth index of commercial banks, and simultaneously raised their risks in capital adequacy, management performance, profitability, and growth.

<Table 2 in Appendix 2>

2.1.2 Classification by Market Maturity

(1) Developed Markets

The data results on commercial banks in developed markets shown in Table 3 show that the subprime crisis had significant negative effects on asset quality and profitability, and raised risks in their capital adequacy, management capability, profitability, and growth index.

(2) Emerging Markets

The commercial-bank results in the emerging markets in Table 4 show that the subprime crisis had significant negative effects on profitability and liquidity, and raised management capability and growth risks.

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[8] Although certain shortcomings of the fixed effects model are addressed by the random effects model, there is a requirement for the assumption that μ_i are uncorrelated with (D_s), D_{ma}, s_1, and s_2.

[9] If $H \leq \chi_k^2$, then the null hypothesis is accepted and the random effects model should yield a better result. If $H > \chi_k^2$, then the null hypothesis is rejected and the fixed effects model should yield a better result.

<*Tables 3 and 4 in Appendix 2*>

In summary, commercial-bank profitability declined significantly, and risk increased in managerial capability and growth following the subprime crisis, regardless of market maturity. Certain commercial banks in emerging markets had weaker liquidity performance because of increased current liabilities over current assets, whereas those located in developed markets showed worse asset quality and significantly increased risk in asset adequacy and profitability. Our results show that commercial banks in developed markets suffered significantly larger negative effects from the crisis than did their counterparts in emerging markets, which is inconsistent with the findings of both Patel and Sarkar (1998) and Bae, Karolyi, and Stulz (2003). These findings may result from two possible causes. First, commercial banks in developed markets have significantly lower capitalization (Appendix 2, Table 2), which is consistent with the comments by Li (2003), Gomez-Gonzales and Kiefer (2009), and Sufian and Habibullah (2010). Second, the subprime crisis occurred in developed markets (i.e. Europe and the United States) where most commercial banks issued securitizations; therefore, commercial banks located in these markets suffered a more direct effect from the crisis. However, the subprime crisis had less significance and a direct effect on emerging markets, possibly because of their higher capitalization, more capital restrictions, and a lower degree of financial maturity.

2.1.3 Classification by Bank Size

According to our sample distribution and the research design by De Haan and Poghosyan (2012a, 2012b), market maturity and bank size should not overlap in our explanatory variables.[10] Table 5 shows that the subprime crisis negatively affected commercial-bank profitability with larger capitalization, whereas other financial variables were not significantly affected. The crisis also increased the risk level in the profitability and growth indices. For other commercial banks with smaller capitalization (Table 6), the subprime crisis had negative effects on capital adequacy, asset quality, managerial capability, profitability, and growth, and increased the risk in capital adequacy, managerial cost capability, shareholder profitability, and growth. Following the subprime crisis, banks with smaller capitalization exhibited worse financial performance (i.e. capital adequacy, asset quality, managerial cost capability, and growth) and increased risk in capital adequacy and managerial cost capability compared to banks with larger capitalization. The results prove that in a financial crisis, commercial banks with larger capitalization are better able to resist negative effects to capital adequacy, asset quality, managerial capability, and growth.

<*Tables 5 and 6 in Appendix 2*>

[10] Larger and smaller bank-size samples, measured by their capitalization and total assets, are simultaneously and unbiasedly scattered in the developed market and developing market under this study. However, De Haan and Poghosyan (2012a, 2012b) simultaneously examined whether bank size and bank concentration significantly affects bank earnings volatility. We regard market maturity in our study as one of the indicators of bank concentration.

