CAPITAL REQUIREMENTS AND LENDING ACTIVITY OF BANKS IN THE US, EUROPE AND ASIA

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Abstract

Capital ratio requirements have important impact on bank lending activities. This thesis studies and compares the relationship between capital ratio and lending growth, practice in loan loss provisions and changes in fee income ratio among the three geographical areas. The results suggest that, in general, Tier 1 capital plays a positive role in supporting lending growth, and Tier 2 capital does not. The effect of Tier 1 capital is statistically significant for small size banks in all three areas. When lending grows in economic upswings, US and European banks tend to make lower loan loss provisions while Asian banks tend to reserve more. Increase in fee income ratio associated with decrease in lending is found among banks in the US and Europe, who experience sharp decline in lending. This negative relation is not found for the case of Asian banks.

Keywords: capital requirements, Basel III, bank capital, bank lending, financial crisis

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ABBREVIATION

BHCs	Bank Holding Companies
CAR	Capital Adequacy Ratio
CPI	Consumer Price Index
D-SIBs	Domestic Systematically Important Banks
G-SIBs	Global Systematically Important Banks
GDP	Gross Domestic Product
RWA	Risk Weighted Assets
WACC	Weighted Average Cost of Capital

1 INTRODUCTION

In the aftermath of the global financial crisis 2008 - 2009, Basel Committee on Bank Supervision issued the Basel III framework as a response to the crisis. The purpose of the framework is to address a number of weaknesses in the pre-crisis regulatory framework and strengthen supervision and risk management of banks. Reform in level and quality of bank capital is one of the key issues of this framework, among other elements of leverage ratio, liquidity requirements and market discipline (disclosures). Minimum ratios and standard of capital are raised significantly from the old framework (Basel II) which was issued in 2004. In addition, a macroprudential overlay which includes capital buffers is added and applied for global systematically important banks (G-SIBs). The higher capital requirements are obviously beneficial for banking sector and the economy in long-term because they help banks in terms of robustness, ability to absorb unexpected severe losses and withstand in economic downturns, thus enhance the stability of the financial system. On the other hand, these requirements lead to higher cost of capital, which impacts lending activity of banks and consequently impacts real activity of the economy. If the changes are significant and potentially affect the business performance, banks need to make adjustments in their balance sheet and business model. It is believed that their responses are different in crisis time and non-crisis time, and different among markets because how they react to the changes should depend on their specific characteristics (such as size, risk attitude, financial position, etc.) and macroeconomic conditions of the economy in which they operate.

A large number of studies find different empirical results on the effects of high capital ratios. Furlong (1989) suggests that the Basel capital requirement reduces incentives for bank to increase risky asset portfolios, while Kim (1988) concludes that it is not effective to limit insolvency risk of banks. U-shaped relationship is found by Calem (1999). In terms of lending supply, improvement in capital ratio supports lending growth according to Hancock and Wilcox (1994), Gambacorta (2004), Berrospide (2010), Francis (2011), Brei (2013). Contradicting evidence is found by Noss (2016), De-Ramon (2016) and Haldane et al (2017). Findings about impact of capital requirements on lending rate are mixed among investigations done by Slovik (2011), Cosimano (2011), Cecchetti (2014) and Šútorová (2013).

The previous research focuses on some major markets like US and European areas. Except for the case of Japanese banks, Asian banks in general are less examined as a separate group but usually included in all-bank sample together with banks in other regions. In addition, sample period in published articles had been until 2010 at the latest. Therefore, focus of this study is to analyze the relationship between the capital ratios and the traditional lending activity of banks in US, European and Asian markets separately over the period from 1995 to 2016 which covers the most recent pre-crisis, crisis and post-crisis time. It also observes

the impact on income structure which is, to my knowledge, less examined in previous studies. In specific, the study seeks to answer the following questions: 1) how the banks change their capital ratio before and after global financial crisis 2008 – 2009 in relative to regulatory capital requirements, 2) how the changes affect loan growth and loan loss provisions, 3) do the banks tend to shift to fee-based services when facing the adverse impact on lending activity, and 4) what are the differences in the responses between large banks and small banks, and among the three markets.

The report is structured as follows: section 2 summarizes background of the issue including the changes of regulatory framework over time and the expected effects, and literature review. Section 3 describes data and analysis method used in this study. Empirical results are presented in section 4. Section 5 concludes.

2 BACKGROUND AND LITERATURE REVIEW

2.1 Background

2.1.1 Capital requirement changes under Basel framework

Basel regulatory framework is a set of international banking regulations developed by the Basel Committee on Bank Supervision, aiming to strengthen regulation, supervision and practices of banks worldwide, and enhance financial stability. The very first framework, Basel I, was published in 1988 with the goal of minimizing credit risk. Bank assets are classified into five groups carrying different risk weights (0%, 10%, 20%, 50% and 100%) based on the nature of the debtors. For example, cash, central bank and government debts are categorized as 0% risk, residential mortgages are placed in 50% risk category, and private sector debts are placed in 100% risk category. International banks are required to maintain a minimum capital at 8% of risk weighted assets (RWA).

In 2004, the revised framework, Basel II, was issued based on three pillars: minimum capital requirements, supervisory review and market discipline. The capital requirements still played the most important role. Although the minimum required capital ratio at 8% of RWA remained unchanged, there was a greater use of credit risk assessment in calculating RWA and regulatory capital in Basel II. Assets were assigned risk weights not only simply by asset category but also by their credit rating. Those with higher credit rating would carry lower risk weight and vice versa. Banks were allowed to use internal ratings-based approach (IRBA), i.e. using their own risk management system to measure credit risk of their portfolios. These banks, however, had to meet certain conditions and disclosure requirements, and obtain approval from their national authorities before adopting the IRBA approach. Other banks were required to adopt standardized approach, using ratings from external credit rating agencies such as Standard & Poor's, Moddy's and Fitch to quantify their regulatory capital.

Following the global financial crisis 2008 – 2009, it is realized that low amount and quality of capital in banking sector is one of the main reasons making the crisis became so severe, among other causes such as excessive leverage, liquidity mismatches, inadequate disclosure and performance measurement. Thus, Basel III was published in December 2010 to address the capital related problems arising during the crisis. It imposes higher standards on bank capital and introduces new elements to monitor leverage and liquidity (the new elements, however, are not in scope of this master's thesis). Table 1 below provides summary of changes in capital adequacy ratios in Basel framework.

Table 1. Strengthened capital framework from Basel I to Basel III

% of risk-weighted assets	Capital requirements							Additional macroprudential overlay	
	Common Equity			Tier 1 capital		Total capital		Counter - cyclical buffer	Additional loss-absorbing capacity for SIFIs
	Minimum	Conservation buffer	Required	Minimum	Required	Minimum	Required		
Basel I				4		8			
Basel II	2			4		8			
Basel III [1] phase [2]	4.5 2015	2.5 2019	7 2019	6 2015	8.5 2019	8 2013	10.5 2019	0 - 2.5	1 - 3.5

(1): New definition and calibration of capital

(2): Effective date to fully comply with the Basel III capital requirements. All dates are as of 1st January.

Under the new framework (Basel III), total regulatory capital ratio is raised from 8% to 10.5%. Requirements of high quality capital increase more significantly. Common equity to RWA ratio is raised from 2% to 4.5% effective on 1st January 2015 and fully effective at 7% on 1st January 2019. Tier 1 to RWA ratio is raised from 4% to 6% and to 8.5% effective on 1st January 2015 and 1st January 2019 respectively. In addition, the new capital buffers are introduced in Basel III. Counter-cyclical buffer up to 2.5% and additional loss absorbing capacity for significant important financial institutions (SIFIs) from 1% to 3.5% are to be implemented by the national supervisor when there is excessive credit growth in the economy. Besides the increase in the capital adequacy ratio, stricter definition of capital under Basel III narrows down the scope of items that qualify as common equity and Tier 1 capital. For example, goodwill, minority interest, deferred tax assets, bank investments in own shares and in other banks, financial institutions and insurance companies are no longer included in common equity. Innovative instruments to generate Tier 1 capital are subject to more stringent conditions under new standards. As a result, different types of hybrid capital instruments that used to be eligible as Tier 1 capital under the old framework are now not qualified. These changes put more pressure on banks in raising capital to meet the new requirements. In addition, counter-cyclical buffer (CCyB) and additional loss-absorbing capacity for SIFIs are introduced, taking into account macroenvironment in which banks operate. When there is an excessive credit growth in the economy, the national supervisor would implement the CCyB to protect banking sector from the overheat of credit growth, which is often associated with the build-up of system risk. SIFIs are institutions those have significant influence on banking sector, and their collapse could trigger a financial crisis. Therefore, an extra capital - additional loss-absorbing capacity - is required on these institutions to enhance their ability to suffer huge losses if any and continue to operate without threatening financial market stability.

2.1.2 Expected effects of higher capital requirements

2.1.2.1 *Benefits and costs of higher capital requirements*

In theory, higher capital requirements obviously bring certain benefits to banking sector and subsequently to the whole economy. Well-capitalized banks are able to absorb losses and withstand shocks better than poorly-capitalized banks. In the events of crisis, these banks are less likely to fail or require much support from government or taxpayers. Thus, strong bank capital would help to reduce the likelihood and severity of crises and contribute to stability of financial markets. Some empirical studies find evidence supporting this theoretical prediction, such as Berger (2013) on US banks over 25 years from 1984 to 2010, and Vazquez (2015) on 11,000 US and European banks over the period 2001 – 1009.

At bank level, a healthy balance sheet structure with high capital ratio is believed to support lending growth because well-capitalized banks are in better position to accept loan requests compared to less-capitalized banks, especially in periods of economic downturn. In the event of failure, capital is the amount at risk for shareholders; therefore, banks tend to be more prudent in taking excessive risky portfolios if their capital is high relative to their liabilities. For this reason, capital also plays a preventive role in risk management. Another decisive condition of the effectiveness of bank capital in dealing with shocks is its quality. High quality capital is the component of capital that banks can use to absorb unexpected losses while continuing their critical functions. Its importance is clearly seen in the lesson from the financial crisis 2008 - 2009, where low amount and quality of bank capital is one of the main reasons of the collapse of banking sector. Thus, it is justified that a regulation aiming to higher capital standards is necessary. This helps to ensure that banks have sufficient solid capital to cope with situations of stress. Basel III has taken this issue as one of the key changes in its reform by requiring a much larger proportion of common equity and Tier 1 capital.

On the other hand, there are concerns about the potential macroeconomic costs of the new standard. In order to meet the higher capital ratios, banks may either widen lending spreads to compensate for the increase of cost of capital or reduce loan volume. As a result, credit growth would be slowed down, affecting negatively real economic activity. It is noted that the basis of this concern contrasts to the Modigliani-Miller theorem, which states that under the assumption of efficient markets (no taxes, no transaction costs, no bankruptcy costs and symmetric information), market value of an entity is independent of its capital structure but determined by its future growth prospect and the riskiness of its underlying assets. The theorem argues that an increase in equity proportion lowers the riskiness for the entity, hence preserves the entity's WACC. In practice, however, not all the assumptions hold. Therefore, the concern of a rise in cost of capital is worth of concern.

It is important to recognize that there are also costs to individual banks to comply with the capital regulation, both in transition period (when banks adjust their capital) and in steady state (after the adjustment is completed). If banks

choose new equity issuance, costs related to raising equity from external sources (underwriting fees, professional fees, marketing fees) are not negligible. Alternatively, banks may increase their capital using retained earnings to minimize the transition costs. Time constraint, however, is the issue of this strategy if banks need to raise capital level rapidly due market pressure. Post capital adjustment, banks incur costs associated with higher equity, for example, loss of tax shield advantage which they would otherwise benefit if having more debt in their funding mix. If banks choose asset reduction strategy, they may have to give up opportunities to grow their business and profitability.

2.1.2.2 Other effects of the new capital regulation

Apart from the effects on macroeconomic performance and bank balance sheet management as mentioned above, the change in capital requirements also causes considerable adjustments of business model and business strategy in banking sector. Exiting operation in geographical areas and/or lines of businesses is one of the strategies that banks, especially international banks, may adopt in the new situation because they need to rise margins but may not afford to do so in all areas. Banks are likely to review their portfolio and withdraw from business segments where return on capital is low, e.g. long-term infrastructure, industrial projects or public services. Similarly, with customer portfolio, banks may systematically review and focus only on high value or low default customers. This practice may go along with tightening lending standard to limit credit volume and improve loan quality. Banks may also adjust their business strategy to maintain profitability by shifting from traditional lending activity to fee-based services (such as underwriting, guarantee, advisory, account services, etc.), leading to a change in banks' s income structure. The purpose is to increase non-interest income in the face of declining net interest income resulted from higher cost of capital and lower credit volume. A positive impact of this move is improvement and innovation on non-fund services in banking sector.

