Capital regulation and bank behavior:

Empirical evidence from Asia

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Abstract of a thesis submitted in partial fulfilment of the requirements for the Degree of Doctor of Philosophy in Finance.

Abstract

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Capital regulation is one of regulators' primary focus in assessing and controlling bank operations. Bank capital represents the shareholders' benefits and induces them to manage risk properly. This effect is of great significance due to banks' interconnectedness that quickly spreads the failure of a specific institution over the whole system. In addition, when losses occur, bank capital acts as the first absorber of loss and reduces the probability of bankruptcy. This can eventually reduce the likelihood and amount of any government bailouts, as well as a tax burden on citizens. However, given the high costs associated with capital, banks prefer to keep lower levels of capital. This study considers the effects of capital regulation on bank behavior. More specifically, it investigates bank responses to capital regulation to determine whether it encourages banks to operate safely or not. This study focuses on Asian banks, which have received limited scholarly attention, compared to the U.S and European countries. Given more convergence in implementing Basel III (international capital standards) among Asian countries, understanding the effects of capital regulation on bank behavior in these countries is of great importance.

Firstly, we examine how capital regulation affects bank capital ratios by adopting the Partial Adjustment Model and employing two-step system Generalized Method of Moments (GMM) regression. Our study confirms that, during the study period (from 2001 to 2016), capital regulation is effective in inducing banks to raise their capital ratios (regardless of different measurements). Secondly, we investigate the effects of capital regulation on bank capital and risk behavior using a Simultaneous Equation Model with Partial Adjustment. The emphasis is on the existence of fixed effects, which are commonly ignored in prior studies. The results show that capital regulation exerts a negative effect on capital adjustments and has no effect on bank risk. Instead, bank capital and risk decisions are largely driven by bank characteristics such as size, profitability, lending, loan quality, tangibility, deposit ratios, and economic growth. Lastly, we investigate the effects of capital regulation on bank balance sheet adjustments in a dynamic and simultaneous model using two-step system GMM. Our empirical results show that capital regulation induces banks to reduce adjustments in shareholder capital and lending, while leading to an increase in investment and other asset adjustments. Nevertheless, these effects of capital regulation vary significantly across developed, emerging, and frontier countries, as well as across Basel Committee members and non-member countries.

Our results are based on a newly proposed measurement of capital regulation, namely the Advanced Capital Regulation Index. This index was designed to reflect both quantitative and qualitative aspects of capital regulation and thus, is capable of capturing most of its effects. The analyses proved the usefulness of this index over the traditional measurements. Our results also suggest some scope for capital regulation reforms, including a simplified leverage ratio, a greater emphasis on new equity raising, more national discretion, an enhancement of risk-weight standards, risk level constraints, and reinforcement of supervisor review process.

Keywords: Asia, Bank risk-taking, Bank behavior, Balance sheet adjustment, Basel III, Capital structure, Capital regulation, Dynamic panel data, Endogeneity, Partial adjustment model, System GMM, Simultaneous equation model.

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Table of Contents

Abstract ii

Acknowledgements iv

Table of Contents v

List of Tables viii

List of Figures x

Abbreviations..........xi

Chapter 1 Introduction **1**

1.1 Background of the Study..........1

1.2 Rationale for the Research..........3

1.3 Research Objectives..........6

1.4 Significance of the Research 6

1.5 Organization of the Thesis 9

Chapter 2 Literature Review..........10

2.1 Introduction 10

2.2 Theories of Capital Structure in Banks.......... 11

2.2.1 Trade-off Theory 12

2.2.2 Pecking Order Theory..........14

2.2.3 Government Guarantees and Capital Regulation 16

2.3 Theories of Bank Behavior under Capital Regulation 17

2.3.1 Moral Hazard Theory 17

2.3.2 Franchise Value Theory..........22

2.3.3 Capital Buffer Theory 24

2.3.4 Agency Problem Theory..........26

2.4 Empirical Studies on Effect of Capital Regulation on Bank Capital Ratios.......... 27

2.5 Empirical Studies on Effect of Capital Regulation on Bank Capital and Risk 29

2.5.1 Effect on Bank Capital 29

2.5.2 Effect on Bank Risk..........30

2.5.3 Simultaneity between Bank Capital and Risk..........33

2.6 Empirical Studies on the Effect of Capital Regulation on Bank's Balance Sheets Adjustments 36

2.7 Measurement of Capital Regulation.......... 39

2.8 Literature Gaps 42

2.9 Conceptual Framework.......... 44

Chapter 3 Research Methodology and Data..........45

3.1 Introduction 45

3.2 Normalization of Changes in Balance Sheet Components.......... 45

3.3 Research Models.......... 47

3.3.1 Partial Adjustment Model of Bank Capital Ratio 47

3.3.2 Simultaneous Equations Model of Bank Capital and Risk Behavior 48

3.3.3 Balance Sheet Adjustments 51
3.4 Estimation Methods 53
3.4.1 Simultaneous Equations Model Estimation for Panel Data 53
3.4.2 Dynamic Panel Data Estimation 55
3.4.3 Consistency and Efficiency of Estimators 56
3.5 Variables and Measurements 59
3.5.1 Bank Capital Ratio 59
3.5.2 Bank Capital and Bank Risk 59
3.5.3 Balance Sheet Components 60
3.5.4 Capital Regulation 61
3.6 Research Data 67
3.7 Data Heterogeneity and Sub-sampling Method 68

Chapter 4 Capital Regulation and Bank Capital Ratio 71
4.1 Introduction 71
4.2 Bank Capital Regulation in Asia 71
4.3 Descriptive Statistics 74
4.4 Regression Results 82
4.4.1 Effect of Capital Regulation on Bank Capital Ratio 82
4.4.2 Effect of Bank and Country Characteristics on Capital Ratios 85
4.4.3 Sub-sampling Regression for Different Country Groups 88
4.4.4 Sub-sampling Regression for BCBS-members and Non-members 91
4.5 Robustness Checks 93
4.5.1 Regression with Different Methods 93
4.5.2 Model Sensitivity with Different Sets of Explanatory Variables 96
4.5.3 Sub-sample Analysis 97
4.6 Chapter Summary 103

Chapter 5 Capital Regulation, Bank Capital and Risk Behavior 104
5.1 Introduction 104
5.2 Preliminary Analysis 104
5.3 Effect of Capital Regulation on Changes in Bank Capital and Risk 107
5.4 Effect of Capital Regulation on Bank Capital and Risk Levels 109
5.5 Further Analysis 112
5.5.1 Moderating Effect of Country Groups 112
5.5.2 Moderating Effect of Basel Committee Membership 115
5.5.3 Moderating Effects of Bank Capitalization Levels 116
5.6 Robustness Checks 122
5.6.1 Simultaneity of Changes in Bank Capital and Risk 122
5.6.2 Different Measurements of Capital Regulation 123
5.6.3 Different Definitions of Capital and Risk 125
5.7 Chapter Summary 131

Chapter 6 Capital Regulation and Balance Sheet Adjustments 132
6.1 Introduction 132
6.2 Changes in Bank Balance Sheet Components 132
6.3 Effect of Capital Regulation on Balance Sheet Adjustments 139
6.3.1 Adjustments on the Liability Side 143

6.3.2 Adjustments on the Asset Side 146
6.4 Moderating Effect of Country Group 149
6.5 Moderating Effect of BCBS Membership 151
6.6 Robustness Checks 154
6.7 Chapter Summary 156

Chapter 7 Conclusion 158
7.1 Introduction 158
7.2 Overview of the Study 158
7.3 Summary of Main Findings and Implications 159
7.3.1 Effects of Capital Regulation on Capital Ratios of Asian Banks........159
7.3.2 Effects of Capital Regulation on the Adjustments of Capital and Risk of Asian Banks 161
7.3.3 Effects of Capital Regulation on Asian Bank Balance Sheet Adjustments 164
7.4 Policy Implications and Recommendations 166
7.4.1 Capital Adequacy Ratio 166
7.4.2 Design of Capital Regulation 167
7.5 Limitations 171
7.6 Directions for Future Research 172

Appendix A International Capital Standards – BASEL Accords........175
A.1 Basel I 175
A.2 Basel II 175
A.3 Basel III 176

Appendix B Asian Countries Key Statistics 178

Appendix C 183

Appendix D 186
References 187

List of Tables

Table 2.1 Quantitative Measurements of Capital Regulation 40
Table 3.1 Design of Advanced Capital Stringency Index 62
Table 3.2 Variable Measurements 65
Table 3.3 Sample Description 68
Table 4.1 Basel Adoption in Selected Asian Countries 72
Table 4.2 Summary Statistics of Main Variables 77
Table 4.3 Summary Statistics of Main Variables by Country Groups 79
Table 4.4 Summary Statistics of Main Variables by BCBS Membership 80
Table 4.5 Pairwise Correlation Matrix 81
Table 4.6 Regression Results for Different Measurements of Capital Ratio 83
Table 4.7 Difference-in-Hansen Tests for Exogeneity of Instruments 84
Table 4.8 Sub-sampling Regression for Different Country Groups 89
Table 4.9 Sub-sampling Regression for BCBS-members and Non-members 92
Table 4.10 Regression Results with Different Methods 94
Table 4.11 SYS-GMM Regression Results with Different Sets of Explanatory Variables 98
Table 4.12 FEM Regression Results with Different Sets of Explanatory Variables 100
Table 4.13 Two-step system GMM regression on capital ratio considering Indonesia and Japan banks 101
Table 5.1 Regressions of Changes in Bank Capital and Risk 108
Table 5.2 Model Choice and Lag Lengths for SYS-GMM Estimation of Bank Capital and Risk Levels 111
Table 5.3 SYS-GMM Estimation of Bank Capital and Risk Levels 112
Table 5.4 Effects of Capital Regulation on Bank Capital and Risk Considering Country Groups 113
Table 5.5 Effects of Capital Regulation on Bank Capital and Risk Considering Basel Committee Membership 115
Table 5.6 2SLS-FE Regression of Changes in Bank Capital and Risk Considering Bank Capitalization Levels Effects 118
Table 5.7 Two-step SYS-GMM Regression of Bank Capital and Risk Considering Bank Capitalization Levels Effects 120
Table 5.8 FEM Regression of Changes in Bank Capital and Risk 123
Table 5.9 2SLS-FE Regression with Different Proxies for Capital Regulation 125
Table 5.10 2SLS-FE Regression of Changes in Capital with Different Capital and Risk Definitions 127
Table 5.11 2SLS-FE Regression of Changes in Risk with Different Capital and Risk Definitions ...129
Table 6.1 Changes in Balance Sheet Components 135
Table 6.2 Normalized Changes in Capital Ratio Components 136
Table 6.3 Normalized Changes in Regulatory Capital Components 137
Table 6.4 Normalized Changes in Risk-weighted Assets Components 138
Table 6.5 FEM Regression of Balance Sheet Adjustments 140
Table 6.6 Information Criteria and R-square of Different Models 142
Table 6.7 SYS-GMM Regression of Balance Sheet Adjustments on the Liability Side 143
Table 6.8 SYS-GMM Regression of Balance Sheet Adjustments on the Asset Side 146
Table 6.9 Riskiness of Asset Components 148
Table 6.10 Effects of Capital Regulation on Balance Sheet Adjustments Considering Country Groups 150
Table 6.11 Effects of Capital Regulation on Balance Sheet Adjustments Considering BCBS Membership 152
Table 6.12 Robustness Checks for Balance Sheet Adjustment Specifications 154
Table 7.1 Summary of Main Findings for Research Objective 1 161
Table 7.2 Summary of Main Findings for Research Objective 2 164
Table 7.3 Summary of Main Findings for Research Objective 3 165

Table B. 1 Key Economic and Financial Statistics of Selected Asian Countries (as of 2016) 178
Table B. 2 Key Banking Statistics of Selected Asian Countries 179
Table B. 3 Two-step system GMM estimation on different measurements of capital ratio for different samples 180
Table B. 4 Two-stage least square with fixed-effect regression on changes in bank capital and bank risk for different samples 182

Table C. 1 Advanced Capital Regulation Index across Countries over Years...............................183
Table C. 2 Distribution of Total Regulatory Capital Ratio over Years 184
Table C. 3 Distribution of Total Regulatory Capital Ratio across Countries 185

Table D. 1 Pooled Two-stage Least Square Regression of Changes in Capital and Risk 186

List of Figures

Figure 1.1 Capital Regulation and Bank Responses 4
Figure 2.1 Conceptual Framework for the Effects of Capital Regulation on Bank Behavior 44
Figure 4.1 Average Advanced Capital Regulation Index and its Components (2001 - 2016) 73
Figure 4.2 Minimum CAR Requirements in Asia 74
Figure 4.3 Distribution of CAR across Banks (2001 – 2016) 75
Figure 4.4 Distribution of CAR across Countries (2001 - 2016) 76
Figure 4.5 Average Total Regulatory Capital Ratio, Tier 1 Ratios, and Leverage Ratios (2001-2016) 76
Figure 5.1 Average Changes in Bank Capital and Bank Risk in Asia (2002-2016) 105
Figure 5.2 Relationship among Changes in Bank Capital, Changes in Bank Risk and Capital regulation 105
Figure 5.3 Relationship among Different Capital and Risk Definitions 106
Figure 6.1 Average Regulatory Capital and Capital Components (2004-2016) 133
Figure 6.2 Average Risk-weighted Assets and Asset Components (2004-2016) 134
Figure 6.3 Normalized Changes in Total Capital Ratio 137
Figure 6.4 Normalized Changes in Regulatory Capital Components 138
Figure 6.5 Normalized Changes in Risk-weighted Asset Components 139
Figure 7.1 Bank Options in Reaching the Increase in Minimum Leverage Ratio Requirement ... 169

Figure A. 1 Basel III Phase-in Arrangements 177

Abbreviations

2SLS	Two-Stage Least Squares
2SLS-FE	Two-Stage Least Squares with Fixed Effects
2SLS-RE	Two-Stage Least Squares with Random Effects
3SLS	Three-Stage Least Squares
ACRI	Advanced Capital Regulation Index
ANOVA	One-way Analysis of Variance
BCBS	Basel Committee on Banking Supervision
BHC	Bank Holding Company
CET1	Common Equity Tier 1
CRI	Capital Regulation Index
D-SIB	Domestic Systemically Important Banks
EU	Europe
FD	First Differences
FD-2SLS	First-differenced Two Stage Least Squares
FD-GMM	Differenced Generalized Method of Moments
FDIC	Federal Deposit Insurance Corporation
FDICIA	Federal Deposit Insurance Corporation Improvement Act
FEM	Fixed Effects Model
FIML	Full Information Maximum Likelihood
FOD-GMM	Forward-orthogonal-deviation Generalized Method of Moments
GLS	Generalized Least Square
GMM	Generalized Method of Moments
G-SIB	Global Systemically Important Bank
G-SIFI	Global Significant Financial Institution
IMA	Internal Models Approach
IRB	Internal Rating-Based
IV	Instrumental Variables
LCR	Liquidity Coverage Ratio
LIML	Limited Information Maximum Likelihood
M&M	Modigliani and Miller
MENA	Middle East and North Africa
NSFR	Net Stable Funding Ratio
OLS	Ordinary Least Square
PAM	Partial Adjustment Model
PCA	Prompt Corrective Action
REM	Random Effects Model
SEM	Simultaneous Equations Model
SEM-PAM	Simultaneous Equations Model with Partial Adjustment
SYS-GMM	System Generalized Method of Moments
U.K	United Kingdom
U.S	United States of America
USD	US Dollar

Chapter 1
Introduction

1.1 Background of the Study

Banks are financial intermediaries that differ significantly from non-financial firms. They provide financial services that connect deficit entities with surplus entities in the economy. Most of their resources come from external sources, mainly customer deposits and other financial institutions. As Kaufman (2000) notes, bank balance sheets always feature (1) low cash levels, (2) high leverage; and (3) maturity mismatches (the difference in maturities between assets and liabilities). On the one hand, this financial structure helps to create liquidity for the economy and provides banks with market discipline by threatening them with exposure to bank runs. On the other hand, it is a source of liquidity risk and insolvency if banks do not manage risk properly or face unfavourable shocks.

Given limited levels of capital, banks have a tendency to take excessive risks with the principle "heads, I win, tails, you lose." This is commonly referred as a moral hazard problem. In order to prevent bank runs, the government (either implicitly or explicitly) insures customer deposits through prudential insurance schemes.[1] These deposit insurances eliminate depositors' incentives to monitor banks' operations, create subsidy for banks, which consequently induce them to take excessive risks at the cost of the insurers (Admati, DeMarzo, Hellwig, & Pfleiderer, 2013). This protection has been identified as one of the primary causes of over a hundred banking crises worldwide over the past 30 years. There were an estimated 147 banking crises over the period of 1970-2011, with an increase in the frequency as well as the magnitude. These crises are accompanied by severe consequences, not only for the banks but also for the economy as a whole. For example, these crises caused a global accumulative output losses of 23% GDP, increases in public debts by 12.1% GDP, and a fiscal cost of 6.8% GDP during the period of 1970-2011 (Laeven & Valencia, 2012).

As a result, regulators have required banks to have more "skin in the game." By representing shareholders' benefits, bank capital motivates banks to manage risk properly and efficiently (Gale, 2010). Besides, since capital is the first absorber of losses, it serves as a cushion against bank failure and reduces the probability of bankruptcy (Allen & Santomero, 2001). From a macro-perspective, there is less likelihood of systemic risk. Government bailouts are also less likely and require smaller amounts of money. Thus the burden on tax-payers would be reduced (Admati et al., 2013).

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[1] As of 2013, there were 189 out of 194 countries adopting either implicit or explicit deposit insurance (Demirgüç-Kunt, Kane, & Laeven, 2015).

Before the Basel Committee on Banking Supervision (hereafter, the Committee)[2] introduced the risk-based capital adequacy ratio in 1988 (also known as the Basel I Accord), capital regulation was associated with minimum capital standards that were independent of bank risk. Such regulation imposed restrictions on bank growth rather than constraining their risk-taking. The risk-based capital standards under the Basel Accord, on the other hand, require banks to maintain a minimum capital ratio relative to their riskiness. In addition to enhancing the credibility and stability of the banking system, the Accord aims to reduce competitive inequalities among international bank organizations with common standards. Since Basel I establishment, the Basel Committee has regularly revised the framework to enhance the quality of banking supervision and further ensure the credibility and stability of the international banking system. The current version of Basel Accord is Basel III, which was first released in 2010 and finalized in 2017.[3]

Despite its initial target for internationally active banks, the Basel Accord soon gained acceptance and adoption worldwide. The Accord has become the standard upon which national jurisdictions establish regulations on bank capital. A 2011 World Bank (2013) report showed that capital regulation in 143 surveyed countries was aligned to either Basel I, II or Basel III (or similarly designed) principles. At the end of June 2015, 95 out of the 117 non-Basel Committee jurisdictions, had adopted, or were in the progress of, Basel III adoption (Financial Stability Institute, 2015).

However, the Accord has been criticized on many aspects, including its risk-weighting system, risk measurements and supervisory regime. For example, Slovik (2012) showed that in 1992, when the Basel rules were first applied, risk-weighted assets accounted for approximately 70% of banks' total assets. However, this ratio has gradually decreased and was at its lowest point (35% in 2008) - the beginning of the global financial crisis. This raises questions about whether the risk-weighted capital ratio accurately reflects banks' actual risk exposures. Besides, due to the risk-weighting system, securities seem to be more favorable than lending with less risk-weights assigned. This situation has contributed to the securitization of assets and the window-dressing of account balance sheets (Admati et al., 2013). Moreover, Basel regulation does not consider independent risk appetites and positions within banks. Specifically, risk-neutral institutions have to behave like risk-averse institutions. They also do not take into account portfolio variance and multiple global risk factors. Moreover, capital requirement calculations are based on the premise that capital relies only on individual asset risks, regardless of total portfolio risks (Masera, 2012).

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[2] The Committee comprises representatives of the central banks and supervisory authorities of G-10 countries (Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, the United Kingdom, and the United States) and Luxembourg. It expanded its membership from G-10 countries to 45 institutions from 28 jurisdictions in 2009 and 2014 (BIS, 2016).

[3] Appendix A provides details of Basel Accords I, II and III.

Given the high cost associated with capital, bankers usually do not favour capital over debt. In terms of interest paid to creditors, debts require less interest payments than equity. Considering the intermediation role and financial services banks provide, the payment is even lower than that of non-financial firms (Miller, 1995). Higher capital also reduces the banks' financial leverage. Given the same return, it reduces banks' returns on equity and thus, their profitability (Cai & Wheale, 2009). Besides, since interest payments on debts are tax-deductible, having more debt can reduce banks' taxable income and increase their after-tax earnings (Modigliani & Miller, 1963). This is a primary source of conflict between banks and regulators.

1.2 Rationale for the Research

The certain weaknesses in capital regulation and different perspectives about bank capital between regulators and bank managers cast doubts on the effectiveness of capital regulation. Debates about whether bank capital should be regulated or whether banks should be allowed to voluntarily establish their optimal capital levels (Aiyar, Calomiris, & Wieladek, 2015; Calomiris & Berry, 2004; Diamond & Rajan, 2000; Furfine, 2001; Mehran & Thakor, 2011; Miller, 1995); whether minimum capital requirements are the only and effective tool (Gopinath, 2010; Hanson, Kashyap, & Stein, 2011; John, Saunders, & Senbet, 2000; Persaud, 2009); the impact of capital regulation on the banking sector (Corcoran, 2010; Jakovljevi, Degryse, & Ongena, 2015; Laeven, Ratnovski, & Tong; Manlagnit, 2015), as well as its impact on the economy (Angelini et al., 2015; Distinguin, Roulet, & Tarazi, 2013; Honda, 2004; Hyun & Rhee, 2011; Juliusz, 2009; Kishan & Opiela, 2006) have not come to an end. A direct method to assess the effectiveness of capital regulation involves studying the behavior of regulated entities, which are banks. Therefore, analyzing banks' responses toward capital requirements is of significant importance.

Following the Basel Accords (Basel I, II and III), capital regulation requires banks to maintain a minimum risk-based capital ratio. This ratio is determined as a ratio of total regulatory capital over bank risk-weighted assets. Calculation of the total regulatory capital and risk-weighted assets strictly follows the requirements set by regulators. In meeting the capital adequacy requirements, banks can adjust their balance sheets which results in changes in capital and risk-weighted assets and consequently, their capital ratios. Thus, assessing bank responses to capital regulation can be approached through the capital ratio, adjustments in bank capital and risk, and adjustments in balance sheet items (see Figure 1.1).

Understanding how banks manage their capital ratios, and more broadly, the capital structure, is important as it relates not only to bank stability but also to its intermediation function (Diamond & Rajan, 2000). In addition, the strategy that banks choose in meeting capital requirements has significant implications for the macro-economy. Specifically, a bank, which desires to improve its capital ratio by raising new equity, may face higher costs due to market imperfections (Myers, 1977; Myers & Majluf, 1984). These costs are passed on to borrowers through higher lending rates (King, 2010) and consequently, constrain loan demands (Slovik & Cournède, 2011). It is not clear whether this increase in lending spread affects economic activities, but it may result in lower quality borrowers and thus increase financial instability (Martynova, 2015). If banks opt to shrink their asset size or reduce high risk-weighted assets such as loans, there may be negative effects on economic growth due to restrictions in investments to be funded, real estate and construction activities, as well as lower asset and security prices (Hancock & Wilcox, 1997; Hanson et al., 2011).

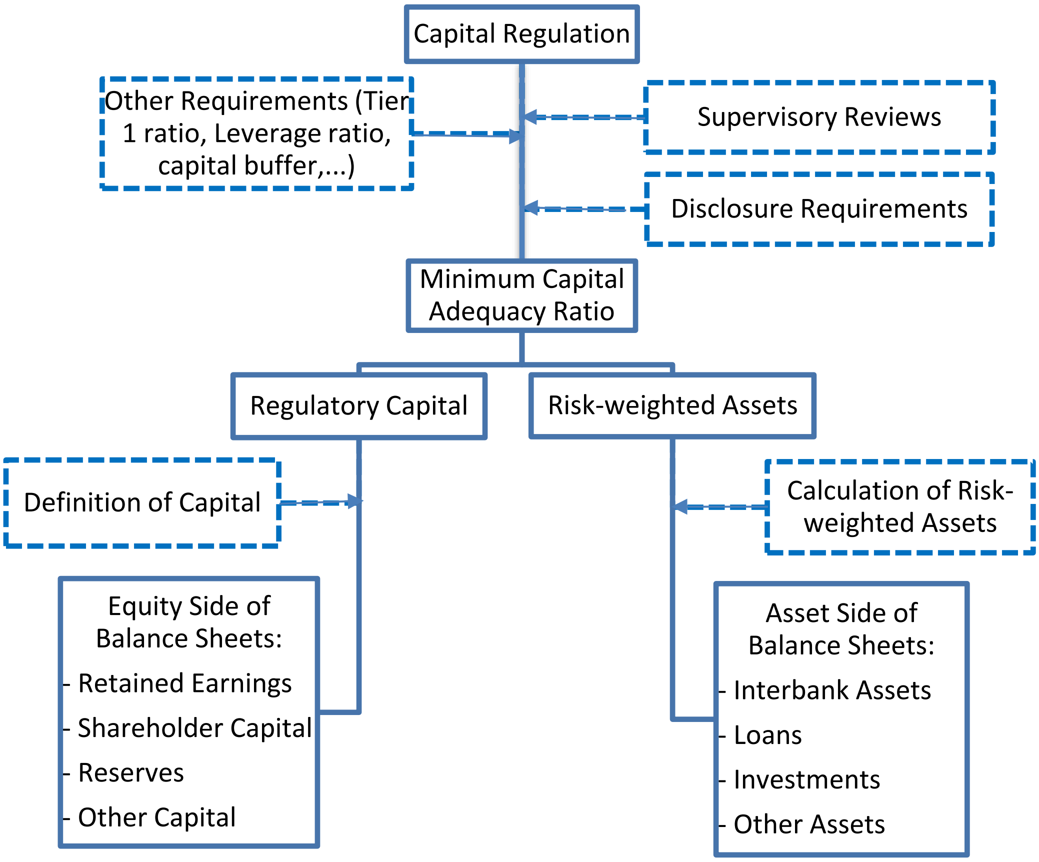

Figure 1.1 Capital Regulation and Bank Responses

(Source: Author's compilation from Basel Accords I, II, and III)

Nevertheless, there are limited studies about the effects of capital regulation on bank capital ratios and, generally, bank capital structure. The main reasons lie in the intermediary role that banks play and the heavy regulation of the industry. It is argued that bank are intermediaries whose debts, mostly in the form of deposits, are not only a source of funds but also a service that banks provide (Allen, Carletti, & Marquez, 2015). There are no other firms with as high leverage levels as banks (Berger, Herring, & Szegö, 1995). In addition, banks are heavily regulated under capital requirements. They tend to hold capital as near to the minimum requirement as possible to minimize the cost of holding capital.

In such way, bank capital is determined by capital requirements (Mishkin, 2007). However, Gropp and Heider (2010) argued that if the capital ratio is determined primarily by the capital requirement, why are there variations in bank capital ratios among banks under the same or similar capital regulation schemes. Alfon, Argimón, and Bascuñana-Ambrós (2005) and Wong, Choi, and Fong (2005) also show that banks are inclined to hold a buffer above the minimum requirement. This raises the question of whether bank capital ratios are mainly regulatory-driven.

Studies about the effects of bank capital regulation on bank capital and risk behavior, and bank balance sheet adjustments, provide mixed results. Although banks are expected to reshuffle their balance sheets in the way with more capital and/or fewer risky assets to meet capital requirements, such behavior is not always observed in empirical studies. For example, Jacques and Nigro (1997) study of U.S banks during 1990-1991 showed that capital regulation reduced bank capital and did not affect the risk-taking of capital-constrained banks. Abreu and Gulamhussen (2010) even showed that U.S banks reduced their capital and increased riskiness during the period of 2003-2006. Van Roy (2005) cross-country analysis of six G-10 countries during 1988-1995, however, revealed that Basel I capital regulation successfully forced undercapitalized banks in Canada, Japan, the U.K and the U.S to raise capital, but not in France and Italy. The authors found no evidence of the influence of capital regulation on bank risk, whether in the U.S or non-U.S countries.

In terms of bank balance sheet adjustments, several scholars have found a reduction in lending and an increase in lower risk-weighted assets, such as single-family mortgages and government securities (Cumming & Nel, 2005; Furfine, 2001; Hall, 1993; Peek & Rosengren, 1995). In contrast, several others have suggested lending expansion (Horiuchi & Shimizu, 1998; Ito & Sasaki, 2002). Similarly, Francis and Osborne (2012) and Kok and Schepens (2013) state that banks only lowered their asset growth to improve capital ratios when facing a capital shortfall. In contrast, Cumming and Nel (2005) and De Jonghe and Öztekin (2015), show that higher capital requirements did not necessarily lead to asset reductions. Banks still maintained asset growth rates and focused on increasing equity levels. In addition, whether banks reach the required capital adequacy ratio through high quality or low quality capital is unclear.

Studies on the effects of capital regulation on bank behavior primarily focus on developed countries, particularly the U.S and Europe (EU), while Asia has received limited attention. Asian economies are different from the U.S and EU in many ways. Specifically, the Asian banking system is less sophisticated and developed compared to its peers in the U.S and the EU. Traditional banking services, such as lending and mobilizing deposits, are still the main activities in Asian banking and interest income accounts for about two-third of most banks' income (Sahay, Lim, Sumi, Walsh, & Schiff, 2015). This characteristic partly explains why they suffered less than their counterparts during the 2008 global financial crisis. During this period, Asian countries led global economic growth, with positive and high GDP growth rates (averaging 5.85%), while the U.S and most economies in the EU evidenced a negative and slow growth rate (less than 1%). Although the banking system plays an important role, providing 72.53% domestic credit to the Asian economy, its size and contribution is smaller than the EU (bank assets account for 100% of GDP and domestic credit provided to the private sector is 82.51% of GDP). In addition, the Asian capital market is much smaller and less active than the U.S market. The average size of the Asian stock market is 110.82% of the total GDP with trading value at 47.18%. In the U.S stock market, these statistics are 146.19% and 236.88%, respectively (World Bank, 2018b).[4] Given these different characteristics and the role of banking in Asia (compared to the U.S and EU), it is doubtful that the findings for these countries are also applicable to Asia. Asia is also more convergent in implementing Basel standards; second to European countries (Seal, 2015). Thus, it is necessary to examine Asian banking systems further.

1.3 Research Objectives

This research investigates the effects of capital regulation on bank behavior in Asia, specifically in terms of the capital ratio, the adjustment of capital and risk, and the adjustment of balance sheets. The research objectives are:

1) To examine the effects of capital regulation on capital ratios of Asian banks

2) To examine how Asian banks adjust their capital and risk in response to capital regulation

3) To examine how capital regulation affects Asian banks' balance sheet adjustments

To answer these questions, we empirically examine banks in 20 Asian countries, over the period of 2001-2016. This period captures several changes in bank capital regulation with the introduction of Basel II in 2004 (revised in 2006), and the introduction of Basel III in 2010 (revised in 2011).

1.4 Significance of the Research

This research contributes to literature on the impact of capital regulation on bank behavior in several ways:

First, we acknowledge the importance of a proper measurement of capital regulation in assessing its effectiveness. Nonetheless, except for the Capital Regulation Index (CRI) developed by Barth, Caprio, and Levine (2001), existing measurements assess capital regulation quantitatively. These measurements usually employ a minimum capital requirement and compare it with banks' actual

[4] Average data for Asia is calculated from World Development Indicators (World Bank, 2018b) for countries in East Asia, Central Asia and South Asia. Taiwan is not included.

capital ratios to assess the regulatory pressure caused by capital regulation (for example, see Teply and Matejasák (2007)). However, the quality of capital, the type of capital (that is, Tier 1 and Tier 2) and the qualified capital instruments matter as well. This explains why an 8% minimum capital requirement in a country, where the capital regulation does not allow for goodwill, for instance, to be included in the total regulatory capital, can be stricter than a country without such restriction. Therefore, to reach the same 8% capital ratio, banks in the latter case have to accumulate other types of capital instead. Although Barth et al. (2001) CRI index takes this into consideration, the index cannot avoid certain limitations, such as the unavailability of data for many countries in Asia and data gaps in years without surveys. Our study develops a new capital regulation measurement, named the Advanced Capital Regulation Index (ACRI), to reflect both quantitative and qualitative aspects of capital regulation. This index uses national legal documents on capital regulation instead of surveys and thus, overcomes the limitations of Barth et al. (2001) CRI index. In addition, the construction of the ACRI index closely follows the requirements of Basel III and better covers Basel Accords' requirements rather than just capital and risk determination. Thus, the new index is a good proxy for capital regulation. We apply this new index in assessing the effects of capital regulation on bank capital ratios, bank capital and risk behavior, and bank balance sheet adjustments, corresponding to the three research objectives outlined above.