We summarize the important results of commercial banks with larger and smaller total assets rather than showing their empirical tables because of limited space in this paper. The subprime crisis had negative effects on asset quality and profitability for commercial banks with larger total assets. Although the results show no effect on other financial variables, the subprime crisis increased profitability risk and growth indices. For commercial banks with smaller total assets, the subprime crisis had significant negative effects on asset quality, profitability, and growth, and increased the level of risk in capital adequacy, managerial capability, shareholder profitability, and growth. Compared to banks with larger total assets, smaller commercial banks exhibited worse financial-growth performance than did their larger counterparts; smaller commercial banks also increased their risk of capital adequacy and managerial cost capability. The empirical results indicate that commercial banks with larger total assets are better able to resist the negative influence on growth during the subprime crisis period.

2.2 Empirical Results of the Panel Data Model

2.2.1 Financial Ratios for the Entire Sample

To reduce size limitations, we combined the Hausman test results with those of panel-data estimations. The panel-data estimations for the entire sample are presented in Table 7, which shows that the fixed-effects model is better for the equity ratio, capital adequacy ratio, operating cost ratio, and current ratio, but the random-effects model is better for financial-performance variables. Table 7 shows that the coefficients of D_S are significantly negative in the coverage ratio of uncollectible accounts, ROA, ROE, current ratio, and sales growth rate of these banks. Our results mean that all commercial banks showed declines in asset quality, profitability, liquidity, and growth indices following the subprime crisis. These asset-quality declines are due to increased overdue lending. Banks were unable to handle emergent events, causing further cash declines resulting from worsening liquidity. Because of significant downward pressure on profitability and growth, banks could not maintain progress in profit and revenue growth.

Considering the control variables in Table 7, the coefficients of D_{ma} show that market maturity exhibits significantly positive effects on the bank-equity ratio and sales-revenue growth rate over the entire sample. This means that developed markets that issued financial-securitized products had higher reserves and sales growth than did emerging markets. The coefficients of s1 show that bank capitalization also positively influenced equity ratios and capital-adequacy ratios, indicating that larger capitalization improves commercial-bank capital adequacy. Thus, more highly capitalized banks could better counteract the negative effects of the subprime crisis on their capital adequacy. However, the coefficients of s_2 show that total assets have a slightly negative influence on the equity ratio, capital adequacy ratio, and current ratio. The result implies that banks with higher total assets may incur worse capital adequacy and liquidity, possibly because of their higher debt levels and risky assets.

2.2.2 Financial Ratios for Commercial Banks after the Crisis

The results of panel data estimations combined with the Hausman test following the crisis are shown in Table 8. Except for the equity ratio fitted with the fixed-effects model, Table 8 shows that other financial-performance variables are fitted with the random-effects model. The coefficients of D_{ma} show that, during the subprime crisis, market maturity had a significantly positive effect on the operation cost ratio, whereas it negatively influenced the equity ratio, capital adequacy ratio, coverage ratio of uncollectible accounts, ROA, and ROE. The results indicate that the subprime crisis directly affected developed markets, which have lower capitalization and primarily issued securitization, causing downward pressure on capital adequacy, asset quality, managerial cost capability, and profitability. The coefficients of s_1 and s_2 show that, after the crisis, bank capitalization and total assets had no significantly negative influence on all anticipated large-value variables (i.e. equity ratio, capital adequacy ratio, coverage ratio of uncollectible accounts, fixed asset turnover ratio, ROA, ROE, current ratio, and sales growth rate). Bank capitalization and total assets exerted no significant positive influence on anticipated small-value variables (e.g. operating cost ratio). Bank-capitalization size had a significantly positive effect on the equity ratio and capital adequacy ratio in the post-subprime crisis period, suggesting that bank capitalization counteracts the negative effects on their capital adequacy during the crisis period. Larger bank size, particularly larger capitalization, reduces the negative effects caused by the subprime crisis.