Higher cost of capital induces banks to review their internal processes to improve capital efficiency. For example, unnecessarily high buffers for loan loss provisions can be avoided with high data quality and flawless assessment process, or with improvements in management information reporting system to help effective cost control.

Overall, the regulatory change does have a positive impact in terms of effectiveness and efficiency of bank operation in long-run. The challenge posed to banks, however, is also considerable, and it seems unlikely for banking industry in short-run to achieve the profitability level of the pre-Basel III time.

2.2 Literature review

This section reviews theoretical and empirical literature and summarizes approaches used in previous studies surrounding the relationship between capital requirements and balance sheet management.

2.2.1 Bank behavior towards capital-based regulations before the Basel III reforms

2.2.1.1 Capital regulations and bank's choices of risky asset portfolio

In the academic literature, studies about the impact of capital regulation on risk-taking behavior of banks present different opinions about this issue among economic theorists. Some view capital as a tool to mitigate the moral hazard created by deposit insurance. For example, Furlong (1989) finds that higher capital requirements, theoretically, reduce marginal gains from increasing asset risk - one of the ways banks use to maximize the value of deposit insurance option, hence reduce the incentives for banks to do so. In contrast, other studies find that the effectiveness of higher capital ratios in risk control is ambiguous. A negative effect can be expected when higher capital requirements are imposed (Koehn, 1980), or simple high capital ratios in regulation is not effective to limit the insolvency risk of banks (Kim, 1988).

The above studies, however, are conducted on a static basis where bank's ex-ante capital position is fixed and only a marginal effect of an increase in capital on bank portfolio choice is considered, so the link between capital position and portfolio choice is not examined (Calem, 1999). Calem (1999), therefore, analyses the effects of capital-based regulations on banks with different capital positions. In particular, the paper assesses risk taking behavior of well-capitalized banks and undercapitalized banks. Data used in the study consists of year-end data from 1984 to 1993 of all US commercial banks having at least $300 million in assets and equity-to-asset ratio at least at 6% as of year-end 1984. First, Calem (1999) builds a basic model in which banks are allowed to choose their portfolio composition only (not portfolio size), so bank size is fixed accordingly. Bank portfolios consist of risky assets and safe assets, and the banks are subject to a flat minimum capital requirement, not a risk-based capital requirement. Stockholders' earning is a function of realized return on risky assets and safe assets netted off by the gross cost of deposits, which incorporates a premium surcharge if bank capital does not meet the regulatory standard. As a result, the earning would be either positive, zero or negative, depending on risky assets in bank portfolio and cost arising from the gap between bank capital and the minimum required capital. Then the study considers the impacts due to regulatory reforms such as capital-based deposit insurance premium, higher capital requirements. Finally, the basic model is expanded to wider real scenarios: banks choose to hold a higher capital level than required. Risk-based capital requirements (adopted in 1988) lead to a

more stringent standard, banks can raise their capital from external sources as well as fund their assets via uninsured liabilities.

Calem (1999) shows that the relationship between bank capital and risk taking is U-shaped. Banks take risky loan portfolios when their capital is either low relative to regulatory minimum (because they want to maximize the value option of deposit insurance) or well above a threshold that insolvency is improbable. Banks are more prudent toward risky portfolios when their capital is close to or higher the regulatory minimum to the level at which future insolvency is less likely, to preserve their charter value. This finding reconciles conflicting views in previous literature as mentioned above. Another implication of the model is, in theory, that both flat capital requirements and risk-based standard can help to control bank's risk taking. The former has effectiveness for banks with comparatively limited risk-taking opportunities while the latter is fairer and more efficient for banks facing different risk-taking opportunities. With regards to capital-based deposit insurance, the study concludes that it promotes risk-taking of undercapitalized banks while its impact on the behavior of well-capitalized banks is unnoticeable. Overall, Calem (1999) implies that capital-based regulations do not have effectiveness in risk control on banks who hold a good buffer relative to required capital ratio.

2.2.1.2 Capital requirements and lending adjustment behavior

A number of theoretical and empirical researches advocate the view that shortfall in capital relative to desired capital ratio may lead to a decrease in bank lending supply. Hancock and Wilcox (1994) examine quarterly reports of US commercial banks from 31 December 1990 to 31 December 1991 and find clear evidence that shortfalls of capital relative to unweighted capital standard accompanied with contraction of bank credit (but the shortfalls relative to risk-weighted standard did not). Gambacorta (2004) performs cross-sectional analysis on 556 Italian credit cooperatives and banks, which represent 82% of total bank credit in Italy, from 3Q1992 to 3Q2001. He finds that capital shocks due to imposition of a specific solvency ratio (higher than 8%) for highly risky banks determine an overall reduction of 20% in lending after two years. Well-capitalized banks can better cope with temporary financial difficulties, e.g. GDP shocks, to maintain lending relationship with their borrowers. In addition, the effect of capital on lending is stronger for small banks compared to that for large banks. Nier (2006) studies data of more than 600 listed banks from 31 different countries over the period 1993 – 2000 using regression method, in which loan growth is regressed on measures of bank's strength (return on equity, capital ratio, loan loss provisions), loan demand (GDP growth), country dummy variables and time-fixed effects. He finds that thin bank capital leads to stronger reduction in bank lending supply during economic downturn.

Similar empirical evidence is found in a more recent study. Berrospide (2010) examines how bank capital affects lending of 165 bank holding companies (BHCs) in the US during the period of 1Q1999 – 3Q2009. All BHCs in the sample

have total assets in excess of $3 billion as of 3Q2008, and the sample represents about 85% total assets in the banking sector. Besides panel-regression techniques, vector autoregression (VAR) model is also employed in this study to address the concern that negative capital shocks may cause some BHCs to leave the sample in the panel data. For panel regression, Berrospide (2010) models the loan growth as a function of its own lags, lags of aggregate economic growth real GDP, lags of inflation rate, lags of change in Federal funds rate, lags of lending standards, lagged BHC-specific characteristics, and estimates of bank capital surpluses/shortfalls. For VAR approach, six variables include real GDP growth, GDP price inflation (excluding food and energy), the Federal funds rate, commercial bank and thrift loan growth, aggregate capital-to-asset ratio of the commercial bank sector and lending standards. Both methods give the same result of modest effects of capital shortfalls and capital ratio shocks on lending growth of the large BHCs. The study, however, finds that other factors such as loan demand of the market and risk attitude of banks are more important in lending decision.

Francis (2011) points out some problems in the above analysis. First, the studies have not isolated the regulatory effects from market effects. The fact is a bank may raise its capital not necessarily because of the regulation, but due to market pressure. Therefore, even all banks are subject to a common set of capital requirements (minimum capital to risk weighted assets ratio at 8% prior to the reforms in Basel III), their behavior in growing loan book depends on the gap between actual bank capital ratio and the required ratio. For example, banks whose capital is near the Basel standard is likely to react more prudently compared to others whose capital is high relative to the standard. Second, the studies have not examined whether banks mostly adjust their loans or alter the level of their capital, e.g. via retain earnings or new issuance, in response to the shocks.

Francis (2011) seeks to address the constraints by using data of commercial banks in the UK, where individual capital requirements are a combination of the minimum ratio and add-ons established by the UK's Financial Services Authority (FSA) after judging market conditions and bank's corporate governance among other things. The purpose of using UK banks is to isolate regulatory effects. It is considered that this sample has implications beyond the UK because of substantial global reach of UK banks. Sample covers the period of 1996 – 2007. After adjusting for merger and acquisition events, and dropping banks who have extreme and missing values, the author obtains the sample that accounts for over 90% of industry total assets on average. To separate regulatory effects and market effects on bank balance sheet management, the analysis proceeds in three steps. First, the author estimates a partial adjustment model of bank capital that depends on bank-specific features including individual capital requirements assigned by the UK's FSA. Second, he derives each bank's target capital and an index of bank capitalization (surplus or deficit) relative to its target. Third, he uses measures of bank capitalization to estimate model of lending, balance sheet and capital growth, i.e. how banks manage their balance sheet to maintain the target ratio. Panel regression method is employed to investigate five options available to banks in responding to regulatory capital requirements and achieving their own target ratios. The five options are changing loans, changing total assets, changing

RWA, revising regulatory capital, and adjusting Tier 1 capital. Control variables for the five estimates include general credit conditions (loan loss provision ratio, charge-offs over assets ratio), macroeconomic conditions (GDP, CPI, official bank rate set by monetary authorities), and quarterly dummy variable to capture seasonal influences. In addition, to test how balance sheet adjustment differs if a known change in capital regulation occurred in the last five quarters, a binary variable is added for this purpose. The study result shows that loan growth, total asset growth and RWA growth increase when capital is improved (the gap between actual and target capital ratios increases), and vice versa. This is consistent with the result of previous studies. When facing a shock in capital requirements, UK banks tend to adjust regulatory risk-weighting of their asset portfolios (shift to lower RWA portfolios) rather than adjust volume of the asset portfolios. In addition, asset growth is adversely affected when credit quality goes down, reflecting via negative correlation between the growth of all balance sheet items with changes in loan loss provisions. On macroeconomic factors, it is found that both GDP and CPI are not important determinants of balance sheet growth. GDP has positive and statistically significant association only with capital growth, which may reflect the relatively lower cost of raising capital in favorable economic conditions.

Bahaj (2016) also studies UK supervised banks over the period of 1989 – 2007, but the empirical evidence found is different from Francis (2001) findings. The sample in Bahaj (2016) focuses on large entities with a substantial UK loan book and a good number of observations, so it has 18 institutions with 573 bank-quarter observations in the panel. This study focuses on the bank behavior following the changes in their individual capital requirements in interaction with economic prospects. An equation to estimate the relationship is constructed for this interest. Dependent variable "net flow of lending" is cumulatively affected by bank fixed effect (capture time invariant heterogeneity across banks), time fixed effect (capture common response across banks over time), bank specific controls (including current and lagged values of bank capital ratio, lending growth, capital requirement, liquidity position and loan loss provisions) and change in capital requirement. The last two independent variables are interacted with business confidence indicator (measures of economic prospects). Running regressions at different time horizons for the equation, the author finds that bank's response to an increase in capital requirements depends on bank balance sheet and economic prospects. If current and new loans are expected to have low returns, banks adjust their balance sheet primarily by cutting lending. If the expected returns of new and current loans are high, banks raise their capital.

After all, the above studies examine behavior of banks under Basel 1 capital framework. For Francis (2011) and Bahaj (2016) specially, the studies focus on UK banks which are regulated under a specific regime. With tighter definition of capital under Basel III, bank behavior among countries or zones may have significant differences. There is a large number of researches investigating impacts of the Basel III regulatory changes on bank lending and growth which we will review in the following section.

2.2.2 Regulatory capital changes and bank lending after the global financial crisis 2008 - 2009

2.2.2.1 Supporting role of bank capital to lending supply

Brei (2013) investigates if bank capital supports lending and if recapitalization were effective in sustaining credit supply during the crisis. Data set of this study consists of 108 pro-forma (merger and acquisition adjusted) large international banks in 14 major advanced economies for the 16-year period, 1995 – 2010. Panel regression method is used, in which bank-specific characteristics are interacted with crisis dummy to estimate response of banks depending on state of economy. Macroeconomic controls and bank-specific rescue dummy (to differentiate behavior of banks that were rescued and those that were not) are other variables of the estimation. Bank specific characteristics include bank size, liquidity ratio, regulatory capital ratio and market funding ratio. Macroeconomic controls include country level- and time-specific variables, in which the former controls for GDP growth, and 3-month interbank rate, the latter controls for time-invariant differences in regulation, accounting standards across countries and fiscal differences. The tests examine the statistical significance of the coefficients between bank-specific characteristics and lending in normal time and crisis time. The results show that small banks tend to supply relatively more lending, probably due to stronger relationship with clients compared to that of large banks. Banks with lower market funding ratio (or higher share of deposits) tend to supply more lending. Well capitalized and high liquid banks also have higher loan growth. The importance of capital for loan supply, however, differs in normal time and crisis time. In normal time, stronger capital ratio sustains loan growth, but in crisis, additional capital can lead to greater lending only once their capitalization already exceeds a critical threshold.

Haldane et al (2017) analyze the correlation of capital position of large international banks prior to the crisis (as at 2006) and their subsequent lending growth (from 2006 until 2016). They find that banks that entered the crisis with higher capital have been able to continue higher lending growth on average, and the relationship is statistically significant. After crisis, lending is backed by larger share of stable sources of funding. This trend is consistent with findings of Kapan (2013), who reports that banks with more stable sources of funding continue to lend more during the crisis relative to other banks, but the higher and better-quality capital is still the key in supporting bank credit supply. Higher capital requirements, however, may have negative effects on lending supply. Haldane et al (2017) compare the changes in bank capital since Basel III was introduced with subsequent lending growth among a panel of large international banks and find that although lending grew over the period 2010 - 2016, the growth in net loans tended to be lower for banks who have seen largest increase in their capital ratio. Some other research using data of individual UK banks' capital requirements finds similar result: higher required capital had negative effects on UK banks' loan supply during favorable economic conditions (Noss, 2016) and the effects increased after the 2008 – 2009 crisis (De-Ramon, 2016).