Second, to the best of our knowledge, there are no cross-country studies on the effects of bank capital regulation on capital ratios in Asia. The few studies that have examined this effect in Asia, did not consider the dynamic nature of the capital ratio (see for example, Bokhari, Ali, and Sultan (2012); Wong et al. (2005); Zahid, Anwar, Aqdas, and Goraya (2015)). We take this issue into account by using the Partial Adjustment Model (PAM). We also address the endogeneity caused by this dynamic nature using the System Generalized Method of Moments (GMM). Given the limited research on capital ratios in Asia, we further explore how other bank characteristics and country environments affect bank capital ratios in this region.

Third, in contrast to previous studies on the effects of capital regulation on bank capital and risk, our study recognizes the importance of bank fixed effects in modelling bank capital and risk behavior. Such effects are usually disregarded, since bank capital and risk behavior are approached through their adjustments and unaffected by bank fixed effects, such as risk preferences (Shrieves & Dahl, 1992). However, as Koehn and Santomero (1980) have noted, low risk-averse institutions reshuffle their balance sheets to a greater extent than their more conservative counterparts. This suggests that bank fixed effects, such as risk preferences, are important and cannot be ignored. Given the existence of bank fixed effects, we also examine the effects of capital regulation on bank capital and risk in their levels using the Simultaneous Equations Model with partial adjustment (SEM-PAM). Although several previous studies have examined bank capital and risk in their levels, they failed to model them properly. Specifically, Bouheni and Rachdi (2015) and Bougatef and Mgadmi (2016) did not consider the partial adjustment of capital and risk. In an imperfect market, the assumption that banks incur no cost in changing their capital and risk is not practical. This cost of adjustment is also one of the motivation for banks to hold a capital buffer above the minimum requirement (Peura & Keppo, 2006). Similarly, Parinduri and Riyanto (2011) ignored the simultaneity between bank capital and risk. In a regulatory environment with risk-based capital requirements, banks cannot decide the amount of capital independently from the amount of risk, and vice versa. This inter-relationship between bank capital and risk has been recognized and confirmed in many studies (see for example, Jacques and Nigro (1997); Rime (2001); Shrieves and Dahl (1992)).

Fourth, we raise concerns about the simultaneity in management decisions of balance sheet components. For instance, the decision to adjust a balance sheet item, such as retained earnings, is dependent on the adjustment of other balance sheet items, such as shareholder capital, loans, and investments, and vice versa. While simultaneity has been discovered and widely accepted for capital and risk adjustments since Shrieves and Dahl (1992) study, it is usually ignored in studies on balance sheet management. Cohen and Scatigna (2016) and Matejasák (2015a, 2015b) show some promise in decomposing the elements of risk-based capital ratio. However, these studies are descriptive in nature and do not clarify the effects of capital requirements.

Fifth, this study contributes to existing literature on the effects of capital regulation by providing empirical evidence on bank behavior in Asia. We utilize a large dataset comprising banks from 20 Asian countries. This cross-country analysis enables us to better understand bank behavior by taking into account the heterogeneity among banks and countries, while retaining regional characteristics. We also notice that our study includes a wide range of countries that differentiate themselves in terms of their levels of economic, financial, and regulatory development. We take into account these factors by investigating bank behavior in countries with similar market characteristics (that is, based on the classification of the country as developed, emerging and frontier) and bank capital regulatory environment (based on whether the country is a member of Basel Committee of not). We also test whether bank behavior is different across these country groups. To the best of our knowledge, no such tests have been formally conducted before.

Given these considerations, the results of this study will provide a detailed picture about the way banks respond to stricter capital regulation. On this basis, bank regulators can gain insight into whether, and to what extent, capital regulation, and more specifically, the Basel Accords, are effective in disciplining banks. In a context where capital regulation possesses certain weaknesses and in need of improvement, this study provides important information, which will help regulators design better capital regulation to achieve their macro-prudential objectives.

1.5 Organization of the Thesis

The remainder of the thesis is structured in the following manner. Chapter 2 reviews related literature about bank capital regulation and its effects on bank behavior. Chapter 3 discusses the research methodology and data used for the study. Chapter 4 presents empirical results about the effects of capital regulation on bank capital ratios, which corresponds with research objective 1. Chapter 5 discusses empirical results on the effects of capital regulation on bank capital and risk behavior, which corresponds with research objective 2. Chapter 6 outlines the results on the effects of capital regulation on bank balance sheet adjustments and corresponds with research objective 3. Chapter 7 concludes the thesis with a discussion of policy implications, limitations, and directions for future studies.

Chapter 2

Literature Review

2.1 Introduction

Bank capital refers to the funds contributed by bank owners. These funds are used to cover bank assets or finance bank tasks (Rose, 2013). This capital is important as it represents shareholder benefits and induces banks to manage risk properly. This effect is of great significance due to banks' interconnectedness, which quickly spreads the failure of a specific institution over the whole system. In addition, when the loss occurs, bank capital acts as the first absorber of loss and reduces the probability of a bankruptcy. This can eventually reduce the likelihood and amount of any government bailout, as well as the tax burden on citizens (Admati et al., 2013; Aiyar et al., 2015).

However, banks do not like holding high levels of capital. It is traditionally believed that capital is expensive. In other words, there are costs associated with holding higher levels of capital. Therefore, banks' choice for capital and debt levels, depends on the trade-off between their related costs and benefits (*trade-off theory*) and/or bank preference (*pecking-order theory*). In addition, due to heavy regulation, banks' determination of capital and debt is also affected by regulation, particularly capital regulation. Theories explaining banks' choice of capital structure are discussed in Section 2.2.

Capital regulation is expected to induce banks to have more capital and/or fewer risky assets. However, such effects are not always supported. In meeting capital requirements, banks can adjust their capital and/or risk, and thus, change balance sheet components. The strategies banks choose have significant implications for the macro-economy. For example, banks can reduce their risk-weighted assets by reducing mortgage lending. This can limit the investment to be funded and consequently, slow down economic growth (Hancock & Wilcox, 1997; Hanson et al., 2011). Section 2.3 reviews theoretical studies on bank behavior in response to capital regulation. These include changes in capital levels, asset portfolios, and overall risk. Sections 2.4 to 2.6 examine empirical research on the effects of capital regulation on bank capital structure, bank capital and risk, as well as bank balance sheet components. Since conclusions about the effects of capital regulation on bank behavior are largely affected by the measurement of capital regulation, a review of different measurements of capital regulation is provided in Section 2.7. From these reviews, section 2.8 identifies literature gaps and section 2.9 outlines the conceptual framework.

2.2 Theories of Capital Structure in Banks

Theories of capital structure in modern corporate finance can be traced back to Modigliani and Miller (1958) proposition (M&M), which states that in a frictionless world and complete market, a firm's market value and thus, the average cost of capital is independent from its capital structure. This is also referred to as the irrelevance capital structure proposition. Given the different nature of banks (from non-financial firms), in terms of their special functions and services provided, one question has raised for over half a century that whether the M&M theory can be extended to banks.

Miller (1995) discusses this issue and states that the M&M proposition still held for banks, but to some extent. First, the author points out that although equity is expensive to raise, especially for small banks, with regards to the cost of raising capital, such as flotation or underwriting cost, the M&M proposition is concerned with holding equity, not raising equity. Second, despite differences in demand deposits – a major source of bank funds – and corporate securities, particularly in term of interest payments, any large, well-known firm could issue similar riskless demand deposits (for example, Merrill Lynch and IBM). What makes demand deposits special are the government guarantees, which are not found in other corporate securities. However, some bankers have complained about the offset effect of insurance premiums on benefits gained from the guarantee. Hence, the subsidy effect of government deposit insurance remains un-confirmed. Third, Miller affirms the M&M irrelevance of capital structure on banks' capital costs and their value. He states that equity costs are not a fixed number (for example, 12%), but that they depend on individual bank risk levels and the degree of leverage. Thus, banks with risk levels lower than the average systematic risk, or lower levels of leverage than the average level, could have lower cost of equity (for example, 6%), instead of the nominal rate (12%). This shows that equity is not costly to have. If this bank has a return on assets at 8%, its market value will be 1.3 times higher than its book value. If increasing debt levels, for example deposits whose interest rate is just 4%, the market value would remain the same. This is because the benefits gained from higher leverage are not enough to compensate for the associated risks. Fourth, while it has been argued that the M&M proposition is not applicable to banking, as evidenced by the no all-equity banks existing in practice, Miller states that this kind of capital structure does not exist anywhere else.

The M&M proposition is only held in a frictionless world, which is too ideal to exist in practice. Since the real market is imperfect with taxes, transaction costs, and information asymmetry, particularly government guarantees for the case of banks, substantial efforts have been focused on departures from the M&M theorem. Relaxing one or more assumptions of the M&M proposition leads to an optimal capital structure. Two theories explaining non-financial firms' choices of optimal capital structures, which can be applied to banks, are the Trade-off and Pecking Order theory.

2.2.1 Trade-off Theory

According to the trade-off theory, banks make decisions about financing options based on their relative costs and benefits. An optimal capital structure is obtained when marginal costs equal marginal benefits (Kraus & Litzenberger, 1973). Traditionally, researchers have been concerned about the tax-shield advantage, as the main benefit of having more debt, and financial distress as its cost. Interest payments on debts are tax-deductible, having more debt will help reduce banks' taxable income and increase its after-tax earnings (Modigliani & Miller, 1963). However, having more debts also increases the cost of financial distress. As debts are legal obligations, banks face financial distress that could eventually lead to bankruptcy if payments are not met in due time (Kraus & Litzenberger, 1973). Thus, this cost creates a disincentive for debt financing that offset its tax advantages.

Several scholars have analyzed the trade-off effect of financial distress and the debt advantage in a static framework using the one-period model (Bradley, Jarrell, & Kim, 1984; DeAngelo & Masulis, 1980; Kim, 1978; Kraus & Litzenberger, 1973; Scott, 1976). However, two problems arise from this static framework. First, the framework neglects the role of retained earnings, which can be accumulated and increase the capital ratio. Second, the framework suggests a closed solution for determining a firm's optimal capital ratio. In addition, it does not allow the firm's capital ratio to deviate from this optimum level. These reasons provide scope for the development of the dynamic trade-off theory, which considers the determination of capital structure in a multi-period and continuous framework (Frank & Goyal, 2007).

Kane, Marcus, and McDonald (1984) and Brennan and Schwartz (1984) were the first to consider whether a firm's capital structure could vary rather than remain at the optimum level . A firm's value is determined through a multi-period process and there are boundaries beyond which the firm will re-optimize its debt position. However, these studies assume that capital structure can be rebalanced freely, which may be unrealistic. Myers (1984) identifies this problem by showing that there is a diversity in firms' observed debt ratios. The author argues that it is necessary to clarify whether these differences are caused by different optimal debt ratios or divergence from the optimum. Adjustment costs seem to explain this wide variation and hence, the observed debt ratio is not the firm's target ratio. Instead, there is a deviation from the optimal level.

Taking this adjustment cost into consideration, Fischer, Heinkel, and Zechner (1989) develops a dynamic capital structure model, which allows a firm's capital structure to change over time. There is a set of boundaries, in which any capital structure was optimal. Firms would restructure their capital structure anytime it fell out of the boundaries. A lower bound is the point at which the leverage is so low that the firm passes a substantial amount of tax shields, while the upper bound is the point at which leverage is so high that the firm could go bankrupt. However, the decision about when a firm reaches these boundaries depends on the cost of recapitalization. The authors showed that even a small recapitalization cost could delay rebalancing and would led to a wide variation of debt ratios over time. The model's numerical solution reveals the negative relationship between the variation of debt ratio with firm size, net tax advantage and bankruptcy cost, and positive relationship with the firm's risk characteristics.

Mauer and Triantis (1994) investigate the effect of investment policies on firm financing policies, as well as the interaction between them, as suggested by Brennan and Schwartz (1984), but in the presence of adjustment costs. Accordingly, an optimal capital structure is determined by the trade-off between debt tax advantages, recapitalization, and financial distress cost. The smaller the operating adjustment costs (which reflect production flexibility), the higher and less varied the firm's average debt ratio. However, there is a substitute effect between operating adjustment costs and recapitalization costs, which lessen the benefits of operating adjustment costs on the firm's tax shield advantage. Nevertheless, when a firm can increase debt in the future, the initial optimal leverage ratio would be lower, since firms wait for the value to rise before increasing debts (Goldstein, Ju, & Leland, 2001). With the existence of real frictions, such as the wedge between the buy and sell price of capital, and the fixed cost of investment, Tserlukevich (2008) further shows that firm leverage ratios will revert to the mean value, with gradual and uneven adjustments.

Another kind of cost that can be weighed against debt's tax advantages is the agency cost. Jensen and Meckling (1976) propose two kinds of agency conflicts faced by any firm; these are shareholder-manager conflicts and equity holder-debt holder conflicts. The conflict between managers and shareholders arise when managers hold less than 100% of equity. In this case, they do not receive the entire benefit from maximizing their own utility yet bear the full cost. This generated the divergence in the interest of managers and shareholders when managers are indulged to maximize their own utility rather than the firm value. They tend to transfer the firm' resources into their own benefits and be less motivated to seek for new profitable investment to avoid personal costs. Jensen and Meckling (1976) suggest that increasing debt would lead to the convergence of these entities' interests due to an increase in the manager's fraction of equity. Moreover, an increase in debt also reduces managers' available cash flows so that they can pursue their own interests.

Morellec (2004) affirms the role of manager-shareholder conflict in explaining low debt levels observed in practice and in variations of capital structure across firms. The analysis also shows that entrenched managers would issue less debt than the optimal level whereas those with lower degrees of entrenchment tend to be threatened by the control challenge and thus, are more motivated to increase their leverage. The author also illustrated the effects of various determinants on leverage choices. For instance, constrained leverage levels will increase with higher levels of volatility because high volatility not only increases the bankruptcy cost but also the possibility of managerial entrenchment. However, if growth options are increased, which implies a decrease in overinvestment costs, constrained leverage levels will drop.

While increasing debt helps align the interests of shareholders and managers, it raises a second kind of conflict; between equity holders and debt holders. Due to limited liabily, equity holders are induced to take excessive risks as they capture most of the gains in the success state. However, debt holders bear the cost in the failed case. Rational debt holders who perceive the probability of this behavior will demand higher interest rates and thus, make the debt costly. The optimal capital structure is then the trade-off between the benefits of debt in reducing the shareholder-manager conflict and the cost of debt financing arising from the equity holder-debt holder conflict (Jensen & Meckling, 1976). Nevertheless, some authors suggested these agency problems could be reduced with the use of appropriate managerial incentives schemes (Barnea, Haugen, & Senbet, 1985; Brander & Poitevin, 1992; Dybvig & Zender, 1991). On this basis, Atkeson and Cole (2005) indicated that determining an optimal capital structure became the problem of choice to pay outside investors and the managers to balance information and agency frictions.

2.2.2 Pecking Order Theory

Myers (1984) and Myers and Majluf (1984) are well known for the pecking order theory which states that there is no target capital structure. In choosing financing policies, firms prefer internal to external financing. If external financing is required, debt is preferable. The rationale behind this order can be explained by the information asymmetry. First, external financing is costly in term of administrative and underwriting costs. Asymmetric information can create opportunity costs when firms choose not to raise external funding and lose the chance to take up profitable investments. However, these costs are not considered if firms have enough internal cash to take up investments. Second, when firms raise external financing by issuing shares, they can either underprice or overpriced as firm information is private to the managers. An issuing decision is only made when the net present value from the investment project is larger than, or equal to, the value of underpriced/overpriced shares. Thus, firms will issue securities with the lowest possibility of value change, when current private information is released in the future. If the firms have favorable information, which makes the shares underpriced at the time of issuing, it will not issue shares and revert to debt instead. If the future's information is unfavorable, which makes the shares overpriced, firms will issue as many shares as possible to maximize this benefit. Given that firms only issue shares when they are overpriced, investors will not buy them unless firms have issued enough debt. Consequently, firms are forced to follow the pecking order when additional financing is required.

Myers and Majluf (1984) add that default-risk-free debt acts as internal financing in its readiness to fund any profitable projects. For other kinds of debts (those that banks regard as risky), they have less average opportunity losses than equity financing and thus, are preferable. Myers (1984) and Myers and Majluf (1984) pecking order theory explains the substantial use of debt for external financing. In particular, it shows the negative relationship between a firm's profit and lending. Less profitable firms have less internal financing available and thus, have to rely on external financing and accumulate debts.

Noe (1988), however, analyzes Myers and Majluf (1984) and Myers (1984) pecking order hypothesis in a signaling game context. The author shows that the pecking order's choice of capital financing is only true when managers have perfect information about a firm's future cash flows. Otherwise, when managers face residual uncertainty, there is an option to the default on debt. This option value is higher for lower-quality firms that have a higher probability of default with debt in the future. These lower-quality firms will try to misprice the debt. If higher-quality firms also issue debt, it may incur mispricing losses due to the pooling of debts with those from lower-quality firms. Therefore, they choose to issue equity instead, to avoid this process of dilution. However, they found no unique pattern for financing options of different firm quality. On average, lower-quality firms finance their assets with equity while higher-quality firms finance with debt.

Considering firm financing choices in a dynamic framework, Viswanath (1993) shows that firms decide to finance new investments, based not only on the dilution of undervalued securities, but also on possible losses of future projects. This leads to a violation of the pecking order by demonstrating that firms might issue equity to finance current projects despite the availability of internal cash flow. In addition, if information about the profitable future projects is available to the market, the degree of undervaluing new equity will be less.

Myers (1984) and Myers and Majluf (1984) pecking order theory begins with established firms with assets-in-place. Considering cases, normally start-ups or IPO firms, when managers create projects and acquire funds to carry out them, Ravid and Spiegel (1997) declare that outside investors only buy securities that do not induce firm managers to take on bad projects (in terms of net present value). Capital financing will, therefore, be a combination of riskless debts and equity. The choice of debt and equity depends on collateralizable assets, project quality, as well as the firm's risk aversion. In particular, the pecking order holds when a firm has a profitable project and is either risk-neutral or has high expectations of future payments.

The pecking order can also be inferred from Jensen and Meckling (1976) agency theory. Prior to this, the preference for internal to external financing was attributed to the avoidance of market disciplines of managers (Myers, 2003). Given the existence of debt holder – equity holder, as well as shareholder

– manager conflicts, a firm with a manager as an owner will use its own capital to finance new assets before turning to external financing. By so doing, s/he can avoid agency costs arising with debt or new equity issuance. After using up all internal sources, if there is still a financing deficit, the manager will choose between issuing debt and new equity. With the use of debt, managers tend to take on risky investments, as the cost of failure is partly borne by creditors. This leads to a redistribution of wealth between creditors and firm managers. As debts increase, there is an increase in the default risk. Creditors who know that the firm will take risky investments will also require higher interest rates to compensate for the risk. These factors force the firm to shift toward outside equity financing. Outside equity is the least preferred option. Since managers bear only part of the cost when maximizing firm utility, they are induced to take larger firm resource for private benefit. This encourages new shareholders to spend more resources on to monitoring the manager's activities. The share price that new shareholders are willing to pay will reflect both this monitoring cost and interest divergence. Thus, the wealth costs of the manager in obtaining additional equity increase. As long as the welfare gained is large enough to offset these costs, issuing equity is still desirable.

2.2.3 Government Guarantees and Capital Regulation

As noted in Miller (1995) discussion on the extension of the M&M proposition to banks, what makes banks unique is the interference of the government. In order to ensure the safety and soundness of the banking system, the government provides banks with safety nets, including deposit insurance schemes, payment guarantees, and discount windows. They also regulate and supervise bank activities (Berger et al., 1995).

Given their special function as financial intermediaries, banks always operate with much higher levels of leverage than non-financial firms. Such high leverage is normally accompanied with a higher probability of financial distress. In non-financial firms, debt holders can demand higher interest rates to cover these risks. They can also establish limits for a firm's future borrowings, as well as the type of debts they can hold and restrictions on firm's operations (Gup, 2005). Debts, in the form of customer deposits, can create market discipline that threatens banks with bank runs anytime depositors are suspicious about banks' business (Diamond & Rajan, 2000). However, banks are less affected by these factors due to the existence of deposit insurance. This deposit insurance creates a subsidy for banks' debts, mostly in the form of deposits, but this depends on the price of the insurance.

Buser, Chen, and Kane (1981) illustrate the effects of government deposit insurance on bank value, which affects its optimal capital structure. Specifically, when there is no charge on deposit insurance, the bankruptcy cost does not exist, as the debts are fully paid by the government when banks fail. Banks will thus increase debt to the maximum level to exploit the insurance benefits. This practice consequently leads to the extreme case of all debt – no equity. A "fair-value" insurance premium will help to exhaust this subsidy effect (Merton, 1977; Sharpe, 1978). However, Diamond and Rajan (2000) claim that if all deposits are insured, even with fair-priced premiums, they were indifferent from capital, as no cost of financial distress will occur. Thus, they suggest not providing insurance for all deposits. As long as there are some deposits uninsured, there will be market discipline, and these will create the cost of using deposits.

As the government's main objective is to ensure the safety and soundness of the banking system, a fair-priced insurance premium means banks are less likely to join the deposit insurance scheme. Therefore, the premium charge should be an acceptable amount that offers banks an opportunity to reach a higher value than that of an uninsured bank (Buser et al., 1981). Therefore, the regulators use other government interference mechanisms such as capital requirements to extract the implicit premium of deposit insurance from banks. In order to meet regulators' capital requirements, banks incur compliance costs, such as the costs of reporting or managing the banks' portfolio. Therefore, the optimal capital structure is determined by trading off the benefits of deposit tax and the net regulatory costs (Gup, 2005). Insured banks' value will be lower than that of an uninsured bank if it has inadequate capital to cover its default risk. As long as banks keep adequate capital levels, as required by the regulators, they can exploit benefits from the deposit insurance scheme (Buser et al., 1981).

2.3 Theories of Bank Behavior under Capital Regulation

When analyzing the impact of capital regulation on bank behavior, some factors should be taken into account. These include the problem of moral hazard, franchise value, agency problems and capital buffers. The effect of these factors can be studied either separately or together to understand the way banks response to capital requirements.

2.3.1 Moral Hazard Theory

Jensen and Meckling (1976) argue that equity represents a call option on the banks' portfolio. This implies that shareholders' profits are unlimited, while the amount of potential losses is limited. Thus, by decreasing the level of capital and investing in risky assets, banks can increase the value of this call option at the cost of depositors. However, banks are relationship lenders, who issue demand deposits to provide capital to finance firms' projects. On one hand, the increased deposits help to create liquidity that permit banks to extend credit. On the other hand, they threaten banks with withdrawals upon demand and thus, discipline bank behavior (Diamond & Dybvig, 1983). If information is not equally distributed, depositors cannot fully assess the riskiness of banks' portfolio and equity holders have incentives to increase their risk and leverage levels (Jensen & Meckling, 1976). This excessive risk-taking behavior is often regarded as a moral hazard problem, described as "the incentives of one party to a transaction to engage in activities detrimental to the other party" (Mishkin, 2015, p. 421). Thus, the capital regulation is expected to reduce this moral hazard.

Adopting a single period mean-variance model, Kim and Santomero (1988) argue that risk-based capital requirements will establish limits on the bank's expected return on equity capital and alter its choices of risk and return. Consequently, banks hesitate to extend credit to assets with high risk-weights and shuffle their asset portfolios toward safer and less risky assets. However, if capital regulation was a flat-based ratio, the conclusion does not differ from Kahane (1977) and Koehn and Santomero (1980) findings. Specifically, with given assets' risks and returns, banks would change the composition of their portfolios to maximize the expected utility. However, imposing a leverage constraint on the ratio of liabilities and equity does not prevent banks from reaching excessive risk levels because they are forced to hold non-optimal portfolios in which they reached the same expected return with higher risks. The degree of portfolio adjustment depends on banks' risk aversion. Consequently, the effect of capital regulation on the overall soundness of the banking industry is dependent on the underlying distribution of risk aversion across banks. The authors suggest that capital requirements are not sufficient in reducing the probability of bank failure and that asset regulation should also be regulated to meet the supervisory authorities' objectives.

The above studies, however, do not consider the effect of the deposit insurance, which is a common form of regulation in banking. The government provides deposit insurance to improve depositors' confidence in the banking system and stabilize the financial system. Deposit insurance has helped reduce the average number of bank failures to less than 15 per year (over the period of 1934-1981) and is now widely applied in many countries (Mishkin & Eakins, 2006). As of 2013, 189 out of 194 countries have either implicit or explicit deposit insurance (Demirgüç-Kunt et al., 2015). However, deposit insurance removes depositors' risk of investing in banks. Thus, they lose incentives to monitor bank behavior.

Merton (1977) argues that deposit insurance can be regarded as a put option, which means that the bank can exploit this option's value by increasing risk and leverage. Neglecting the option value of deposit insurance can distort conclusions about the effects of capital regulation on bank behavior (Keeley & Furlong, 1990). Adopting Merton (1977) option pricing model, Flannery (1989); Furlong and Keeley (1989); Keeley and Furlong (1990) conclude that increasing capital requirements will reduce banks' gains from increasing its portfolio risk and thus, lower the banks' incentive to increase its asset riskiness. Moreover, these banks will be able to meet the higher capital requirements partly by raising capital rather than by merely shrinking assets and retiring deposits (Furlong & Keeley, 1989). In such a way, banks could maximize their asset volume and thus, the value of the deposit insurance subsidy. Embedding this insurance put option value into the traditional risk-aversion framework, Flannery (1989) adds that if capital regulation was combined with loan regulation, insured banks would prefer relatively low-risk individual loans.

Cooper and Ross (2002) analyze the costs and benefits associated with deposit insurance and capital requirements on reducing bank moral hazard. They show that deposit insurance reduces depositors' incentives to monitor the bank and that banks are induced to invest in excessively high risk assets. However, an adequate amount of capital can reduce bank managers' likelihood to gamble with their debts and reduce their risk preferences.

The aforementioned studies have so far ignored one important underlying source of moral hazard; the limited liability of banks. Taking this factor into consideration, Rochet (1992) claims that capital ratio constraints could induce banks to choose very "extreme" asset portfolios with specialization in some assets. This negative effect eventually dominates the risk aversion characteristic and even correct risk weights could not prevent banks from inefficient asset allocations.

Gjerde and Semmen (1995) analyze both risk-based capital requirements and leverage requirements on insured banks. They show that under leverage restrictions, bank managers maximize both leverage (up to the regulator's restrictions), and the asset risk to exploit the maximum benefit of the deposit insurance. However, the total bank value is a negative function of the risk-based equity ratio. The higher risk-based equity ratio reduces possible investment in riskiest assets, and thus, lowers the value of deposit insurance. Therefore, with a constrained amount of equity, banks will be able to minimize their leverage and invest in higher risk assets. When the amount of equity is not constrained, bank managers can raise equity until all funds are invested in the riskiest assets. Therefore, either minimum leverage ratio or risk-based capital ratios are efficient in regulating bank risk if the risk weights are optimal. However, if there are suboptimal risk weights (which is very likely in practice), a combination of both capital ratios are necessary to control bank portfolio risk.

Arguing that evaluating and monitoring loans are costly, Gennotte and Pyle (1991) depart significantly from previous research by assuming that bank assets are non-zero net present value investments. Therefore, loan cost is an increasing and convex function of asset risk and the level of investment. When exploiting the benefits of deposit insurance subsidy, banks expand the size and risk of their asset portfolio up to the extent that the negative value of the loan offset the marginal increase in the deposit insurance subsidy. In such way, deposit insurance encourages banks to take on inefficient investments. The authors show that in certain circumstances, increasing capital requirements led banks to simultaneously reduce levels of investment and offset decreases with an increase in asset risk. In these cases, bank asset portfolios are comprised of both relatively safe assets and risky assets with a higher fraction invested in the riskier assets.

Concerned about lending costs, Thakor (1996) argues that an increase in risk-based capital requirements elevates the cost of loan funding, including both pre-lending (screening) and post-lending (monitoring) costs. When operating in a competitive environment, banks cannot transfer these costs to the borrowers. Thus, binding capital requirements diminish banks' expected profits. This will increase the probability of credit screening and denied credit, as well as credit quality. Besides, due to higher funding costs, lending will become less attractive in comparison to government securities, which incur no capital requirements. As a result, bank will reduce their lending and invest more in government securities, which results in lower default risks.

Calem and Rob (1999) argue that static framework, as in aforementioned studies, might neglect the intertemporal consequences of risk-taking behaviors of banks and preclude cross-sectional predictions of banks with different capital positions. They develop a dynamic model, which allows for variations of individual bank capital positions over time and across banks to predict bank risk-taking behavior under the capital regulation. In this model, banks operate in a multi-period setting and aim to maximize the discounted value of their profits. In each period, based on a specific capital position, banks will determine their portfolio by choosing between safe and risky assets. From this portfolio choice, banks' returns are realized. This realization of returns, together with the pre-existing capital position, will determine the next period's capital position. The process is carried out in such a way that banks face the same portfolio choice with different capital positions in each period, and equivalently for different banks with different capital positions. Calibrating the model using empirical data from U.S banks over the period of 1984-1993, the authors show that under increasingly stringent capital requirements, bank risk taking levels depend on their current capital position with a roughly U-shaped relationship. Bank risk taking is restrained only if the risk-based capital standard is stringent enough.

In terms of the dynamic of capital regulation, Blum (1999) analyzes the effect of multi-period capital regulation. The author shows that if a bank faces capital requirement only in the first period, it will decrease its risk levels due to an increase in equity. However, tightening capital ratios in the second period generates two possible effects. First, it lowers banks' expected profits. Bank managers are induced to take more risks with the perception that they have less to lose in the case of bankruptcy. Second, binding regulation increases marginal returns on risk and reinforces the first effect. Consequently, the overall risk of regulated banks increases. Silva (2007) completes Blum (1999) model by providing the computed values of the threshold requirements for which the risk chosen by the bank converges to the zero bankruptcy cost and social optimum. These values, in turn, depend on the banks' initial equity. The author confirms that constant capital requirements can efficiently reduce bank risk taking and thus achieve zero bankruptcy costs as well as socially efficient levels of risk. However, this effect requires a very high level of capital requirement, which may not be practical.

Building on the intertemporal effect of bank capital regulation, rather than focusing only on the minimum capital requirement (Pillar 1 under Basel II), Decamps, Rochet, and Roger (2004) consider its interaction with the other two pillars, namely supervisory (Pillar 2) and market discipline (Pillar 3). They discover that banks lack incentives to monitor their investments when they are insufficiently capitalized. Minimum capital requirements (Pillar 1) play the role as a closure threshold to prevent these banks from monitoring absence. However, due to information asymmetry, the value of bank assets is only known to regulators if they conduct intensive supervision. In order to avoid such costly audits, the regulator has to set higher capital requirements than publicly observable. This suggests a substitution between supervision (Pillar 2) and capital requirements (Pillar 1). With market discipline (Pillar 3), the tension of regulatory intervention can be reduced as long as banking supervisors are protected from political interference.

Kopecky and VanHoose (2006) note that in the real world, not every bank is capital constrained. They examine the effects of capital regulation when these requirements bind only a subset of banks. The analysis shows that the enforcement of capital requirements partially on the banking system can lead to a reduction in the proportion of banks that monitor their borrowers, as well as a slight decrease in aggregate lending. In general, it does not necessarily lead to higher quality loans.