<Tables 7 and 8 in Appendix 2>

3. Conclusion

We examined a sample of the world's top 200 commercial banks to prove that larger banks, particularly larger capitalization, have an economies-of-scale advantage to resist negative effects on financial performance resulting from the subprime crisis. These results are consistent with the findings by Li (2003), Gomez-Gonzales and Kiefer (2009), and Sufian and Habibullah (2010), who argued that bank scale determines a bank's ability to withstand financial-crisis effects. Therefore, government authorities should limit large financial-institution mergers to avoid bankruptcy and eliminate consolidation constraints on financial firms to increase bank competitiveness and enhance their ability to adequately respond to negative effects caused by future financial crises. Government authorities should also avoid saving larger banks to reduce the possibility that partial bank performance may result from government policy. Commercial banks should increase their size to enhance their competitiveness and reduce their debt level and risky assets to strengthen their own capital. We showed that developed markets suffered a greater negative influence than did emerging markets following the subprime crisis, causing downward pressure on worse asset quality performance and increased capital adequacy risk and profitability, which is inconsistent with the results by Bae, Karolyi, and Stulz (2003). The subprime crisis directly affected the financial performance of developed market commercial banks with lower capitalization and issued financial securitized products, whereas banks in

emerging markets experienced an indirect influence, possibly because of their higher capitalization, greater capital limitations, and low financial development. Governments in developed markets should implement financial policies for raising bank capitalization to reduce bank failure during financial crises and should supervise financial institutions in regulatory systems. Finally, financial supervisors, particularly in developed markets, should strengthen their bank capital adequacy, asset quality, and profitability to manage future financial crises.

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Appendix 1

Several previous studies explore the correlation of financial crises to bank performance. Among them, Sufian and Habibullah (2010) examine the impact of the Asian financial crisis on Indonesian banks' performance. Their results found that the crisis exerted significantly negative impact on these banks' profitability, and income diversification and capitalization positively correlated with their profitability. Gomez-Gonzalez and Kiefer (2009) investigate the bank failure during the financial crisis in Colombia. They find that the failure of banks during that period can be explained by differences in banks' financial health and prudence, and the capitalization ratio is the most negatively significant index explaining bank failure. Marcia M. Cornett et al. (2010) examine government ownership and involvement in a country's banking system after bank performance fell during the Asian financial crisis. They find that deterioration in cash flow returns, core capital and credit quality of state-owned banks was significantly greater than that of privately-owned banks after the Asian crisis occurred.

Appendix 2

Table 1 Summary Statistics

Items	Mean	Median	Maximum	Minimum	Std. dev	Sample size
Panel A: the entire sample						
ln(capitalization)	5.099	3.890	6.990	-0.398	5.912	148
ln(total assets)	6.068	5.034	7.890	1.533	6.824	
Panel B: developed market sample						
ln(capitalization)	4.307	3.947	5.354	2.736	4.460	103
ln(total assets)	5.533	5.136	6.476	3.878	5.687	
Panel C: developing market sample						
ln(capitalization)	5.564	3.735	6.990	-0.398	6.162	45
ln(total assets)	5.487	4.757	7.890	1.533	7.075	

Source: Authors' calculation.

Table 2 Average and Variance in Commercial Bank Variables for the Entire Sample Z and F Test Results

Panel A: Average

	Equity ratio	Capital adequacy	Coverage ratio of uncollectible accounts ratio	Operating cost	Fixed asset turnover ratio
H_1:	$u_1>u_2$	$u_1>u_2$	$u_1>u_2$	$u_1<u_2$	$u_1>u_2$
Pre-crisis(u_1) (Average)	7.201	12.999	153.063	1.948	1.839
Post-crisis (u_2) (Average)	7.521	13.134	107.257	1.689	1.937
Z-statistic	-1.327	-0.619	5.829 ***	0.954	-0.411

	ROA	ROE	Liquidity ratio	Growth rate
H_1:	$u_1>u_2$	$u_1>u_2$	$u_1>u_2$	$u_1>u_2$
Pre-crisis (u_1) (Average)	1.177	15.557	25.039	0.250
Post-crisis (u_2) (Average)	0.650	8.160	23.033	-0.153
Z-statistic	7.084 ***	8.129 ***	1.390 *	1.883 **