2.2.2.2 *Impacts of Basel III regulation on lending rate and lending growth*

Most of literature finds evidence of decline in lending volume and increase in leading rates/spreads as the results of Basel III capital requirements. Final report of Bank for International Settlements assessing macroeconomic impact of the transition to stronger capital requirements (BIS, 2010), estimates significant wider lending spreads and reduced lending volumes. The study assumes banks implement capital increase at a constant pace over eight years to achieve the regulatory requirements which will be fully effective as of 1st January 2019. For a one percentage point increase in capital ratio, lending volume is estimated to decline by 1.4 percent by the 35th quarter and 1.5 percent at the end of the simulation, while lending spreads are expected to increase by 15.5 basis points, followed by a 12.2 basis points increase relative to the baseline.

Slovik (2011) investigates potential impact of Basel III on lending spreads of banks in three main OECD economies - US, Eurozone and Japan - based on bank lending spread sensitivities and capital increases. Under Basel III, minimum required capital ratio for common equity is raised from 2% to 4.5% of RWA and Tier 1 capital from 4% to 6% of RWA effective as of 1st January 2015, and further increases to 7% and 8.5% are required by 1st January 2019. However, prior to the introduction of Basel III in Dec 2010, the banks already increased their capital relative to pre-crisis level (as of end-2006) due to market pressure, so the author estimates the remaining increases in capital ratio that the banks need to raise further to meet the new requirements. On the part of lending spreads, it is assumed that banks can directly affect the spreads only on their loans to households and non-financial corporations. Other bank assets such as interbank assets, government bonds, assets held on trading book, are market driven, and bank cannot directly affect the pricing of these assets. By postulating the return on banks assets equal to bank funding costs, the author calculates how much lending spreads need to be increased in response to the additional capital increase. Aggregated bank balance sheets averaged over the last three pre-crisis years 2004 – 2006 are used to estimate the spread sensitivities, which in turn are used in estimating expected spread increases. This exercise predicts that the banks could widen their lending spreads by approximately 15 and 50 basis points by 2015 and 2019 respectively to compensate for higher funding cost arising from a one percentage point increase in bank capital requirements. Cohen (2016), which analyzes data of 101 large banks from advanced and emerging economies over the period 2009 - 2012, draws a similar conclusion that lending spreads increase as an effect of higher capital requirements. In addition, this paper points out that higher GDP growth is not accompanied by higher credit growth for advanced countries, though this relationship is stronger for emerging countries.

Cosimano (2011) finds that increase in equity-to-asset ratio is associated with increase in loan rate and decline in loan volume in long run. The author examines annual data of commercial banks and BHCs for a large number of advanced countries over the period 2001 – 2009. The examination is conducted for three groupings of the sample: 100 largest commercial banks and BHCs (measured by total assets in 2006), commercial banks and BHCs that experienced a

banking crisis between 2007-2009, and commercial banks and BHCs that did not experience a banking crisis between 2007-2009. Cosimano (2011) uses generalized method of moments estimation for empirical tests as banks simultaneously choose optimal level of capital to hold, the loan rate and the loan volume. As viewed by the author and some previous studies (Chami and Cosimano, 2001, 2010; Barajas and others, 2010), to decide optimal capital level, banks forecast whether future loans bring them higher marginal cost or higher marginal revenue. Therefore, in the first-stage regression to determine the optimal level of capital, the author considers the following variables: the change in the capital-to-asset ratio, interest and non-interest expenses, nonperforming loan-to-total asset ratio, and the interaction of these variables to capital-to-asset ratio of the previous period as well. The predicted optimal capital level is then used in regression for loan rate in the second stage. Increase in costs of deposits, loan loss provisions, and economic activity (measured by real GDP and inflation rate) are other variables taken into account in the second regression. Finally, regression for the loan volume is estimated using the predicted loan rates and the level of economic activity. The estimates find that the largest banks in the world would increase their lending rates on average by 16 basis points for a 1.3 percentage point increase in their equity-to-asset ratio to meet the new regulation of 7% for equity-to-RWA ratio, and the increase in lending rates would cause a reduction of loan growth by 1.3 percent in long-run. For country-by-country estimations, it is found that most of the countries, regardless whether they experienced the crisis or not, expect negative effects on lending as the result of the new capital regulations. For the crisis countries (group 2), the average impact of a 1.3 percentage point increase in equity-to-asset ratio is a 4.6% decline in lending growth. For non-crisis countries (group 3), the impact is significantly stronger with a reduction of 14.67% on average, especially Denmark (32.61%) and Japan (19.81%). The lending rates increase by 11 and 22 basis points for group 2 and group 3 respectively. If the crisis period is excluded from the estimation (tests for the period of 2001 – 2007), the drop of loan growth of countries in group 3 is higher with 17.96%. The impact of Basel III is different among groups, and this is explained by cross-country variations in bank's net cost of raising equity and elasticities of loan demand towards changes in lending rates.

Kashyap et al (2010) report similar finding for large US banks (with total assets greater than $10 billion as of 2008). To assess the effects, Kashyap et al use model-based calibration approach instead of simply basing only on an analysis of historical data. Two scenarios are considered for calibrations: i) increase in capital requirements leads banks to replace long-term debt financing with equity, and ii) increase in capital requirements leads banks to replace short-term debt financing with equity. A key assumption is made for the approach: bank's cost of equity falls when banks shift to a capital structure with more equity financing. The rationale of the assumption is that a bank is less risky with the more equity financing capital structure, so its investors should demand a lower risk premium for holding the equity. Under each scenario, the authors calculate the incremental effect of a given increase in equity-to-asset ratio on weighted average cost of cap-

ital (WACC) and hence on loan rates. The results of the calibrations show an increase in WACC and loan rates. The increase, however, is insignificant with a one percentage-point increase in the capital requirements leads to only 2.5 to 4.5 basis points increase in loan rates. The authors conclude that the more stringent Basel III capital requirements probably do not cause major concern on cost of lending, but raise the concerns relating to the reshaping of how credit will be provided.

De-Ramon (2016), a study focusing on balance sheet management practice of UK banks concludes that a one percentage point increase in capital requirements lowers total asset growth by 14 basis points before the crisis and 20 basis points after the crisis. The effects on loan growth, however, are similar before and after the crisis, by 8 basis point decrease. This paper examines semi-annual data of UK banking institutions with time spanning from 1989 to 2013. Data filter and three-step approach are performed similarly to those conducted in Francis (2011) as mentioned in section 2.2.1.2 above.

Empirical findings in Cecchetti (2014), interestingly, are not as the above papers predict. This study reviews the impact of capital requirements on performance and lending of about 200 largest banks in the world over the period 2009 – 2013 based on data of lending spreads of selected economies (US, Euro area, Germany, UK and Japan), survey responses on lending standards (sourced from Federal Reserve Board, European Central Bank, Bank of England and Bank of Japan) over the studied period, and bank credit-to-GDP ratio in 2006 and 2013 of countries where the banks in the sample operate. The author finds that, with exception of Eurozone, banks' total assets increased, lending spread narrowed, lending standard eased, and credit-to-GDP ratio went up. For Eurozone, the opposite effects are explained by the sequence of stress tests and capital exercise conducted in this zone. Instead of raising additional capital to offset the shortfall like US banks did, European banks shrank their total assets and RWA by cutting lending to meet the stricter capital requirements. In general, the author concludes that rapid increase in capital has very little impact on anything but banks' profitability as their net interest margin and profits are down.

Šútorová (2013) estimates support Cecchetti (2014) finding about the effects on EU banks. The paper employs data of 594 EU banks during the period of 2006 – 2011 to investigate impact of Basel III regulation on EU lending rates. The results suggest a small reduction in level of loans (by 2% from the level as of 2011) and a modest increase in lending rates of only 18.8 basis points on a one percentage increase in common equity ratio. One of reasons for the mild effects is that many European banks are already complying with the new capital requirements while they still have 7 years to fully achieve the requirements (by 1st January 2019). In addition, elasticity of demand for loans in EU zone is relatively low at 0.156.

Andrle (2017) assesses bank response in nine EU emerging economies to the new regulations. Five largest commercial banks in each country are chosen based on their asset size, but the final sample consists of 38 banks after excluding those whose accounting data are not available over the entire period of 2008 - 2014. All banks in the sample have total capital ratio higher than 8% in 2008. These banks, however, are small as measured by the world-asset-size ranking,

and most of them are subsidiaries of a parent bank in an advanced market country. As the paper identifies, possible strategies which banks can adopt to achieve higher capital ratio are new equity issuance, dividend payment reduction, retained earnings and RWA adjustments. Accumulative capital - book value of equity - is decomposed into subcomponents based on accounting identity: book value of equity in previous period, newly-issued equity, net interest income, net operating income, other net income, dividend payments and revaluations. This decomposition is employed to inspect via which strategies banks raise their capital. The outcome of the exercise shows that while increasing retained earnings is most adopted, cutting lending to meet the stricter capital requirements happens only in countries where banking sector struggles with profitability.

2.2.2.3 Optimal capital ratio and Basel III benchmarks

Basel III framework requires capital ratio for common equity at least at 7% of RWA. The ratio applied for global systematically important banks (G-SIBs) is 9.5%. Minimum Tier 1 capital and total capital are required at 8.5% and 10.5% of RWA respectively.

Cline (2016) estimates the optimal level of common equity by reviewing benefit and cost of higher capital requirements from macroeconomic view. For benefit side, the paper quantifies expected output (GDP) losses and frequency of banking crises. A "benefit curve" is then translated from the expected losses avoided thanks to the higher capital requirements which help to reduce the risk of occurrence of banking crises. For cost side, a "cost curve" is estimated from economic costs to the level of bank capital. The increase in cost of capital for banks is passed to lending rates, raises the cost of capital to the economy, consequently reduces investment and output. The optimal capital ratio is at the level at which the slopes of the benefit curve equals to the slope of the cost curve. The study uses data of 22 banking crises from 1977 to 2008 in advanced industrial countries and average growth rate of real GDP from 1980 to 2014 of the countries. The calculation result suggests that optimal level for tangible common equity is about 6.6% of total assets and 11.7% of RWA. Conservative estimate at the 75th percentile is about 7.9% and 14.1% respectively. According to this result, the Basel III benchmarks are significantly lower than the optimal ones estimated by the paper.

For Tier 1 risk-weighted capital, the Long-term Economic Impact (LEI) study implies this ratio should range between 16-19%, while the Bank of England judges that the optimal Tier 1 capital is 13.5% of RWA (Haldane et al, 2017). These estimates are also surprisingly higher than Basel III requirement at 8.5%.

The most recent information of actual balance sheet adjustment from 2007 to 2016 for 189 G-SIBs and domestic systematically important banks (D-SIBs) is provided in Haldane et al (2017). The capital changes over the time were significant: Tier 1 risk-weighted capital ratios almost doubled from 7-8% to 13-14%, and leverage ratio also doubled from 3% to 6%. It is interesting to observe that the actual capital held by the banks are very close to the estimated optimal level. This

means these banks do maintain good capital buffers above the minimum standard. Thus, it is questionable that if the current Basel III requirements are sufficient to minimize the probability of banking crisis, and if they should be revised up.

2.2.2.4 Effect on income structure

As a result of the regulatory changes which effect lending, it is predicted that banks would shift from interest income to non-interest income in the transition to higher bank capital ratios. In the situation that traditional banking activities face constraint and interest margins are compressed, banks need to diversify their income generating sources to maintain profitability level and support growth. The level of the diversification would differ across bank types (e.g. foreign banks vs. domestic banks, large banks vs. small banks), or banks' activities (e.g. saving/cooperative banks vs. investment banks).

Some studies find evidence of the shift toward fee income, despite this move associates with increased risk in terms of volatility of bank return. William (2013) examines annual reports of 56 Australian banks from 1988 to 2010 and points out that there is a trade-off between fee income and interest margin. Although there is fluctuation, the share of fee income in total revenue increases in general, implying the trend of income diversification. It drops when credit is blooming and notably goes up during the economic recessions (early 1990s and 2008-2009). Cohen (2016) analyzes data of 101 large banks from advanced and emerging economies from 2009 to 2012 and finds that the predicted effect took place for the emerging-economy banks but did not take place for the advanced-economy banks and the whole sample.