Zweifel, Pfaff, and Kühn (2015) re-confirm the negative effects of capital regulation on bank default risk, using a model to depict the behaviors of a representative bank under the requirements of Basel Accords (that is, Basel I, II and III). Assuming a bank targeting at risk-adjusted return on capital maximization (RORAC), bank optimal capital level will be determined through a three-stage process. In the first stage, the bank faces exogenous shocks on expected returns and volatility, which affects its solvency level adjustment in the second stage in a way of maximizing the RORAC. In the third stage, the bank will rebalance its assets in response to changes in the solvency level by choosing new values for expected returns and risk. They form an internal efficiency frontier with its slope depending on the capital regulation, such as Basel I and Basel II. Against the expectation that these regulations can reduce the slope of the efficient frontier (that is, banks chose lower expected returns and volatility), the study shows that both Basel I and Basel II may lead banks to choose higher risk positions than they would otherwise. The risk is likely to increase even in the case of Basel III regulation.

Conversely, Bhatta (2015) considers the effects of moral hazard, monitoring costs and exogenous shocks in affecting the borrower's project in a dynamic model of borrower and lender behavior under capital regulation. The author shows that the banks' profit not only depends on the interest rate but also the probability of loan default over time. An increase in capital requirements will thus induce banks to spend more efforts on monitoring loans to reduce this loan loss probability. Therefore, bank lending inefficiency will decrease and financial stability will be preserved. Even if there are moral hazard incentives from the borrowers, increased monitoring efforts due to intensive capital requirements are helpful in lowering the amount of bad loans.

2.3.2 Franchise Value Theory

Under the moral hazard framework, capital regulations induce banks to increase capital and reduce risk. However, results do not always support this hypothesis. This may be due to neglecting the banks' franchise value. Franchise value refers to the accumulated present value of banks' expected future profits if it operates continuously. This represents an opportunity cost if the bank goes bankrupt (Northcott, 2004). The higher the franchise value is, the more bankers stand to lose by becoming insolvent. In contrast, a bank with no franchise value has nothing to protect and no worry about bankruptcy.

Two main sources of banks' franchise value are "market-related" and "bank-related" factors (Demsetz, Saidenberg, & Strahan, 1996). "Market-related" factors such as a competitive environment, legislation restrictions and technology innovation create differences in franchise values in banks across geographic or product markets. In contrast, "bank-related" factors are associated with efficiency variations in their operations, relationship management or branch networks. For instance, Marcus (1984) and Keeley (1990) show that banks with high market power can generate larger profits and thus have higher franchise values. This results in great opportunity costs of bankruptcy and drives bank managers away from excessive risk taking. However, with an increase in competition, banks' market power declines and a contraction in the franchise value can lead the bank to adopt riskier strategies. Even though in the condition of increasing competition or restrictions, there are some banks which are more efficient than others. These banks, thus, can derive franchise value from their less efficient competitors (Jayaratne & Strahan, 1998).

Banks which successfully build up their franchise value will try to preserve it and operate safely. Likewise, they tend to voluntarily hold a strong capital position to protect these values from insolvency. Demsetz et al. (1996)'s report on the average riskiness of bank holding companies in the U.S during the period of 1986-1994 reveals that low-franchise-value banks are consistently riskier than those with high franchise values. Thus, franchise value is believed to have a moderating effect on the relationship between capital regulation and bank behavior.

Developing the moral hazard framework, Park (1997) analyzes bank responses to capital regulation by optimizing their capital ratios and asset portfolios to maximize their value. In this way, banks' decision is a function of investment opportunities, franchise values and regulatory parameters. Within multidimensional regulation, where supervisory authorities not only regulate bank capital but also other factors such as asset quality, management, earnings and liquidity, it is difficult to predict banks' responses exactly. For instance, under certain rules of classifying risky banks, tightening capital standards may induce banks to reduce their capital levels and pursue safer asset portfolios. But if banks can successfully hide their actual risk to prevent them from being classified as risky institutions, high-variance investment opportunities will induce them to raise capital and acquire larger portfolios of risky assets. Besides, the banks' option value is a decreasing function of the failure probability and the franchise value. However, the franchise value is not a substitute for bank regulation. Under lax regulation, banks with higher franchise values can also take on higher risk investments (than those with lower franchise values).

With the view that competition contributes to the erosion of franchise value and reduces banks' motivation to take less risks, Hellmann, Murdock, and Stiglitz (2000) investigate the effect of capital standards in competitive environments. They argue that capital requirements reduce banks' moral hazard by putting their equity at risk, which they regard as the capital-at-risk effect. In contrast, they can have adverse effects by harming banks' franchise value due to lower per-period future profits, and thus induce them to take more risks. The latter consequence is known as the franchise-value effect. Liberalization will intensify competition among banks and encourage them to offer inefficient deposit rates to steal shares from their competitors. In such an event, banks can only increase their franchise value by gambling. Therefore, in a competitive deposit environment, capital requirements cannot guarantee banks will pursue a prudent investment strategy. The authors suggest that a combination of deposit rate ceilings and capital requirements will help address this problem.[5]

Repullo (2004) re-examines the franchise value effect, but in an explicit model of imperfect competition. The author finds that Hellmann et al. (2000) conclusion is only true in the case of a very competitive deposit market, where intermediaries can earn low return margins. In markets where banks can earn intermediate margins, banks can invest in both risky and safe assets. In the extreme case of monopolistic markets, only prudent investments exist. Moreover, if the cost of capital, due to an increase in capital requirements, exceeds the returns of the safe assets, capital requirements are always effective in preventing banks from taking excessive risks. Repullo (2004) explains this interesting result as a consequence of the assumption that banks can transfer all of the costs of higher capital requirements to depositors. This made the equilibrium expected margins remain unchanged, as do franchise values. In this case, increased capital reduces the equilibrium deposit rates so that bank franchise values do not change and thus, reduce incentives to take on very risky assets.

Zhang, Wu, and Liu (2008) add that an increase in capital ratios result in decreased bank franchise values, and thus, induce banks to reduce their capital levels. As long as the banks' capital ratio is above

[5] While Lam and Chen (1985) examine this joint effect, their study produced ambiguous results. The authors distinguish between capital requirement effects on bank behavior when the deposit rate was both regulated and unregulated. In the first case, banks will invest more in risky assets until marginal risk-adjusted returns reach equilibrium for each asset to maximize shareholder wealth. However, the probability of bank failure can increase or decrease due to the unidentified effect of portfolio adjustment on expected profits. In the latter case, banks' risk adjustment is undetermined since it now responds to the risky deposit rate in addition to the risky asset returns. Depending on existing levels of capital, banks might behave differently.

the minimum adequacy standard, bank will hold as little as possible capital to maximize its expected income or its franchise value. But once its capital ratio falls below the minimum standard, the bank will raise more capital to meet the requirement. Besides, while the capital ratio increases, according to the tightened capital regulations, the bank will change its risk preference toward less risky investments.

Deviating from Hellmann et al. (2000) framework, Behr, Schmidt, and Xie (2010) examine how stricter capital requirement affect banks' risk-taking behavior in different market structures. Their results are somewhat similar to Repullo (2004) except for the case when banks operate in a moderately competitive environment. The difference may derive from the assumption of the objective functions of banks. Behr et al. (2010) show that in low concentrated markets, banks have lower franchise values. Their objective in such environments is to maximize short-term profits and thus, they have a greater incentive to take risks to increase their franchise value. In these cases, capital regulation provides discipline to reduce bank risk-taking. In contrast, in highly concentrated markets, where banks do not have to compete with each other, franchise values are higher. Their objectives are not only to maximize short-term profits but also expected future profits, which are the franchise values. Banks, therefore, are less likely to invest in high-risk assets, as these will threaten their high franchise values. The role of capital regulation in this case is less clear.

2.3.3 Capital Buffer Theory

Extending the franchise value literature, emerging studies focus on the dynamic of bank franchise value, which forms a new theory of bank behavior under capital regulation – the capital buffer theory. Accordingly, there are costs in changing levels of capital (recapitalization) and falling below the required capital level. These costs can be implicit or explicit. Implicit costs arise from regulatory intervention which aims to limit the likelihood of deposit insurance whereas explicit costs refer to regulators' restrictions or penalties due to non-compliance with minimum capital requirements or even liquidation (Buser et al., 1981). In order to avoid these costs, banks have incentives to hold a buffer above the minimum capital requirement (Milne, 2002; Milne & Whalley, 2001).

Taking into account this incentive effect of capital regulation, Milne and Whalley (2001) show that bank attitudes to risk depend on their capital buffers and that in the long run, capital regulation has no impact on bank risk behavior. However, this is only true when deposits are not remunerated. When one allows for deposit repayments, an increase in capital requirements increases bank franchise values[6] and affect the desired capital buffer. The risk-taking incentive is thus reduced. But if the bank

[6] This is because capital is viewed as an endogenous response to capital regulation. This means that an increase in capital constraints leads to bank recapitalization either through reducing dividends or issuing new equity. Although shareholder value declines, the present value of all future expected payments to shareholders is higher. Therefore, higher capital requirements are associated with higher franchise values.

has adequate earnings, capital requirements exert little impact on their risk-taking. In the short run, bank risk behavior is similar to franchise value theory predictions. More specifically, fully-capitalized banks, which have successfully built up desired levels of capital are insured against the cost of recapitalization and liquidation, so they aim to minimize cash-flow uncertainty and tend to be risk-averse. However, if these banks suffer from severe deterioration of cash flow, but not enough to destroy shareholder value, they will take greater risks to avoid costly equity issuances. In contrast, those with less than the minimum required capital (normally when the regulatory audit is random) are under the threat of regulation intervention. They want to maximize cash-flow uncertainty and thus, tend to be risk-lovers.

Milne (2002) examines the incentive effect of capital requirements on bank portfolio choices. The author shows that in the short run, banks struggling to meet regulatory capital requirements will reduce the holding of high-risk assets while well-capitalized banks face little regulatory pressure in allocating their portfolios. An exceptional case is failing banks which consider capital regulation breaches as unavoidable and choose their portfolio without considering the effect of regulation. However, to the extent that the value of bank assets can be realized (for example, through loan trading or securitization), the risk-based capital requirements have no impact on bank portfolio choices. In the medium term, banks raise capital until the marginal expected cost of breaching regulatory requirements equal the marginal financing costs of equity and debt. The effect of capital requirements on bank asset portfolios, thus, depends on the marginal costs of debt and equity finance.

However, in reality, banks need substantial time to prepare for capital raising. Peura and Keppo (2006) take into account a delay in bank capital raising policies. As a consequence, the likelihood of liquidation is strictly positive. Afraid of losing their franchise value, banks tend to recapitalize at a positive level of capital buffer. This explains why banks always hold a capital level higher than regulatory requirements.

So far, the analysis of bank behavior is based on one representative bank. This, by accident, neglects the inter-connection of banks and consequently, the contagion effect, which is a recent concern, particularly since the mass failure of banks during the financial crisis in 2008. Tian, Yang, and Zhang (2013) apply the capital buffer theory in a two-bank model with a syndicated asset, in which one bank fails. They show that if the partner bank can properly estimate the probability of the other banks' failure, it will hold a sufficient amount of capital and thus avoid the contagion. However, if this failure is underestimated, or the fraction of investment of the healthy bank in the joint-project is large, or in the case of low bargaining power, lower exposure and larger loss of market value from the interlinkage asset, the healthy bank is more likely to have a lower capital level than the requirement. In such a case, contagion is highly promoted. This intensifies the anticipation of a government bailouts.

2.3.4 Agency Problem Theory

While a higher capital level helps to reduce conflicts between banks' shareholders and debt holders, in this case, the depositors, it may reinforce conflicts between shareholders and managers (Berger et al., 1995). Most theoretical studies up to this point consider that banks are run by owner-managers, which means that the banks' major shareholder is also the manager. However, this is not always the case. Jensen and Meckling (1976, p. 308) identify an agency relationship where "one or more persons (the principal) engage another person (the agent) to perform some service on their behalf which involves delegating some decision-making authority to the agent." In banking, shareholders normally delegate the operation of the bank to the managers. Both parties aim to maximize their benefits. It would be difficult for the principal to ensure that the agent is acting in the best interests of the principal. This is regarded as an agency problem between insiders and is usually associated with the separation of ownership and control.

Many studies report a negative relationship between the degree of managerial control and non-bank risk-taking (see for example, Agrawal and Mandelker (1987); Amihud and Lev (1981)). With regulatory intervention, it is expected that conflicts among inside stockholders will be exacerbated, and so do their risk-taking incentives. Saunders, Strock, and Travlos (1990) examine the effect of this agency problem on bank risk-taking by comparing the risk behavior of managerially - and stockholder-controlled banks. The managerially -controlled banks and stockholder-controlled banks are distinguished by the share of bank ownership. A bank is considered to be managerially-controlled if managers hold a relatively small proportion of bank shares and being stockholder-controlled banks otherwise. Depending on ownership proportions, bank managers and shareholders' interests could be the same or different. Regarding managers as utility-maximizers and stockholders as value-maximizers, Saunders et al. (1990) show that managerially-controlled banks are more risk averse than stockholder-controlled banks[7] and that conflicts of interest will be diverged with deregulation.

Besanko and Kanatas (1996) analyze the agency problem between inside managers and outside shareholders. Developing Gennotte and Pyle (1991) analysis of bank assets as non-zero net present value investments, Besanko and Kanatas (1996) argue that underpriced deposit insurance adds to the banks' surplus from lending. This motivates bank managers to manage loans efficiently in order to realize this surplus. However, increasing capital leads to a higher cost of funds and reduces the managers' surplus. Together with the issuance of new equity, insider ownership is sufficiently diluted to reduce their incentives to monitor the loans. This negative effect of enforced capital requirement

[7] Due to limited liability and information asymmetry, stockholders are incentivized to increase the risk status of their portfolios to increase the value of their equity call options. Together with the existence of underpriced deposit insurance, which results in a put option as analysed in the previous section on moral hazard, stockholders want to maximize these values by raising risk (see also Galai and Masulis (1976); Kareken and Wallace (1978); Marcus and Shaked (1984); Merton (1977); Ronn and Verma (1986); Sharpe (1978)).

can be greater than the benefit of asset substitution by requiring shareholders to put more "skin in the game". The net effect is a rise in the overall riskiness of bank assets.

Incorporating the difference in manager incentives with those of the shareholders and deposit insurers in a model with four distinct characteristics on the risk-return asset profiles, Jeitschko and Jeung (2005) state that under capital regulation, banks' risk will vary depending on the relative forces of the three agents and the risk-return characteristics of the banks' asset portfolio. Specifically, if the shareholders' objectives dominate, or risk-return profiles are strict mean-variance ordering, the banks' risk may decrease with higher capital requirements. In contrast, a manager-driven bank is inclined to undertake more risks under tightened capital regulations or when asset characteristics exhibit higher risk-high returns. This is because in such case, the manager's private benefit is larger than the increase in asset risks.

Taking into account the effect of general equilibrium, Gale (2010) suggests that increasing capital requirements may have an adverse effect on bank risk-taking behavior. Given the fact that the manager's private benefit could be harmed if the bank goes bankrupt, managers have an incentive to be risk-averse. They will therefore aim to maximize the probability of the success state of the investments, subject to the bank capital constraints. Hence, they will choose assets with the lowest return but larger than those in the case without capital constraints. Given the high risk, high return assumption, banks' risk will increase. The model is tested with a risk-based capital requirement but yields the same result. The author argues that even if the risk of individual assets remains constant, the risk of the whole portfolio might increase due to the high correlation of these assets returns.

2.4 Empirical Studies on Effect of Capital Regulation on Bank Capital Ratios

While there is a large amount of literature on the capital structure of non-financial firms, there is little on financial firms, particularly banks. The reasons lie primarily with the intermediary role that banks play and the heavy regulation of the industry. As being intermediaries, bank debts (mostly in the form of deposits) are not only a source of funds, but also a service that banks provide. It has been found that the average book leverage of banks in the U.S and EU between 1991 and 2004 was 92.6%, nearly four times higher than that of non-financial firms (Gropp & Heider, 2010). Although the role of deposits have changed over time, they are still the most important source of bank funds (Allen et al., 2015). Besides, banks are heavily regulated under capital regulation. They tend to hold capital as near to the minimum requirement as possible to minimize the cost of holding capital. It is for this reason that bank capital is believed to be determined by capital requirements (Mishkin, 2007).

However, bank capital structure is important as it not only affects bank stability but also the intermediation function (Diamond & Rajan, 2000). Marques and Coutinho dos Santos (2004) survey in

Portugal over the period of 1989-1998 reveals that capital structures matter for banks' CEOs. These managers prefer the trade-off model in making capital decision using similar determinants as non-financial firms. In addition, actual bank capital levels vary greatly over time and across banks (Gropp & Heider, 2010). Furthermore, banks tend to hold a buffer above the minimum requirement (Alfon et al., 2005; Wong et al., 2005). This raises the question of whether bank capital ratios are mainly regulatory-driven.

In an attempt to clarify whether changes in bank capital ratios are caused by regulatory pressure or market factors, Wall and Peterson (1987, 1995) construct a regulatory model reflecting the regulatory forces and a market model reflecting the market discipline of bank holding companies (BHC). The actual changes in banks' capital ratio equal the maximum value of these two models. Using this approach, they found that increases in bank capital ratios were generated by regulatory requirements rather than market discipline. Thus, they suggest that bank capital dynamics are strongly impacted by capital regulation. Keeley (1988) examines 100 largest U.S BHCs and further shows that capital requirements successfully induce capital-deficient banks to increase their capital ratios.

Ediz, Michael, and Perraudin (1998) conduct a quarterly study of U.K banks over the period of 1989-1995. Employing a dynamic and multivariate panel regression model, in which changes in bank capital ratio depend on beginning-period capital ratios and internal targets, the authors show that regulatory capital requirements affect bank capital ratios more than their internal targets. This effect is significantly positive, implying that banks enhance their capital ratios in response to higher regulatory pressure.

Replicating Ediz et al. (1998) study, Nachane, Narain, Ghosh, and Sahoo (2000, 2001) acquire similar results for Indian public sector banks during the years 1997 to 2001. Their extended study (which covers the period from 1996-2002), suggests that undercapitalized banks with capital ratios lower than the stipulated level are under greater pressure to increase their capital ratios (Saibal, Nachane, & Partha, 2004). Taking into account the recapitalization dummy for banks that raise their capital, the authors show a positive influence of capital regulation on bank capital ratios. This positive effect of capital regulation on bank capital ratios is widely supported in the literature (see Alfon et al. (2005); Wong et al. (2005) Francis and Osborne (2010); Zahid et al. (2015)). Francis and Osborne (2010) add that this relationship is not asymmetric. The effect is stronger in larger banks with larger size and lower capital buffers. The authors also provide evidence of the pro-cyclical effect of capital regulation by showing that banks increase capital ratios more during favorable economic conditions.

Brewer III, Kaufman, and Wall (2008) conduct a cross-country study on bank capital ratios of 78 largest banks in 12 developed countries over the period of 1992 and 2001. They examine capital regulation together with other public and policy factors, such as the degree of external governance, supervisory authority independence, prompt corrective action, and the safety nets to explain variations in capital ratios among these banks. The study shows that banks have higher capital ratios in countries with more active prompt corrective actions, stringent capital requirements and effective corporate governance. These effects are more pronounced for equity over assets ratios than risk-based capital ratios. Thus, the authors suggest the limitation of Basel I standards in reducing cross-country capital ratio differences among large banks.

Ahmad, Ariff, and Skully (2008) investigate the issue empirically in Malaysia during the Basel I adoption period. The authors take into account the changes in regulatory pressure by designing specific dummy variables to capture the stricter and higher capital requirement introduced in the years 1996 and 1999, as well as the different pressure for banks below industry averages. The study reveals that banks in Malaysia negatively responded to stricter capital regulation but increased their capital adequacy ratios following the announcement of an increase in capital requirements from 8% to 10% in 1999. They conclude that risk-based capital requirements have no influence on capital adequacy ratios of low-capitalized banks, which may be due to banking fragility during the examined period. The positive effect of capital regulation is only observed for well-capitalized banks (and normally smaller banks) with capital ratios above industry levels.

In contrast, Bokhari et al. (2012); Gropp and Heider (2010); Marcus (1983); Sharpe (1995) found no effect of capital regulation on bank capital ratios. They suggest that capital regulation is of secondary importance in affecting bank capital ratios. In addition, bank capital ratios are impacted by similar factors like non-financial firms such as bank size, profitability, tangibility and economic growth. Flannery and Rangan (2008) also found little evidence of capital regulation effects on increases in capital ratios of U.S banks during the 1986-2001 period. They suggest that capital regulation creates an environment that emphasizes the role of market discipline. Accordingly, banks are under greater pressure to control their default probabilities and closely align their capital ratios with portfolio risks.

2.5 Empirical Studies on Effect of Capital Regulation on Bank Capital and Risk

2.5.1 Effect on Bank Capital

Empirical studies on the effect of bank capital regulation on bank capital can be traced back to Peltzman (1970) research, which investigates whether government capital regulation has substantial effects on bank capital flow. They use state aggregate data in the U.S during the period of 1963-1965. The results surprisingly show that capital regulation has a significantly negative impact on bank capital. Moreover, banks substitute deposit insurance for capital. This suggests that capital regulation is ineffective and there are discrepancies between regulators’ expectations and banks’ actual behavior.

Mayne (1972) supplemented Peltzman (1970) study by testing the difference in capital held among banks in different supervisory classes; more specifically national banks, state banks and state non-member banks. The results reveal no evidence of significant differences in levels of bank capital held by these banks. This is explained by the offsetting effect of systematic differences in the management or responsiveness among banks in different examined classes to agency standards, which then cancels the regulatory impact on bank capital.

Contrary to these findings, Mingo (1975) argues that regulatory capital requirements significantly influence banks' capital decisions. Rather than using state-aggregated data, which neglects variations in individual adequate bank capital ratios across banks, the author uses disaggregated data from 323 banks in 32 states in 1970. The author reveals that a decline in the banks' actual to required capital ratios led to a greater holding of capital. However, Federal Reserve member banks increase capital less than non-member banks.

However, Mingo (1975) ignores the effect of deposit interest rate ceilings. When regulators establish a ceiling on deposit interest rates, it might induce banks to increase their capital to attract depositors due to increased risk-adjusted expected returns. Taking into account this effect, Dietrich and James (1983) re-examine Mingo (1975) results for more than 10,000 U.S banks during the period of 1971-1975. The authors confirm Peltzman (1970) finding that capital regulation is ineffective on bank capital decisions.

2.5.2 Effect on Bank Risk

Another way banks can respond to capital regulation is through changing their risk-taking behavior. Hovakimian and Kane (2000) examine this effect quarterly, over the period of 1985-1994, for U.S commercial banks. Using a robust option model, they suggest that successful capital regulation will reduce bank risk with an increase in leverage and fair deposit insurance premiums, which implies a negative relationship between them. However, the regression result yields positive coefficients between risk and examined variables, which are leverage and deposit insurance premiums. Therefore, they conclude that capital regulation does not restrict bank risk-taking. Moreover, low-capitalized banks increase their risk more than well-capitalized institutions. However, to some extent, the mixed use of book value and market value for bank leverage confuses regulatory effects and market discipline and limits the study's interpretation.

Using a longer time frame (1950 to 2004), Bhattacharya (2013) compares the risk-taking behavior of U.S banks with, and without, capital regulation. The author shows that capital regulation, which has been applied since 1980, encourages, rather than drives, banks away from taking high risks. The binding capital-asset ratio reduces bank asset generation capacities by half and thus, motivates banks to seek high-returns or high-risk investments to satisfy required returns on equity from shareholders. As a result, the U.S banking sector has witnessed an increase in losses on assets by 2.5 times since regulation came into effect. The positive relationship of bank asset loss and capital ratios suggests that capital regulation has a negative effect.

Focusing on the impact of different regulations on bank risk taking, Hendrickson and Nichols (2001) claim that certain types of regulations (for example, branching and deposit insurance) contribute to bank risk, while some others (for example, capital requirements, loan activities and deposit rate regulations), enhance the industry's stability. By comparing differences in legislation between the U.S and Canada over a relatively long time period (from 1936 to 1989), the authors investigate how these differences might explain the risk. Their results show that higher capital holdings of U. S banks (in comparison to Canada) are associated with lower bank risks. Thus, they support the effectiveness of capital regulation in reducing bank risk-taking. A failure model based on the annual percentage of bank failure in the U.S confirms the positive contribution of capital requirement in stabilizing the financial system.

Barth, Caprio, and Levine (2004) support the Hendrickson and Nichols (2001) study. They emphasize that bank regulation and supervision are unavoidably interrelated. Their results suggest that it would be incomplete to examine the effects of a specific regulation (for example, restrictions on bank security activities) ignoring related regulatory factors (for example, the power of supervisory authorities or the degree of government ownership). They investigate how these regulatory and supervisory practices effect bank outcomes, including non-performing loans ratio. The most innovative aspect of Barth et al. (2004) research is their use of the capital regulatory index (CRI) which incorporates both quantitative and qualitative characteristics of capital stringency. Their results indicate that there is a great divergence in bank regulation and supervision across countries, regions and income groups. Furthermore, a negative and significant coefficient between the CRI index and the ratio of non-performing loans reflects the effectiveness of capital regulation in reducing bank risk. However, upon further analysis, this result is not very robust when the risk is considered as the likelihood of banking crises, and when considering the moderating effect of deposit insurance, official supervisory power as well as private monitoring did not provide supportive evidence.

Several scholars have also applied the CRI index to study the effect of capital regulation on bank risk in cross-country analyses (see for example, Agoraki, Delis, and Pasiouras (2011); Alam (2014); Albaity and Toobaee (2017); Behr et al. (2010); Delis, Tran, and Tsionas (2012); Laeven and Levine (2009); Lee and Hsieh (2013); Lee and Lu (2015)). With an emphasis on the agency problems between bank managers and owners in risk behavior, Laeven and Levine (2009) found that the effect of capital regulation, together with other macro-policies (such as deposit insurance and restrictions on bank activities), on bank risk depends on bank ownership concentration. The more concentrated the ownership of a bank is, the greater the risk-taking, since owners want to cover utility losses from capital regulation with higher risks. In contrast, Agoraki et al. (2011) and Lee and Lu (2015), show that capital regulation generally reduces bank risk. However, if banks have market power, this effect is lessened or even reversed (Agoraki et al., 2011). Examining the effect of capital regulation on bank risk in different market structures, Behr et al. (2010) also find that the desired effect of capital regulation in mitigating bank risk is only achieved in lowly concentrated markets.

The above conclusions differ in terms of the proxies for bank risk. Laeven and Levine (2009) rely on Z-scores, while Agoraki et al. (2011), Lee and Lu (2015) and Behr et al. (2010) all use non-performing loan ratios. Using different bank risk proxies, Lee and Hsieh (2013) show that the effect of capital regulation on bank risk varies with risk measurements. Specifically, greater capital stringency increases the volatility of return on equity but reduces the loan loss reserves ratio. Meanwhile, it exerts no influence on the volatility of return on assets. Alam (2014) reaches the same conclusion on the loan loss reserves ratio. The author is also concerned about the effect of supervisory power (as a proxy for Pillar 2) and private monitoring (as a proxy for Pillar 3) under Basel II on bank risk. The analysis shows that private monitoring forces banks to reduce risk despite the insignificant effect of supervisory power. The author argues that an increase in entry barriers, associated with stricter capital regulations, may limit the pressure of competition and induce banks to behave prudently. Using risk-weighted asset ratios as a proxy for bank risk, Albaity and Toobaee (2017) add that capital regulation has a positive effect on bank risk. Moreover, it helps moderate the effects of asset volatility on bank risk by reducing the impact of asset volatility.

Nevertheless, Delis et al. (2012) indicate that capital regulation has no influence on bank risk, regardless of how it is measured (as non-performing loan ratios, Z-score, or returns on asset volatility). Instead, applying the local estimation technique in a semi-parametric smooth coefficient model, they reveal that the effect of capital regulation is heterogeneous across banks. This heterogeneity results from bank characteristics, as well as regulatory and macro conditions. In addition, heterogeneity is substantial in banks with negative capitalization. The authors conclude that common capital standards are not efficient enough to ensure financial stability.

Camara, Lepetit, and Tarazi (2013) attempt to clarify different responses among banks with different capital positions. They conduct a detailed study on 17 European countries over the period of 1996-2002. Categorizing banks into groups of different risk-weighted capital ratios, the authors find that banks behave differently in response to changes in capital (as a consequence of capital regulation). Specifically, highly and moderately capitalized banks (those with capital ratios in excess of 10% and ranging between 8% and 10%, respectively) adjust their risk and capital in the same direction.

However, undercapitalized banks with capital ratios below the 8% minimum requirement reduce their investment in risky assets when increasing capital to meet regulatory standards. Further investigation into sub-samples of undercapitalized banks shows that only moderately undercapitalized banks, which have Tier 1 capital in excess of the required 4% ratio, behave prudently. Strongly undercapitalized banks act in the same way as highly capitalized banks. The authors explain this behavior as either a consequence of persistently negative outcomes of past poor-quality investments or maximizing expected returns on equity objectives. Furthermore, an increase in equity ratio will positively affect the risk-taking of highly, adequately and strongly undercapitalized banks while exerting a negative effect on moderately undercapitalized banks. However, all banks react in the same positive way with changes in subordinated debts. These results illustrate the need to regulate banks differently according to their capitalization status.

While most studies focus on the book value of bank risk, Laiola (2015) emphasizes market risk as the market value of standard deviation of bank return on equity. Using a sample of 30 largest BHCs during the period of 2003-2013 and R-squared statistical tests, the author shows that Tier 1 capital ratio requirements have no impact on the market risk of these banks.

2.5.3 Simultaneity between Bank Capital and Risk

While studying bank capital and risk behavior in relation to capital regulation, researchers recognize the influence of bank risk on capital, and vice versa. However, the direction of impact is not clear. While some studies have found a positive relationship between these two factors, others have discovered a negative association. Such interactions may cause endogeneity problems and lead to incorrect conclusions when analyzing bank behavior.

Shrieves and Dahl (1992) were the first to incorporate this inter-relationship in a simultaneous equation model (SEM), which gained substantial support from academic researchers. They analyze bank capital and risk behavior of 1800 Federal Deposit Insurance Corporation (FDIC) insured independent and holding company affiliated commercial banks during the period of 1984-1986. In their study, banks were considered to be under regulatory pressure if their capital ratio was less than the minimum capital requirement, which was 7%. Their analysis indicates that banks under regulatory pressure raise their equity capital ratio and reduce the risk-weighted assets. The authors also found a positive relationship between bank capital and risk. Moreover, the faster adjustment speed (more than 20%) towards the target capital level of undercapitalized banks, in comparison with well-capitalized banks (just 7%), provides support for the effectiveness of capital regulation, at least for undercapitalized banks.

Jacques and Nigro (1997) adopt and modify Shrieves and Dahl (1992) approach to account for the effect of new risk-based capital regulations which require U.S banks to hold a minimum of 7.25% capital over their risk-weighted assets during the year 1990-1991. The authors found a positive effect of risk-based capital standards on the U.S banks; those above regulatory requirements typically increased their regulatory capital ratios and reduced risk-weighted assets. The effect was greater for banks with capital ratios significantly above the minimum ratio. However, the regulatory effect on risk-based constrained banks was flawed and inconclusive. Nachane and Saibal (2001) replicate these results in their study of 27 public banks in India during 1997-1998. This limitation may be due to the short period of study (just one year) when risk-based capital standards first came into effect.

Aggarwal and Jacques (2001) extend Jacques and Nigro (1997) study to include a longer period, up to 1997, and integrate the regulation on supervisor's early intervention in troubled banks under Prompt Corrective Action (PCA)[8]. They show that all banks respond to the new regulation by increasing their Tier 1 ratios rather than their risk-based capital ratios. One possible explanation for this behavior is that banks increase their capital ratios prior to PCA announcements and the enforcement of the new Tier 1 ratios would have placed much pressure on all banks. Not surprisingly, undercapitalized banks adjust their Tier 1 ratios faster than adequately and well-capitalized banks. Besides, undercapitalized and well-capitalized banks only reduce their risk levels when regulations came into full effect in 1993. Abreu and Gulamhussen (2010) do not support these results. They re-define undercapitalized banks by reducing the threshold arbitrary to determine regulatory pressure and allowing for a continuous shifting regime in their behavior. In their study, banks with low capital buffers would typically reduce their capital and increase riskiness regardless of bank capital measurements.