Panel B: Variance

	Equity ratio	Capital adequacy	Coverage ratio of uncollectible accounts ratio	Operating cost	Fixed asset turnover ratio
H_1:	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$
Pre-crisis (σ^2_1) (Variance)	11.700	12.031	18698.694	6.975	5.820
Post-crisis (σ^2_2) (Variance)	14.123	9.052	8697.268	25.580	19.352
F-value	1.207 **	0.753	0.465	3.667 ***	3.325 ***

	ROA	ROE	Liquidity ratio	Growth rate
H_1:	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$
Pre-crisis (σ^2_1) (Variance)	0.959	66.104	534.441	0.593
Post-crisis (σ^2_2) (Variance)	1.501	301.633	391.066	19.701
F-value	1.566 ***	4.563 ***	0.732	33.247 ***

Note: ***, ** and * indicate significance at the 0.01, 0.05 and 0.1 levels, respectively.

Source: Authors' calculation.

Table 3 Average and Variance in Commercial Bank Variables in Developed Markets Z and F Test Results

Panel A: Average

	Equity ratio	Capital adequacy	Coverage ratio of uncollectible accounts ratio	Operating cost	Fixed asset turnover ratio
H_1:	$u_1>u_2$	$u_1>u_2$	$u_1>u_2$	$u_1<u_2$	$u_1>u_2$
Pre-crisis(u_1) (Average)	8.935	15.408	116.518	1.856	1.884
Post-crisis (u_2) (Average)	9.493	14.742	109.561	0.806	1.679
Z-statistic	-1.194	1.250	0.630	1.716	0.578

	ROA	ROE	Liquidity ratio	Growth rate
H_1:	$u_1>u_2$	$u_1>u_2$	$u_1>u_2$	$u_1>u_2$
Pre-crisis (u_1) (Average)	1.818	18.333	27.130	0.393
Post-crisis (u_2) (Average)	1.396	14.496	23.974	-0.633
Z-statistic	2.614	2.992 ***	1.756 ***	1.223 **

Panel B: Variance

	Equity ratio	Capital adequacy	Coverage ratio of uncollectible accounts ratio	Operating cost	Fixed asset turnover ratio
H_1:	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$
Pre-crisis (σ^2_1) (Variance)	16.719	24.091	12415.312	2.018	11.679
Post-crisis (σ^2_2) (Variance)	12.763	12.206	4069.719	48.479	5.270
F-value	0.763	0.507	0.328	24.026 ***	0.451

	ROA	ROE	Liquidity ratio	Growth rate
H_1:	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$
Pre-crisis (σ^2_1) (Variance)	1.917	107.321	292.644	0.550
Post-crisis (σ^2_2) (Variance)	1.593	114.669	143.181	47.275
F-value	0.831	1.068	0.489	85.910 ***

Note: ***, ** and * indicate significance at the 0.01, 0.05 and 0.1 levels, respectively.

Source: Authors' calculation.

Table 4 Average and Variance in Commercial Bank Variables in Emerging Markets Z and F Test Results

Panel A: Average

	Equity ratio	Capital adequacy	Coverage ratio of uncollectible accounts ratio	Operating cost	Fixed asset turnover ratio
H_1:	$u_1>u_2$	$u_1>u_2$	$u_1>u_2$	$u_1<u_2$	$u_1>u_2$
Pre-crisis(u_1) (Average)	6.462	11.965	170.010	1.991	1.832
Post-crisis (u_2) (Average)	6.667	12.418	106.660	2.076	2.064
Z-statistic	-0.798	-2.604	6.236 ***	-0.300	-0.753

	ROA	ROE	Liquidity ratio	Growth rate
H_1:	$u_1>u_2$	$u_1>u_2$	$u_1>u_2$	$u_1>u_2$
Pre-crisis (u_1) (Average)	0.894	14.194	24.258	0.189
Post-crisis (u_2) (Average)	0.322	5.361	22.751	0.058
Z-statistic	8.415 ***	7.693 ***	0.779	0.797