Overall, the common conclusion of literature is that solid capital and stable deposit-funding sources do support bank lending supply. When facing a shock of capital requirements, banks behave differently in adjusting their capital size and capital composition, depending on their balance sheet position and economic prospects. Lending spreads are widened in most of countries as an effect of higher required capital ratios. The effect on lending growth and income structure of banks varies among markets, e.g. between EU and non-EU, between advanced economies and emerging economies. And it seems that macroeconomic factors (GDP and CPI) have weak relationship with credit growth, especially in advanced markets.

3 DATA AND METHOD

3.1 Data description

Bank level data are obtained from Datastream for current active banks during the period of 22 years from 1995 to 2016. Banks whose information of loans and capital are missing for more than 10 years are dropped from the sample. The final sample is divided into three geographical areas: US, Europe and Asia with the number of banks are 131, 101 and 86 respectively. Table 2 provides the list of number of banks in the sample by country and information of their total assets as at end of 2006.

Table 2. Total assets of the banks in the sample by country. Source: Datastream

	Number of banks	Total assets as at end of 2006 (billion USD)		
		Average	Max	Min
US	**131**	**54.3**	**1,884.3**	**0.2**
Europe	**101**	**225.4**	**1,981.1**	**0.3**
Austria	4	9.1	17.4	2.4
Belgium	2	268.9	428.6	109.2
Czech Republic	1	28.4	28.4	28.4
Denmark	14	39.8	485.4	0.3
Finland	1	2.9	2.9	2.9
France	9	429.9	1,898.8	9.0
Germany	3	763.2	1,481.5	11.9
Greece	6	54.6	100.7	4.1
Hungary	1	37.0	37.0	37.0
Ireland	2	203.0	208.9	197.0
Italy	11	155.5	1,077.6	0.5
Norway	10	26.2	205.7	1.4
Poland	3	13.3	16.8	8.5
Portugal	2	75.3	103.9	46.8
Spain	3	562.0	1,088.4	60.6
Sweden	4	299.9	457.5	197.8
Switzerland	18	181.9	1,981.1	1.5
United Kingdom	7	907.0	1,955.5	0.6
Asia	**86**	**47.5**	**903.2**	**2.6**
China	1	33.3	33.3	33.3
Hong Kong	4	36.5	86.1	8.1
Japan	60	48.7	903.2	5.3
Malaysia	10	25.2	60.7	5.0
Singapore	3	110.8	128.7	98.6
South Korea	2	96.8	191.1	2.6
Taiwan	6	34.6	52.2	6.0

As at end of 2006, average total assets of the US sample is USD54.3 billion, with only 3 banks out of 131 banks having total assets of over USD1,000 billion. The figure for the sample of 101 European banks is USD225.4 billion, mainly contributed by 10 big banks from UK (3), France (2), Switzerland (2), Germany (1), Spain (1) and Italy (1) whose total assets are over USD1,000 billion. For Asian market, Japan dominates the sample in terms of number of banks (60 Japanese banks out of 86 banks in total), and the average total assets is USD47.5 billion.

Table 3 shows statistics of bank specific variables by region used in this study, including bank size, total capital adequacy ratio (CAR), Tier 1 capital adequacy ratio (CAR_Tier1), leverage ratio, market funding ratio and annual lending growth rate. The statistics base on bank level annual data from 1995 to 2016.

Bank size - one of the important factors that may affect lending policy - is measured by the natural logarithm of total assets, which are reported in USD. For banks whose reporting currency is not USD, total assets are converted into USD using exchange rate of respective reporting year to ensure a consistent basis in size measurement. CAR and CAR_Tier1 are RWA based. The ratios reflect the level of meeting minimum capital requirement of banks. Information of the capital ratios are obtained directly from Datastream. Market funding ratio tells us how much a bank relies on non-deposits to fund its assets. Leverage ratio measures the level of financial obligations, of which total debt represents all interest bearing and capitalized lease obligations. It is noted that the leverage ratio measure in this study is different from capital leverage ratio in Basel III framework. The one in Basel III is calculated by ratio of Tier 1 capital to Exposure measure and serves as a non-risk based metric to supplement risk based capital ratios. Market funding and leverage ratios are calculated with the following formulae:

Market funding ratio:

MkFundR = (Total Liabilities – Total Deposits) / Total Assets.

Leverage ratio:

LeverageR = Total Debt / Total Assets

Table 3. Description of variables by geographical area. Source: Datastream

Variables	USA		EUROPE		ASIA	
	Mean	SD	Mean	SD	Mean	SD
Annual growth rate of loans	8.9	14.8	7.8	29.0	4.0	9.2
Size (logarithm of total assets)	15.2	1.9	16.8	2.3	17.1	1.0
Total capital adequacy ratio (*)	14.8	4.9	14.0	4.0	12.0	2.8
Tier 1 capital adequacy ratio (*)	13.1	5.1	11.6	4.5	11.3	9.8
Market funding ratio	15.6	11.0	42.3	19.3	9.3	8.9
Leverage ratio	14.9	12.0	32.3	16.4	5.4	7.0
Provision to Loans ratio	0.6	0.9	0.7	1.0	0.6	0.8
Fee income to Total operating income ratio	38.1	821.0	206.7	2,098.1	66.9	596.0

(*) % of Risk weighted assets

Annual lending growth rate of the US and European banks in general is considerably higher than the lending growth rate of the Asian banks. Asian banks seem to rely much on deposits for asset funding, reflected via low market funding ratio of 9.3%. This ratio for the European banks is significantly higher (42.3%), suggesting these banks are more vulnerable to changes in wholesale markets, hence face higher risk of liquidity problem. US banks' market funding ratio (15.6%) is quite higher than that of the Asian banks but still much lower than that of European banks. Leverage ratios of the three areas have similar pattern, suggesting balance sheet structure of European banks is riskier relative to that of the US and Asian banks.

It is interesting to note that mean value of capital adequacy ratios in the three geographical areas (ranging from 12% to 14.8% for CAR and 11.3% to 13.1% for CAR_Tier1) are well higher than the Basel 3 requirements (CAR at 10.5% and CAR_Tier1 at 8.5%). Figure 1 further shows the trend of average level of total capital ratio and Tier 1 capital ratio for each geographical area over the period 2003 – 2016, in which capital data of the majority of the banks are available. For Tier 1 capital ratio of Asian banks, the period is 2007 – 2016 because the data for most of the Asian banks is not available before 2007. It can be seen from the figure 1 that, overall, banks have been holding capital level above required level before, during and after the global financial crisis 2008 – 2009. The capital ratios of US banks strongly increased right after 2008, widening the gap between bank capital ratio and the required ratio to about 8%. However, the decreasing trend after 2012 made the gap smaller, about just above 4% towards 2015 – 2016. European banks keep raising their capital ratios after the crisis in line with Basel requirements and also maintain a stable buffer at the same time. For Asian banks, Tier 1 capital ratio fell off to about 10% (but still higher than Basel requirement) before a rise starting from 2010. Total capital ratio gradually increases over the period with a slight decline since 2014.

Subsamples of large and small banks are selected based on total assets as at fiscal year-end 2006. Small banks are banks with total assets equal or smaller than 10 billion USD. Large banks are those with total assets equal or higher than 50 billion USD. Detail of the subsamples are shown in Table 4. In Asia, capital ratios and credit growth rate of small banks are in average lower than that of large banks. The opposite situation is observed in the US banks: small banks hold higher level of capital ratios and have higher credit growth. For the European banks, large banks hold lower capital ratio but have stronger lending growth relative to small banks. The common characteristics among the three subsamples are that small banks rely less on wholesale markets and have lower debt-to-assets ratio. The gap between large and small banks in these two indicators is quite big in all three areas, implying a riskier balance sheet structure of large banks.

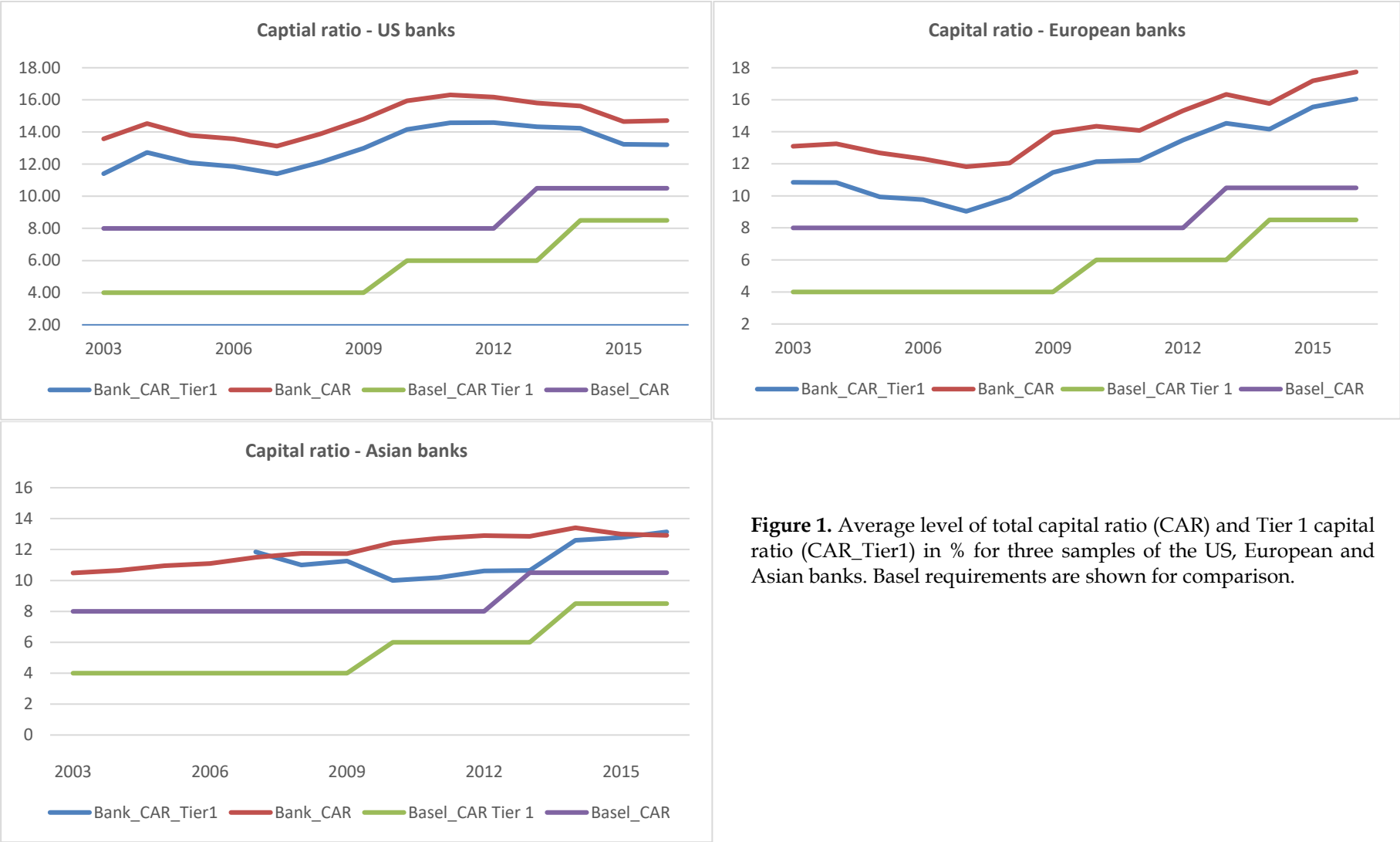


Figure 1. Average level of total capital ratio (CAR) and Tier 1 capital ratio (CAR_Tier1) in % for three samples of the US, European and Asian banks. Basel requirements are shown for comparison.