Applying the same method to 154 Swiss banks during 1989-1995, Rime (2001) reveals a positive relationship between capital standards and capital ratio (both equity capital and adequacy capital ratios). However, the author found no significant impact on bank risk-taking. The author suggests that raising capital through retained earnings or issuing equity is less costly than adjusting portfolio risks. This is possibly due to the absence of a well-developed market for asset-backed securities.

In an attempt to compare bank behavior in the U.S and other countries, Van Roy (2005) conducts a cross-country analysis on six G-10 countries during 1988-1995. The author separates market effects from regulatory effects. The author shows that Basel I capital regulation successfully forces undercapitalized banks, whose capital ratios fall below the minimum capital ratio plus one bank-

[8] Under the PCA, banks are classified into five capital categories: (1) well-capitalized; (2) adequately capitalized; (3) undercapitalized; (4) significantly undercapitalized; and (5) critically undercapitalized, respectively, depending on their (1) total risk-based capital ratio; (2) Tier 1 risk-based capital ratio; and (3) Tier 1 leverage ratio. Bank regulators are authorized to reclassify banks into lower capital categories if they suspect their operations to be unsafe or unsound (Aggarwal & Jacques, 2001).

specific standard deviation in Canada, Japan, the U.K and the U.S to raise capital, but not in France and Italy. However, the study found no evidence on the influence of capital regulation on bank risk, whether in the U.S or non-U.S countries.

Cannata and Quagliariello (2006) study of Italian banks in the period 1994-2003 produced different results. They show that undercapitalized banks increase both their capital and risk under the pressure of capital regulation. However, different definitions of undercapitalized banks with relative capital buffers below the 25th percentile make these two studies difficult to compare. It is also worth noting that results for the U.S banks require further reassessment due to the coincidence of the Basel Accord's second stage implementation with the passage of the Federal Deposit Insurance Corporation Improvement Act (FDICIA) in 1991 (Van Roy, 2005). Teply and Matejasák (2007) extended analysis on the U.S and EU-15 banks shows that U.S banks decrease their risks. Van Roy (2008) considers the FDICIA implementation and re-analyzes the data using a different measure of regulatory pressure. Undercapitalized banks are those with capital ratios below the 10% minimum requirements or Tier 1 capital below 6%. Surprisingly, there is no difference in capital and risk behavior between undercapitalized and well-capitalized banks for the whole sample, except for Japanese banks.

Criticizing the above studies for measuring regulatory pressure as dummy variables with restrictions, Heid, Porath, and Stolz (2003) apply a scrolling window approach which allows for differences in the coordination of capital and risk, as well as the continuous changes in regulation, depending on the banks' capital position. Their analysis of German banks during 1994-2002 reveals that banks with low capital buffers tried to rebuild appropriate capital buffers by raising capital while simultaneously lowering risk. However, banks with high buffers maintained their capital buffer by increasing risk with an increase in capital.

While most attention has focused on developed countries (in the U.S and EU), there have been a few studies of emerging and developing countries. Individual studies of emerging and developing countries have produced interesting results. For example, in Tunisia, banks under capital regulatory pressure increased their risk-weighted asset ratios (Bouri, 2006) and reduced their equity capital ratios (Bouheni & Rachdi, 2015), while undercapitalized Chinese banks strengthened regulatory capital (Zhang et al., 2008). In contrast, Indonesia banks responded to capital regulation mainly through reducing risk. They only raise capital when capital ratios are near the regulatory minimum requirement (Parinduri & Riyanto, 2011). Only Brazilian banks simultaneously increase capital and reduce risk (Pereira & Saito, 2015).

In an attempt to generalize bank responses, Godlewski (2004) carries out a thorough investigation of banks in 30 emerging economies during the period of 1996-2001. The author discovers cautious behavior of banks in these countries, where banks with low capital positions reduce their risk and those with high capital positions increase their capital. In addition, other regulatory factors (deposit insurance schemes and the disclosure of risk management procedures), institutional (foreign or domestic states, financial- or nonfinancial-held controlling shareholders), and legal environment (transparency of government policies, efficiency and integrity of the legal environment), also impact bank behavior. These results highlight the importance of regulatory, institutional and legal environments in emerging markets.

However, Saadaoui (2011) found no evidence of cautious behavior in his study of banks in 29 emerging countries during the period of 1995-2005. The author argues that banks in these countries tend to be excessive risk-takers. They are motivated to make risky decisions in order to increase capital quickly, even though they are also induced to increase capital. Saadaoui (2011) examines banks in G-10 countries. The author found a positive effect of capital regulation on bank capital only.

For banks in developing countries, Hussain and Hassan (2005) suggest that they reduce capital (both Tier 1 and total regulatory capital) under the effect of capital regulation. Islamic banks adjust capital more than conventional banks (Ghosh, 2014). Besides, their risk is not affected by capital regulation. Instead, it is the level of financial development that helps to reduce bank risk (Hussain & Hassan, 2005). In contrast, banks in developing Middle East and North Africa (MENA) countries, do not change either capital or risk under capital regulation (Bougatef & Mgadmi, 2016). These findings contradict those found in developed and emerging markets.

Nevertheless, Lin, Hwang, Wang, and Xie (2013) study on a sample of U.S and 21 developed and developing non-U.S countries over the period of 2003 to 2009 reveals similar behavior between these two groups of countries. Specifically, low-capitalized banks reduce their risk-taking while increasing capital, whereas high-capitalized banks increase their risk at the same time.

2.6 Empirical Studies on the Effect of Capital Regulation on Bank's Balance Sheets Adjustments

To meet the capital requirements, banks can adjust their balance sheets, either through the liability and/or the asset side. Liability adjustment primarily involves changing retained earnings, shareholder equity and/or subordinated debts. Changes in the asset side can be made through the asset size or portfolio mix. Banks' choice in adjusting its balance sheet may vary depending on the ease of adjustment of each method. For instance, a large financial corporation may find it easier to raise new equity, while a smaller bank may choose to reduce the size of its asset portfolio or reduce its risk. During periods of economic upturn when there is easy access to various sources of funding, banks tend to increase their capital ratios. In contrast, during economic downturns, they may prefer to reduce their loans (Jackson et al., 1999).

The strategies that banks choose have significant implications for the macro-economy. A bank which improves its capital ratio by raising new equity, may face higher costs due to market imperfections (Myers, 1977; Myers & Majluf, 1984). These costs are passed onto borrowers through higher lending rates (King, 2010) and consequently, constrain loan demands (Slovik & Cournède, 2011). It is not clear whether an increase in lending spread affects economic activity, but it may attract lower quality borrowers and increase financial instability (Martynova, 2015). Higher lending rates can be the result of a boost in banks' profits or an attempt to increase its retained earnings (Cohen & Scatigna, 2016). However, if banks opt to shrink their assets or reduce high risk-weighted assets such as loans, there may be negative effects on economic growth. Specifically, a reduction in lending can limit investment to be funded, and lower asset and security prices (Hanson et al., 2011). A reduction of higher risk-weighted assets such as real estate loans can lead to a decline in real estate and construction activities, and thus slows down the economy growth (Hancock & Wilcox, 1997).

It is for these reasons that researchers have spent a lot of time investigating how banks adjust their balance sheets in response to capital regulation. A reduction in lending, as a result of higher capital requirements, has been documented in many studies (see for example, Furfine (2001); Peek and Rosengren (1995)). This is commonly referred to as a "capital crunch." In a quasi-natural experiment study of 18 European banks under the 2011 European Banking Authority capital exercise, Gropp, Mosk, Ongena, and Wix (2018) find that capital-exercised banks, which are required to strengthen their core Tier 1 capital ratios, reduce their lending by 12 percentage points compared to non-capital exercise banks. The reduction primarily involves retail and corporate lending. Other studies, such as Cumming and Nel (2005); Hall (1993) also reveal a re-shuffle of asset portfolio in a way that lower risk-weighted assets, such as single-family mortgages and government securities, increase and higher risk-weighted assets, such as commercial and industrial loans, decrease. The increase in government securities and decrease in commercial and industrial loans are lessened when banks' capital positions improve (Haubrich & Wachtel, 1993). In addition, the reduction in bank lending is greater for banks with weaker capital positions (Catalan, Hoffmaister, & Harun, 2017) and vary across different sectors of the economy (Bridges et al., 2014).

Conversely, Horiuchi and Shimizu (1998) found evidence from Japanese banks with low capital ratios who expanded their lending. Acknowledging that U.S banks are subject to several capital requirements, including a 3% minimum leverage ratio, while Japanese banks are restricted to only risk-based capital ratios, the authors explain the reverse impact of capital regulation by its weaker restrictive effect. While Ito and Sasaki (2002) support this finding, they note that there are loan decreases among city banks. Berrospide and Edge (2010) note that other factors such as loan demand or increased risks may offset the effects of capital requirements. However, Francis and Osborne (2012) argue that the effects of capital requirements on bank lending depends on individual banks' levels of capitalization. If banks have capital ratios above the desired target levels, they will increase lending. Eber and Minoiu (2016) study of EU banks also shows that a reduction in bank lending is only true in the case of weak banks with very low capital ratios.

Francis and Osborne (2012) and Kok and Schepens (2013) suggest that banks lower their asset growth to improve capital ratios when facing a capital shortfall. In contrast, Cumming and Nel (2005) and De Jonghe and Öztekin (2015), show that higher capital requirements do not necessarily lead to a reduction of assets. Banks still maintain their asset growth rates and focus on increasing equity. Cohen and Scatigna (2016) also show that global significant financial institutions (G-SIFIs) increase their total assets by 8% and their lending by 6.2% during the period of stricter capital standards (2009-2012). Except for European banks, which reduce both lending and total assets, other banks either increase their assets (such as banks in advanced economies, global systemically important banks (G-SIBs) or increase both assets and lending (such as banks in emerging economies, advanced non-GSIBs and the U.S banks). However, these positive asset growth rates are outpaced by increases in capital levels. The authors emphasize that these banks rely on increasing capital. Czech and large German banks apply similar strategies during the same period (Matejasák, 2015a; Memmel & Raupach, 2010). However, for Slovakian and Japanese banks, decreasing risk was important as well (Matejasák, 2015b; Shimizu, 2015).

The adjustment of bank balance sheet via liability management also differs across studies. Dahl and Shrieves (1990) study of US FDIC-insured banks during 1985- 1986 shows that bank equity issuances under the effect of capital regulation depend on their degree of undercapitalization. They found that a mere 12% of undercapitalized banks issued new equity. These were independent banks, whose behavior had little signalling effect. Nevertheless, Aggarwal and Jacques (1997) found that U.S banks focused more on adjusting Tier 1 capital in comparison with other elements of capital base, because the FDICIA impacted Tier 1 target ratios more than total capital ratios. In contrast, Japanese banks raised their capital adequacy ratios by issuing a large amount of subordinate debt, which were primarily absorbed by their major shareholders, such as insurance companies and non-financial firms (Horiuchi & Shimizu, 1998; Ito & Sasaki, 2002). Similarly, Francis and Osborne (2012) found that U.K banks raised their capital ratios primarily through less expensive and lower quality Tier 2 capital rather than high-quality Tier 1 capital. However, after the global financial crisis, they turned to Tier 1 capital to respond to higher capital requirements (De-Ramon, Francis, & Harris, 2016). Cohen and Scatigna (2016) further show that increases in bank capital in advanced economies during the period of 2009-2012 was achieved through reducing dividend payouts while banks in emerging economies benefited from higher earnings and accumulated them to increase their capital ratios.

2.7 Measurement of Capital Regulation

Conclusions about the effects of capital regulation on bank behavior are affected by the measurements of capital regulation. However, measuring capital regulation is a difficult task because it is a multi-faceted issue. Traditionally, researchers assess the effects of capital regulation quantitatively through the regulatory pressure it creates. Capital regulation puts banks under pressure to maintain adequate regulatory capital ratios by strengthening their capital and/or better managing their risks. Breaching regulation will lead to expensive costs such as higher capital requirements, restrictions, or government interventions in banks' operations. Empirical studies on capital regulation show that researchers use different methods to measure the effects of capital regulation. These measurements vary from each other in determining the level of regulatory pressure. Table 2.1 provides a summary of these quantitative measurements of capital regulation.

The determination of regulatory pressure using quantitative measurements (as shown in Table 2.1) is dependent on individual bank capital ratios. In studies where the dependent variable is capital ratio, the use of such measurements can lead to spurious conclusions, due to the correlation between the dependent variable and capital regulation by construction. In studies where bank capital is a determinant of bank risk, such measurement can imply endogeneity. Another drawback of these quantitative measurements is the lack of knowledge of capital regulation stringency in terms of qualified capital and determination of risk-weighted assets. For example, an 8% minimum capital requirement in a country, where the capital regulation does not allow for goodwill, for instance, to be included in the total regulatory capital, can be stricter than a country without such restriction (for example, Korea versus Kyrgyzstan). Therefore, to reach the same 8% capital ratio, banks in the latter case have to accumulate other type of capital instead. Similarly, an 8% minimum capital requirement in a country where the capital charges are not required for market and operational risks will not be as strict as countries with such requirements (for example, Vietnam versus Korea).

Concerned about the qualitative aspect of capital regulation, Barth et al. (2001) developed the Capital Regulation Index (CRI) for capital regulation measurement. They constructed the index using World Bank surveys on bank capital regulation and supervision practices across countries.[9] It is the sum of two sub-indices. While the first index, Overall Capital Stringency, reflects the level of risk coverage and capital quality of the capital requirement, the other sub-index, Initial Capital Stringency, measures the rules for initial disbursement and subsequent injections of capital.

[9] The index is constructed from the World Banks' survey on bank capital regulation and supervision practices across countries (World Bank, 2013). During 1999-2011, four surveys were carried out every four years and covered more than 100 countries worldwide. The latest update of this index is provided in Barth, Caprio, and Levine (2013). The survey has provided a rich source of information for researchers and policy makers in assessing levels of global practice relating to bank regulation and supervision.

Table 2.1 Quantitative Measurements of Capital Regulation

Measurements	Contents	Threshold	Authors
Dummy Approach	Assign value 1 for banks with capital ratio less than certain threshold, and 0 otherwise	Minimum capital requirement	Shrieves & Dahl (1992), Saibal, et al. (2004), Van Roy (2008), Godlewski (2005), Parinduri & Riyanto (2011), Bougatef & Mgadmi (2016)
		Individual capital requirement	Wong et al. (2005), Alfon et al. (2005), Gropp & Heider (2010), Francis & Osborne (2010)
		25th percentile of the least capitalized banks	Kleff & Weber (2008)
		Industry average	Ahmad et al. (2008)
		Prompt Corrective Action standards	Camara et al. (2013), Aggarwal & Jacques (2001), Rime (2001)
		0	Abreu & Gulamhussen (2010)
Probabilistic Approach	Assign value 1 for banks which are probably to be under regulatory pressure, and 0 otherwise	Minimum capital requirement plus 1.5%	Flannery & Rangan (2008)
		Minimum capital requirement plus standard deviation of banks' capital ratio	Ediz et al. (1998), Nachane et al. (2000, 2001), Rime (2001), Van Roy (2005), Ghosh et al. (2003), Bouheni & Rachdi (2015), Saadaoui (2011), Teply & Matejasák (2007), Lin, et al. (2013), Parinduri & Riyanto (2011)
		Median standardized capital buffer	Heid et al. (2003)
		25th percentile of bank capital buffer	Cannata & Quagliariello (2006)
		10th percentile of bank's absolute buffer	Pereira & Saito (2015)
Gap Approach	Difference between bank capital ratio and the threshold	Mean capital ratio of all banks	Marcus (1983)
		Minimum capital requirement	Peltzman (1970), Mingo (1975), Dietrich & James (1983), Jacques & Nigro (1997), Nachane & Saibal (2001), Godlewski (2005), Hussain & Hassan (2005), Bouri (2006), Teply & Matejasák (2007), Zhang et al. (2008), Zahid et al. (2015),
Continuous Approach	The inverse of capital ratio		Abreu & Gulamhussen (2010)
	Minimum capital requirement over bank capital ratio		Ghosh (2014)

Source: Author's compilation from the literature.

Barth et al. (2004) first applied the CRI index to examine the effects of bank regulation and supervision on banking development, efficiency and fragility across 107 countries. It has gained popularity in cross-country analyses due to different definitions of capital ratios across countries which make capital ratios less comparable (Behr et al., 2010). The CRI index has also been employed in studies on the effects of capital regulation on bank capital ratios (Brewer III et al. (2008); De Jonghe and Öztekin (2015)), and bank risk (Agoraki et al. (2011); Alam (2014); Albaity and Toobaee (2017); Behr et al. (2010); Delis et al. (2012); Laeven and Levine (2009); Lee and Hsieh (2013); Lee and Lu (2015)).[10]

Despite its popularity, Barth et al. (2001) CRI index cannot avoid certain limitations. First, since the index is highly dependent on the surveys carried out, data is not available for every year. Official data is only available for the years 1999 (Survey I), 2003 (Survey II), 2007 (Survey III), and 2011 (Survey IV). In addition, since these surveys cover a wide range of countries, there is a lag in the time sending and receiving responses. For example, although responses to the first survey in 1999 were received from 1998 to 2000, the majority of the answers refer to policies from 1999 (Barth et al., 2013). Therefore, it is impossible to study capital regulation in a continuous manner without manually updating information for the missing years or using assumptions before and after the survey to fill in the year gaps. For instance, Lee and Lu (2015) made assumptions about information before and after the survey to fill in gap years. Specifically, the authors use data in Survey I for the period 1999-2001, Survey II for the period 2002-2005, Survey III for the period 2006-2008 and Survey IV over the period 2009-2011. Agoraki et al. (2011) made slightly different assumptions, using data in Survey I, II and III for the periods 1998-2000, 2001-2003, and 2004-2005, respectively. These assumptions ignore continuous changes in the legislation as well as the time it takes to initiate these changes in different countries. This problem is less important when there are infrequent changes in regulation. However, given the controversies around capital regulation and the fact that national regulators and Basel Committee are continuously working on this framework, changes in capital regulation are more frequent than being assumed.

Second, there is a restriction in term of countries providing responses. Barth et al. (2013) report that there are unequal numbers of countries participating in each survey. Specifically, while Survey I covered 118 countries, Survey II covered 151 countries. Survey III and IV cover142 and 125 countries, respectively. Among these countries, 73 of them respond to all four surveys. This number reduces to 50% of the total countries in Asia. Asia is the least covered region in the surveys compared to other regions (such as Americas, EU or Africa). The restriction adds to the gap in studying capital regulation across countries, particularly in Asia.

Third, the CRI index primarily focuses on Pillar 1 of Basel III Accord. Pillar 2 and Pillar 3 are partly reflected in other indices, namely the Official Supervisory Power index, and the Private Monitoring and External Governance index. However, these indices measure the power of supervisors and private

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[10] Brewer III et al. (2008) used only questions 1, 3 and 4 in the set of 8 questions of the Capital Regulatory Index. De Jonghe and Öztekin (2015) used the Overall Capital Stringency index (a sub-index of Capital Regulatory index).Behr et al. (2010) extended the set of questions for the Capital Regulation index by including two more questions about the legal requirements of capital verification and reserve requirements at the Central bank.

investors for bank regulation in general, rather than the capital regulation alone. Thus, they do not sufficiently capture capital stringency as outlined in Pillar 2 and Pillar 3.

The CRI index limitations are due primarily to the nature of the survey method. Neyapti and Dincer (2005) suggest an alternative method using letters of law to assess the stringency of capital regulation. Utilizing Basel core principles, Basel guidelines and documents, together with national banking laws in specific countries, the authors develop an index for capital requirements, together with seven other indices of banking regulation and supervision; namely Lending, Ownership structure, Directors and Managers, Reporting-recording requirements, Corrective action, Supervision, and Deposit insurance. These indices are applied to investigate the effects of banking regulation and supervision on economic growth in transition economies (Neyapti & Dincer, 2005), the determinants of legal quality of bank regulation and supervision (Dincer & Neyapti, 2008), and the impact of bank regulation and supervision on banking-sector performance (Neyapti & Dincer, 2014). However, the index for capital requirements in these studies only covered the regulation on licensing, limitations on holding risky assets, and restrictions on capital acquisitions. Therefore, the need for a proper measurement of capital regulation remains.

2.8 Literature Gaps

This chapter reviewed both theoretical and empirical studies about bank capital structure and bank behaviors toward capital regulation. The literature shows that banks' choices of capital structure not only satisfy the objectives of profit and value maximization following the trade-off and pecking order theories, but also ensures that they do not violate regulators' requirements. Empirical studies confirm that bank capital ratio is affected by similar factors as non-financial firms. These include bank characteristics such as size, profitability, tangibility and macro-economic factors, such as economic growth, stock market development and competition. In addition, other bank characteristics, such as bank lending, loan loss provisions and bank deposits are also important determinants. However, findings about the effect of capital regulation on bank capital structures are inconclusive. In addition, no cross-country analyses have been conducted for banks' total capital adequacy ratios. In the context of Asia, the issue is limited to a few studies in India, Hong Kong, Malaysia and Pakistan (Ahmad et al., 2008; Nachane, Narain, Ghosh, & Sahoo, 2000, 2001; Saibal et al., 2004; Wong et al., 2005; Zahid et al., 2015). However, these studies do not consider the dynamic nature of capital ratios as suggested by the literature and most empirical corporate finance studies.

Several explanations have been provided on the impact of capital regulation on bank behavior. These explanations vary with assumptions about bank behavior and considered factors, such as the moral hazard, franchise value, agency problems and capital buffers. While empirical studies on the topic are substantial, most of them have been conducted in developed countries where internationally active banks operate, primarily in the US and European countries. Less-mature financial markets, such as those in Asia, have received less attention. Studies on the effects of capital regulation on bank capital and risk in individual Asian countries are also limited to India, China and Indonesia ((Nachane & Saibal, 2001; Parinduri & Riyanto, 2011; Zhang et al., 2008). In terms of cross-country analyses, Asian countries are covered in Godlewski (2005); Hussain and Hassan (2005); Lin et al. (2013); Saadaoui (2011); Van Roy (2005, 2008) studies. Studies on bank balance sheet management under capital regulation in Asia are also limited (see Catalan et al. (2017); Cohen and Scatigna (2016); Horiuchi and Shimizu (1998); Ito and Sasaki (2002)). Moreover, a unified conclusion has not been reached.

Different conclusions about the effects of capital regulation on bank behavior can be attributed to the various sample used, the research models, and the measurement of variables (particularly dependent and capital regulation variables). Among these factors, the design of the research model and variables measurements are of particular importance. We note that in examining bank capital and risk behavior toward capital regulation, a simultaneous equations model with partial adjustment is widely employed. In addition, bank capital and risk behavior are approached through their adjustments. In these models, bank fixed effects, such as risk preference are usually disregarded, with the reason that these factors do not affect changes in bank capital and risk (Shrieves & Dahl, 1992). However, as Koehn and Santomero (1980) state, low risk-averse institutions reshuffle their balance sheets to a greater extent than their conservative counterparts. This suggests the importance of bank fixed effects in studying bank capital and risk behavior.

While the inter-relationship between capital and risk adjustment has been widely accepted since the Shrieves and Dahl (1992) study, it is usually ignored in balance sheet management studies. Early attempts are evident in Cohen and Scatigna (2016); Matejasák (2015a, 2015b) studies, which decompose elements of risk-based capital ratios. However, these are descriptive studies and do not clarify the effects of capital requirements.

In terms of capital regulation measurement, a proper proxy for capital regulation requires further consideration. Previous studies have attempted to design a variable that can capture capital regulation effects. However, most of these measurements reflect the quantitative feature of capital regulation and depend greatly on individual bank capital ratios. These quantitative measurements may cause spurious conclusions when the dependent variable is capital ratio or an endogeneity problem when the capital ratio is simultaneously introduced as a determinant of bank risk. Barth et al. (2001) suggests the need to examine capital regulation in both quantitative and qualitative aspects. In short, measuring capital regulation by quantity alone cannot fully assess the effects of capital regulation. Although qualitative measurement like Barth et al. (2001) CRI index have gained popularity in recent years, it suffers from certain limitations; in particular, data unavailability for many countries in Asia, data gaps in years without surveys, and the coverage of capital regulations.

Conceptual Framework

Figure 2.1 illustrates the conceptual framework for our study. The bank capital ratio is affected by capital regulation, bank characteristics, macro-factors, as well as bank and time fixed effects. Since bank capital ratios are determined by regulatory capital and risk-weighted assets, which comprise of balance sheet assets and liability items, the adjustment of bank capital and risk, and bank balance sheet items are also affected by similar factors. In modelling the effects of capital regulation on these adjustments, we take into account the inter-relationship between capital and risk as well as balance sheet items. Thus, a simultaneous equations model following Shrieves and Dahl (1992) suggestion is applied. In addition, we also consider the adjustment costs in maintaining target capital ratios, adjusting bank capital and risk, and adjusting balance sheet components by modelling bank behavior toward capital regulation in a dynamic framework with a partial adjustment model.

Although a hypothesis is useful in setting out the researcher's expectation and testable relationships between variables, the literature has shown inconclusive effects of capital regulation on bank capital ratio, bank capital and risk adjustments, as well as bank balance sheet adjustments. This makes the hypothesis development redundant because there are always three possible expected results – positive, negative, and no effect. Therefore, we do not state out the hypotheses for the research.

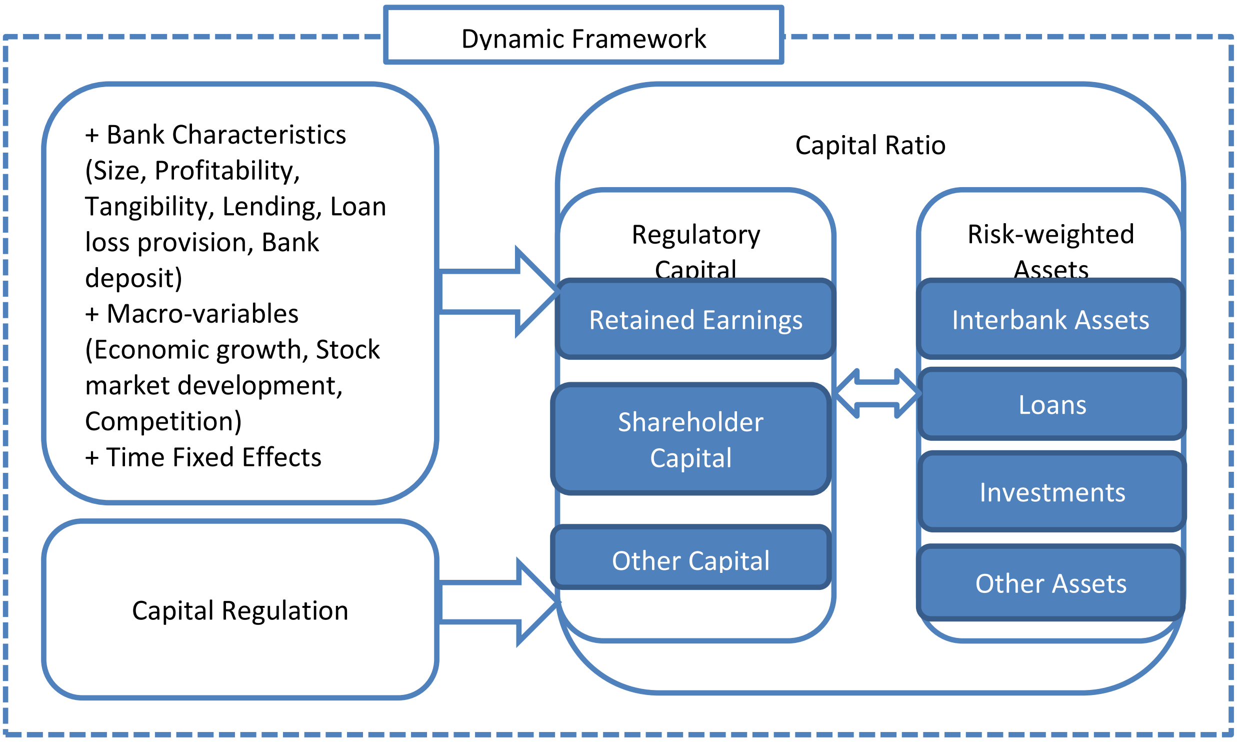


Figure 2.1 Conceptual Framework for the Effects of Capital Regulation on Bank Behavior

Chapter 3

Research Methodology and Data

3.1 Introduction

Having reviewed the relevant literature in the previous chapter, this chapter describes the methodology and data employed in this study. Data analysis for each research objective is presented in three steps: preliminary analysis, which involves primarily descriptive statistics, formal regression analysis, and robustness checks.

Section 3.2 describes the normalization method, which is used to analyze changes in bank capital and risk-weighted asset components. Section 3.3 presents the empirical models used to analyze the effects of capital regulation on bank capital ratio, bank capital and risk adjustments, and balance sheet adjustments corresponding to the three research objectives. Sections 3.4 and 3.5, respectively, discuss estimation methods and variables used in these models. Section 3.6 describes the data collection, data cleaning process, and the research sample. Section 3.7 discusses the heterogeneity of the data and the sub-sampling method.

3.2 Normalization of Changes in Balance Sheet Components

In order to examine how banks shuffle their balance sheets to reach required capital ratios, we adopt Cohen and Scatigna (2015) normalization method. Accordingly, the change in the risk-based capital ratio from time $t = 0$ to time $t = 1$ is expressed as follows:

$$\frac{CAR_1}{CAR_0} = \frac{CAP_1/CAP_0}{\left(\frac{RWA_1/TA_1}{RWA_0/TA_0}\right)\frac{TA_1}{TA_0}} \tag{3.1}$$

where CAR denotes total regulatory capital ratio, CAP denotes total regulatory capital, RWA denotes risk-weighted assets, and TA denotes total assets. Equation (3.1) illustrates three channels that banks use to meet the capital requirements: (i) changes in regulatory capital, (ii) changes in risk-weighted assets, and (iii) changes in total assets.

Taking the logarithm of equation (3.1):

$$Log\left(\frac{CAP_1/RWA_1}{CAP_0/RWA_0}\right) = Log\left(\frac{CAP_1/CAP_0}{\left(\frac{RWA_1/TA_1}{RWA_0/TA_0}\right)\frac{TA_1}{TA_0}}\right) \tag{3.2}$$

Next, multiplying both sides of equation (3.2) by a common normalization factor F, we have an equation that expresses these changes in percentage-point change in capital ratio:

$$\frac{CAP_1}{RWA_1} - \frac{CAP_0}{RWA_0} = F.\mathrm{Log}\left(\frac{CAP_1}{CAP_0}\right) - F.Log\left(\frac{RWA_1}{RWA_0}\right) = F.\mathrm{Log}\left(\frac{CAP_1}{CAP_0}\right) - F.\left(Log\left(\frac{RWA_1}{TA_1}\right) - Log\left(\frac{RWA_0}{TA_0}\right)\right) - F.Log\left(\frac{TA_1}{TA_0}\right) \quad (3.3)$$

where, F is the normalization factor, and equals:

$$F = \frac{\frac{CAP_1}{RWA_1} - \frac{CAP_0}{RWA_0}}{Log(\frac{CAP_1}{RWA_1}) - \mathrm{Log}(\frac{CAP_0}{RWA_0})} \quad (3.4)$$

Computing the elements in equation (3.3) reveals how much changes in capital ratios are caused by changes in regulatory capital, in risk-weighted assets and in total assets.

Banks can increase their capital by retaining more earnings, issuing new equity and other capital instruments. In term of asset and risk adjustment, banks can change the proportion of interbank assets, investments, loans and other assets, as well as their relative size. Therefore, our study extends Cohen and Scatigna (2016) work further by decomposing regulatory capital and risk-weighted assets. Although Cohen and Scatigna (2016) decomposed regulatory capital, their focus was bank cash flow, such as income and dividend payments. In contrast, our study, focuses on the type of regulatory capital, particularly Tier 1 capital. The normalized regulatory capital and risk-weighted assets in equation (3.3) can be transformed into their corresponding components as follows:

$$F.\mathrm{Log}\left(\frac{CAP_1}{CAP_0}\right) = G.\left(\frac{RE_1}{CAP_0}\right) + G.\left(\frac{SHC_1}{CAP_0}\right) + G.\left(\frac{OC_1}{CAP_0}\right) \quad (3.5)$$

$$F.Log\left(\frac{RWA_1}{RWA_0}\right) = H.\left(\frac{IA_1}{TA_0}\right) + H.\left(\frac{INV_1}{TA_0}\right) + H.\left(\frac{LOAN_1}{TA_0}\right) + H.\left(\frac{OA_1}{TA_0}\right) \quad (3.6)$$

where, G and H are normalization factors and are defined as:

$$G = \frac{F.Log\left(\frac{CAP_1}{CAP_0}\right)}{\frac{CAP_1}{CAP_0}} \quad (3.7)$$

$$H = \frac{F.Log\left(\frac{RWA_1}{RWA_0}\right)}{\frac{TA_1}{TA_0}} \quad (3.8)$$

RE, SHC, OC, IA, INV, LOAN, and *OA* are retained earnings, shareholder capital, other capital, interbank assets, investments, loans, and other assets, respectively. Other capital is the residual of total regulatory capital after excluding retained earnings and shareholder capital. Other assets are the residuals of total assets after subtracting for interbank assets, loans and investments.