Panel B: Variance

	Equity ratio	Capital adequacy	Coverage ratio of uncollectible accounts ratio	Operating cost	Fixed asset turnover ratio
H_1:	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$
Pre-crisis (σ^2_1) (Variance)	7.698	3.138	20755.669	9.238	3.305
Post-crisis (σ^2_2) (Variance)	12.426	6.120	10825.602	15.359	25.728
F-value	1.614 ***	1.950 ***	0.522	1.663 ***	7.785 ***

	ROA	ROE	Liquidity ratio	Growth rate
H_1:	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$
Pre-crisis (σ^2_1) (Variance)	0.287	41.386	643.072	0.606
Post-crisis (σ^2_2) (Variance)	1.126	361.955	502.775	7.707
F-value	3.923 ***	8.746 ***	0.782	12.722 ***

Note: ***, ** and * indicate significance at the 0.01, 0.05 and 0.1 levels, respectively.

Source: Authors' calculation.

Table 5 Average and Variance in Commercial Bank Variables for Larger Capitalization Sample Z and F Test Results

Panel A: Average

	Equity ratio	Capital adequacy	Coverage ratio of uncollectible accounts ratio	Operating cost	Fixed asset turnover ratio
H_1:	$u_1>u_2$	$u_1>u_2$	$u_1>u_2$	$u_1<u_2$	$u_1>u_2$
Pre-crisis(u_1) (Average)	5.737	12.697	120.834	1.907	1.533
Post-crisis (u_2) (Average)	6.236	13.167	89.793	1.924	1.391
Z-statistic	-0.950	-0.914	1.375 *	-0.059	0.749

	ROA	ROE	Liquidity ratio	Growth rate
H_1:	$u_1>u_2$	$u_1>u_2$	$u_1>u_2$	$u_1>u_2$
Pre-crisis (u_1) (Average)	0.984	15.018	31.135	0.234
Post-crisis (u_2) (Average)	0.644	7.433	26.193	0.005
Z-statistic	2.375 ***	3.517 ***	1.216	0.679

Panel B: Variance

	Equity ratio	Capital adequacy	Coverage ratio of uncollectible accounts ratio	Operating cost	Fixed asset turnover ratio
H_1:	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$
Pre-crisis (σ^2_1) (Variance)	12.101	14.955	11372.667	4.851	1.656
Post-crisis (σ^2_2) (Variance)	10.266	6.440	2455.796	1.607	1.277
F-value	0.848	0.431	0.216	0.331	0.771

	ROA	ROE	Liquidity ratio	Growth rate
H_1:	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$
Pre-crisis (σ^2_1) (Variance)	0.634	85.020	418.245	1.117
Post-crisis (σ^2_2) (Variance)	1.034	291.738	247.696	8.128
F-value	1.630 **	3.431 ***	0.592	7.277 ***

Note: ***, ** and * indicate significance at the 0.01, 0.05 and 0.1 levels, respectively.

Source: Authors' calculation.

Table 6 Average and Variance in Commercial Bank Variables for Smaller Capitalization Sample Z and F Test Results

Panel A: Average

	Equity ratio	Capital adequacy	Coverage ratio of uncollectible accounts ratio	Operating cost	Fixed asset turnover ratio
H_1:	$u_1>u_2$	$u_1>u_2$	$u_1>u_2$	$u_1<u_2$	$u_1>u_2$
Pre-crisis(u_1) (Average)	7.698	12.948	191.202	1.483	1.998
Post-crisis (u_2) (Average)	8.992	13.098	149.596	0.932	1.821
Z-statistic	-2.041 ***	-0.364	1.391	0.563 ***	0.382

	ROA	ROE	Liquidity ratio	Growth rate
H_1:	$u_1>u_2$	$u_1>u_2$	$u_1>u_2$	$u_1>u_2$
Pre-crisis (u_1) (Average)	1.344	15.403	18.549	0.272
Post-crisis (u_2) (Average)	0.621	8.240	19.161	-1.066
Z-statistic	4.026	4.370 **	-0.282	1.346 ***