Table 4. Description of data in subsamples of small and large banks. Source: Datastream

	US banks				European banks				Asian banks			
	Small (96)		Large (14)		Small (37)		Large (34)		Small (10)		Large (18)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Annual growth rate of loans	9.2	13.7	7.7	22.8	6.6	18.5	9.0	40.8	4.2	9.2	6.1	11.1
Size (logarithm of total assets)	14.3	1.1	18.9	1.3	14.7	1.3	19.3	1.4	15.6	0.7	18.3	0.9
Total capital adequacy ratio (*)	15.0	5.4	13.6	1.9	14.7	3.6	13.4	3.6	11.8	3.7	13.6	2.7
Tier 1 capital adequacy ratio (*)	13.6	5.5	10.3	2.1	13.0	4.6	10.1	3.5	10.5	3.3	14.4	17.2
Market funding ratio	13.4	10.0	26.5	11.9	31.8	16.4	54.2	16.9	7.0	5.7	16.4	11.0
Leverage ratio	12.9	10.0	25.1	19.5	27.3	16.5	36.9	15.6	4.7	8.1	9.5	7.4
Provision to Loans ratio	0.5	0.8	0.9	1.0	0.7	1.2	0.6	0.8	0.7	1.1	0.6	0.8
Fee income to Total operating income ratio	42.7	406.4	(29.8)	2,282.3	348.2	3,259.2	119.9	514.3	(36.4)	1,250.0	74.2	211.8
Loans to Total Assets ratio	64.3	12.0	62.6	14.4	80.5	12.4	57.7	19.3	73.1	8.9	66.0	7.9
Total capital to Total Assets ratio	16.1	7.3	21.5	12.5	25.6	12.8	18.4	11.0	8.0	4.4	10.2	4.5

(*) % of Risk weighted assets

3.2 Method

Because of unavailability of data for some banks mainly in the early stage of the examined period (unbalanced data), and further to Hausman test, fixed effects regression method is employed in this study. Following the approach used in Brei (2013), the regressions (1), (2,) and (3) below are estimated to examine how lending growth, loan loss provisions and income structure respectively change over the sample period:

$$\Delta L_{it} = \alpha_i + \omega C_t + (\beta + \beta^* C_t) B_{it-1} + \gamma M_t + \varepsilon_{it} \quad (1)$$

$$RProv_{it} = \alpha_i + \omega C_t + (\beta + \beta^* C_t) B'_{it-1} + \gamma M_t + \varepsilon_{it} \quad (2)$$

$$RFeeInc_{it} = \alpha_i + \omega C_t + (\beta + \beta^* C_t) B'_{it-1} + \gamma M_t + \varepsilon_{it} \quad (3)$$

where ΔL_{it} is annual growth rate of loans, $RProv_{it}$ is the ratio of loan loss provisions to total loans, and $RFeeInc_{it}$ is the ratio of fee income to total operating income, in period t of bank i. Bank specific variables are denoted by B and B', macroeconomic controls are denoted by M and C represents crisis dummy variable. Bank specific variables are lagged once (t-1) in regression to mitigate a possible endogeneity problem.

Five bank specific characteristics of bank size, CAR, CAR_Tier1, leverage ratio and market funding are included in B_{it-1} of equation (1) to investigate the possible effect of the changes in balance sheet items on lending growth. B'_{it-1} in equation (2) and (3) includes four bank specific variables of bank size, CAR, CAR_Tier1 and lending growth. Leverage and market funding are not considered in these two regressions because by nature, they should not be the factors that influence loan loss provisions as well as income structure. Lending growth is added as an observed variable in equation (2) since lending has a direct link

with the dependent variable of loan loss provisions and in equation (3) to test if the constraint on lending activity affects income structure of banks.

Macroeconomic variables are real GDP growth rate and CPI at country level. In addition, monetary policy rate is included in regression for US banks (FED funds rate). For European and Asian samples, however, this macroeconomic variable is not included due to certain reasons. While in Europe, there were structural changes in regime and monetary policy of some countries when Euro-zone was formed in 1999 and other countries who joined the monetary union later during the sample period, in Asia, most of countries, except Japan, do not have efficient money market; therefore, including monetary policy rate for these two samples may give an inaccurate regression result.

In order to distinguish the effects in normal time and crisis time, crisis dummy variable is created for the estimate and interacted with all bank specific variables. With regards to crisis time of the financial crisis 2008 - 2009, the seizure in the banking system in the US and Europe actually began in August 2007 and quickly spread across regions. Toward the end of 2007, most of the Asian economies were impacted and entered the recession as well. The global economy was on the turn from the second quarter of 2009 in Asian economies, followed by the US and European markets in the second half of 2009. Crisis variable is, therefore, defined based on the stages of the crisis in each region and the information of fiscal year-end of each bank during the time. It takes the value of 1 in crisis time and zero otherwise.

4 EMPIRICAL RESULTS

4.1 Lending growth

Table 5 shows the set of coefficients for the US, European and Asian areas following panel data regressions for the sample in the period 1995 – 2016. For each area, the first two columns report regression results when crisis is not interacted with bank specific variables (C = 0), and the last two columns report the results when crisis is included in the regression (C = 0 or 1).

The results of the US area show that all variables have statistical significant effect on lending growth of the banks. While bank size and total capital ratio have negative impact on lending growth, the effect of Tier 1 capital is positive. Leverage ratio has negative relationship with lending growth as expected. Positive coefficient with market funding ratio implies that banks who rely more on wholesales market may primarily use this source to fund for customer loans. When crisis variable is included in the regression, the signs of the coefficients and the significance level are mostly more or less the same. The three macroeconomic variables have the expected signs as well.

For European banks, the coefficient of bank size gains a statistical significance with negative relationship like the US sample. Coefficients of capital ratios have the same sign (positive for Tier 1 capital and negative for total capital) but are lower compared to that in the US banks. The relationship of lending growth with market funding and with leverage ratio are in opposite sign with the result in the US sample; they are, however, not statistically significant. When crisis variable is taken into account, the coefficients reported are higher and statistically significant for variables of size, total capital ratio and leverage ratio. Similar to the result for US market, macroeconomic controls (GDP and CPI) also have significant and positive coefficients with lending growth.

For Asian banks, there is a resemblance in correlation between variables to that of US banks. In general, bank size, total capital ratio and leverage ratio are factors having negative coefficients, while Tier 1 capital, market funding ratio, GDP and CPI have positive effects on lending growth. Total capital and GDP, however, do not have statistical significance. The result also does not suggest statistical significant effects of these variables in crisis time.

There are common results on size, capital ratios and macroeconomic variables for the three geographical areas. Size have negative relationship with lending growth, suggesting that small banks have been more flexible in adjusting lending policy to increase their loans. Positive coefficient of Tier 1 capital with lending growth implies that banks having higher capital ratio have been able to increase their loan growth rate even during the crisis. This positive relationship is particularly significant for the US and Asian banks while the evidence is not strong for the European banks (the relationship is negative for these banks in crisis time). Total capital ratio, however, is reported having a negative (but not

statistically significant) coefficient with annual lending growth rate. As such, the result implies that high Tier 1 capital ratio, rather than total capital ratio, provides a competitive advantage for banks to expand lending. In terms of macroeconomic controls, the result suggests that overall, they do have strong impact on lending growth rate (except for only GDP in Asia area where the positive coefficient is not statistically significant). This finding is different from previous studies as mentioned in section 2.2 above, that macroeconomic factors have weak relationship with credit growth, especially in advanced markets.

The finding in this study that high total capital ratio has adverse effect on lending growth is different from to the conclusion in Brei (2013) which suggests that total regulatory capital ratio plays a very important role in supporting bank lending, and Francis (2011) which finds that loan growth is improved when the gap between actual and targeted capital ratios increases. This study finds that Tier 1 capital ratio is the component that helps banks to sustain their lending growth; Francis (2011) and Brei (2013), however, do not investigate the effect of Tier 1 capital ratio on loan growth separately. It is also noted that Francis (2011) focuses on UK banks only, and the sample periods in Brei (2013) and Francis (2011) do not cover post crisis time. The importance of high quality capital Tier 1 in supporting credit supply for banks who have high market funding and low liquidity ratios is also evidenced in Kapan (2013). Figure 2 provides charts of the development of average year-on-year lending growth and capital change in the three areas. The trend suggests that lending growth rate have strong correlation with the change of bank capital over the whole sample period 1995 - 2016, especially in Europe and the US. Before a sharp decline in 2008-2009 as a result of global financial crisis, capital increased significantly in the period 2004 – 2007 for the US and Asian banks. In European banks, the increase and decrease in capital take place in earlier stage of about 2 years. This change is probably due to the issuance of Basel II framework with changes in RWA calculation and hence capital required. Forward looking of economic prospect based on GDP and market pressure might also be other reasons for banks to raise their capital. After crisis time, capital and lending in US and Asia have a pick-up (though there is some fluctuation), but in Europe the decreasing trend continues.

In terms of market funding ratio, finding in this study is strikingly different from Brei (2013) and Kapan (2013). Except for European area, positive and statistically significant coefficients are found for the cases of the US and Asian banks, especially in normal time, which means banks who are more dependent on market funding have better expanded their lending relative to other banks. This may be explained by the significant low level of market funding ratios in these two areas (15.6% for the US banks and 9.3% for the Asian banks as seen in Table 2) compared to that in European area. Thanks to the large share of deposits in balance sheet, the US and Asian banks are less vulnerable to the volatility of wholesale markets, so they may use market funding source to further increase their loans in normal time. In crisis time, the effect becomes weak for the US banks and negative for Asian banks; but the coefficients are not statistically significant nevertheless. European area is different because of very high market funding ratio (42.3%). These banks are more sensitive to changes in the wholesale

markets, therefore those with more stable deposit funding source have higher lending growth rate. The relationship, however, is not statistically significant.

Table 6 presents regression results of small and large banks in each geographical area. The sign of coefficients for small US banks is same as that for the whole US sample, i.e. Tier 1 capital ratio and market funding ratio have positive effect while size, total capital and leverage ratio have negative effect on annual lending growth rate, and all the effects are statistically significant. For large US banks, only size and capital ratio gain statistical significance. Lending growth of both small and large categories have strong relationship with macroeconomic controls, especially GDP and FED funds rate.

For European banks, size still matters (negative) to lending growth rate and capital ratios impact differently for small banks and large banks. The regression result suggests that small banks with higher Tier 1 capital ratio have been able to better extend credit in normal time, but the effect become negative in crisis. For large banks, the coefficients are in opposite sign, low and not statistically significant, implying that capital ratios do not have significant effect on lending activity of these banks. Market funding and leverage ratio effects on lending growth are also different between small and large size group; the relationships, however, are insignificant.

Bank size supporting loan growth is the exceptional case for small Asian banks. The positive coefficient means that in the group of banks whose total assets is less than 10 billion USD, bigger banks have grown their credit portfolio stronger than smaller ones. However, bank size effect becomes adverse in crisis time. Another exception in Asian area is negative relationship between lending expansion and Tier 1 capital for large banks in normal time, which means higher Tier 1 capital ratio have slowed down credit growth. In crisis, however, Tier 1 capital is a supporting factor for the banks to increase lending. Effect of market funding and leverage ratio on lending are similar between the two categories.

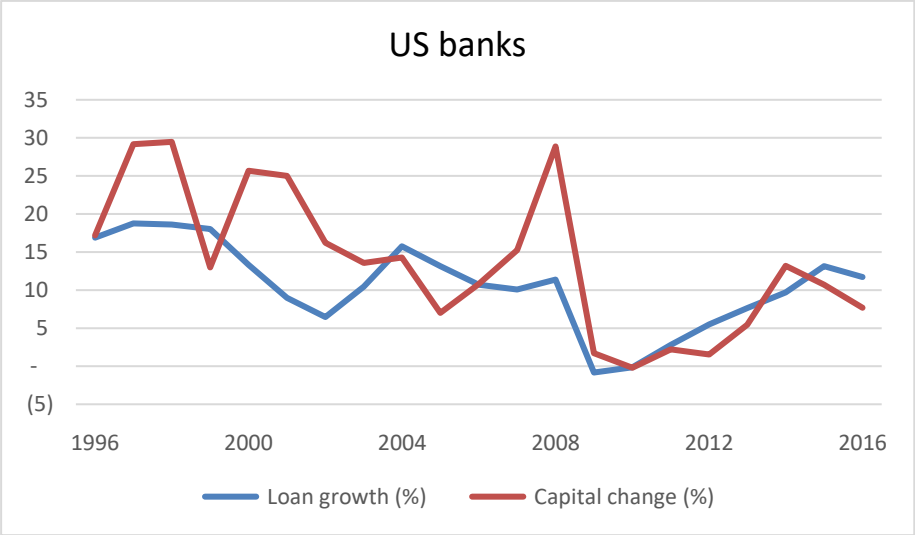
Overall, there is no major difference between small and large US banks in terms of relationship between capital ratio and lending growth rate. This is, however, not the case for European and Asian samples, where higher Tier 1 capital seems to be beneficial for small banks but adverse for large banks. It is also found in these two samples that the relationship in small banks is stronger and statistically significant relative to large banks.