3.3 Research Models

3.3.1 Partial Adjustment Model of Bank Capital Ratio

The literature on bank capital structure suggests that there is an optimal (target capital structure) (CAR_{it}^{*}) that banks try to reach. This target capital ratio is unobservable and is approximated through a set of explanatory factors $(X_{k,it})$:

$$CAR_{it}^{*} = \alpha_0 + \sum_{k=1}^{K} \alpha_k X_{k,it} \qquad (3.9)$$

Where α is a vector of parameters and X is a vector of K explanatory factors.

Previous studies have found that bank target capital ratios are affected by similar factors to non-financial firms. These include bank characteristics such as size (*SIZE*), profitability (*ROA*), tangibility (*FA_RATIO*) and macro-economic factors, such as economic growth (*GDP_GROWTH*), stock market development (*MARKET_CAP*) and competition (*COMP*) (Asarkaya & Ozcan, 2007; De Jong, Kabir, & Nguyen, 2008; Gropp & Heider, 2010; Wong et al., 2005; Wu & Bowe, 2010). Other bank characteristics such as bank lending (*LOAN_RATIO*), loan loss provisions (*LLP_TO_TA*) and bank deposits (*DEPOSIT_RATIO*) are also important determinants (Bateni, Vakilifard, & Asghari, 2014; Berger, DeYoung, Flannery, Lee, & Öztekin, 2008; Büyüksalvarci & Abdioglu, 2011; Francis & Osborne, 2010). Due to heavy regulation, bank capital ratios are further affected by capital regulation (*REG*) (Mishkin, 2007).

However, due to market friction, it takes time for banks to reach target capital levels. Moreover, maintaining capital ratio at the target level is costly; thus banks keep their capital structure away from this target. Myers (1984) suggests that adjustment costs are significant and thus, actual capital ratios are not the target ratios but deviate from this target. This argument has been widely accepted and thus, capital ratios is usually estimated through a partial adjustment model (PAM) (see for example, Asarkaya and Ozcan (2007); Brewer III et al. (2008); Francis and Osborne (2010); Marcus (1983)). Accordingly, adjustments in bank capital ratios $\left(CAR_{it} - CAR_{i,t-1}\right)$ are proportional to differences between the target level (CAR_{it}^{*}) and the observed level in the previous period $(CAR_{i,t-1})$:

$$\left(CAR_{it} - CAR_{i,t-1}\right) = \lambda\left(CAR_{it}^{*} - CAR_{i,t-1}\right) + \varepsilon_{it} \qquad (3.10)$$

Where, λ is the adjustment speed and ranges from 0 to 1. The higher the value of λ, the faster the bank adjusts its capital ratio to reach the desired level. If $\lambda = 0$, no adjustment is made, as doing so may create a cost greater than the cost of operating at a suboptimal level. In contrast, when $\lambda = 1$, this indicates that the bank makes full adjustment toward the target level. In other words, the bank reaches its target level immediately and the cost of adjustment is zero (Watson & Teelucksingh, 2002). ε_{it} is the error term.

Since we are more interested in the level of capital ratios, we transform equation (3.10) by adding $CAR_{i,t-1}$ to both sides of the equation:

$$CAR_{it} = \lambda CAR^{*}_{it} + (1-\lambda)CAR_{i,t-1} + \varepsilon_{it} \quad (3.11)$$

Integrating equation (3.9) into equation (3.11) using the full set of explanatory variables, we now have a model for determining bank capital ratios as follows:

$$CAR_{it} = \beta_0 + \beta_1 CAR_{i,t-1} + \beta_2 REG_{it} + \beta_3 SIZE_{it} + \beta_4 ROA_{it} + \beta_5 LOAN\_RATIO_{it} + \beta_6 LLP\_TO\_TA_{it} + \beta_7 FA\_RATIO_{it} + \beta_8 DEPOSIT\_RATIO_{it} + \beta_9 GDP\_GROWTH_{it} + \beta_{10} MARKET\_CAP_{it} + \beta_{11} COMP_{it} + \beta_i + \varepsilon_{it} \quad (3.12)$$

Where, β is a vector of estimated coefficients, and:

$$\begin{cases} \beta_0 = \lambda\alpha_0 \\ \beta_1 = 1-\lambda \\ \beta_k = \lambda\alpha_k \end{cases} \quad (3.13)$$

Equation (3.9) represents the target capital ratio, which is in equilibrium and in the long-run. Therefore, the coefficients α_0 and α_k are considered long-run coefficients, which reflect the long-run impact of explanatory variables X on bank capital ratios. Equation (3.12) is the short-run function of capital ratios. The coefficients β_0 and β_k, thus, are short-run coefficients and represent the short-run impact of explanatory variables X on bank capital ratios (Gujarati, 2009). The effects of capital regulation on bank capital ratios is expressed by coefficient β_2. Coefficient β_i captures bank fixed effects.

3.3.2 Simultaneous Equations Model of Bank Capital and Risk Behavior

To examine the effects of capital regulation on bank capital and risk behavior, we adopt the simultaneous equations model with partial adjustment (SEM-PAM). The model was proposed by Shrieves and Dahl (1992) and widely used in studying bank capital and risk behavior. The model is as follows:

$$\Delta CAP_{it} = \alpha(CAP^{*}{}_{it} - CAP_{i,t-1}) + \Delta RISK_{it} + E_{it} \quad (3.14)$$

$$\Delta RISK_{it} = \beta(RISK^{*}{}_{it} - RISK_{i,t-1}) + \Delta CAP_{it} + U_{it} \quad (3.15)$$

According to this model, changes in bank capital (ΔCAP_{it}) and risk ($\Delta RISK_{it}$) result from discretionary factors, which are proportional to the difference between target levels ($CAP^{*}{}_{it}$ and $RISK^{*}{}_{it}$) and observed levels in the previous period ($CAP_{i,t-1}$ and $RISK_{i,t-1}$), and exogenously determined random shocks (E_{jt} and U_{jt}). In addition, there is an inter-relationship between changes in capital and risk (Shrieves & Dahl, 1992).

Discretionary factors are modeled using the PAM model (Shrieves & Dahl, 1992). Therefore, α and β are parameters that reflect adjustment speeds toward the target capital and risk levels and range from 0 to 1. An adjustment speed equaling 1 indicates that there are no adjustment costs and banks can reach their desired capital (or risk) immediately. If this parameter is 0, banks do not make any adjustment in their capital (or risk). The closer this parameter moves toward unity (1), the faster the adjustment is (Watson & Teelucksingh, 2002).

Shrieves and Dahl (1992) also suggest that target capital and risk are difficult to observe directly. Hence, they are assumed to depend on some observable variables. Consistent with the literature, in this study, target capital and risk levels are determined by a number of explanatory variables including, bank size (*SIZE*), profitability (*ROA*), amount of lending (*LOAN_RATIO*), assets quality (*LLP_TO_TA*), economic growth (*GDP_GROWTH*), and capital regulation (*REG*) (Pereira & Saito, 2015; Rime, 2001; Van Roy, 2008). We additionally control for tangibility (*FA_RATIO*), and deposit ratios (*DEPOSIT_RATIO*) in the target capital and risk model. These two variables have been proven to affect bank capital ratios (see for example, Amidu (2007); Kleff and Weber (2008); Klepczarek (2015); Octavia and Brown (2010)) and thus, are expected to affect bank capital and risk. Other macroeconomic shocks are captured through year dummies.

Incorporating factors affecting target capital and risk into equations (3.14) and (3.15), the empirical model to be estimated as follows:

$$\Delta CAP_{it} = a_0 + a_1 SIZE_{it} + a_2 ROA_{it} + a_3 LOAN\_RATIO_{it} + a_4 LLP\_TO\_TA_{it} + a_5 FA\_TO\_TA_{it} + a_6 DEPOSIT\_RATIO_{it} + a_7 REG_{it} + a_8 GDP\_GROWTH_{it} + a_9 CAP_{i,t-1} + \sum_t a_{10t} YEAR_t + a_{11} \Delta RISK_{it} + a_i + \nu_{it} \quad (3.16)$$

$$\Delta RISK_{it} = b_0 + b_1 SIZE_{it} + b_2 ROA_{it} + b_3 LOAN\_RATIO_{it} + b_4 LLP\_TO\_TA_{it} + b_5 FA\_TO\_TA_{it} + b_6 DEPOSIT\_RATIO_{it} + b_7 REG_{it} + b_8 GDP\_GROWTH_{it} + b_9 RISK_{i,t-1} + \sum_t b_{10t} YEAR_t + b_{11} \Delta CAP_{it} + b_i + \omega_{it} \quad (3.17)$$

Where, a and b are vectors of parameters to be estimated; a_j and b_j are bank fixed-effects; ν_{it} and ω_{it} are error terms with zero mean and constant variances. Of particular interest are coefficients a_7 and b_7, which represent the effects of capital regulation on changes in bank capital and risk; a_9 and b_9, represent partial adjustment of the model; a_{11} and b_{11}, represent the inter-relationship between changes in bank risk and capital. The significance of these coefficients will confirm the effects of capital regulation and the usefulness of the model.

Since changes in bank capital and risk can be either positive or negative, a positive relationship between capital regulation and changes in bank capital, for example, can be interpreted as "capital regulation induces banks to increase capital more or reduce capital less, ceteris paribus." Similar interpretation is applied for changes in bank risk. Therefore, capital regulation is considered to be effective when a_7 is positive and b_7 is negative.

In relation to equations (3.14) and (3.15), a_9 and b_9 equal the inverse of α and β, and reflect the adjustment speed of bank capital and risk. Following the assumption of the PAM model, a_9 and b_9 should have negative signs and range from -1 to 0.

The dependent variables in equations (3.16) and (3.17) are changes in bank capital (ΔCAP_{it}) and changes in bank risk $(\Delta RISK_{it})$. These variables have been used to study bank capital and risk behavior since Shrieves and Dahl (1992) study because they are unaffected by bank risk preferences. Thus, data is pooled across banks. However, Koehn and Santomero (1980) state that low risk-averse institutions reshuffle their balance sheets to a greater extent than their conservative counterparts. Therefore, risk preferences may still have an influence on changes in capital and risk. This factor and other unobserved time-invariant factors are captured in our model through bank fixed effects, represented by a_i in the capital equation (equation (3.16)) and b_i in the risk equation (equation (3.17)).

Due to the existence of fixed effects, such as bank risk preferences, bank capital and risk levels can also be used as dependent variables to assess bank behavior. Although several previous studies have examined these variables in levels, they have failed to model them correctly. Specifically, Bouheni and Rachdi (2015) and Bougatef and Mgadmi (2016) do not consider the partial adjustment of capital and risk. In an imperfect market, the assumption that banks incur no costs in changing their capital and risk levels is not practical. This cost of adjustment is also one of banks' motivations for holding a capital buffer above the minimum requirement (Peura & Keppo, 2006). Parinduri and Riyanto (2011) ignore the simultaneity between them. In a regulatory environment with risk-based capital requirements, banks cannot decide the amount of capital independently from the amount of risk, and vice versa. Many studies have confirmed this inter-relationship between bank capital and risk (see for example, Jacques and Nigro (1997); Rime (2001); Shrieves and Dahl (1992)). Therefore, we model bank capital and risk levels using the SEM-PAM model, similar to changes in bank capital and risk. For this reason, we transform equations (3.14) and (3.15) by adding $CAP_{i,t-1}$ and $RISK_{i,t-1}$ to both sides of the capital and risk equation, respectively. $RISK_{it}$ and CAP_{it} are included instead of their changes to capture the inter-relationship between capital and risk behavior. Accordingly,

$$CAP_{it} = \alpha CAP^{*}{}_{it} + (1-\alpha)CAP_{i,t-1} + RISK_{it} + E_{it} \tag{3.18}$$

$$RISK_{it} = \beta RISK^{*}{}_{it} + (1-\beta)RISK_{i,t-1} + CAP_{it} + U_{i,t} \tag{3.19}$$

Using the same set of explanatory variables that affect bank target capital and risk, we estimate the model with capital and risk levels as dependent variables, as outlined below:

$$CAP_{it} = c_0 + c_1SIZE_{it} + c_2ROA_{it} + c_3LOAN\_RATIO_{it} + c_4LLP\_TO\_TA_{it} + c_5FA\_TO\_TA_{it} + c_6DEPOSIT\_RATIO_{it} + c_7REG_{it} + c_8GDP\_GROWTH_{it} + c_9CAP_{i,t-1} + \sum_t c_{10t}YEAR_t + c_{11}RISK_{it} + c_i + \phi_{it} \quad (3.20)$$

$$RISK_{it} = d_0 + d_1SIZE_{it} + d_2ROA_{it} + d_3LOAN\_RATIO_{it} + d_4LLP\_TO\_TA_{it} + d_5FA\_TO\_TA_{it} + d_6DEPOSIT\_RATIO_{it} + d_7REG_{it} + d_8GDP\_GROWTH_{it} + d_9RISK_{i,t-1} + \sum_t d_{10t}YEAR_t + d_{11}CAP_{it} + d_i + \psi_{it} \quad (3.21)$$

Where c and d are parameters to be estimated. c_i and d_j are bank fixed effects. ϕ_{it} and ψ_{it} are error terms.

3.3.3 Balance Sheet Adjustments

Francis and Osborne (2012) suggest that banks adjust their balance sheets to maintain target capital ratios and that these adjustments depend on the variation between the banks' actual and target capital ratios. The authors modeled the adjustments in bank assets and capital (ΔBS_{jit}) as a function of the level of bank capitalization ($Z_{i,t-1}$), and a set of control variables ($Control_{it}$):

$$\Delta BS_{jit} = \beta_{0ji} + \beta_{2j}Z_{i,t-1} + \beta_{cj}Control_{it} + \varepsilon_{jit} \quad (3.22)$$

Where, β_{0ji} are bank fixed effects; β_{2j} and β_{cj} are parameters; and ε_{jit} is the error term.

Although Francis and Osborne (2012) were concerned about the dynamic of the model, there was no lagged dependent variable included in their study. They reasoned that both fixed effects and system GMM regression rejected the significance of the lagged dependent variable. However, using the same data for U.K banks with a longer time period (1989-2013), De-Ramon et al. (2016), show that there is a dynamic effect of balance sheet adjustments. Thus, our study includes lagged dependent variables to capture the dynamic of balance sheet adjustments.

Following Francis and Osborne (2012), the value of bank capitalization ($Z_{i,t-1}$) depends on the banks' actual capital ratio ($CAR_{i,t-1}$) and target capital ratio ($CAR^*_{i,t-1}$). Instead of using the level of bank capitalization ($Z_{i,t-1}$), which involves estimating the target capital ratio ($CAR^*_{i,t-1}$), our study uses the determinants of $Z_{i,t-1}$ to avoid doubling the bias.[11] Specifically, factors affecting the target capital ratio

[11] For the same reason, we do not use control variables to determine balance sheet adjustments, similar to Francis and Osborne (2012)'s study.

(as modelled in equation (3.9)) and bank actual capital ratios are incorporated into equation (3.22). The model of bank balance sheet adjustments is given as follows: [12]

$$\Delta BS_{jit} = \gamma_{0ji} + \beta_{1j}\Delta BS_{ji,t-1} + \beta_{2j}CAR_{i,t-1} + \gamma_{1j}REG_{i,t-1} + \gamma_{2j}\mathrm{SIZE}_{i,t-1} + \gamma_{3j}\mathrm{ROA}_{i,t-1} + \gamma_{4j}\mathrm{LOAN\_RATIO}_{i,t-1} + \gamma_{5j}\mathrm{LLP\_TO\_TA}_{i,t-1} + \gamma_{6j}\mathrm{FA\_RATIO}_{i,t-1} + \gamma_{7j}\mathrm{DEPOSIT\_RATIO}_{i,t-1} + \gamma_{8j}\mathrm{GDP\_GROWTH}_{i,t-1} + \varepsilon_{jit} \quad (3.23)$$

Where γ and β are vectors of parameters to be estimated. The dynamic of the adjustment of balance sheet component j is captured through β_{1j}. The effect of capital regulation (REG) on the adjustment of balance sheet component j is reflected in γ_{1j}.

Our study is interested in adjustments in balance sheet components and the effect of capital regulation. Therefore, equation (3.23) is estimated repeatedly for regulatory capital components, including retained earnings (*RE*), shareholder capital (*SHC*), other capital (*OC*), and asset components, including interbank assets (*IA*), investments (*INV*), loans (*LOAN*), and other assets (*OA*).

Shrieves and Dahl (1992) suggest that there is an inter-relationship between capital and risk decisions of risk-based capital ratios and estimate the effects of capital regulation on bank capital and risk behaviors using a SEM model. This inter-relationship has been reported in many studies (see for example, Aggarwal and Jacques (2001); Bougatef and Mgadmi (2016); Jacques and Nigro (1997); Pereira and Saito (2015)). Therefore, it is reasonable to expect that decisions to adjust a balance sheet item, such as retained earnings, are dependent on the adjustment of other balance sheet items, such as shareholder capital, loans, investments, and vice versa. Thus, we include the remaining components of capital and risk-weighted assets (ΔBS_{hit}) as explanatory variables in equation (3.23) as follows:

$$\Delta BS_{jit} = \gamma_{0ji} + \beta_{1j}\Delta BS_{ji,t-1} + \sum_{h\neq j}\beta_h \Delta BS_{hit} + \beta_{2j}CAR_{i,t-1} + \gamma_{1j}REG_{i,t-1} + \gamma_{2j}\mathrm{SIZE}_{i,t-1} + \gamma_{3j}\mathrm{ROA}_{i,t-1} + \gamma_{4j}\mathrm{LOAN\_RATIO}_{i,t-1} + \gamma_{5j}\mathrm{LLP\_TO\_TA}_{i,t-1} + \gamma_{6j}\mathrm{FA\_RATIO}_{i,t-1} + \gamma_{7j}\mathrm{DEPOSIT\_RATIO}_{i,t-1} + \gamma_{8j}\mathrm{GDP\_GROWTH}_{i,t-1} + \varepsilon_{jit} \quad (3.24)$$

Capital component is expected to be slower in adjustment than asset components. Therefore, we also include lag 2 periods of capital components to fully capture their dynamic.

[12] The set of variables that affect bank target capital ratio levels also includes stock market development (*MARKET_CAP*) and competition (*COMP*). However, we find a small impact of stock market development on bank capital ratio (around 0.01%) and significant impact of competition only at a 10% significance level. In addition, the inclusion of these variables also leads to a large reduction of observation (23% of the sample). Therefore, these variables are not included in the specification.

3.4 Estimation Methods

3.4.1 Simultaneous Equations Model Estimation for Panel Data

Our study employs panel data consisting of N banks across T years. For simplicity, we can write a general form of our equations to be estimated (that is, equations (3.12), (3.16), (3.17), (3.20), (3.21) and (3.24)) as follows:

$$y_{it} = \alpha + \beta x_{it} + a_i + \varepsilon_{it}, i = 1,2, \dots, N;\ t = 1,2, \dots, T \quad (3.25)$$

where y_{it} is the dependent variable of bank i in year t; x_{it} is a $k\ x$ 1 vector of regressors; β is a k - dimensional vector of parameters; α is the intercept; a_i is individual effect; ε_{it} is the error term.

Since a_i is the individual effect and captures all unobserved, time invariant factors that affect y_{it}, the estimation of equation (3.25) depends on assumptions about this individual effect (Greene, 2018). If a_i is constant, equation (3.25) can be estimated using pooled ordinary least square (pooled-OLS). However, if a_i differs across i, OLS estimator is biased depending on the degree of heterogeneity of a_i and the correlation between a_i and x_{it} (Pesaran, 2015).

Two different models derive from this point, which differ in assumptions about the correlation between a_i and x_{it}. Specifically, the Fixed Effects model (FEM) assumes that a_i and x_{it} are correlated. The error term can be rewritten as a composite error $v_{it} = a_i + \varepsilon_{it}$. The composite error v_{it} is correlated with x_{it}. Thus, the OLS estimator becomes biased due to omitting variable a_i. Therefore, the estimation method needs to remove a_i. This can be done by first-differencing the data (First Differencing), using dummy variables for each i groups (Least Square Dummy Variable) or time-demean the data (Fixed Effects) (Wooldridge, 2015).

In contrast, the Random Effects model (REM) assumes that a_i is uncorrelated with x_{it}. A transformation to remove a_i could result inefficient estimators. Since a_i is included in the composite error v_{it}, v_{it} is serially correlated across time. Thus, OLS estimation is also biased. In order to obtain consistent estimation, the data should be transformed to eliminate the serial correlation in the errors. This can be done by subtracting a fraction of time average from all corresponding variables (quasi-demeaned data). This estimation technique is known as Generalized Least Square (GLS) (Wooldridge, 2015).

The choice of either Pooled-OLS, FEM or REM can be accomplished based on several tests. Specifically, the heteroscedasticity of individual effects a_i can be tested with an F-test. The test has the null hypothesis that all individual effects are jointly zero. A rejection of this test, therefore, indicates the bias of Pooled-OLS and FEM estimation is preferred (Greene, 2018). The random effects can be tested using the Lagrange Multiplier test (Breusch & Pagan, 1980). Under the null hypothesis, there are no random effects, i.e., $\sigma_a^2 = 0$. The test has a χ^2 distribution with 1 degree of freedom and a rejection of the null suggests the appropriateness of REM (Greene, 2018). The random effect can also be tested using the Hausman test (Hausman, 1978). This test compares the estimators from FEM and REM under the null hypothesis that there is no correlation between the error terms and explanatory variables. FEM estimators are consistent whether the null is true or not, while REM estimators are consistent under the null but inconsistent if the null is false. Thus the test statistic is based on the mean difference between the estimators from the two methods. This statistic has a χ^2 asymptotically distribution with the degree of freedom equals the number of parameters. A rejection of the null implies that the key assumption under REM is false and thus, FEM should be used (Greene, 2018).

An important assumption of equation (3.25) is that x_{it} should be strictly exogenous. That is, x_{it} is independent of current, past, and future value of the error term v_{it} (Wooldridge, 2015). However, such an assumption cannot be met in the SEM model. As can be seen in equations (3.16), (3.17), (3.20), (3.21) and (3.24), some of the independent variables x_{it} and y_{it} are interdependent. Variables x_{it} can be grouped into endogenous x_{1it} variables and exogenous variables x_{21it}. Equation (3.25), and the regression of x_{1it} on y_{it} and other exogenous explanatory variables x_{22it} can be re-written in the form of the SEM model as:

$$y_{it} = \alpha_1 + \beta_1 x_{1it} + \beta_2 x_{21it} + a_{1i} + \varepsilon_{1it}, i = 1,2, \dots, N;\ t = 1,2, \dots, T \qquad (3.26)$$

$$x_{1it} = \alpha_2 + \delta_1 y_{it} + \delta_2 x_{22it} + a_{2i} + \varepsilon_{2it}, i = 1,2, \dots, N;\ t = 1,2, \dots, T \qquad (3.27)$$

In the SEM model, neither pooled OLS, FEM nor REM estimation can provide consistent and efficient estimators due to the correlation between endogenous variables and error terms, which are y_{it} and ε_{2it}, x_{1it} and ε_{1it} (Asteriou & Hall, 2007). This is referred to as a simultaneity bias caused by the simultaneity between dependent and independent variables and is a source of endogeneity (Wooldridge, 2015).

There are two approaches to address this endogeneity; namely the single-equation methods (also known as the limited information method) and the system method (also known as the full information method). The single-equation method estimates each equation in the system individually while the system method estimates all equations simultaneously. Common single-equation methods are Two-Stage Least Squares (2SLS), Generalized Method of Moments (GMM), and Limited Information Maximum Likelihood (LIML). For systems methods, common techniques are Three-Stage Least Squares (3SLS), Generalized Method of Moments (GMM) and Full Information Maximum Likelihood (FIML). These are instrumental variables (IV) approaches, which allow for the consistent estimation of the parameters in the case of endogeneity and systems methods of estimation are asymptotically better. However, systems methods suffer from two main problems. First, systems methods are very sensitive to specification errors. Any specification errors, such as wrong functional form or omitted variables, will be propagated throughout the system. Second, in the finite sample, the variation of estimated covariance matrix will be transmitted through the system, which may eventually be as large as, or larger than, that of the single-equation method such as the 2SLS (Greene, 2018). Therefore, our study uses the single-equation method.

We employ the 2SLS method for panel data following Wooldridge (2015) suggestion to estimate equations (3.16) and (3.17). This method is not applied to estimate equations (3.20), (3.21), and (3.24) despite their simultaneous nature because they have a dynamic pattern. We discuss the dynamic panel data estimation further in Section 3.4.2.

The 2SLS method for panel data firstly transforms the data by treating fixed effects a_i either through demeaning (FEM), first-differencing (FD) or quasi-demeaning the data (REM) depending on the assumption about the correlation between a_i and x_{it}. We test for this assumption using a Hausman test (Hausman, 1978). Next, 2SLS estimation is applied on the transformed data to deal with the endogenous variables, which are x_{1it} and y_{it}.

3.4.2 Dynamic Panel Data Estimation

As noted in equations (3.12), (3.20), (3.21) and (3.24), there is a presence of lagged dependent variable. Equation (3.25) is re-written to include this lagged dependent variable as follows:

$$y_{it} = \alpha + \lambda y_{i,t-1} + \beta x_{it} + a_i + \varepsilon_{it}, i = 1,2,\dots,N;\ t = 1,2,\dots,T \qquad (3.28)$$

The presence of the lagged dependent variable among the independent variables leads to two issues. First, $y_{i,t-1}$ is not strictly exogenous. By construction, $y_{i,t-1}$ is correlated with the individual effect a_i, and the lagged error term ε_{it-1}. Second, when T is small, there is the non-vanishing effects of the initial value of y_{i0} on y_{it}. The properties of various estimators depend on the assumption about this initial value (Pesaran, 2015). Therefore, pooled-OLS and GLS cannot provide consistent estimators (Greene, 2018). FEM does not solve the problem either. Nickell (1981) argues that there is a bias of order $(1/T)$ in FEM estimation. The bias disappears only when $T \rightarrow \infty$, but substantial when T is small or when λ is close to 1.

Anderson and Hsiao (1981) propose the use of first-differenced Two Stage Least Squares (FD-2SLS) to remove the individual effect a_i through first-differencing and then instrumenting $\Delta y_{i,t-1}$ by $y_{i,t-2}$. The variable $y_{i,t-2}$ is considered as a good instrument since it is correlated with $\Delta y_{i,t-1}$, and not correlated with $\Delta\varepsilon_{it}$ conditional on no serial correlation of ε_{it}. However, $y_{i,t-2}$ becomes a weak instrument when λ is close to 1. In addition, FD-2SLS provides consistent but not efficient estimates since the estimation does not take into account all available moment conditions (Ahn & Schmidt, 1995).

For such reasons, attention has been given to the GMM method. Arellano and Bond (1991) suggest that utilizing the orthogonality conditions between the lagged dependent variables $y_{i,t-s}$ $(s < t)$ and the error term ε_{it}, additional moment conditions can be obtained to provide more efficient estimators. They proposed the use of Differenced Generalized Method of Moments (FD-GMM) in which the model is first-differenced to get rid of individual effects a_i and then instrument the differenced lagged dependent variable $\Delta y_{i,t-1}$ with all available past levels of dependent variables y_{it}.

However, if the panel is unbalanced, differencing results in a substantial loss of the total variation in the data. Arellano and Bover (1995) suggest an alternative to FD-GMM, which is known as Forward-orthogonal-deviation Generalized Method of Moments (FOD-GMM). While FD-GMM transforms variables by subtracting previous observations from the current ones, FOD-GMM subtracts the average of all future available observations instead. By characterizing the valid transformations of relevant models, Arellano and Bover (1995) show that the optimal estimators are invariant to the transformation methods and FOD-GMM can preserve orthogonality among the errors.

Alonso-Borrego and Arellano (1999) show that FD-GMM suffers from the large finite sample bias and less precision in simulation studies. In such a case, the lagged levels of dependent variables $y_{i,t-s}$ convey little information about future changes and become weak instruments for the differenced lagged dependent variable $\Delta y_{i,t-1}$. This is the case when λ moves toward 1 or when the relative variance of a_i increases (Blundell & Bond, 1998). In addition, if the explanatory variables x_{it} are uncorrelated with the individual effect a_i, exploiting information in levels can improve the efficiency of estimates (Arellano & Bover, 1995). Given such considerations, Blundell and Bond (1998) impose further restrictions on the initial value of y_{it}, which allow for the use of lagged differences of y_{it} as instruments in levels equation. The method is known as the System Generalized Method of Moments (SYS-GMM), which exploits the lagged differences of the dependent variable $\Delta y_{i,t-1}$ as instruments for equations in levels, in addition to lagged levels of dependent variables $y_{i,t-s}$ as instruments for equations in first differences. By reasoning that these past changes may be more predictive of current levels than the revision, the new additional instruments are more relevant. Subsequent simulations show that the use of these additional instruments yield substantial gains of efficiency over standard GMM estimations such as FD-GMM and non-linear GMM (Blundell & Bond, 2000; Blundell, Bond, & Windmeijer, 2001; Hahn, 1999). For such reasons, equations (3.12), (3.20), (3.21) and (3.24) are estimated using SYS-GMM.

3.4.3 Consistency and Efficiency of Estimators

Existence of Endogeneity

Both 2SLS and GMM are IV estimations that provide consistent and efficient estimators in the case of endogeneity; that is, the independent variables are correlated with the error term. However, if there is no endogeneity, IV estimations are consistent but not efficient (that is, they have smaller variance) (Gujarati, 2009). Therefore, a test for the endogeneity of suspicious endogenous variables is necessary. This can be done using the Durbin-Wu-Hausman test (Durbin, 1954; Hausman, 1978; Wu, 1973). The test involves estimating the model using both OLS and IV methods and then comparing the estimated coefficient vectors. The null hypothesis is that the OLS estimator is consistent and fully efficient. The test statistic has χ^2distribution and m degree of freedom, which equals the number of endogenous variables tested. A rejection of the null indicates that IV estimation is necessary (Hausman, 1978).

In GMM, the endogeneity of variables can also be tested using the difference-in-Hansen test (also known as the "difference distance" test (Ruud, 2000) or the "C-test" (Hayashi, 2000). The test has difference-in-Hansen statistic computed as the difference between the Sargan – Hansen statistics of the equations with and without the tested endogenous variable(s). The C-statistic has χ^2distribution with the degree of freedom equal the number of tested variables. The null hypothesis is that the tested variables are exogenous. A rejection of the null suggests that the tested variables are endogenous (Baum, Schaffer, & Stillman, 2003).

Relevance and Validity of Instruments

In order to be good instruments, instrumental variables must satisfy two conditions: (1) be correlated with endogenous variables that they instrument for, and (2) be uncorrelated with the error term. The former can be regarded as the relevance condition and the latter as the exogeneity condition (Greene, 2018).

The relevance of instruments is important since the inclusion of instruments with little explanatory power will increase the bias of the IV estimators. The bias is not less than that of OLS estimation. This makes IV estimations inconsistent. In such case, there is no efficiency gain from the IV approach (Hahn & Hausman, 2002). The relevance condition can be tested using the F-statistic of reduced form regression of the endogenous variable on the set of instruments. The null hypothesis is that all instruments are jointly insignificant. In other words, the instruments are weak and irrelevant to the endogenous variable. The weak instruments exist even in cases when the F-statistic is significant at conventional levels, for example at 5% or 1% and in large samples. Therefore, a rule of thumb is that the regression of the endogenous variable on the set of instruments should have F-statistic at least 10 (Staiger & Stock, 1994).