Panel B: Variance

	Equity ratio	Capital adequacy	Coverage ratio of uncollectible accounts ratio	Operating cost	Fixed asset turnover ratio
H_1:	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$
Pre-crisis (σ^2_1) (Variance)	1.9322	31.0414	45.738	0.306	0.006
Post-crisis (σ^2_2) (Variance)	43.668	95.648	60.328	0.371	0.002
F-value	0.044	0.325	0.758	0.825	3.761 ***

	ROA	ROE	Liquidity ratio	Growth rate
H_1:	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$	$\sigma^2_1>\sigma^2_2$
Pre-crisis (σ^2_1) (Variance)	1.042	835.322	752.989	0.753
Post-crisis (σ^2_2) (Variance)	50.102	153.051	203.996	0.487
F-value	0.021	5.458 ***	3.691 ***	1.548 *

Note: ***, ** and * indicate significance at the 0.01, 0.05 and 0.1 levels, respectively.

Source: Authors' calculation.

Table 7 Panel Data Model for the Entire Sample

Dependent / Independent	*Equity ratio*	*Capital adequacy*	*Coverage ratio of uncollecti-ble accounts*	*Operating cost ratio*	*Fixed asset turnover ratio*	*ROA*	*ROE*	*Current ratio*	*Sales growth rate*
Constant	0.000	0.000	152.728***	0.000	1.846***	1.146***	15.199***	0.000	0.257
D_s	0.322***	0.212	-45.818***	-0.256	0.099	-0.542***	-7.401***	-1.670**	-0.444**
D_{ma}	0.002*	0.001	-0.002	-0.004	0.000	-0.000	-0.000	-0.002**	0.003***
S1	0.001*	2.329***	-0.001	1.248	-0.001	0.001	0.001	0.002	-0.004
S2	-0.001	-0.004	0.002	-0.002	0.001	0.001	0.001	-0.003	0.006
Hausman test	FE	FE	RE	FE	RE	RE	RE	FE	RE
RSS	1921.306	2849.608	5004346.935	11509.768	4917.436	516.455	118972.077	69181.189	8175.887
Total sample no.	888	888	888	888	888	888	888	888	888

Notes: [a] RSS refers to the residual sum of squares. [b] ***, ** and * indicate significance at the 0.01, 0.05 and 0.1 levels, respectively. [c] FE represents that the fixed effects model is used, and RE represents that the random effects model is used.

Source: Authors' calculation.

Table 8 Panel Data Model for the Post-Crisis Sample

Dependent / Independent	*Equity ratio*	*Capital adequacy*	*Coverage ratio of uncollecti-ble accounts*	*Operating cost ratio*	*Fixed asset turnover ratio*	*ROA*	*ROE*	*Current ratio*	*Sales growth rate*
Constant	0.000	13.084***	108.007***	1.683***	1.963***	0.604***	7.736***	23.095***	-0.170
D_{ma}	-0.003*	-0.010***	-0.003*	0.002***	-0.000	-0.003*	-0.001*	-0.000	0.003
S1	0.002**	0.002**	0.001	-0.002	0.003	0.001	-0.002	-0.004	-0.001
S2	-0.002	-0.000	-0.000	0.000	-0.001	0.001	0.001	0.000	0.002
Hausman test	FE	RE	RE	RE	RE	RE	RE	RE	RE
RSS	485.093	1268.179	1527580.288	7261.877	1969.334	354.185	92736.650	23765.717	6088.946
Total sample no.	444	444	444	444	444	444	444	444	444

Notes: [a] RSS refers to the residual sum of squares. [b] ***, ** and * indicate significance at the 0.01, 0.05 and 0.1 levels, respectively. [c] FE represents that the fixed effects model is used, and RE represents that the random effects model is used.

Source: Authors' calculation.