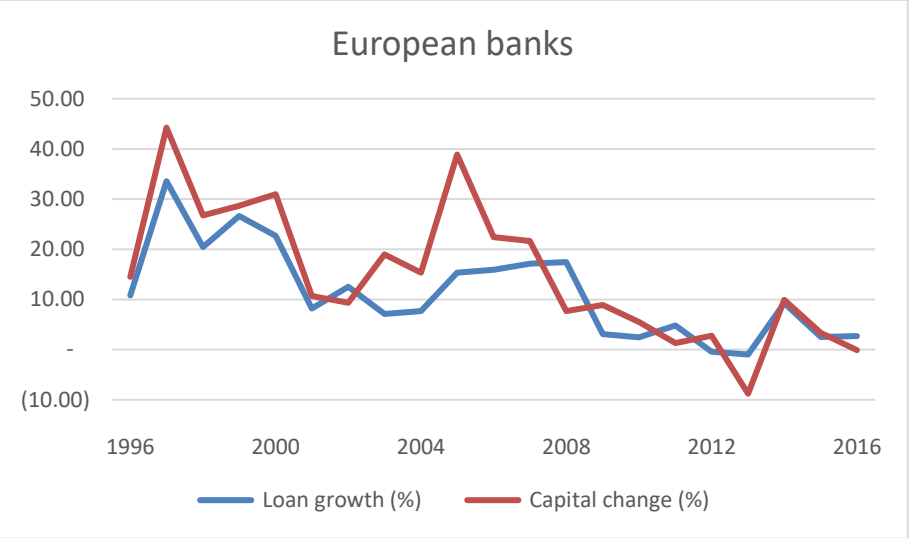
Table 5. Regression results of equation 1 for lending growth by geographical area. The sample consists of 131 US banks, 101 European banks and 86 Asian banks. The period is 1995 – 2016.

Dependent variable:	**US banks**				**European banks**				**Asian banks**			
Annual growth rate of loans (ΔL_{it})	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**
Crisis interaction	No		Yes		No		Yes		No		Yes	
Bank specific variables												
$Size_{t-1}$	-4.666 ***	1.273	-3.224 **	1.304	-6.159 ***	1.196	-6.762 ***	1.201	-2.706 ***	0.917	-3.186 ***	0.994
$Size_{t-1}$*C			0.211	0.665			-0.987	0.953			1.534 *	0.901
CAR_Tier 1_{t-1}	1.259 ***	0.398	1.186 ***	0.414	0.121	0.444	0.636	0.456	1.110 ***	0.314	0.900 ***	0.323
CAR_Tier 1_{t-1}*C			0.315	0.851			-1.824 *	1.033			0.054	0.585
CAR_{t-1}	-0.976 **	0.406	-0.839 **	0.423	-0.604	0.454	-0.910 **	0.462	-0.447	0.315	-0.253	0.321
CAR_{t-1}*C			-0.304	0.869			2.025 *	1.096			-0.921	0.651
$MkFundR_{t-1}$	0.989 ***	0.353	0.982 ***	0.353	-0.129	0.111	-0.187	0.113	0.523 ***	0.195	0.656 ***	0.206
$MkFundR_{t-1}$*C			0.111	0.415			0.236	0.149			-0.279	0.232
$LeverageR_{t-1}$	-0.899 **	0.361	-0.982 ***	0.362	0.185 *	0.107	0.240 **	0.110	-0.606 ***	0.217	-0.754 ***	0.231
$LeverageR_{t-1}$*C			-0.104	0.429			-0.142	0.162			0.266	0.292
Macroeconomic variables												
GDP_t	1.412 ***	0.252	3.179 ***	0.411	0.658 ***	0.202	1.114 ***	0.226	0.121	0.081	0.025	0.122
CPI_t	1.499 **	0.600	1.637 ***	0.598	1.223 ***	0.412	1.099 ***	0.413	0.616 ***	0.228	0.708 ***	0.244
FED funds $rate_t$	-0.885 ***	0.263	-0.574 **	0.267								
Other control												
Crisis (C)			6.742	9.795			10.872	18.464			-16.383	16.504
No. of Observations	1,499		1,499		1,046		1,046		692		692	

Note:

- *Size is measured by logarithm of total assets, CAR and CAR_Tier 1 are RWA-based total capital ratio and Tier 1 capital ratio respectively, MkFundR is Market Funding Ratio, measured by (Total Liabilities – Total Deposits)/Total Assets, LeverageR is Leverage ratio, measured by Total Debt/Total Assets.*
- ****, ** and * represent significance at the 1%, 5% and 10% level respectively.*





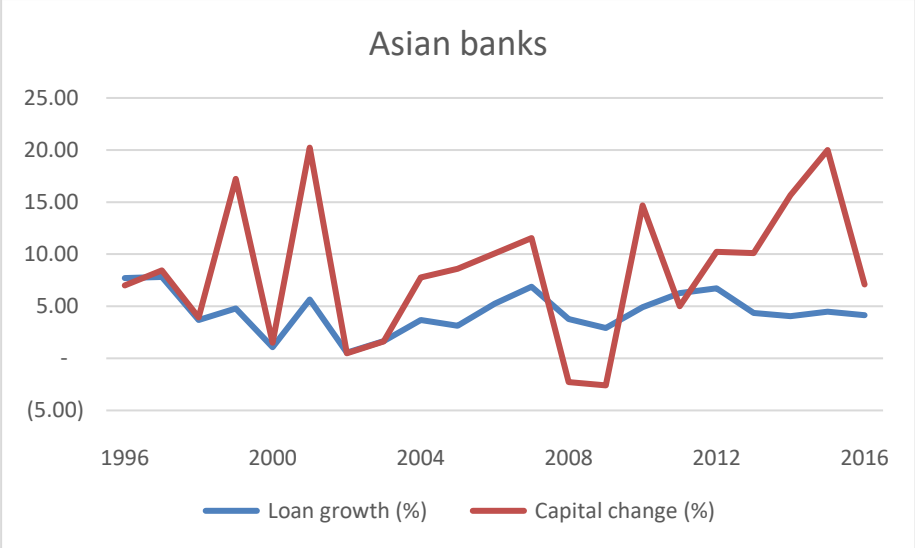


Figure 2. Year-on-year loan growth and capital change of banks in each geographical area. Average numbers are shown.

Table 6. Regression results of equation 1 for lending growth for subsample of small and large banks of each geographical area. The period is 1995 – 2016.

Dependent variable:	**Small US banks (96)**				**Large US banks (14)**				**Small European banks (37)**				**Large European banks (34)**				**Small Asian banks (10)**				**Large Asian banks (18)**			
Annual growth rate of loans (ΔL_{it})	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**
Crisis interaction	No		Yes		No		Yes		No		Yes		No		Yes		No		Yes		No		Yes	
Bank specific variables																								
$Size_{t-1}$	-3.650 **	1.549	-2.420	1.581	-9.292 **	3.632	-9.543 **	3.718	-8.006 ***	1.769	-8.957 ***	1.800	-7.970 **	1.837	-9.051 ***	1.890	7.056	4.924	6.522	5.874	-0.845	2.672	-1.887	2.822
$Size_{t-1}$*C			-1.886 *	1.032			5.834	4.533			-5.709 **	2.372			-2.054	3.088			-36.975	34.672			3.415	2.958
CAR_Tier 1_{t-1}	1.233 ***	0.470	1.188 **	0.494	1.833	1.493	3.258 **	1.494	1.181 **	0.567	1.663 ***	0.583	-0.376	0.652	0.178	0.672	1.577 *	0.797	1.430 *	0.801	-0.221	0.965	-0.430	1.031
CAR_Tier 1_{t-1}*C			0.079	1.095			3.807 *	6.520			-2.385 **	1.180			-1.254	2.776			-23.660	14.388			0.769	2.430
CAR_{t-1}	-0.964 **	0.481	-0.873 *	0.506	-1.861	1.298	-1.446	1.269	-1.761 ***	0.606	-1.681 ***	0.640	0.018	0.646	-0.315	0.653	-1.675 *	0.853	-1.483 *	0.882	0.935	0.956	0.930	1.001
CAR_{t-1}*C			-0.228	1.136			-4.655 *	5.255			0.840	1.415			1.305	2.131			13.922	11.471			-0.413	2.873
$MkFundR_{t-1}$	1.620 ***	0.595	1.423 **	0.611	0.229	0.592	0.499	0.586	-0.222	0.269	-0.105	0.269	0.160	0.163	0.162	0.169	0.445	1.059	0.469	1.260	0.303	0.304	0.526	0.360
$MkFundR_{t-1}$*C			2.030	1.505			-0.852	0.871			-0.995	0.718			-0.062	0.248			-0.312	0.849			-0.307	0.493
$LeverageR_{t-1}$	-1.565 ***	0.603	-1.421 **	0.620	0.099	0.641	-0.335	0.645	0.219	0.251	0.131	0.252	-0.038	0.152	-0.010	0.161	-0.314	1.177	-0.648	1.424	-0.682 *	0.391	-0.919 **	0.451
$LeverageR_{t-1}$*C			-2.008	1.505			0.367	1.140			0.937	0.762			-0.121	0.261			-3.571	3.496			-0.215	0.696
Macroeconomic variables																								
GDP_t	1.355 ***	0.301	2.623 ***	0.493	1.783 *	0.941	5.795 ***	1.831	0.583	0.354	1.425 ***	0.492	0.723 **	0.271	1.102 ***	0.296	0.704	0.477	0.497	0.587	0.115	0.205	-0.053 ***	0.307
CPI_t	1.012	0.722	1.125	0.721	3.091	2.227	5.490 **	2.305	0.407	0.649	-0.041	0.669	1.642 **	0.586	1.456 **	0.586	3.398 ***	1.185	2.127	1.462	0.861 *	0.497	1.126 **	0.560
FED funds $rate_t$	-0.594 *	0.314	-0.248	0.324	-2.451 ***	0.904	-2.425 **	1.148																
Other control																								
Crisis (C)			34.748	15.274			-44.217	80.894			112.684 ***	39.901			52.710	61.795			666.271	562.995			-62.073	59.792
No. of Observations	1,103		1,103		165		165.000		291		291		487		487		69		69		157		157	

Note:

- *Small and large banks are categorized based on their total assets as at end of 2006. Banks with total assets equal or less than 10 billion USD are small banks. Banks with total assets equal or more than 50 billion USD are large banks.*
- *Size is measured by logarithm of total assets, CAR and CAR_Tier 1 are RWA-based total capital ratio and Tier 1 capital ratio respectively, MkFundR is Market Funding Ratio, measured by (Total Liabilities – Total Deposits)/Total Assets, LeverageR is Leverage ratio, measured by Total Debt/Total Assets.*
- ****, ** and * represent significance at the 1%, 5% and 10% level respectively.*

4.2 Loan loss provisions

This section discusses how loan loss provision ratio is affected by lending growth, size, capital ratios and macroeconomic variables. According to traditional capital management hypothesis, loan loss provisions is managed to reduce expected regulatory costs associated with not adhering to capital requirements (Fonseca, 2008). Low-capital banks tend to increase their loan loss provisions because part of the provisions can be included in total capital (general provision is a component of Tier 2 capital). Thus, a negative coefficient between loan loss provisions and capital ratios is predicted. With regards to the relationship with GDP and with annual growth rate of loans, positive coefficients are expected because growing GDP leads to credit expansion, which in turn requires a higher provision to take into account additional credit risk. This effect is also predicted in risk management hypothesis, which states that for income smoothing purpose, banks would build up provisions for expected losses in good times to draw on in bad times (Fonseca, 2008).

Table 7 presents the coefficients between loan loss provisions and the control variables. Statistically significant and negative coefficients between Tier 1 capital ratio and loan loss provisions are found for three areas and this result is consistent with the prediction of capital management hypothesis and findings in some empirical researches, e.g. Bouvatier (2014) on European commercial banks in the period of 2004 - 2009 and Anandarajan (2007) on Australian commercial banks in the period of 1991 - 2001. The coefficients of total capital, however, are positive for the cases of the US and European banks. This is contrary to the hypothesis, but consistent with finding in Fonseca (2008), the empirical research examines non-US banks over the period of 1995-2002 and finds that their capital has positive relationship with loan loss provisions.

Lending growth and GDP are positively related with loan loss provision ratio as predicted by the risk management hypothesis for Asian banks, indicating that the provision is built up in this group when there is credit expansion. The coefficients for the US and European banks, however, are negative. Their loan loss provision ratio decreases when GDP and lending growth rate increase. A possible reason of this relationship is creditworthiness of banks' customers. When economic prospect is positive and reflected in GDP, opportunities for business growth improve ability to repay loan and lower probability of default, and the creditworthiness of banks' customers is better. As a result, banks reserve for loan losses at a lower level relative to the level when the economy is in slowdowns.

Bank size has positive coefficient for the case of the US banks, which is same as the finding in Anandarajan (2007) for Australian banks. This result indicates that larger US banks have higher loan loss provision ratio probably due to wider scope of business activity, hence more provision for additional risk. The

relation of size and provisions in the European and Asian banks, however, are negative.