IV estimation requires at least as many excluded instruments (L) (that is, the instruments that are not in the equation) as endogenous variables (M). The model is said to be exactly identified or just identified if the number of excluded instruments equals the number of endogenous variables ($L = M$). Otherwise, it is over-identified (Hill, Griffiths, & Lim, 2011). The exogeneity condition can be tested when there are over-identifying instruments ($L > M$). Two common tests for the exogeneity condition are Sargan test and Hansen J-test. These tests have test statistic with χ^2 distribution and the degree of freedom equal to the number of overidentifying restrictions. A rejection of the null hypothesis implies that the overidentifying instruments do not satisfy the exogeneity condition (Baum et al., 2003). The Sargan statistic is valid under the condition of homoscedasticity of the error term. In the presence of heteroscedasticity, Hansen J-statistic is reliable. Nevertheless, Hansen J-statistic is weakened by too many instruments (Roodman, 2006).

Apart from weakening the Hansen J-test, the use of too many instruments in IV estimation, particularly GMM, can create an over-fitting bias caused by the quadratic increase in the number of instruments as the time (T) increases (Arellano, 2016). It can also lead to imprecise estimates of the optimal weighting matrix in finite sample and downward bias standard errors in two-step GMM (Roodman, 2009). To address the problem of too many instruments, we follow Roodman (2006, 2009) suggestion by collapsing the instruments and limiting the number of instruments by using certain lags instead of all available lags for instruments.

Robust Standard Errors

In panel data, it is expected that observations on the same individual at different times are correlated with each other, but that those on different individuals are not. Therefore, a cluster robust inference for the standard errors is needed (Arellano & Bond, 1991; Pesaran, 2015). In GMM, this can be done with a sandwich-typed proxy based on one-step residuals. This method, in one-step GMM, is equivalent to two-step GMM, in which the estimators of coefficients are efficient and robust to both heteroscedasticity and individual-cross correlation covariance of error terms (Roodman, 2006). However, in small samples, the estimated standard errors of two-step GMM are downward biased (Arellano & Bond, 1991). Windmeijer (2005) suggests a correction for this bias based on the Taylor-series expansion. The author also found that two-step GMM performed better than one-step GMM in estimating coefficients with lower biases and standard errors. Together with the correction for small-sample biases, the two-step GMM modestly outperforms the cluster-robust one-step GMM. Therefore, we employ a two-step SYS-GMM with robust standard errors corrected for small sample biases, as suggested by Windmeijer (2005).

In addition, we also use time dummies to remove universal time-related shocks, following Roodman (2006) suggestion. The use of time dummies helps ensure the assumption of uncorrelated errors terms across individuals in GMM (Roodman, 2006). However, in models with macro-variables, such as ours, the effect of macro-variables might partly reflect in time dummies. Wooldridge (2015) also warns about the use of time dummies together with macro-variables. The results in such cases should be read with care. For this reason, we conduct some robustness checks, and treat these macro-variables and time dummies separately.

Correlation of the Error Terms

GMM estimation additionally assumes that error terms outside the fixed effects ε_{it} are not serially correlated. Otherwise, the second lag of the dependent variable y_{it} will become an invalid instrument. To ensure this assumption, the Arellano–Bond test for second-order serial correlations in residual differences (also known as AR(2) test) is applied (Arellano & Bond, 1991). Intuitively, since $\Delta\varepsilon_{it} = \varepsilon_{it} - \varepsilon_{i,t-1}$ and $\Delta\varepsilon_{i,t-1} = \varepsilon_{i,t-1} - \varepsilon_{i,t-2}$, a negative first-order serial correlation in differences is expected. Therefore, the existence of first-order serial correlation in levels can be tested through the second-order serial correlation in differences. The null hypothesis is there is no second-order serial correlation in differences of residuals. Failing to reject the null indicates that the second lag of the dependent variable is a valid instrument (Arellano & Bond, 1991).

3.5 Variables and Measurements

3.5.1 Bank Capital Ratio

Bank capital ratio is measured as total Regulatory Capital Ratio (*CAR*). This is the most regulated capital ratio in the context of capital regulation during the study period and is calculated as $Total\ regulatory\ capital/Risk - weighted\ assets$. The regulation on components and eligible capital for calculating regulatory capital changes over time. This is similar for the risk weights assigned to different types of assets, as well as the types of risk to be considered in calculating the risk-weighted assets. Therefore, we use the total regulatory capital ratio as reported by banks at the given time period.

In order to ensure the robustness of our results, we include two other measures of capital ratio, which are Tier 1 capital ratio (*TIER1*) and the Equity over Assets ratio (*EQTA*) (also known as Leverage ratio). Tier 1 capital is an important component of total regulatory capital and reflects the capital quality. On the other hand, the Equity over Assets ratio is the most basic and simple definition of capital. It is widely used in studies about the capital structure of non-financial firms. In addition, the importance of the Equity over Assets ratio has been recognized under Basel III and regulated as a Leverage ratio (BCBS, 2010a). Tier 1 capital ratio is calculated as $Tier\ 1\ capital/Risk - weighted\ assets$ and Leverage ratio is calculated as $Equity/Total\ assets$.

3.5.2 Bank Capital and Bank Risk

Since the primary focus of our study is on the regulatory effects of capital regulation, we use regulatory definitions of capital and risk as proxies for bank capital and bank risk. Accordingly, bank capital is measured as $Total\ Regulatory\ Capital/Total\ Assets$ (*CAPTA*) and bank risk is measured as $Risk - weighted\ Assets/Total\ Assets$ (*RWATA*). However, it is worth noting that the literature suggests a number of alternative measurements. Common measurements of capital are $Equity/Total\ Assets$

(*EQTA*) (see for example,Bouheni and Rachdi (2015); Godlewski (2004); Shrieves and Dahl (1992)) and $Tier\ 1\ Capital/Total\ Assets$ (*TIER1TA*) (see for example, Abreu and Gulamhussen (2010); Hussain and Hassan (2005); Van Roy (2008)). Tier 1 capital ratio is an additional regulatory measurement to the Total capital ratio, while the Equity ratio is a non-risk-based measurement commonly used by the public.

Given the controversies around the risk-weighing system, alternative measurements of risk, such as the Non-performing Loans ratio (*NPL*) and Z-scores (*ZSCORE*) are also used (see for example, Ghosh (2014); Godlewski (2004); Lin et al. (2013); Saadaoui (2011)). Non-performing Loan ratio is an ex-post measure, which captures credit risk and reflects the risk of traditional banks whose main activity is lending (Tanda, 2015). In contrast, Z-scores reflect the probability of bank insolvency and provide a good measure for overall risk. The higher the Z-score, the less probability of bank default (Lepetit & Strobel, 2013). Therefore, we back up our regulatory measurements with these proxies as robustness checks. Non-performing Loan ratios are calculated as $Non-performing\ Loans/Total\ Loans$ following Saadaoui (2011) and Lin et al. (2013). Z-scores are calculated as $\log(1+Z)$, where Z equals $(Equity/Assets\ +\ ROA)/(Standard\ deviation\ (ROA)$ following Lepetit and Strobel (2013) and Ghosh (2014) methods.[13]

3.5.3 Balance Sheet Components

Changes in balance sheet components cover the annual growth rate of balance sheet components, which is calculated as $(BS_{jit} - BS_{ji,t-1})/BS_{ji,t-1}$. The liability side of the balance sheet includes retained earnings (RE), shareholder capital (SHC), and other capital (OC). Retained earnings are the cumulative undistributed earnings, while shareholder capital refers to the total shareholder equity. Other capital is the residual of total regulatory capital after excluding retained earnings and shareholder capital.

The asset side of the balance sheet includes interbank assets (IA), investments (INV), loans ($LOAN$) and other assets (OA). Interbank assets are inter-banking assets, which also include securities purchased with reverse repurchase agreements. Investments comprise both short-term and long-term

[13] In calculating Z-score, there have been several approaches which are different in choosing the period for moving mean and standard deviation of ROA and the time period of CAR (see Lepetit and Strobel (2013)). Lepetit and Strobel (2013) examine the fitness of these approaches to real data using a panel of banks for the G20 group of countries covering the period 1992–2009. The result suggests that using mean and standard deviation estimates of ROA calculated over the full sample combined with the current value of CAR is preferred.
The logarithm of Z-score reduces the skewness of the distribution. Lepetit, Saghi-Zedek, and Tarazi (2015)also shows that the log-transformation of Z-score is attractive and unproblematic to use and support its emerging use in the literature. In addition, the log-transformation is not applicable to negative values. In such cases, there would be a data drop. In our case, there are 148 observations with negative Z-score. Therefore, we follow Ghosh (2014) to measure Z-score as log(1+Z).

investments. Loans are total loans, including commercial loans, consumer loans and other loans. Other assets are the residual of total assets after subtracting for interbank assets, loans and investments.

3.5.4 Capital Regulation

Given the limitations of traditional capital regulation measurements, as well as Barth et al. (2001) CRI index discussed in Section 2.7, we propose a new measurement of capital regulation, namely the Advanced Capital Regulation Index (ACRI).

Design of the Advanced Capital Regulation Index

The CRI index is the sum of two sub-indices, which are the Overall capital stringency and the Initial capital stringency. It comprises answers for 8 questions, in which, questions 1 to 5 measure the Overall capital stringency and questions 6 to 8 measure the Initial capital stringency. The questions are: (1) Is the capital-asset ratio risk weighted consistent with the Basel I guidelines? (2) Does the minimum capital-asset ratio vary as a function of an individual bank's credit risk? (3) Does the minimum capital-asset ratio vary as a function of market risk? (4) Before minimum capital adequacy is determined, what is (are) deducted from the book value of capital? (4.1) Market value of loan losses not realized in accounting books? (4.2) Unrealized losses in securities portfolios? Or,(4.3) Unrealized foreign exchange losses? (5) What fraction of revaluation gains is allowed as part of capital? (6) Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities? (7) Can the initial disbursement or subsequent injections of capital be done with assets other than cash or government securities? (8) Can initial disbursement of capital be done with borrowed funds?

The construction of ACRI is built on the questions developed by Barth et al. (2001), but extended to better cover other aspects of the Basel rules. Specifically, in the latest version of the Basel Accord (that is, Basel III), the Basel Committee raises five issues for strengthening the global capital framework, which are: (1) the quality, consistency and transparency of the capital base, (2) the risk coverage, (3) the role of the leverage ratio, (4) the importance of reducing pro-cyclicality and promoting countercyclical buffers, and (5) the systemic risk and interconnectedness. In addition, Pillar 2 (Supervisory Reviews) and Pillar 3 (Market Discipline) are further enhanced (BCBS, 2010a). Therefore, the ACRI is designed to incorporate these issues. Accordingly, five components of capital regulation are determined, including *Definition of capital* to address issue (1), *Risk coverage* for issue (2), *Supplement requirements* for issue (3), (4) and (5), *Supervisory Power* for Pillar 2 and *Market Disciplines* for Pillar 3. Table 3.1 describes the list of questions for each component.

Table 3.1 Design of Advanced Capital Stringency Index

Component	Item	Contents	Considered in CRI
Definition of Capital	1	Are goodwill and other intangibles deducted from core capital?	No
	2	Are deferred tax assets deducted from core capital?	No
	3	Is cash flow hedge reserves deducted from core capital?	No
	4	Is gain on sale related to securitization transactions deducted from core capital?	No
	5	Are cumulative gains and losses due to changes in own credit risk on fair valued financial liabilities deducted from core capital?	No
	6	Are investments in own shares deducted from core capital?	No
	7	Are reciprocal cross holdings in the capital of banking, financial and insurance entities deducted from the same or higher tier of capital?	No
	8	Are investments in the capital of banking, financial and insurance entities that are outside the scope of regulatory consolidation deducted from the same or higher tier of capital?	No
	9	Are innovative hybrid capital instruments (cumulative perpetual preference shares with incentives to redeem) excluded from calculating regulatory capital?	No
	10	Do the sources of funds to be used as capital need approval of the regulatory/supervisory authorities?	Yes
Risk Coverage	11	Does the capital ratio vary as a function of banks' credit risk?	Yes
	12	Does the capital ratio vary as a function of banks' market risk?	Yes
	13	Does the capital ratio vary as a function of banks' operational risk?	No
Supplementary Requirements	14	Is the minimum capital requirement higher than 8%?	No
	15	Is there a minimum requirement for Tier 1 capital?	No
	16	Is there a minimum requirement for Common Equity Tier 1 capital?	No
	17	Is there a minimum requirement for Leverage ratio?	No
	18	Is there a minimum requirement for Capital Conservation Buffer?	No
	19	Is the Countercyclical Buffer requirement taken into account?	No
Supervisory Power	20	Are banks required to self-assess the capital adequacy to cover all potential exposures?	No
	21	Does the regulator have the power to require additional capital charges to cover all bank risks?	No
	22	Are corrective actions (such as providing additional capital, and restrictions on dividend distribution) applied when requirements are not met?	No
Market Disciplines	23	Are elements of capital required to be publicly disclosed to the reported accounts?	No

Source: Author's development.

The first component - *Definition of capital* – focuses on the ineligible elements, which should be derecognized when calculating the regulatory capital to ensure that bank risks are sufficiently backed up by high quality capital. Items 1 to 8 in Table 3.1 closely follow Basel III regulatory adjustments. Regulatory adjustments in Basel III also include, “shortfall of the stock of provisions to expected losses” and “defined benefit pension fund assets and liabilities” (BCBS, 2010a). However, we disregard these adjustments for several reasons. First, the adjustment for “shortfall of the stock of provisions to expected losses” is only required for banks using the Internal Ratings-Based approach to calculate credit risk. Second, most Asian banks use the Standardized approach (Sheng, 2013). Some countries, such as India, Malaysia, the Maldives and Sri Lanka even mandate the use of the Standardized approach even though Basel Accord allows for a choice between the different methods. Third, a OECD (2009) report about pension schemes in Asia-Pacific shows that Asia’s pension system is not sustainable and defined benefit pension schemes are only available in India, Japan, Korea, Pakistan, Philippines, Chinese Taipei, Thailand and Vietnam. Besides, given the different definitions of capital in legislation across countries, and the newly introduction of Common Equity Tier 1 capital (CET1) from Basel III, core capital is regarded for a generalization. Furthermore, the exclusion of innovative hybrid capital instruments is also considered, since these capital instruments, which are limited to 15% of the Tier 1 capital, are phased out in Basel III. Item 10 is the same as Barth et al. (2001) CRI questions.

The second component - *Risk coverage* – takes into account three measurable types of risk under Basel III. They are on- and off-balance sheet credit risk, market risk and operational risk. Credit risk is the basis for calculating risk-weighted assets since the introduction of the Basel I Accord (BCBS, 1988). Market risk and operational risk were introduced later in the revision of Basel I in 1996 and Basel II in 2004 (BCBS, 1996, 2004). The ACRI index improves the CRI index by taking operational risk under concerns. The wider the risk coverage, the more regulatory capital is required. Therefore, capital regulation is stricter in such way.

The third component - *Supplement requirements* – relates to other requirements needed to enhance capital standards. Under capital regulation, banks are required to maintain a minimum total regulatory capital ratio. However, the specific minimum requirement varies across countries. Hence, in order to measure the stringency of capital regulations, this minimum capital adequacy ratio is benchmarked against the 8% requirement of international standards (that is, Basel I, II and III). If the national capital adequacy requirement is higher than 8%, capital regulation is considered to be strict. In addition, other requirements for Tier 1 ratios and CET1 ratios are necessary to ensure the quality of capital base while requirements for Leverage ratio, Capital Conservation Buffer, and Countercyclical Buffer recognize the destabilising elements of a crisis and supplement the capital requirements.

The last two components - *Supervisory Power* and *Market Disciplines* - closely follow Pillar 2 and Pillar 3 standards set in Basel II and further enhanced in Basel III. Specifically, under Pillar 2, banks are encouraged to implement better risk management strategies. Supervisors play an important role in monitoring this process and intervene at an early stage. Meanwhile, Pillar 3 stresses the importance of market participants as a complement for Pillar 2 in ensuring the capital adequacy of the bank (BCBS, 2004, 2010a).

In addition to the differences from the CRI, documented in Table 3.1, the ACRI also differs from the CRI by disregarding the regulatory capital adequacy regime, certain deductions from regulatory capital and initial disbursement regulation. In terms of the regulatory capital adequacy regime, all countries in our study adopt Basel standards during the examined period. Barth et al. (2001) survey also shows that 100 out of 107 countries aligned their capital regulations with Basel I guidelines. In the World Bank (2013) survey, all 143 countries who provided responses said they were using either Basel I, II or Basel III (or similarly designed) for capital regulation. Therefore, there is no need for a question about regulatory capital adequacy regimes. The CRI also includes questions about capital deductions, such as the market value of loan losses, unrealized losses in securities portfolios, unrealized foreign exchange losses and revaluation gains. However, these unrealized gains and losses recognized on the balance sheet are not considered regulatory adjustments under Basel III. On the basis that the ACRI is designed following Basel III, such questions are disregarded. The same is true for initial disbursement and capital injection (BCBS, 2010a).

Scoring Method

In an attempt to avoid the limitations of the survey method, we follow Neyapti and Dincer (2005) approach by using national legal documents on capital regulation to construct the ACRI index. These documents are available on the national regulatory and supervisory authorities' websites. The ACRI index is constructed for each selected Asian country annually during the study period (2001-2016).

Similar to Barth et al. (2001), we use a "0/1" scheme to code the answers. Specifically, each "yes" answer to the questions in Table 3.1 will receive a value "1". A "0" value will be assigned if the answer to the question is "no" or when the content is not regulated. For rules that take time to be implemented, such as the Leverage ratio or Countercyclical Buffer, a value of "1" will be assigned from the time the rule comes into effect and "0 for the preceding periods. The total score for all questions is the value of the ACRI index. The minimum value of the ACRI is 0 and the maximum value is 23. The higher the index, the more stringent the capital regulation.

Table 3.2 presents measurements of other explanatory variables, following previous studies, dependent variables, and capital regulation.

Table 3.2 Variable Measurements

Variable	Label	Measurement	Reference
Bank Capital Ratio			
Total Regulatory Capital Ratio	CAR	Total Regulatory Capital/ Risk-weighted Assets	Ahmad et al. (2008); Alfon et al. (2005); Francis and Osborne (2010)
Tier 1 Capital Ratio	TIER1	Tier 1 Capital/Risk-weighted Assets	Brewer III et al. (2008); Saibal et al. (2004)
Leverage Ratio	EQTA	Total Equity/Total Assets	Brewer III et al. (2008); De Jonghe and Öztekin (2015); Kleff and Weber (2008)
Bank Capital			
Total Regulatory Capital Ratio	CAPTA	Total Regulatory Capital/Total Assets	Rime (2001); Van Roy (2008); Zhang et al. (2008)
Tier 1 Capital Ratio	TIER1TA	Tier 1 Capital/Total Assets	Abreu and Gulamhussen (2010); Hussain and Hassan (2005); Van Roy (2008)
Leverage ratio	EQTA	Equity/Total Assets	Bouheni and Rachdi (2015); Godlewski (2005); Shrieves and Dahl (1992)
Bank Risk			
Risk-weighted Assets	RWATA	Risk-weighted Assets/Total Assets	Rime (2001); Van Roy (2008); Zhang et al. (2008)
Non-performing Loan Ratio	NPL	Non-performing Loans/Total Loans	Godlewski (2005); Saadaoui (2011); Shrieves and Dahl (1992)
Z-score	ZSCORE	Log(1+Z), where Z=(Equity/Assets + ROA)/(Standard deviation (ROA))	Ghosh (2014); Lepetit and Strobel (2013)
Balance Sheet Components			
Retained Earnings	RE	Cumulative Undistributed Earnings	Bloomberg
Shareholder Capital	SHC	Total Shareholder Equity	Bloomberg
Other Capital	OC	Total Regulatory Capital - Retained Earnings - Shareholder Capital	
Interbank Assets	IA	Inter-banking Assets	Bloomberg
Investments	INV	Short-term and Long-term Investments	Bloomberg
Loans	LOAN	Total Loans	Bloomberg
Other Assets	OA	Total Assets - Interbank Assets – Investments – Loans	
Capital Regulation	REG	Advanced Capital Regulation Index	Author’s development
Bank-level Variables			

Variable	Label	Measurement	Reference
Size	SIZE	Log (Total Assets)	Alfon et al. (2005); Brewer III et al. (2008); Rime (2001); Shrieves and Dahl (1992)
Profitability	ROA	Net Income/Total Assets	Büyüksalvarci and Abdioglu (2011); Godlewski (2005); Hussain and Hassan (2005); Romdhane (2010)
Bank Lending	LOAN_RATIO	Total Loans/Total Assets	Büyüksalvarci and Abdioglu (2011); Polat and Al-khalaf (2014); Van Roy (2008)
Asset Quality	LLP_TO_TA	Loan Loss Provisions/Total Assets	Aggarwal and Jacques (2001); Demirguc-Kunt, Detragiache, and Merrouche (2013); Hussain and Hassan (2005); Zahid et al. (2015)
Tangibility	FA_RATIO	Net Fixed Assets/Total Assets	Amidu (2007); Octavia and Brown (2010)
Deposit Ratio	DEPOSIT_RATIO	Customer Deposits/Total Liabilities	Alfon et al. (2005); Asarkaya and Ozcan (2007); Klepczarek (2015)
Macro-variables			
Economic Growth	GDP_GROWTH	Annual GDP Growth Rate	Alfon et al. (2005); Francis and Osborne (2010); Van Roy (2008)
Stock Market Development	MARKET_CAP	Stock Market Capitalization/GDP	Behr et al. (2010); De Jong et al. (2008); De Jonghe and Öztekin (2015)
Competition	BOONE	Boone Indicator	Boone (2008); Diallo (2015); Kasman and Kasman (2015)

3.6 Research Data

This study collects data from several sources. Historical bank-level data is obtained from the Bloomberg database. Therefore, only data for listed banks is available. This study does not include Islamic banks due to their different principles of operation and regulation. Macroeconomic data are extracted from the Global Financial Development Database (World Bank, 2018a) and the World Development Indicator database (World Bank, 2018b). Data for constructing the ACRI index is collected from letters of law available on national regulatory and supervisory authorities' websites.

Data is collected annually for banks in Asia during the period of 2000-2016, using US dollars (USD) as the same currency for consistency. After obtaining the raw dataset, some selection criteria are applied to obtain the final data for model analysis. First, due to the use of lagged dependent variables, only banks with data reported in at least two consecutive years are kept. Second, all bank-year observations with missing data on any of main variables are dropped using list-wise deletion. Third, in cases where there are both solo-bank and consolidated data, consolidated data is chosen, since most capital management is made at the ultimate owner level. Forth, all unusual data of the main variables, which might be caused by input mistakes, are treated as missing values. These include data with negative fixed assets, negative loan ratios, equity-over-assets ratios and deposit ratios in excess of 100%. Fifth, small banks with total assets less than one million USD are excluded. The final dataset comprises of 545 banks across 20 Asian countries over a 15-year period (see Table 3.3). Appendix B provides key statistics of the financial and banking sectors in these countries.

However, not all banks reporting total regulatory capital ratios also report total regulatory capital and risk-weighted assets. Since this information is not required to be published before Basel II implementation, the missing data can be explained as a result of the public disclosure requirement. Therefore, the sample used to analyze research objective 2 drops to 2,765 observations, covering 440 banks across 19 countries.[14]

Similarly, there are only a few banks with data on balance sheet adjustments prior to 2004. Therefore, the timeframe for research objective 3 begins from 2004. In addition, we exclude observations that have growth rates of balance sheet components larger (smaller) than 100% or 99th percentile (1th percentile), depending on which value is larger (smaller). This removal is useful since we do not have enough information to control for merger and acquisition transactions, which are the main source of such substantial changes. Therefore, the sample size for research objective 3 reduces to 1459 observations, distributed across 290 banks in 15 countries.[15] Despite the different sample size, our

[14] Vietnamese banks do not report this data.
[15] Azerbaijan, Israel, Japan, Georgia and Vietnam are not included.

robustness check in Table B.3 in the Appendix shows no significant difference in the estimations from samples. Thus, the reduction in the sample size in research objectives 2 and 3 is not a major concern.

Table 3.3 Sample Description

	Observations	Banks	Percent	BCBS-member
Developed	**639**	**74**	**16.02**	
Hong Kong	172	16	4.31	Yes
Israel	138	16	3.46	No
Japan	296	39	7.42	Yes
Singapore	33	3	0.83	Yes
Emerging	**2860**	**373**	**71.70**	
China	405	79	10.15	Yes
India	535	63	13.41	Yes
Indonesia	848	85	21.26	Yes
Korea	151	27	3.79	Yes
Malaysia	196	26	4.91	No
Philippines	175	22	4.39	No
Taiwan	263	35	6.59	No
Thailand	193	21	4.84	No
Turkey	94	15	2.36	Yes
Frontier	**490**	**98**	**12.28**	
Azerbaijan	21	11	0.53	No
Bangladesh	48	14	1.20	No
Georgia	18	5	0.45	No
Kazakhstan	68	15	1.70	No
Pakistan	239	34	5.99	No
Sri Lanka	71	12	1.78	No
Vietnam	25	7	0.63	No
Total	**3989**	**545**	**100**	

Source: Author's calculations.

3.7 Data Heterogeneity and Sub-sampling Method

The dataset covers a relatively wide range of countries that differentiate themselves in terms of their levels of economic, financial, and regulatory development. We take these factors into account by investigating bank behavior in countries with similar market characteristics (that is, based on classifications of the country as developed, emerging or frontier market) and the bank capital regulatory environment (that is, based on whether the country is a member of BCBS of not).

We follow the Dow Jones Indexes (2011) country classification and classify countries into three groups; namely Developed markets (*Developed*), Emerging markets (*Emerging*) and Frontier markets

(*Frontier*).[16] Dummy variables for each country group are set to 1 if the country belongs to that group, and 0 otherwise.

Information about BCBS membership is obtained from the list of BCBS members, which is available on the Bank for International Settlements' (BIS, 2016) website. A dummy variable (*BCBS*) equals 1 if the bank is a BCBS-member country, and 0 otherwise. BCBS- members are mandatorily bound to the Basel capital standards while other countries are not. Therefore, countries with BCBS membership are expected to be under stricter supervision and behave more prudently than non-member countries.

Sub-sampling method is used to examine the characteristics of bank- and country-level variables across different markets and BCBS membership. A t-test is conducted to examine mean differences between banks in countries with and without BCBS membership. One-way analysis of variance (ANOVA) is used to test for mean-differences across different markets since there are more than two groups to be compared. Bonferroni adjustments for multiple-comparisons are applied for ANOVA tests (Rupert, 2012).

Next, we regress equation (3.12) for each country group, BCBS members and non-members. A dummy-variables approach is used to test whether there is significant difference in the effects of capital regulation and other determinants across country groups, BCBS members and non-members, as well as the structural stability of the full-sample model. Specifically, dummy variables for country groups and BCBS membership are included and interacted with independent variables in equation (3.12). Significant differences in the effects of capital regulation and other determinants between country groups (developed and frontier markets, emerging and frontier markets, emerging and frontier markets) and BCBS membership (BCBS and non-BCBS members) can be tested using the t-test for each interaction variable. For example, differences in the effects of capital regulation between developed and frontier markets is examined using the t-test for the significance of the *Developed*REG* variable, using *Frontier* as the reference group. Significant differences in the effects of capital regulation (and other determinants) across country groups can be tested using the Wald test for the joint-significance of interaction variables between capital regulation (other determinants) and country groups. For example, the country effect on the relationship between capital regulation and capital ratio is tested using the Wald test for the joint-significance of *Developed*REG* and *Emerging*REG* (*Frontier* is the reference group). The structural stability of the full-sample model is examined using an F-test with the null hypothesis that the coefficients of all interaction variables are jointly zero. A rejection of the F-test implies a structural effect of country groups (Basel Committee membership) in the model (Gujarati,

[16] Since Azerbaijan and Georgia are not included in the classification, we treat them as frontier markets.

1970a, 1970b). This dummy-variables approach is advantagous compared to the traditional Chow test since it shows the source of variation and is more flexible in the case of more than two group comparisons (Gujarati, 2009).

For bank capital and risk adjustments, as well as balance sheet adjustments, dummy variables for country groups and BCBS membership are included and interacted with the capital regulation variable (*REG*) in equations (3.16), (3.17) and (3.24). The coefficients of interaction variables (for example, *Emerging*REG*) indicate the marginal effect of capital regulation for the specified group (that is, emerging markets). Significant differences between a specified group (for example, emerging markets) and the reference group (that is, developed markets) can be tested using the t-test. The full effect of capital regulation for a group (for example, emerging markets) is a linear combination of coefficients of that variable (that is, *REG*) and the interaction variable for that group (for example, *Emerging*REG*), and can be tested using the t-test. The moderating effect of each country group is examined using the Wald test for the joint significance of the interaction variables.

Chapter 4

Capital Regulation and Bank Capital Ratio

4.1 Introduction

Having outlined the study's methodology in the previous chapter, this chapter investigates the first research objective or the effects of capital regulation on the capital ratios of Asian banks. First, the chapter provides an overview of capital regulation and the adoption of Basel Accords in selected Asian countries (Section 4.2). Next, we include descriptive statistics to define the trend and distribution of bank capital ratios in the sample. We also present the summary statistics of other country specific variables and bank characteristics. Then, a pairwise correlation matrix is employed to test the relationship between these factors and bank capital ratios. We also conduct the Variance Tolerance Factor analysis to ensure there is no multi-collinearity problem among the model's independent variables. These statistics are displayed in Section 4.3.

Formal regression results are presented in Section 4.4 to examine the effects of capital regulation on capital ratios. We control for bank characteristics and country-specific factors following equation (3.12). We use two-step system GMM. In order to generalize our results, we employ three different proxies for capital ratios, which are Total Regulatory Capital ratio, Equity ratio and Tier 1 ratio. Nevertheless, our focus is on the regulatory measurement of capital ratios, which is Total Regulatory Capital ratio. Given the wide coverage of countries with different market characteristics and regulatory environment in the sample, we also carry out sub-sample regressions and examine how these results vary. To ensure the robustness of our results, we conduct several robustness checks using different regression methods and different explanatory variables. These results are reported in Section 4.5. Section 4.6 outlines the key contributions of the chapter.

4.2 Bank Capital Regulation in Asia

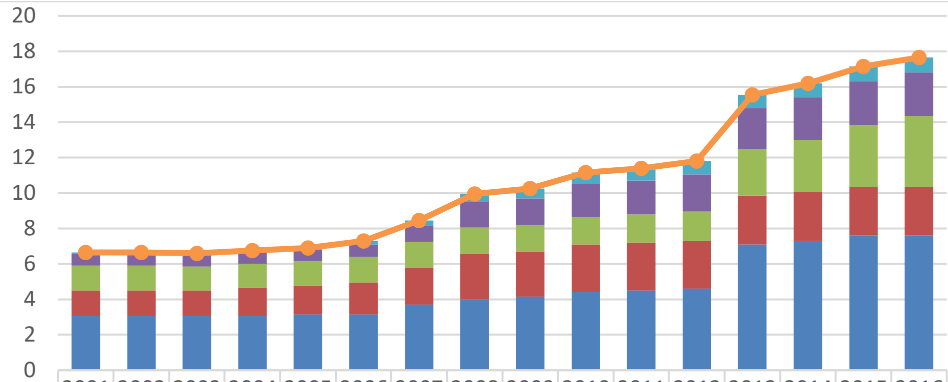
Many countries in Asia are more convergent in implementing Basel standards, compared to other regions such as Africa and the Western Hemisphere (Seal, 2015). At the end of 2016, Asian countries in the sample implemented Basel III. Three exceptional cases are Azerbaijan, Georgia and Vietnam, whose capital regulation is more in line with Basel I. In addition, bank capital regulatory and supervision authorities are not the same across countries. While the central bank is the only regulatory and supervisory authority in most countries, some countries have a supervisory authority separate from the central bank (such as Korea, Taiwan, and Turkey). Some countries changed the supervisory role from the central banks to independent supervisory authorities; these include China (from 2003), Indonesia (after 2014), and Kazakhstan (after 2004). In contrast, banks in Japan are under multiple supervisory authorities including the Financial Services Agency and central bank (see Table 4.1).