Table 8 shows the regression results by small and large banks of each area. The coefficients of the macroeconomic variables in small US banks suggest that these banks see a lower credit risk when the economy is in good times. The effect is different for large US banks with strong evidence of uncorrelation between provision ratio with the variables (all coefficients are zero), probably because large US banks do not take these external factors into assessment of creditworthiness of their customers. Among bank specific characteristics, capital ratios and lending growth have similar coefficients between the two categories and same signs as those of the whole US sample. For size effect, the coefficients are positive in small size group and negative in large size group. The result of large size group saying that in the group of banks having total assets more than 50 billion USD, bigger banks estimate lower loan loss provisions relative to others, is contrary to the result of the whole US sample.

In European area, size and lending growth rate have similar effect in both categories of large and small banks. On average and in normal time, larger size and higher growth rate are seen associated with lower provision ratio and vice versa. The coefficients are statistically significant for small size group. In crisis, the relation turns to positive, meaning larger banks reserve more relative to smaller banks. The effects of total capital ratio and Tier 1 capital ratio on loan loss provisions in each category are different, and they are also different between categories. In small size category, Tier 1 capital ratio have negative relation (which is consistent with capital management hypothesis) while total capital ratio has positive relation with provision ratio. The signs are opposite for large size group.

For Asian subsamples, except for size and lending growth rate, other control variables have same sign effects on loan loss provisions when comparing small and large bank groups. The relationship with size is negative for small banks and positive for large banks. Correlation of lending growth rate and loan loss provisions are moderate in both groups.

Table 7 and 8 raise the following points. First, impact of capital ratios on loan loss provisions are similar in terms of sign of the coefficients between large and small banks in the US and Asia but mixed within European subsamples and among geographical areas. The opposite effect of total capital and Tier 1 capital implies that Tier 2 capital causes the difference. This raises a question if general loan loss provision (which is included in Tier 2 capital) is estimated for reporting purpose rather than for risk purpose, and if yes, to what extent. Second, there is evidence of different provisioning practice between Asian group and the other two. In upswings, Asian banks tend to make high provision while US and European banks reduce it. In recession, the trend reverses. The behavior is same for small and large Asian banks but varies across small and large size groups in the US and European samples. Figure 3 illustrates the development of loan loss provision ratio by region over the sample period. The trend for banks in Asia is quite stable with just a slight increase in crisis time, probably thanks to the release of provisions accumulated in good times. Provision ratios of the US and European banks increase significantly in 2008 and reach the peak in 2009 after a decreasing

trend during 2002 – 2007. This fact indicates that banks in the US and Europe hold insufficient reserves for loan losses in upswings and delay bad debt provision until too late. As such, Asian banks is observed to have more prudent practice in bad debt provision than US and European banks. This finding is contrary to the empirical result of Laeven (2003), which finds that insufficient provision during good times is more common among banks in Asia than among banks in US and Europe. However, it is noted that the sample examined in Laeven (2003) covers the period of 1988 – 1999. There might be change in practice in countries over time.

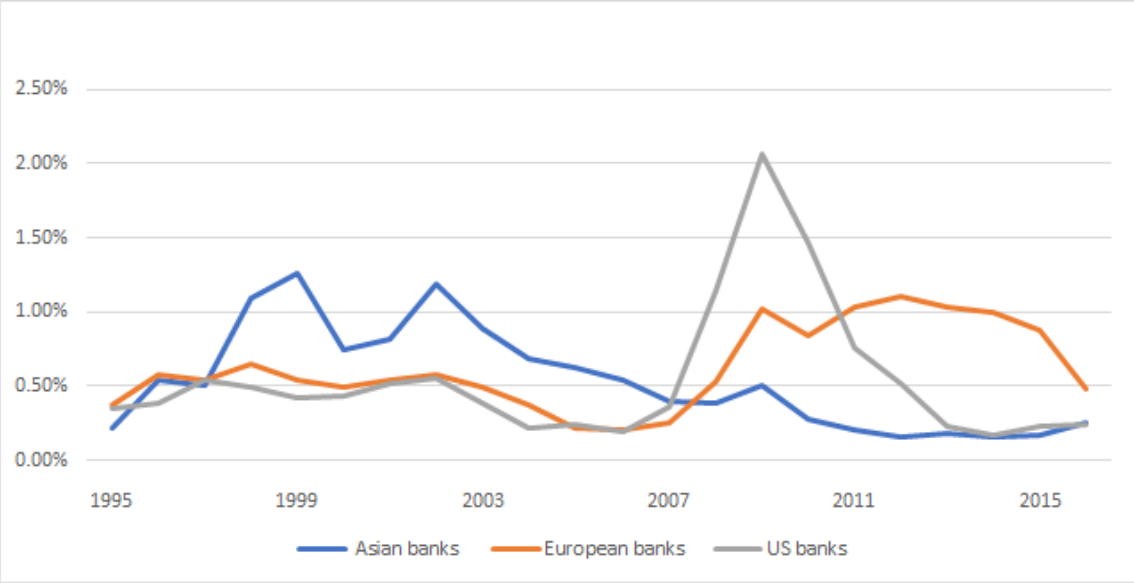


Figure 3. Development of loan loss provision ratio over the period 1995 – 2016 of US banks (131), European banks (101) and Asian banks (86). Average numbers are shown. Source: Datastream.

Table 7. Regression results of equation 2 for Loan Loss Provision ratio. The sample consists of 131 US banks, 101 European banks and 86 Asian banks, and covers the period of 1995 – 2016.

Dependent variable:	**US banks**				**European banks**				**Asian banks**			
Loan loss provision ratio ($RProv_{it}$)	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**
Crisis interaction	No		Yes		No		Yes		No		Yes	
Bank specific variables												
$Size_{t-1}$	0.076	0.108	0.069	0.109	-0.207	0.126	-0.222 *	0.127	-0.189	0.136	-0.200	0.136
$Size_{t-1}$*C			0.091 **	0.038			0.038	0.034			-0.058	0.055
CAR_Tier 1_{t-1}	-0.087 ***	0.028	-0.084 ***	0.029	-0.070 ***	0.025	-0.066 ***	0.025	-0.037 *	0.021	-0.035	0.022
CAR_Tier 1_{t-1}*C			0.014	0.060			-0.030	0.056			-0.018	0.035
CAR_{t-1}	0.092 ***	0.028	0.086 ***	0.030	0.031	0.024	0.025	0.025	-0.095 ***	0.020	-0.102 ***	0.021
CAR_{t-1}*C			0.004	0.061			0.062	0.059			0.049	0.034
ΔL_{it}	-0.016 ***	0.002	-0.018 ***	0.002	-0.005 **	0.002	-0.006 ***	0.002	0.005 *	0.003	0.007 **	0.003
ΔL_{it} *C			0.006	0.004			0.004	0.005			-0.007	0.007
Macroeconomic variables												
GDP_t	-0.043	0.089	-0.077	0.091	-0.052 ***	0.015	-0.051 ***	0.015	0.022	0.017	0.020	0.017
CPI_t	-0.189	0.195	-0.215	0.200	-0.160 ***	0.029	-0.157 ***	0.030	-0.025	0.021	-0.027	0.021
FED funds $rate_t$	0.144	0.123	0.157	0.130								
Other control												
Crisis (C)			-2.235 ***	0.734			-1.250	1.110			0.000 ***	0.000
Summary statistics												
No. of Observations	1,472		1,472		1,042		1,042		655		655	

Note:

- *Loan loss provision ratio ($RProv_{it}$) is the ratio of Loan Loss Provisions to Total Loans. Size is measured by logarithm of total assets, CAR and CAR_Tier 1 are RWA-based total capital ratio and Tier 1 capital ratio respectively. ΔL_{it} is annual growth rate of loans.*
- ****, ** and * represent significance at the 1%, 5% and 10% level respectively.*

Table 8. Regression results of equation 2 for Loan Loss Provision ratio for subsample of small and large banks of each geographical area. The period is 1995 – 2016.

Dependent variable:	Small US banks (96)				Large US banks (14)				Small European banks (37)				Large European banks (34)				Small Asian banks (10)				Large Asian banks (18)			
Loan loss provision ratio ($RProv_{it}$)	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error
Crisis interaction	No		Yes		No		Yes		No		Yes		No		Yes		No		Yes		No		Yes	
Bank specific variables																								
$Size_{t-1}$	0.109	0.123	0.125	0.124	-0.014	0.263	-0.024	0.265	-1.054 **	0.425	-1.047 **	0.432	-0.174	0.132	-0.210	0.132	-0.186	0.947	-0.161	0.898	0.054	0.103	0.041	0.106
$Size_{t-1}$*C			0.047	0.065			0.113	0.102			0.158	0.215			0.224 ***	0.076			-2.001 **	0.941			-0.054	0.050
CAR_Tier 1_{t-1}	-0.041	0.032	-0.060 *	0.034	-0.030	0.082	-0.035	0.084	-0.208 ***	0.059	-0.218 ***	0.062	0.039	0.030	0.041	0.030	0.009	0.045	0.042	0.040	0.049 **	0.022	0.051 **	0.023
CAR_Tier 1_{t-1}*C			0.102	0.074			0.235	0.305			0.039	0.117			-0.021	0.108			-0.760	0.478			-0.039	0.050
CAR_{t-1}	0.035	0.033	0.054	0.035	0.088	0.067	0.084	0.069	0.195 ***	0.058	0.207 ***	0.064	-0.045	0.028	-0.047 *	0.028	-0.235 ***	0.052	-0.283 ***	0.045	-0.046 **	0.020	-0.049 **	0.021
CAR_{t-1}*C			-0.090	0.075			-0.092	0.242			-0.057	0.134			0.054	0.086			0.620 ***	0.136			0.038	0.051
ΔL_{it}	-0.019 ***	0.002	-0.020 ***	0.002	-0.002	0.004	-0.006	0.007	-0.016 ***	0.006	-0.018 **	0.007	-0.004 **	0.002	-0.006 **	0.002	0.000	0.008	-0.003	0.009	0.000	0.003	0.000	0.003
ΔL_{it} *C			0.005	0.005			0.006	0.008			0.007	0.014			0.008	0.006			0.006	0.072			-0.003	0.008
Macroeconomic variables																								
GDP_t	-0.048	0.087	-0.076	0.090	0.000 ***	0.000	0.000 ***	0.000	0.092	0.070	0.081	0.074	-0.058 ***	0.014	-0.058 ***	0.014	0.034	0.057	0.055	0.076	0.026 **	0.011	0.025 **	0.011
CPI_t	-0.118	0.192	-0.131	0.199	0.000 ***	0.000	0.000 ***	0.000	-0.031	0.076	-0.036	0.078	-0.191 ***	0.034	-0.191 ***	0.034	-0.087	0.098	-0.157	0.128	-0.008	0.012	-0.009	0.012
FED funds $rate_t$	0.131	0.121	0.159	0.130	0.000 ***	0.000	0.000 ***	0.000																
Other control																								
Crisis (C)			-1.193	1.069			0.000 ***	0.000			-2.397	4.080			0.000 ***	0.000			0.000 ***	0.000			0.000 ***	0.000
Summary statistics																								
No. of Observations	1,085		1,085		165		165		285		285		489		489		67		67		149		149	

Note:

- *Small and large banks are categorized based on their total assets as at end of 2006. Banks with total assets equal or less than 10 billion USD are small banks. Banks with total assets equal or more than 50 billion USD are large banks.*
- *Loan loss provision ratio ($RProv_{it}$) is the ratio of Loan Loss Provisions to Total Loans. Size is measured by logarithm of total assets, CAR and CAR_Tier 1 are RWA-based total capital ratio and Tier 1 capital ratio respectively. ΔL_{it} is annual growth rate of loans.*
- ****, ** and * represent significance at the 1%, 5% and 10% level respectively.*

4.3 Fee income ratio

As discussed above, ratio of fee income to total operating income is predicted to increase as a consequence of the regulatory and economic changes after the crisis. Table 9 presents regression results of equation (3), and Table 10 shows summary statistics of fee income ratio and annual growth rate of loans before and after crisis. For statistics in Table 10, crisis time is excluded because the extremely high volatility of operating income in this period would otherwise distort the average number of fee income ratio.

Expected negative coefficient between lending growth rate and fee income ratio are found for the samples of US and Europe. Moreover, significant decrease in annual growth rate of loans associated with increase in fee income ratio after the financial crisis against before crisis of these two samples (Table 10) support the prediction. The shift toward fee income, however, does not seem to occur among Asian banks, probably because they do not experience sharp decline or fluctuation in lending like banks in the US and Europe (as seen in Figure 2). Lending growth of Asian banks is quite stable over the whole study period and even reaches a higher average level after crisis (from 3.8% to 4.6%). As such, the result implies that banks deal with pressure on lending via income diversification, of which offering more fee-based services is one of the solutions.

Macroeconomic variables' effects on fee income ratio are positive and statistically significant in European banks. As concerned in previous literature, fee-based income, especially from non-traditional activities, is risk increasing rather than risk reducing because this income type is more volatile than interest-based income (e.g. DeYoung 2004, DeYoung 2013). The positive relationship, therefore, indicate that a good economic condition helps reduce the volatility and the banks expect to gain benefits from income diversification. However, for the case of the US banks and Asian banks, the effects are mixed and the coefficients are mostly not statistically significant.

Impact of capital and size varies across samples. This result might be affected by population of small and large banks in each sample and key activities (e.g. traditional vs. non-traditional activity) among banks and regions. Regression by size discussed in the following part will provide some more information on the difference.

Table 11 shows the regression results of fee income ratio with variables for small and large size categories in each region. For both categories of US banks, the positive coefficients between Tier 1 capital ratio and fee income ratio indicate that in general, US banks with higher Tier 1 capital have increased fee income ratio more than those have lower Tier 1 capital ratio on average and in normal time, but in crisis, the relationship turns to negative, implying a less diversification of income during bad times. They probably aim to reduce risk exposure caused by high volatility of income from fee-based services and focus in traditional lending activity (reflected via positive coefficient between Tier 1 capital

and lending growth in regression results of equation 1. The result of coefficients by size implies that overall small US banks tend to increase the share of fee-based income more than large banks. This is possibly explained by different effects from income diversification to banks similar to findings in some studies such as Köhler (2015), William (2016). These papers conclude that high ratio of non-interest income is good for small banks since this source of income helps them to be less dependent on the interest income, while it may increase risk for large banks (mostly investment banks) who already have large number of non-traditional activities. Thus, the risk of overdiversification could be the reason that reduces the trend of offering more fee-based services among large banks.

For European and Asian banks, the relationship between fee income ratio and size, in both whole sample and subsample, are in contrast with the result for US banks. Testing on the whole samples shows that larger banks have higher share of fee income in total revenues. While the same positive relation is observed for large size group (and statistically significant for large Asian banks), negative relation is found for small size group, i.e. among banks whose total assets is equal or less than 10 billion USD, smaller banks have higher fee income ratio. Lending growth rate positively correlate with fee income ratio across European and Asian subsamples on average and in normal time. Expected negative correlation is only found for Asian banks and large European banks in crisis.

With regards to macroeconomic factors, the impact overall is stronger (and statistically significant) on small banks than on large banks. There is also strong evidence of no correlation between macroeconomic controls and the shift of income structure for large US banks.

As such, the trend of increasing fee income ratio as a result of decreasing annual growth rate of loans is seen among banks in the US and Europe, who have experienced large fall or fluctuation in lending. This is not the case for Asian banks, probably thanks to quite stable loan growth compared to those in the US and Europe. The result implies that when interest-based income faces (potential) decline, banks increase fee-based services to supplement the decrease in interest income. If banks can still maintain loan growth, they may not make the shift because fee-based income is more volatile than interest income. The effect on small and large European banks, however, is not consistent with the whole sample, suggesting further detail examination may be desired. The relationship between size and fee income ratio also varies across small and large size groups within each area and among areas.

Table 9. Regression results of equation 3 for Fee Income Ratio. The sample consists of 131 US banks, 101 European banks and 86 Asian banks, and covers the period of 1995 – 2016.

Dependent variable:	**US banks**				**European banks**				**Asian banks**			
Fee income ratio ($RFee_{it}$)	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**	**Coeff.**	**S. Error**
Crisis interaction	No		Yes		No		Yes		No		Yes	
Bank specific variables												
$Size_{t-1}$	-120.833	161.905	-168.058	163.943	207.809	226.718	244.536	229.658	71.354	111.200	61.100	109.686
$Size_{t-1}$*C			85.331	56.388			-19.895	62.424			17.007	43.983
CAR_Tier 1_{t-1}	84.402 **	40.126	101.405 **	42.026	-64.556	44.492	-67.470	45.394	22.870	17.652	7.804	17.752
CAR_Tier 1_{t-1}*C			-22.145	88.616			79.214	99.955			79.495 ***	28.114
CAR_{t-1}	-77.472 *	41.839	-95.317 **	44.188	13.284	44.088	13.744	45.292	-36.569 **	16.853	-20.669	16.941
CAR_{t-1}*C			13.576	94.479			0.658	105.515			-128.624 ***	27.830
ΔL_{it}	-2.747	2.858	-2.214	3.262	-1.540	3.481	-2.199	3.872	2.432	2.249	0.390	2.321
ΔL_{it} *C			-2.280	6.475			3.506	8.172			7.370	5.781
Macroeconomic variables												
GDP_t	153.436	138.254	203.929	144.710	54.013 **	26.344	52.761 **	26.453	-0.718	13.867	4.585	13.807
CPI_t	-498.579	304.217	-570.371 *	308.772	117.174 **	52.893	112.346 **	53.141	-4.006	17.490	-2.342	17.205
FED funds $rate_t$	47.285	184.084	-34.960	188.591								
Other control												
Crisis (C)			-101.975	1,162.765			-723.314	2,000.205			0.000 ***	0.000
Summary statistics												
No. of Observations	1,486		1,486		1,045		1,045		692		692.00	

Note:

- *Fee Income Ratio ($RFee_{it}$) is the ratio of Fee Income to Total Operating Income. Size is measured by logarithm of total assets, CAR and CAR_Tier 1 are RWA-based total capital ratio and Tier 1 capital ratio respectively. ΔL_{it} is annual growth rate of loans.*
- ****, ** and * represent significance at the 1%, 5% and 10% level respectively*

Table 10. Statistic data of fee income ratio and lending growth rate before and after the financial crisis 2008 – 2009. Source: Datastream

	Before crisis			After crisis			
	No. of observations	Mean	SD	No. of observations	Mean	SD	% Increase / (Decrease)
US banks							
Annual growth rate of loans	1,533	11.4	14.1	894	5.9	15.0	(48.44)
Fee income ratio	1,640	52.0	163.3	906	63.0	552.8	21.22
European banks							
Annual growth rate of loans	1,072	11.4	21.9	689	1.6	35.6	(85.61)
Fee income ratio	1,175	187.7	2,428.4	701	196.1	1,513.4	4.45
Asian banks							
Annual growth rate of loans	952	3.8	10.2	601	4.6	8.2	22.31
Fee income ratio	1,030	70.3	747.1	602	68.0	84.1	(3.21)

Note: Fee income ratio is the ratio of fee income to total operating income. Before crisis covers the period from 1995 to 2007. After crisis covers the period from 2010 to 2016.

Table 11. Regression results of equation 3 for Fee Income Ratio for subsample of small and large banks of each geographical area. The period is 1995 – 2016.

Dependent variable:	Small US banks (96)				Large US banks (14)				Small European banks (37)				Large European banks (34)				Small Asian banks (10)				Large Asian banks (18)			
Fee income ratio ($RFee_{it}$)	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error	Coeff.	S. Error
Crisis interaction	No		Yes		No		Yes		No		Yes		No		Yes		No		Yes		No		Yes	
Bank specific variables																								
$Size_{t-1}$	56.98	89.5	39.59	90.1	-1106.3	1403.3	-1226.82	1421.7	-162.57	1043.2	-145.15	1056.3	31.20	124.4	54.85	126.6	-127.08	103.2	-11.68	89.2	56.37 ***	17.9	57.05 ***	18.3
$Size_{t-1}$*C			51.12	48.8			477.94	550.2			326.48	544.9			-93.86	72.9			-463.38 ***	93.4			-3.31	8.7
CAR_Tier 1_{t-1}	77.52 ***	21.9	89.94 ***	23.1	241.03	438.1	311.03	448.4	-179.01	145.7	-193.11	152.4	15.00	27.9	15.76	28.2	1.43	4.9	1.61	3.9	-3.60	3.9	-2.73	4.0
CAR_Tier 1_{t-1}*C			-39.48	52.2			-681.37	1635.7			132.02	289.3			-35.26	103.5			-85.20 *	47.4			-0.98	7.6
CAR_{t-1}	-61.08 ***	23.3	-73.93 ***	24.6	-17.76	358.7	6.03	370.5	14.24	144.9	-49.03	157.3	-14.34	26.1	-15.00	26.5	-3.68	5.6	-4.91	4.4	-0.22	3.5	-1.19	3.6
CAR_{t-1}*C			36.77	56.8			151.97	1301.1			262.77	323.7			5.23	81.8			15.94	13.5			7.26	7.7
ΔL_{it}	-0.75	1.6	-0.02	1.7	-18.23	23.3	-30.26	35.3	2.48	15.6	5.62	18.3	1.44	2.0	1.45	2.2	1.60 *	0.9	1.76 *	0.9	0.39	0.3	0.47	0.3
ΔL_{it} *C			-3.49	4.0			19.47	42.9			0.04	35.1			-0.10	5.4			-6.10	7.2			-0.33	1.3
Macroeconomic variables																								
GDP_t	172.58 ***	65.8	223.22 ***	68.7	0.00 ***	0.0	0.00 ***	0.0	354.12 **	172.7	402.25 **	182.1	5.17	13.4	5.51	13.4	18.27 ***	6.1	7.08	7.6	-0.61	1.9	-0.82	1.9
CPI_t	-625.30 ***	144.6	-643.00 ***	147.6	0.00 ***	0.0	0.00 ***	0.0	418.31 **	187.2	452.65 **	190.2	40.31	32.3	40.09	32.4	-15.24	10.6	-6.18	12.7	2.87	2.1	2.68	2.1
FED funds $rate_t$	17.15	87.6	-27.43	90.5	0.00 ***	0.0	0.00 ***	0.0																
Other control																								
Crisis (C)			236.27	818.6			0.00 ***	0.0			-11581.99	10200.8			0.00 ***	0.0			0.00 ***	0.0			0.00 ***	0.0
Summary statistics																								
No. of Observations	1,091		1,091		165		165		290		290		488		488		69		69		157		157	

Note:

- *Small and large banks are categorized based on their total assets as at end of 2006. Banks with total assets equal or less than 10 billion USD are small banks. Banks with total assets equal or more than 50 billion USD are large banks.*
- *Fee Income Ratio ($RFee_{it}$) is the ratio of Fee Income to Total Operating Income. Size is measured by logarithm of total assets, CAR and CAR_Tier 1 are RWA-based total capital ratio and Tier 1 capital ratio respectively. ΔL_{it} is annual growth rate of loans.*
- ****, ** and * represent significance at the 1%, 5% and 10% level respective*

5 CONCLUSIONS

The study examines the relationship between bank capital ratios, lending growth and loan loss provisions, and reviews the change on income structure as a consequence. The sample consists of three separate data sets of the US, European and Asian banks over the period from 1995 to 2016.

On average, banks in the three areas have been holding Tier 1 and total capital ratios well above the Basel requirements over the whole sample period. The study finds that overall Tier 1 capital supports banks to increase loans while total capital ratio has negative effect in most of the cases. This implies that there is a difference between impacts of Tier 1 and Tier 2 capital ratios, and that a high Tier 2 capital ratio does not help banks in lending growth. This is a new finding not yet discussed in published research, which has focused on Tier 2 capital. It is probably because the sample period of this study covers the most recent post-crisis time. Annual growth rate of loans is affected by capital change stronger in the US and European banks than in the Asian banks. In terms of size, negative correlation across the three regions suggests that small banks are better in adjusting lending policy to increase their loans compared to large banks. On the analysis by subsample, while the relation between capital ratio and lending growth rate is same for small and large banks in the US, supporting role of Tier 1 capital is seen in small European and Asian banks (with statistically significant coefficients), but not seen in large size group.

Effect of market funding ratio on lending activity varies depending on the level of the market funding ratio. Banks who have relative low reliance on wholesale markets (which are US and Asian banks in our data) may use market funding as a source to increase loans in normal time. Among banks who are much reliant on wholesale markets (which are European banks in our data), those have more stable deposit funding source have been able to better grow lending.

Loan loss provision practice in Asian banks is found different from that in the US and European banks. Asian banks make high provision during upswings to withdraw in downswings, thus their loan loss provisions do not jump up in crisis time like the US and European banks. This approach is proved to be more prudent given the fact that Asian banks do not hit huge losses due to significant loan loss provisions during the recent global financial crisis and still maintain better lending growth relative to the banks in the US and Europe. With reference to the empirical result of Laeven (2003), this finding suggests that the banks have changed their practice overtime. Fee income ratio has negative relationship with lending growth among banks in the US and European regions who experience strong fluctuation or decline in lending activity. Meanwhile, the relationship is positive for Asian banks. This result implies that banks move to fee-based activities to diversify source of income when facing difficulty in traditional lending. As such, in general, Asian banks behave differently from the US and European banks in responding to the changes that affect lending activity.

Finally, macroeconomic factors are found to have statistically significant positive relationship with annual growth rate of loans in all three geographical areas. This finding is different from many previous papers, which conclude that the relationship is weak, especially in advanced economies.

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