Table 4.1 Basel Adoption in Selected Asian Countries

Country	Regulatory and Supervisory Authorities	Basel I	Basel II	Basel III
Azerbaijan	+ From 2016: Financial Market Supervisory Authority (FMSA) + Before 2016: The Central Bank the Republic of Azerbaijan (CBA)	2004[a]	No	No
Bangladesh	Bangladesh Bank (BB)	1996	2010	2015
China	+ From 2003: China Banking Regulatory Commission (CBRC) + Before 2003: People's Bank of China (PBOC)	N/A[b]	2004	2013
Georgia	The National Bank of Georgia (NBG)	2002	No	No
Hong Kong	The Hong Kong Monetary Authority (HKMA)	1988	2007	2013
India	Reserve Bank of India (RBI)	1992	2008	2013
Indonesia	+ After 2014: The Indonesian Financial Services Authority (OJK) + Before 2014: Bank Indonesia (BI)	1991	2007	2013
Israel	Bank of Israel (Supervisor of Bank)	N/A[b]	2007	2013
Japan	Financial Services Agency (FSA) Bank of Japan (for supervision)	1988	2007	2012
Kazakhstan	+ After 2004: Agency of the Republic of Kazakhstan on Regulation and Supervision of Financial Markets and Financial Institutions (FSA) + Before 2004: the National Bank of Kazakhstan (NBK)	1988	2005	2015
Korea	Financial Supervisory Service (FSS)	1992	2008	2013
Malaysia	Bank Negara Malaysia (BNM)	1989	2008	2013
Pakistan	State Bank of Pakistan (SBP)	1997	2006	2013
Philippines	The Bangko Sentral ng Pilipinas (BSP)	2001	2007	2014
Singapore	Monetary Authority of Singapore (MAS)	1992	2008	2013
Sri Lanka	The Central Bank of Sri Lanka	1998	2008	2017
Taiwan	Financial Supervisory Commission (FSC)	1998	2007	2013
Thailand	Bank of Thailand (BOT)	1993	2008	2013
Turkey	Banking Regulation and Supervision Agency of Turkey (BRSA)	1989	2006	2014
Vietnam	The State Bank of Vietnam (SBV)	2005	No	No

Notes: [a] The minimum risk-weighted capital ratio was required before 2004.
[b] There is no information about the adoption of Basel I, but minimum risk-weighted capital ratio was required before 2000 (Bank of Israel, 2007; Sun, 2009).
Source: Author's compilation from national regulatory bodies' websites.

Capital regulation has been tightened over the years (see Figure 4.1). Major enforcement was observed in 2006 following the introduction of Basel II in 2004, and in 2013 when Basel III came into effect. The enhancement of capital regulation took place slowly after Basel II's introduction with little changes in capital regulation components. In contrast, right after Basel III's introduction in 2010, some countries strengthened their capital regulations. These countries include Bangladesh, Malaysia and Vietnam. From 2013 onwards, all of countries in the sample, with the exception of Georgia and Sri Lanka, have stricter capital regulation than in 2010. In addition, the quality of regulatory capital, risk coverage, supplement requirements, the supervisory review process, and market discipline have also been enhanced (see Table C. 1).



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Average of MD	0.10	0.10	0.10	0.10	0.10	0.20	0.30	0.45	0.55	0.65	0.70	0.75	0.75	0.80	0.85	0.85
Average of SP	0.65	0.65	0.65	0.65	0.65	0.70	0.90	1.45	1.50	1.85	1.90	2.10	2.30	2.40	2.45	2.45
Average of SR	1.40	1.40	1.35	1.35	1.40	1.45	1.45	1.50	1.50	1.55	1.60	1.65	2.65	2.95	3.50	4.00
Average of RC	1.45	1.45	1.45	1.60	1.60	1.80	2.10	2.55	2.55	2.70	2.70	2.70	2.75	2.75	2.75	2.75
Average of CD	3.05	3.05	3.05	3.05	3.15	3.15	3.70	4.00	4.15	4.40	4.50	4.60	7.10	7.30	7.60	7.60
Average of ACRI	6.65	6.65	6.60	6.75	6.90	7.30	8.45	9.95	10.25	11.15	11.40	11.80	15.55	16.20	17.15	17.65

Figure 4.1 Average Advanced Capital Regulation Index and its Components (2001 - 2016)

Note: MD= Market Disciplines; SP = Supervisory Power; SR=Supplement Requirements; RC = Risk Coverage; CD = Capital Definition; ACRI = Advanced Capital Regulation Index.

The Moody's Investors Service (2014) survey about Basel III implementation further indicates that the adoption of Basel III's rules varies among jurisdictions in Asia. For capital definition, many countries in Asia apply stricter deduction rules, either by shortening/eliminating the phase-in period (for example, the Philippines, China, Saudi Arabia and Kuwait) or increasing the limited deductions (for example, Singapore, Indonesia, Malaysia, Thailand, Philippines, and India). For non-qualifying capital instruments, some countries shorten the phase-out periods to five years (for example, Qatar), and two years (for example, the Philippines). They also impose higher minimum requirements for CET1, Tier 1 and CAR than the Basel standards. As shown in Figure 4.2, higher minimum capital ratio requirements are evident in Israel, Singapore, China, the Philippines, Thailand, and frontier countries. Israel, Bangladesh, Pakistan, Sri Lanka and Vietnam even increased the minimum CAR requirements during the period of 2001-2016.

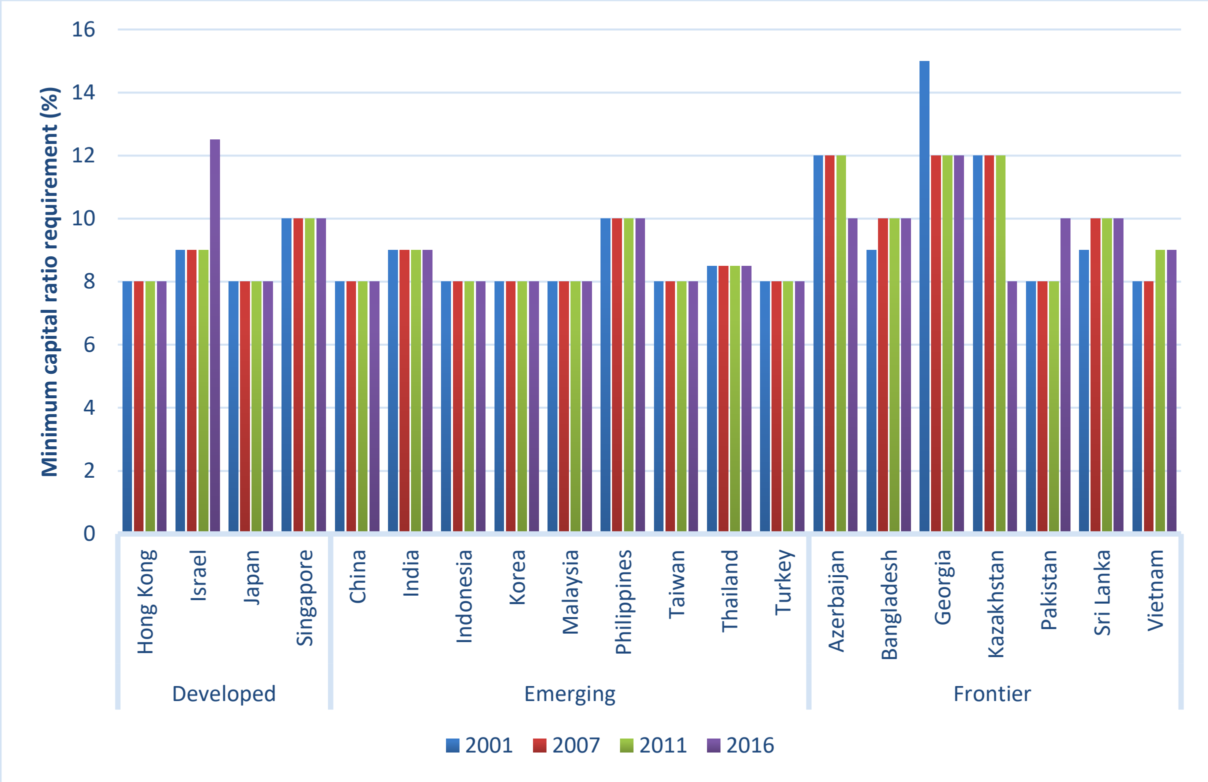


Figure 4.2 Minimum CAR Requirements in Asia

In summary, it is obvious that capital regulation in Asia has become stricter and more homogenous since 2013, as Basel standards become more popular. However, to a certain extent, there is disparity among national legislations. This is due to the consideration of specific country environments, in establishing the regulation by the jurisdictions as well as the flexibility in implementation that the Basel Committee provides.

4.3 Descriptive Statistics

Figure 4.3 shows the distribution of capital ratios of Asian banks during the period of 2001-2016. The figure shows that bank capital ratios fluctuated over time, particularly for banks with capital ratios higher than the median. Except for a decline in capital ratios among highly-capitalized banks (75^{th} percentile), there was an increase for most other banks. Specifically, the median of bank capital ratios increased from 12.46% in 2001 to 14.22% in 2016. In contrast, for the lower-quantile (25^{th} percentile), the capital ratio increased from 10.42% in 2001 to 12.5% in 2016. There has been a convergence of capital ratios among banks, evidenced by the smaller gap between highly-capitalized banks and lowly-capitalized banks. In 2016 this gap was half that of 2001 (See Table C. 2 for further details).

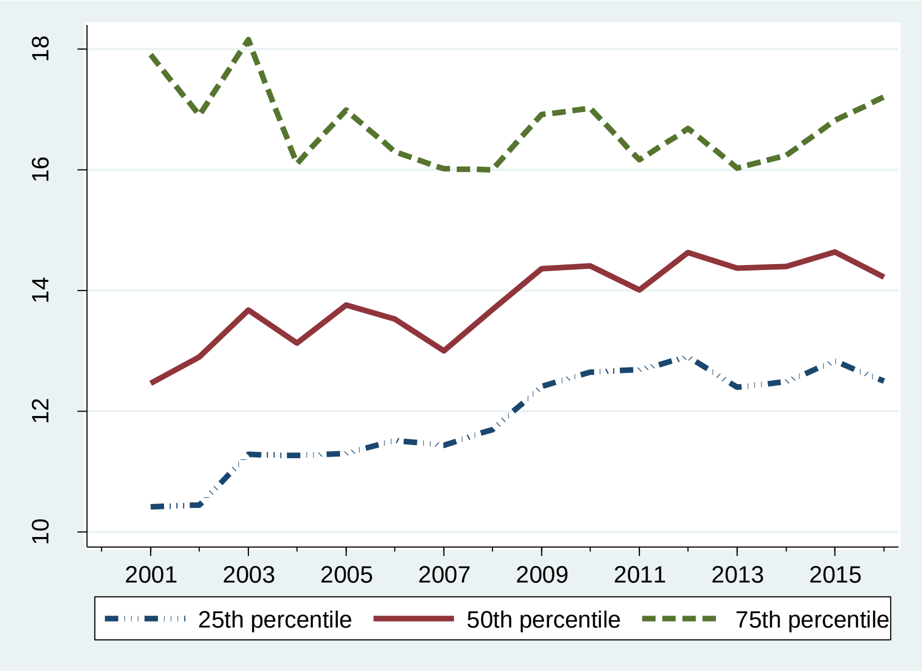


Figure 4.3 Distribution of CAR across Banks (2001 – 2016)

Capital ratios also vary across countries (see Figure 4.4). Azerbaijan, Kazakhstan, and the Philippines have the highest median capital ratios among banks (approximately 17%) while the median capital ratio is the lowest in Bangladesh (11.48%). Capital ratios in Georgia, Indonesia and Pakistan vary substantially among banks. The wedge between banks with the lowest capital ratios (lower bound) and those with the highest capital ratios (upper bound) in these countries is more than 7%. The lowest range, which is less than 2%, is seen in Bangladeshi and Malaysian banks (see Table C. 3 for further details).

Figure 4.5 additionally shows that Asian banks have maintained the average total regulatory capital ratio, around 15%, and that there is a slight increase in regulatory capital ratios from 15.47% in 2001 to 15.52% in 2016. This ratio is almost double the minimum capital ratio requirement, which is around 8%. Both Tier 1 ratios and Leverage ratios have experienced continued growth since 2001. This implies that Asian banks have focused more on improving the quality of their capital. Another reason is the tighter enforcement of minimum Tier 1 capital requirements, which raised the average minimum Tier 1 capital ratio from 2.23% to 5.94% during the period of 2001-2016.[17] The increase in Tier 1 capital ratio requirements is associated with the widespread adoption of Basel III in these countries, which set the minimum Tier 1 ratio at 6% (BCBS, 2010a).

[17] It is worth noting that most countries require a minimum Tier 1 ratio of 4%, following Basel capital standards. However, several countries do not follow the Tier 1 capital ratios, so this is set at 0%. Thisis the case of Indonesia before 2008 and Vietnam before 2004.

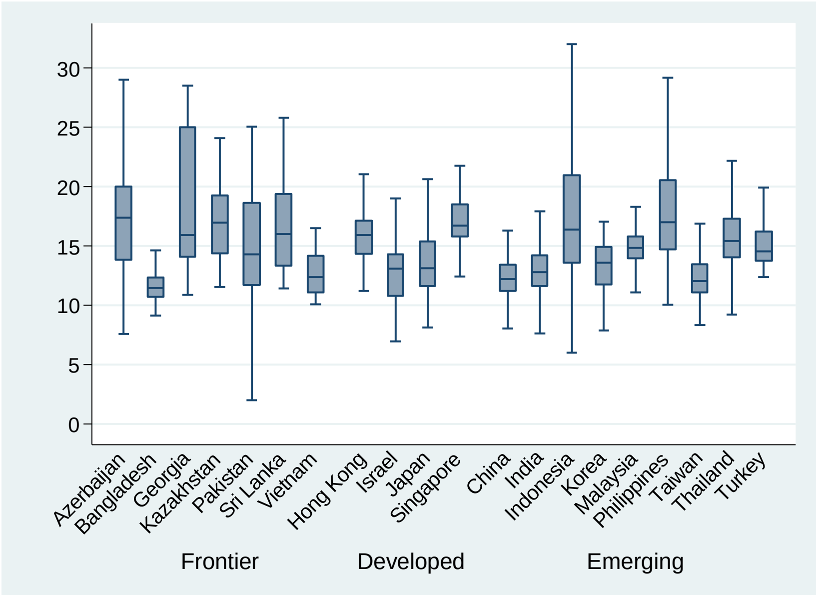


Figure 4.4 Distribution of CAR across Countries (2001 - 2016)

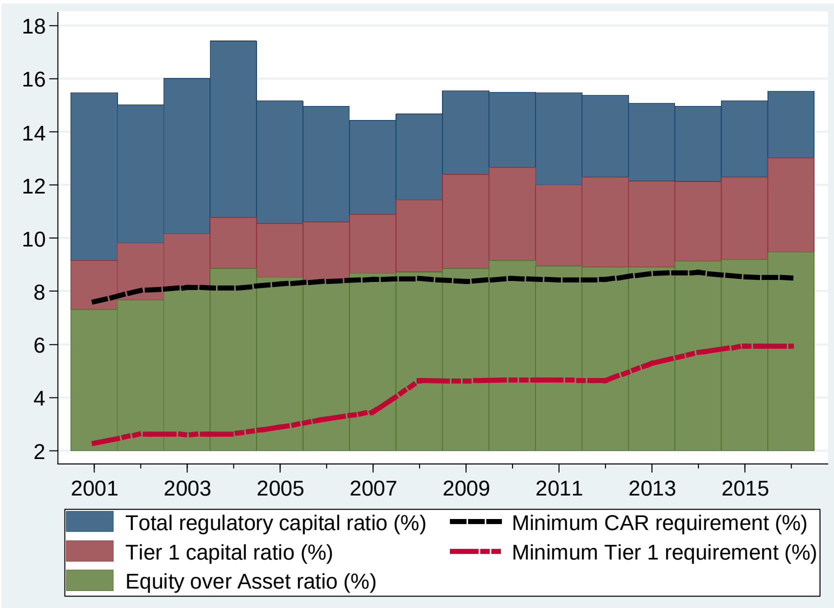


Figure 4.5 Average Total Regulatory Capital Ratio, Tier 1 Ratios, and Leverage Ratios (2001- 2016)

Table 4.2 reports summary statistics of Total Regulatory Capital Ratios and the main variables for equation (3.12). Asian banks in the sample have an average capital ratio of 15.29%, much higher than the 8% minimum requirement of Basel International capital standards. However, there is a large variation in the capital ratios, with a standard deviation of more than 6%. Most banks have capital ratios in the range of 10.75% to 20.70%. Noticeably, there are banks with extremely low capital ratios (as low as 0.08%). These banks are located primarily in Kazakhstan and Pakistan. Conversely, banks with extremely high capital ratios (larger than 50%) operate mainly in Indonesia and the Philippines.

Table 4.2 Summary Statistics of Main Variables

Variable	Obs.	Mean	SD	Min	Max	10th percentile	90th percentile
CAR	3,989	15.29	6.7739	0.08	148.09	10.75	20.70
SIZE	3,989	9.39	2.0818	1.76	15.06	6.60	11.68
ROA	3,989	0.92	1.3341	-12.88	22.28	0.14	2.01
LOAN_RATIO	3,989	58.24	13.4147	9.62	99.64	39.55	73.18
LLP_TO_TA	3,989	0.61	1.1137	-20.92	16.33	0.01	1.37
FA_RATIO	3,989	1.58	1.4952	0.01	24.87	0.44	2.99
DEPOSIT_RATIO	3,989	80.37	13.2909	0.47	99.87	64.22	94.50
REG	3,989	12.49	4.9100	4.00	23.00	7.00	20.00
GDP_GROWTH	3,989	5.08	3.0021	-5.53	34.50	1.18	8.48
MARKET_CAP	3,119	54.59	35.5690	0.00	259.61	16.55	97.19
COMP	3,652	0.0019	0.1738	-1.52	2.18	-0.09	0.07

Source: Author's calculations.

Banks in the sample have relatively large size; with an average of 9.39, which is equivalent to 12 billion USD. Although there are small banks with total assets of 6 million USD, there are extremely large banks with total assets of more than 3,000 billion USD. This is the case of Industrial and Commercial Bank of China, and China Construction Bank Corporation. These two banks are also among the G-SIBs list identified by the Financial Stability Board (2016).[18] Nevertheless, most banks have total assets more than 700 million USD. Bank ROA is positive but not high. Most banks have ROA's below 2.01% and the average ROA is 0.92%. This corresponds to the average 1% ROA in banking (Borio, Gambacorta, & Hofmann, 2017; García-Meca, García-Sánchez, & Martínez-Ferrero, 2015) and indicates that Asian banks make effective use of their assets. These banks are less dependent on providing loans, indicated by the average loan ratio of 58%. Although there are banks that mainly earn profits from loans (nearly a 100% loan ratio), most banks have more diversified asset portfolios, with lending accounting for around 70% of their total assets. The quality of loans is good in term of low ratios of loan loss provisions to total assets. The average loan loss provision ratio is 0.61% and most banks have a ratio below 1.37%. Banks in the sample do not hold too many fixed assets. The average fixed asset ratio is just 1.58%, while the maximum ratio is 25%. In addition, most banks have a ratio below 3%. This is popular for financial firms, particularly banks. Deposits are still the main source of funding for Asian banks. The

[18] Other G-SIBs banks in the sample include Mitsubishi UFJ FG, Mizuho FG, and Sumitomo Mitsui FG in Japan, Agricultural Bank of China and Bank of China in China (Financial Stability Board, 2016).

average deposit ratio is 80% and most banks in the sample have a ratio in the range of 64% to 95% (see Table 4.2).

In term of the macro environment, Table 4.2 shows that most Asian countries do not have very strict capital regulations. The average ACRI index (*REG*) is 12.49, while the maximum is as high as 23. Countries with the strictest capital regulations in the sample (ACRI index > 20) are Bangladesh, China, Hong Kong, Japan, Korea, Malaysia and Singapore (Appendix C.1). Asian countries have high GDP growth rates, but moderate stock market development. Competition in these markets is quite high with low Boone indicators; 90% of banks have this indicator less than 0.07.

Table 4.3 reports the summary statistics of the main variables in equation (3.12) by country groups. The last three columns in the table report the ANOVA test results for mean differences between banks in different country groups using the Bonferroni adjustment for multiple comparisons. It can be seen that banks in developed countries have lower total regulatory capital ratios than those in emerging and frontier countries. However, there is no difference in total regulatory capital ratios among banks in emerging and frontier countries. In addition, banks in developed and emerging countries are larger in size, have lower loan loss provision ratios, lower tangibility and higher customer deposit ratios than those in frontier countries. These countries also implement stricter capital regulations and have higher stock market development than banks in frontier countries. However, banks in developed countries are less profitable than those in emerging and frontier countries. While developed countries have lower economic growth than emerging and frontier countries, their competition and lending levels are similar.

Table 4.4 reports the summary statistics of the main variables in equation (3.12) for banks with and without BCBS membership. Statistics in the last column in the table are t-tests for mean difference between these two groups. The results indicate that banks with BCBS membership have lower capital ratios, profits, and fixed asset ratios but are larger in size and have higher lending rates than non-BCBS members. In addition, member countries have stricter capital regulations and higher levels of competition. These two groups of countries do not differ substantially in term of loan loss provision ratios, deposit ratios, economic growth rates and stock market development. Together with the variations of bank and country characteristics across country groups, these results suggest the difference of their influence on bank capital ratios.

Table 4.3 Summary Statistics of Main Variables by Country Groups

	Developed		Emerging		Frontier		Difference		
	Mean	SD	Mean	SD	Mean	SD	Developed vs. Frontier	Emerging vs. Frontier	Emerging vs. Developed
CAR	14.342	3.041	15.417	7.308	15.779	6.959	-1.438***	-0.362	1.075***
SIZE	10.974	1.590	9.314	2.056	7.790	1.204	3.184***	1.523***	-1.661***
ROA	0.534	0.578	0.988	1.338	1.031	1.838	-0.497***	-0.043	0.454***
LOAN_RATIO	58.719	13.015	58.128	13.121	58.285	15.482	0.434	-0.157	-0.591
LLP_TO_TA	0.220	0.350	0.609	1.079	1.100	1.645	-0.881***	-0.491***	0.389***
FA_RATIO	1.186	0.677	1.475	1.350	2.684	2.343	-1.498***	-1.209***	0 .289***
DEPOSIT_RATIO	80.663	14.365	81.257	12.695	74.808	13.909	5.855***	6.448***	0 .593
REG	12.279	5.566	12.774	4.743	11.069	4.702	1.209***	1.704***	0.495*
GDP_GROWTH	2.310	2.799	5.690	2.565	5.132	3.550	-2.822***	0.558***	3.380***
MARKET_CAP	80.510	39.901	57.369	31.256	15.035	11.610	65.475***	42.334***	-23.141***
COMP	0.009	0.129	0.001	0.174	-0.002	0.220	0.011	0 .003	-0.008

Notes: *, **, *** represent significance levels at 0.1, 0.05 and 0.01, respectively. N = 3989.
Source: Author's calculations.

Table 4.4 Summary Statistics of Main Variables by BCBS Membership

	BCBS Members		Non-BCBS Members		Difference
	Mean	SD	Mean	SD	
CAR	14.758	4.519	15.691	8.047	-0.933***
SIZE	10.139	2.177	8.829	1.814	1.311***
ROA	0.825	1.184	0.993	1.433	-0.168***
LOAN_RATIO	58.767	12.083	57.845	14.328	0 .922**
LLP_TO_TA	0.579	0.832	0.628	1.286	-0.048
FA_RATIO	1.212	1.106	1.852	1.681	-0.640***
DEPOSIT_RATIO	80.248	13.048	80.461	13.474	-0.214
REG	14.642	4.455	10.857	4.601	3.785***
GDP_GROWTH	5.127	3.026	5.044	2.984	0.083
MARKET_CAP	56.789	25.359	52.896	41.663	3.893
COMP	0.020	0.220	-0.011	0.130	0 .031***

Notes: *, **, *** represent significance levels at 0.1, 0.05 and 0.01, respectively. N= 3989.
Source: Author's calculations.

Table 4.5 Pairwise Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12
CAR	1.0000											
L.CAR	0.7180*	1.0000										
SIZE	-0.2962*	-0.3187*	1.0000									
ROA	0.3981*	0.2251*	0.0087	1.0000								
LOAN_RATIO	-0.2054*	-0.2160*	-0.0627*	-0.0760*	1.0000							
LLP_TO_TA	-0.2776*	-0.0790*	-0.1028*	-0.5484*	0.1853*	1.0000						
FA_RATIO	0.1974*	0.2370*	-0.4266*	-0.1140*	-0.0356*	0.2278*	1.0000					
DEPOSIT_RATIO	-0.0354*	0.0189	-0.2543*	-0.1059*	0.1315*	0.0494*	0.1320*	1.0000				
REG	-0.0107	-0.0172	0.2615*	-0.0229	0.0001	-0.0569*	-0.2115*	-0.0639*	1.0000			
GDP_GROWTH	-0.0270*	0.0027	-0.1090*	0.1398*	-0.0890*	0.0147	0.0001	-0.0578*	-0.0754*	1.0000		
MARKET_CAP	-0.1037*	-0.1260*	0.4359*	-0.0582*	0.0901*	-0.1420*	-0.3445*	-0.0728*	0.1651*	0.0120	1.0000	
COMP	0.0152	0.0230	0.0369*	0.0354*	0.1117*	0.0600*	-0.0119	-0.0982*	0.1050*	-0.0970*	-0.1726*	1.0000
VIF		**1.33**	**1.71**	**1.62**	**1.20**	**1.62**	**1.40**	**1.11**	**1.10**	**1.08**	**1.46**	**1.12**

Notes: 1 = *CAR*; 2 = *L.CAR*; 3 = *SIZE*; 4 = *ROA*; 5 = *LOAN_RATIO*; 6 = *LLP_TO_TA*; 7 = *FA_RATIO*; 8 = *DEPOSIT_RATIO*; 9 = *REG*; 10 = *GDP_GROWTH*; 11 = *MARKET_CAP*; 12 = *COMP*.
VIF = Variance Inflation Factor, calculated after pooling regression of equation ((3.12)).
* indicates significance level at 0.1. N = 3989.
Source: Author's calculations.

Table 4.5 presents the relationship between the dependent variable (*CAR*) and independent variables in equation (3.12). Capital ratios in the previous period (*L.CAR*) and the current period (*CAR*) are highly correlated. Their correlation coefficient is 71.8% and is statistically significant. This demonstrates the consistency of bank capital ratios as well as the existence of adjustment costs. While most of the independent variables are significantly correlated with bank capital ratios (*CAR*), capital regulation (*REG*) and competition (*COMP*) show no significant correlation. Nevertheless, it is too early to conclude that these variables do not affect bank capital ratios since other factors are not controlled. The other columns in Table 4.5 report the relationships among the independent variables. All of them have a weak to moderate correlation. The variance inflation factors (VIF) in the last row of Table 4.5 are all less than 10. Therefore, there is no multicollinearity problem in the model (Gujarati, 2009).

4.4 Regression Results

4.4.1 Effect of Capital Regulation on Bank Capital Ratio

Table 4.6 reports the regression results of equation (3.12) on the set of explanatory variables, including capital regulation, bank characteristics and country-specific variables. Diagnostic tests reported at the end of Table 4.6 exhibit the p-value of the Durbin-Wu-Hausman test less than 0.01 for all three models. This is in accordance with the suspicious endogeneity of lagged dependent variable suggested by the literature. Further, the F- statistics for the relevance of instruments are larger than 10, which indicates that the instruments used in the models have large explanatory power to the endogenous variable. The AR (2) test shows p-values larger than the 0.1 significance level. Therefore, we cannot reject the null hypothesis that there is no second-order serial correlation in differences of residuals and conclude that instruments from lag 2 period of dependent variables are appropriate instruments for the endogenous variable. Similarly, the Hansen test for over-identifying instruments have p-values larger than the 0.1 significance level. This suggests that the over-identifying instruments in the model are valid.

Table 4.6 Regression Results for Different Measurements of Capital Ratio

	CAR	EQTA	TIER1
	(1)	(2)	(3)
Panel A: Capital Regulation			
REG	0.061***	0.096***	0.100***
	(0.019)	(0.017)	(0.018)
Panel B: Bank Specific Variables			
L.CAR	0.372***		
	(0.071)		
L.EQTA		0.414***	
		(0.080)	
L.TIER1			0.377***
			(0.053)
SIZE	-0.681***	-0.495***	-0.519***
	(0.100)	(0.086)	(0.088)
ROA	1.487***	1.031***	0.752***
	(0.201)	(0.145)	(0.119)
LOAN_RATIO	-0.055***	0.016***	-0.056***
	(0.012)	(0.005)	(0.013)
LLP_TO_TA	-0.905**	-0.158	0.655***
	(0.401)	(0.218)	(0.186)
FA_RATIO	0.605***	0.628***	0.221
	(0.140)	(0.090)	(0.148)
DEPOSIT_RATIO	-0.044***	-0.024***	0.007
	(0.013)	(0.008)	(0.009)
Panel C: Country-specific Variables			
GDP_GROWTH	-0.191***	-0.065***	-0.112***
	(0.033)	(0.018)	(0.027)
MARKET_CAP	0.017***	0.008***	0.010***
	(0.003)	(0.002)	(0.003)
COMP	0.720*	0.051	0.849***
	(0.389)	(0.219)	(0.305)
Constant	20.162***	7.712***	12.483***
	(2.476)	(1.505)	(1.755)
Observations	3119	3119	2379
Banks	458	458	387
Instruments	18	16	14
Durbin-Wu-Hausman Test (P-value)	<0.001	0.012	<0.001
Relevance Condition (F statistic)	39.994	102.843	51.878
AR(2) Test (P-value)	0.225	0.118	0.927
Hansen Test (P-value)	0.354	0.956	0.462

Notes: This table reports regression results of equation (3.12) for different measurements of capital ratio. Estimation is carried out through two-step SYS-GMM, robust standard errors are corrected for finite sample bias. Instruments in differences equation are lags 2 to 7 periods for *CAR*, lags 2 to 5 periods for *EQTA* and lags 2 to 3 periods for *TIER1*. All instruments are collapsed. Forward-orthogonal-deviation is applied in transforming variables for differences equation. *, **, *** represent significance levels at 0.1, 0.05 and 0.01, respectively. Robust standard errors in parentheses.
Source: Author's estimations.

Furthermore, the Difference-in-Hansen tests in Table 4.7 have p-values larger than the 0.1 significance level for all subsets of instruments and thus confirm their exogeneity. These diagnostic tests collectively suggest the consistency and efficiency of the estimations in Table 4.6.

Table 4.7 Difference-in-Hansen Tests for Exogeneity of Instruments

Instruments	**CAR**	**EQTA**	**TIER1**
	(1)	**(2)**	**(3)**
GMM Instruments for Levels	0.857	0.455	0.613
SIZE	0.676	0.460	0.543
ROA	0.460	0.500	0.255
LOAN_RATIO	0.344	0.612	0.355
LLP_TO_TA	0.853	0.680	0.625
FA_RATIO	0.707	0.622	0.833
DEPOSIT_RATIO	0.208	0.463	0.480
REG	0.260	0.599	0.231
GDP_GROWTH	0.475	0.452	0.921
MARKET_CAP	0.462	0.770	0.406
COMP	0.542	0.590	0.478

Notes: This table reports p-value of difference-in-Hansen test for instruments used in SYS-GMM regression of equation (3.12) for different measurements of capital ratio. Estimation is carried out through two-step SYS-GMM, robust standard errors are corrected for finite sample bias. Instruments in differences equation are lags 2 to 7 periods for *CAR*, lags 2 to 5 periods for *EQTA* and lags 2 to 3 periods for *TIER1*. All instruments are collapsed. Forward-orthogonal-deviation is applied in transforming variables for differences equation.
Source: Author's estimations.

The results in Panel A of column (1) in Table 4.6 reveal a positive relationship between capital regulation and bank capital ratio, as measured by Total Regulatory Capital ratio. The *REG* coefficient is 0.064, which means that if regulators strengthen any of the rules of the regulatory capital standards (as specified in the list of questions for the ACRI in Table 3.1), banks will increase their capital ratios by 0.064%. The finding conforms the Alfon et al. (2005); Francis and Osborne (2010); Wong et al. (2005) studies, which measure capital regulation as individual capital requirements set by national authorities. It also aligns with Ahmad et al. (2008) study, which uses a time dummy to indicate increases in capital adequacy standards in Malaysia, and Zahid et al. (2015) study in Pakistan, which measures capital regulation as the distance from the minimum capital requirement. The result implies the efficiency of the new capital regulation index – the ACRI - and confirms the effectiveness of capital regulation in Asia in term of inducing banks to raise their capital ratios.

We also compare our conclusion on the effects of capital regulation with other studies on Equity ratios and Tier 1 capital ratios by using the same dependent variables. The results reported in Panel A of columns (2) and (3) in Table 4.6 show that capital regulation also has a positive and significant impact on bank Equity ratios and Tier 1 capital ratios. This indicates that capital regulation is effective in forcing banks to improve their capital, both in terms of quantity and quality. In term of Equity ratio, our results are consistent with the Brewer III et al. (2008) study which uses Barth et al. (2001) Capital Regulation Index. However, our result contradict Kleff and Weber (2008) findings on German banks, Bouheni and Rachdi (2015) work on Tunisia banks, and De Jonghe and Öztekin (2015) study of banks in 64 countries. These studies found a negative impact of capital regulation. Saibal et al. (2004) and Brewer III et al. (2008) both examine the effects of capital regulation on Tier 1 capital ratios. These studies show negative and no effect of capital regulation, respectively. The difference in our conclusion with most previous studies can be attributed to the measurement of capital regulation. Since capital regulation measures in previous research primarily reflect the total capital adequacy ratio, there is little explanation for variations in Equity ratios and Tier 1 capital ratios.

4.4.2 Effect of Bank and Country Characteristics on Capital Ratios

The regression results in Table 4.6 also show that bank capital ratio is further affected by bank characteristics and country-specific variables. Regarding bank-specific variables, the estimations in column (1) in Table 4.6 show that bank capital ratio, measured by total regulatory capital ratio, is positively affected by the capital ratio in the previous period (*L.CAR*), profitability (*ROA*), asset quality (*LLP_TO_TA*), tangibility (*FA_RATIO*), and negatively affected by size (*SIZE*), lending (*LOAN_RATIO*), and deposit ratio (*DEPOSIT_RATIO*).

The positive effect of capital ratio in the previous period (*L.CAR*) confirms the existence of the adjustment cost as well as the target capital level. The coefficient of *L.CAR* is 0.367 and thus, the speed of adjustment is 0.628 (which equals $(1 - 0.372)$ following equation (3.13)). This suggests that banks in Asia adjust their capital ratios toward the target level quite quickly. On average, it takes banks more than one and a half years to close the gap to the target level.[19] This speed is similar to the findings for Turkish banks (Asarkaya & Ozcan, 2007), which is 0.593. In contrast, banks in developed countries such as the U.S and the U.K have lower speeds of adjustment; these vary between 0.28 to 0.41 for the U.S (Berger et al., 2008), and 0.23 for the U.K (Francis & Osborne, 2010).

The negative impact of bank size on capital ratios supports the argument that larger banks keep their capital ratios near the minimum requirement to maximize profits with the belief that they can raise capital easily when needed (Aggarwal & Jacques, 2001). In contrast, smaller banks have more difficulty in raising capital and thus, choose to operate with higher capital ratios (Alfon et al., 2005). The result is similar to Alfon et al. (2005); Brewer III et al. (2008); Romdhane (2010); Zahid et al. (2015) studies. Possible explanations for such a relationship may be due to the larger investment opportunities, a

[19] Banks complete 0.628 of the gap toward target levels in 1 year. Therefore, time required to close the gap (that is, $gap = 1$) equals $(1/0.628)$ is thus 1.59 years.

greater ability for asset diversification and better risk management techniques associated with large banks. Together with the belief of "too-big-to-fail", larger banks can take on more debts and have lower capital ratios (Ahmad et al., 2008; Alfon et al., 2005; Wong et al., 2005).

The effect of profitability on bank capital ratios is positive and the largest among bank characteristic factors. A 1% increase in *ROA* will lead banks to increase their capital ratios by 1.487%. Together with previous empirical evidence (Bateni et al. (2014); Büyüksalvarci and Abdioglu (2011); Romdhane (2010)), this finding supports the pecking-order theory that banks prefer financing their activities with internal sources (Myers, 1984; Myers & Majluf, 1984). It can also be inferred that banks may use their profits to pay debts or reinvest profits which consequently increases capital ratios (Fischer et al., 1989; Hennessy & Whited, 2005).

The negative effect of bank lending on capital ratios suggests that lending in Asia is costly. Asian countries, particularly emerging and frontier markets, have high levels of asymmetric information. This increases the cost of lending and induces banks to lower their capital ratios in order to make profits. Together with the fact that the banking industry in this region is competitive (as indicated by low Boone indicators in Table 4.2), banks encounter more difficulty in transferring these costs to borrowers, and thus are motivated to finance these loans with cheap sources of funds, such as deposits (Gennotte & Pyle, 1991; Thakor, 1996). This finding is consistent with Büyüksalvarci and Abdioglu (2011) study of Turkish banks and Polat and Al-khalaf (2014) work on banks in Saudi Arabia.

In contrast to Büyüksalvarci and Abdioglu (2011); Francis and Osborne (2010) suggestion that banks with high loan loss provisions (that is, lower asset quality) cannot operate with too much leverage and should have higher capital ratios, our study finds a negative relationship between loan loss provisions and bank capital ratios. The finding suggests the moral hazard motivation and difficulties in increasing the capital ratios of these banks.

The positive effect of tangibility on capital ratios highlights the importance of fixed assets in reducing information asymmetry and the cost of equity so that banks can have higher capital ratios (Harris & Raviv, 1991). There is also a possibility that banks with high amounts of fixed assets have already found a stable source of return, which provide them with adequate internal funds and discourages them from using external financing sources, such as debts. The result is consistent with previous research (see Amidu (2007); Gocmen and Sahin (2014); Hossain and Yakub (2014); Octavia and Brown (2010)).

The effect of deposit ratios on capital ratios is negative and small, which is about 0.044%. This suggests that customer deposits do not create enough market discipline for banks to increase their capital ratios. Instead, this effect provides supportive evidence for the static trade-off theory which attributes low bank capital ratios (when deposits increase) to dividend distributions and tax-shield incentives (Bradley et al., 1984). The result is accordant to prior research (see Asarkaya and Ozcan (2007); Bokhari et al. (2012); Klepczarek (2015)).

In term of macro-variables, economic growth (*GDP_GROWTH*) has a significant and negative impact on bank capital ratios. The result supports previous findings about the pro-cyclical behavior of bank capital ratios (that is, the negative co-movement of bank capital ratios and economic growth) (Alfon et al., 2005; Ayuso, Pérez, & Saurina, 2004; Francis & Osborne, 2010; Jokipii & Milne, 2008; Wong et al., 2005). Specifically, during economic upturns, there are more growth opportunities, thus loan demand is high, while credit ratings are high and the likelihood of bankruptcy is lower, banks can expand their portfolios without building up their capital. Therefore, they hold a lower capital ratio to take advantage of these opportunities. However, during downturns, the risk of bankruptcy is higher, loan demands and investment opportunities also decrease. Such economic condition is not favorable for expanding operations and banks need to have higher capital ratios to cover higher risks (Bokhari et al., 2012).

In contrast, stock market development (*MARKET_CAP*) has a positive effect on bank capital ratios. This suggests that stock market development helps to provide more funds, greater opportunities for growth and portfolio diversification, more efficient aggregate information, and thus facilitates the issuance and trade of equity to positively affect bank capital ratios (De Jong et al., 2008; Demirgüç-Kunt & Maksimovic, 1996). Moreover, the liquidity of the stock market capitals enables investors to quickly convert equity into cash and promotes capital accumulation (Levine & Zervos, 1998). However, the magnitude of the influence is small (0.017%) and implies the limited role of the stock market in increasing the capital ratios of Asian banks.

Bank capital ratio is additionally impacted by competition. The *COMP* coefficient is positive and significant at a 10% level which suggests a negative effect of competition on bank capital ratios (since a higher Boone indicator means lower competition). This finding supports the franchise value hypothesis which states that a more competitive environment erodes bank franchise value and induces them to take more risks (Besanko & Thakor, 2004; Keeley, 1990; Marcus, 1984). As a function of risk, total regulatory capital ratio will, therefore, decrease. In contrast, lower competition enables banks to have high franchise value. Banks are induced to protect their franchise value by operating safely with higher capital ratios (Berger, Klapper, & Turk-Ariss, 2009; Soedarmono, Machrouh, & Tarazi, 2013; Wu & Bowe, 2010).

Nevertheless, when the capital ratio is measured as Equity ratio and Tier 1 capital ratio, the effects of lending, asset quality, tangibility, deposit ratio and competition change substantially (see columns 2 and 3 in Table 4.6). Specifically, lending (*LOAN_RATIO*) still has a negative and significant effect on Tier 1 capital ratios, but has a positive impact on Equity/Asset ratio. Asset quality (*LLP_TO_TA*) has a negative and significant influence on the Tier 1 capital ratio, but no influence on Equity/Asset ratio. The impact of tangibility (*FA_RATIO*) and the deposit ratio (*DEPOSIT_RATIO*) are similar for the Total Regulatory Capital ratio and Equity/Assets ratio, but no significant effect was found for the Tier 1 capital ratio. In contrast, competition (*COMP*) impacts both the Total Regulatory Capital ratio and the Tier 1 capital ratio, but it has no impact on Equity ratio. Therefore, cautious inference should be made when considering different capital ratio measurements.

4.4.3 Sub-sampling Regression for Different Country Groups

Table 4.8 reports the regression results of equation (3.12) for total regulatory capital ratio (*CAR*) on different country groups; namely developed, emerging and frontier countries. These results were obtained using two-step SYS-GMM. The results show that capital regulation (*REG*) has a positive impact on bank capital ratios in developed and emerging countries, while it exerts no influence on banks in frontier countries. However, there is no significant difference in the effect of capital regulation between banks in emerging and frontier countries, as well as those in emerging and developed countries. Thus, overall, the effect of capital regulation on bank capital ratios do not vary across country groups. The impact of size (*SIZE*), lending (*LOAN_RATIO*), asset quality (*LLP_TO_TA*) and competition (*COMP*) are also not significantly different among country groups.

However, capital ratios in the previous period (*L.CAR*), profitability (*ROA*), tangibility (*FA_RATIO*), deposit ratios (*DEPOSIT_RATIO*), economic growth (*GDP_GROWTH*) and stock market developments (*MARKET_CAP*) impact bank capital ratios differently across country groups. Specifically, the positive effects of capital ratio in the previous period (*L.CAR*) and profitability (*ROA*) on capital ratios are found for banks in emerging and frontier countries only. The t-tests in columns (4) to (6) (Table 4.8) further indicate that the effect of capital ratios in the previous period (*L.CAR*) in emerging countries is significantly smaller than that in frontier countries. This suggests that banks in emerging countries adjust capital ratios toward target levels much faster than those in frontier countries. The speed of adjustment in emerging countries is 74.8% while in frontier countries it is only 13.7%. The effect of profitability (*ROA*) on capital ratios in emerging countries is significantly higher than the other two groups.

Table 4.8 Sub-sampling Regression for Different Country Groups

	Sub-sample Regression			Significance of Differences (z-statistic)			Joint-significance (χ^2 (2))
	Developed	Emerging	Frontier	Developed vs. Frontier	Emerging vs. Frontier	Emerging vs. Developed	H0: $\boldsymbol{\beta_{kD} = \beta_{kE} = 0}$
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Panel A: Capital Regulation							
REG	0.171***	0.071**	-0.023	2.06**	1.61	-0.80	4.42
	(0.051)	(0.057)	(0.030)				
Panel B: Bank Specific Variables							
L.CAR	0.281	0.252***	0.863***	-1.61	-3.13***	-0.90	10.05***
	(0.188)	(0.197)	(0.064)				
SIZE	-0.475**	-0.718***	-0.249	-0.47	-1.42	-2.41**	4.46
	(0.191)	(0.366)	(0.121)				
ROA	0.737	1.725***	0.476**	-0.05	3.56***	2.75***	12.89***
	(0.894)	(0.207)	(0.329)				
LOAN_RATIO	-0.080**	-0.054***	-0.048*	-0.37	-0.37	0.28	0.19
	(0.032)	(0.025)	(0.016)				
LLP_TO_TA	0.188	-0.977	0.304*	-0.70	-1.70*	-2.35**	3.27
	(0.549)	(0.166)	(0.612)				
FA_RATIO	-0.595	1.075***	0.019	-1.45	3.69***	4.52***	17.28***
	(0.384)	(0.135)	(0.235)				
DEPOSIT_RATIO	-0.020	-0.032	0.023	-1.62	-2.24**	-1.30	5.42*
	(0.018)	(0.020)	(0.023)				
Panel C: Country-specific Variables							
GDP_GROWTH	0.033	-0.181***	-0.028	0.67	-2.15**	-1.73*	14.23***
	(0.032)	(0.059)	(0.039)				
MARKET_CAP	-0.003	0.0188***	-0.020	0.85	2.16**	3.02***	11.51***
	(0.006)	(0.019)	(0.004)				
COMP	-2.829**	0.258	-0.356	-1.11	0.49	0.77	2.81

	Sub-sample Regression			Significance of Differences (z-statistic)			Joint-significance (χ^2 (2))
	Developed	**Emerging**	**Frontier**	**Developed vs. Frontier**	**Emerging vs. Frontier**	**Emerging vs. Developed**	**H₀: $\boldsymbol{\beta_{kD} = \beta_{kE} = 0}$**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
	(1.340)	(1.058)	(0.413)				
Constant	20.18***	20.16***	4.722	1.52	2.31**	1.12	5.43*
	(5.524)	(7.024)	(3.019)				
No. of Observations	437	2238	444	3119	3119	3119	3119
No. of Banks	57	305	96	458	458	458	458
No. of Instruments	19	18	15	45	45	45	45
AR(2) Test (p-value)	0.187	0.474	0.192	0.690	0.690	0.690	0.690
Hansen Test (p-value)	0.112	0.147	0.292	0.042	0.042	0.042	0.042
Model Structural Stability							χ^2(24) = 137.06***

Notes: Columns (1) to (3) report regression results of equation (3.12) for banks in developed, emerging and frontier markets. Columns (4), (5) and (7) report z- and χ2 statistics for t-tests and Wald tests, respectively, for the significant difference of interaction variables in the following specification: $CAR_{it} = \beta_0 + \beta_{0D}Developed_i + \beta_{0E}Emerging_i + \beta_1 CAR_{i,t-1} + \beta_{1D}CAR_{i,t-1} \times Developed_i + \beta_{1E}CAR_{i,t-1} \times Emerging_i + \sum_{k=2}^{K}\beta_k X_{it} + \sum_{k=2}^{K}\beta_{kD}(X_{it} \times Developed_i) + \sum_{k=2}^{K}\beta_{kE}(X_{it} \times Emerging_i) + \beta_i + \varepsilon_{it}$. Column (6) reports z statistics of t-tests for the significant difference of interaction variables in the following specification: $CAR_{it} = \beta_0 + \beta_{0F}Frontier_i + \beta_{0E}Emerging_i + \beta_1 CAR_{i,t-1} + \beta_{1D}CAR_{i,t-1} \times Frontier_i + \beta_{1E}CAR_{i,t-1} \times Emerging_i + \sum_{k=2}^{K}\beta_k X_{it} + \sum_{k=2}^{K}\beta_{kD}(X_{it} \times Frontier_i) + \sum_{k=2}^{K}\beta_{kE}(X_{it} \times Frontier_i) + \beta_i + \varepsilon_{it}$. Where *X* = (*REG, SIZE, ROA, LOAN_RATIO, LLP_TO_TA, FA_RATIO, DEPOSIT_RATIO, GDP_GROWTH, MARKET_CAP, COMP*). The test for model structural stability is the F-test of all interaction variables. Two-step SYS-GMM with robust standard errors corrected for finite-sample bias is used. Forward-orthogonal-deviation is applied in transforming data for differences equation. The dependent variable is *CAR.* Endogenous variables are *L.CAR* and its interaction variables, instrumented by lags 2 to 8 periods of *CAR* for Developed group (Column 1), lags 2 to 7 periods for Emerging group (column 2), lags 2 to 4 periods for Frontier group (Column 3), and lags 2 to 4 periods in columns (4) to (7). All instruments are collapsed. *, **, *** represent significance levels at 0.1, 0.05 and 0.01, respectively. Robust standard errors in parentheses.
Source: Author's calculations.

In contrast, the positive effects of tangibility (*FA_RATIO*) and stock market development (*MARKET_CAP*) and negative effect of economic growth (*GDP_GROWTH*) on capital ratios are only found for banks in emerging countries. These effects on bank capital ratios in emerging countries are significantly larger than those in developed and frontier countries. Deposit ratios have no significant influence on capital ratios of banks in either developed, emerging or frontier countries (Table 4.8).

The F-test for model structural stability at the end of Table 4.8 has a p-value less than 0.01. Therefore, there is a significant difference in the effect of bank characteristics and macro-factors in relation to bank capital ratios. Thus cross-country studies on bank capital ratios should take into account this effect.

4.4.4 Sub-sampling Regression for BCBS-members and Non-members

Table 4.9 reports the regression results of equation (3.12) for banks in countries with and without BCBS membership. The estimation shows that the effect of capital regulation (*REG*) is quite similar between the two groups. This contradicts our expectation that banks in BCBS-member countries with stricter supervision of regulators would be more likely to have higher capital ratios. The effects of size (*SIZE*), tangibility (*FA_RATIO*), economic growth (*GDP_GROWTH*), stock market development (*MARKET_CAP*), and competition (*COMP*) between the two groups are also similar. However, BCBS-membered banks have a higher speed of adjustment towards the target capital ratio (*1- coefficient (L.CAR)*) than non-members. Their capital ratios are less affected by profitability (*ROA*), but more influenced by loan ratios (*LOAN_RATIO*). In addition, the negative effects of loan loss provisions (*LLP_TO_TA*) and deposit ratios (*DEPOSIT_RATIO*) on capital ratios are found for banks in non-BCBS member countries only. The F-test for model structural stability (at the end of Table 4.9) has a p-value less than 0.001. Therefore, the effect of BCBS membership is also important in studying bank capital ratios.

Table 4.9 Sub-sampling Regression for BCBS-members and Non-members

	Sub-sample Regression		Significance of Differences (Z-statistic)
	BCBS Members	Non-BCBS Members	Members vs. Non Members
	(1)	(2)	(3)
Panel A: Capital Regulation			
REG	0.049**	0.046	0.38
	(0.024)	(0.028)	
Panel B: Bank Specific Variables			
L.CAR	0.152**	0.515***	-1.74*
	(0.074)	(0.116)	
SIZE	-0.518***	-0.630***	0.29
	(0.0865)	(0.153)	
ROA	1.077***	1.530***	-1.74*
	(0.142)	(0.289)	
LOAN_RATIO	-0.060***	-0.036*	-2.44**
	(0.021)	(0.018)	
LLP_TO_TA	0.803***	-1.144**	4.76***
	(0.297)	(0.506)	
FA_RATIO	0.636***	0.385**	-0.18
	(0.230)	(0.173)	
DEPOSIT_RATIO	0.00518	-0.049***	3.02***
	(0.014)	(0.015)	
Panel C: Country Specific Variables			
GDP_GROWTH	-0.192***	-0.143***	-1.60
	(0.035)	(0.053)	
MARKET_CAP	0.012***	0.016***	0.77
	(0.005)	(0.005)	
COMP	0.162	2.029**	-1.36
	(0.274)	(0.981)	
Constant	18.04***	17.00***	0.37
	(2.148)	(4.050)	
Observations	1353	1766	3119
Banks	259	333	458
Instruments	18	18	26
AR(2) Test (p-value)	0.595	0.173	0.450
Hansen Test (p-value)	0.076	0.267	0.279
Model Structural Stability	$\chi^2(12)$ = 66.01***		

Notes: Columns (1) and (2) report regression results of equation (3.12) for banks in countries with and without BCBS-membership. Column (3) reports z- statistics of t-tests for the significant difference of interaction variables in the following specification: $CAR_{it} = \beta_0 + \beta_{0B}BCBS_i + \beta_1 CAR_{i,t-1} + \beta_{1B}CAR_{i,t-1} \times BCBS_i + \sum_{k=2}^{K}\beta_k X_{it} + \sum_{k=2}^{K}\beta_{kB}(X_{it} \times BCBS_i) + \beta_i + \varepsilon_{it}$. Where X = (*REG, SIZE, ROA, LOAN_RATIO, LLP_TO_TA, FA_RATIO, DEPOSIT_RATIO, GDP_GROWTH, MARKET_CAP, COMP*). The test for model structural stability is the F-test which was used for all interaction variables. Two-step SYS-GMM with robust standard errors corrected for finite-sample bias is used. Forward-orthogonal-deviation is applied in in transforming data for differences equation. The dependent variable is *CAR*. The endogenous variable is *L.CAR*, instrumented by lags 2 to 7 periods of *CAR* in columns (1) and (2), and lags 2 period of *CAR* in column (3). All instruments are collapsed. *, **, *** represent significance levels at 0.1, 0.05 and 0.01, respectively. Robust standard errors in parentheses.
Source: Author's calculations.

4.5 Robustness Checks

4.5.1 Regression with Different Methods

In order to ensure the robustness of the results, we re-estimate equation (3.12) using several alternative methods, including FOD-GMM, FEM, 2SLS-FE and Pooled OLS. The results reported in Table 4.10 show that the estimations are quite similar across different methods. Notably, the coefficient of *L.CAR* in the FEM estimation is small and not significant. While these coefficients in SYS-GMM and FOD-GMM are higher than that in the Pooled-OLS estimation, only SYS-GMM finds that this coefficient is smaller than estimation by FEM. Following Bond (2002) recommendation that true estimators of lagged dependent variables should lie between the FEM and Pooled-OLS estimations, the estimation of *L.CAR* using SYS-GMM is more efficient. The COMP coefficient is not significant in all regressions except for SYS-GMM. In addition, estimations by SYS-GMM have the smallest variance among the estimation methods. Therefore, we can conclude that our estimations using SYS-GMM are more consistent and efficient compared to the other methods.

Table 4.10 Regression Results with Different Methods

	SYS-GMM	FOD – GMM	FEM	2SLS-FE	Pooled-OLS
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Panel A: Capital Regulation					
REG	0.061***	0.188***	0.209***	0.244***	0.038**
	(0.019)	(0.035)	(0.047)	(0.041)	(0.015)
Panel B: Bank Specific Variables					
L.CAR	0.372***	0.315***	0.362***	0.167	0.605***
	(0.071)	(0.076)	(0.036)	(0.102)	(0.034)
SIZE	-0.681***	-1.918***	-2.203***	-2.856***	-0.478***
	(0.100)	(0.480)	(0.583)	(0.587)	(0.084)
ROA	1.487***	1.520***	1.507***	1.640***	1.230***
	(0.201)	(0.304)	(0.267)	(0.305)	(0.233)
LOAN_RATIO	-0.055***	-0.073***	-0.079***	-0.116***	-0.026**
	(0.012)	(0.020)	(0.021)	(0.024)	(0.011)
LLP_TO_TA	-0.905**	-1.195**	-1.079*	-1.190**	-1.058*
	(0.401)	(0.508)	(0.586)	(0.488)	(0.559)
FA_RATIO	0.605***	0.650***	0.721***	0.752***	0.437***
	(0.140)	(0.153)	(0.171)	(0.265)	(0.139)
DEPOSIT_RATIO	-0.044***	-0.075***	-0.088***	-0.120***	-0.036**
	(0.013)	(0.026)	(0.031)	(0.034)	(0.014)
Panel C: Country Specific Variables					
GDP_GROWTH	-0.191***	-0.097**	-0.126**	-0.170***	-0.191***
	(0.033)	(0.048)	(0.055)	(0.051)	(0.031)
MARKET_CAP	0.017***	0.029***	0.030***	0.033***	0.010***
	(0.003)	(0.007)	(0.008)	(0.008)	(0.003)
COMP	0.720*	0.036	0.015	-0.284	0.315
	(0.389)	(0.492)	(0.488)	(0.449)	(0.288)
Constant	20.162***		36.413***		13.674***
	(2.476)		(7.010)		(2.088)
Observations	3119	2661	3119	2608	3119
Banks	458	393	458	342	

	SYS-GMM	FOD – GMM	FEM	2SLS-FE	Pooled-OLS
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Instruments	18	16			11
AR(2) Test (p-value)	0.225	0.313			
Hansen Test (p-value)	0.354	0.157			

Notes: This table reports regression results of equation (3.12) using different estimation methods. The dependent variable is *CAR*. The endogenous variable is *L.CAR*. FOD-GMM estimation uses two-step estimation with robust standard errors corrected for finite-sample bias similar to SYS-GMM. Instruments for lagged dependent variable in FOD-GMM regression are lags 2 to 7 periods of *CAR* and collapsed. Instruments for lagged dependent variable in 2SLS-FE regression are its first difference. *, **, *** represent significance levels at 0.1, 0.05 and 0.01, respectively. Robust standard errors in parentheses.
Source: Author's calculations.

4.5.2 Model Sensitivity with Different Sets of Explanatory Variables

We also examine our model's sensitivity by re-estimating equation (3.12) using SYS-GMM for different sets of explanatory variables. The presence of different sets of variables aims to see how the results are sensitive to: (a) macro-variables, (b) country dummies and (c) time dummies in the model. Regarding the role of macro-variables, results in columns (1) and (3) in Table 4.11 show that estimations in the two models are similar, except for the *LLP_TO_TA* coefficient. This coefficient is insignificant when only bank characteristics are considered, but becomes significant at a 5% level when macro-variables are included. Therefore, the inclusion of macro-variables provides a better explanation of bank capital ratios.

Turning to country effects, results in columns (3) and (5) in Table 4.11 reveal that estimations do not vary much between the two models. However, the *COMP* coefficient, despite being positive, is significant in column (3) only. One possible reason is that the effect of competition has been partly explained by these country as an invariant factors.[20] Furthermore, the Hansen test for over-identifying instruments in column (5) has a p-value less than 0.05 and thus, suggests the invalidity of over-identifying instruments. Furthermore, estimations in columns (4) and (6) in Table 4.11 show that there were substantial deviations in macro variables coefficients between the two models. Again, the Hansen test of column (4) has a p-value less than 0.05 and illustrates the invalidity of over-identifying instruments. In short, country dummies are not important in the mode

In terms of time effects, we compare estimations in columns (3) and (6) in Table 4.11. The coefficients in the two models are quite similar, except for the *COMP* and *REG* coefficients. Specifically, the *COMP* coefficient is significant in column (3) but insignificant in column (6). The *REG* coefficient is significant at a 1% level in column (3), but significant only at a 10% level in column (6). In addition, all time dummies coefficients (not reported), except for the *Year2013* and *Year2014*, are insignificant. The regression results in Table 4.12 further show that the inclusion of time dummies provides more explanatory power for bank capital ratios (it has a higher R-square). However, the effect of macro-variables becomes insignificant in columns (1) to (5) in Table 4.12. This suggests a multicollinearity problem between time dummies and macro-variables. Since our interest is in the effect of capital regulation, time dummies can be disregarded.

Due to the different results related to macro-variables, particularly *COMP* and *REG*, when including macro-variables, time and/or country dummies at the same time, we compare column (2) with column (3) in Table 4.11. The results indicate that while most estimators are consistent, the *LLP_TO_TA*

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[20] In the full regression results of models with country dummies (columns (2), (4) and (5)), there are omission of some countries dummies, which provides evidence of for their multicollinearity with macro-variables.

coefficient, again, is not. This variable is only significant when macro-variables are considered. Moreover, the p-value of the Hansen test in column (2) is less than the 10% significance level and thus, implies the invalidity of over-identifying instruments. Therefore, macro-variables are necessary and more important than country and time dummies, and our specification as equation (3.12) is appropriate.

4.5.3 Sub-sample Analysis

The sample description in Table 3.3 shows that Indonesian banks have the largest representation (21%) in the sample. Therefore, we run a subsample analysis on two samples: (1) Indonesian banks and (2) other countries excluding Indonesian banks. The results reported in Table 4.13 show that excluding Indonesian banks does not affect the results of the whole sample. Therefore, our findings are not driven by Indonesian banks behavior. In addition, since Japanese banks are rather different in landscape due to their main bank system, we also run a sub-sample analysis on Japanese banks and other countries excluding both Japanese and Indonesian banks. The estimation is different for Japanese banks, which can be due to the small sample (276 observations and 38 banks, respectively). However, the results when excluding both Japanese and Indonesian banks are quite similar to the baseline results and suggests that our findings are not affected by banks in these countries. This is because we already controlled for unobserved characteristics through bank fixed-effects in the model.

Table 4.11 SYS-GMM Regression Results with Different Sets of Explanatory Variables

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Capital Regulation						
REG	0.0959***		0.0612***	-0.0788	0.0834***	0.109*
	(0.0224)		(0.0189)	(0.0567)	(0.0209)	(0.0559)
Panel B: Bank Specific Variables						
L.CAR	0.334***	0.519***	0.372***	0.493***	0.396***	0.391***
	(0.0788)	(0.0775)	(0.0707)	(0.0746)	(0.0676)	(0.0785)
SIZE	-0.522***	-0.517***	-0.681***	-0.620***	-0.624***	-0.665***
	(0.0890)	(0.0981)	(0.100)	(0.103)	(0.103)	(0.102)
ROA	1.117***	1.156***	1.487***	1.438***	1.455***	1.450***
	(0.202)	(0.162)	(0.201)	(0.181)	(0.218)	(0.199)
LOAN_RATIO	-0.0570***	-0.0592***	-0.0549***	-0.0609***	-0.0665***	-0.0522***
	(0.0149)	(0.0178)	(0.0123)	(0.0161)	(0.0146)	(0.0143)
LLP_TO_TA	-0.364	-0.574	-0.905**	-0.975**	-0.899**	-0.855**
	(0.600)	(0.508)	(0.401)	(0.383)	(0.417)	(0.419)
FA_RATIO	0.548***	0.489***	0.605***	0.575***	0.641***	0.589***
	(0.132)	(0.118)	(0.140)	(0.142)	(0.164)	(0.132)
DEPOSIT_RATIO	-0.0262*	-0.0418***	-0.0442***	-0.0551***	-0.0520***	-0.0464***
	(0.0155)	(0.0125)	(0.0129)	(0.0132)	(0.0141)	(0.0135)
Panel C: Country Specific Variables						
GDP_GROWTH			-0.191***	-0.0751	-0.104**	-0.206***
			(0.0333)	(0.0459)	(0.0466)	(0.0320)
MARKET_CAP			0.0166***	0.00121	0.0155***	0.0148***
			(0.00346)	(0.00575)	(0.00546)	(0.00387)
COMP			0.720*	0.110	0.319	0.523
			(0.389)	(0.447)	(0.442)	(0.445)
Constant	17.52***	16.66***	20.16***	18.64***	19.00***	19.38***
	(2.260)	(3.240)	(2.476)	(3.464)	(3.206)	(2.441)
Time Dummies	No	Yes	No	Yes	No	Yes
Country Dummies	No	Yes	No	Yes	Yes	No
Observations	3989	3989	3119	3119	3119	3119

	(1)	(2)	(3)	(4)	(5)	(6)
Banks	545	545	458	458	458	458
Instruments	15	49	18	48	34	32
AR(2) Test (p-value)	0.215	0.135	0.225	0.149	0.208	0.204
Hansen Test (p-value)	0.119	0.083	0.354	0.030	0.032	0.423

Notes: This table reports regression results of equation (3.12) with different sets of explanatory variables using two-step SYS-GMM with robust standard errors corrected for finite-sample bias. Forward-orthogonal-deviation is applied in transforming data for differences equation. The dependent variable is *CAR*. The endogenous variable is *L.CAR*, instrumented by lags 2 to 7 periods of *CAR* and collapsed. *, **, *** represent significance levels at 0.1, 0.05 and 0.01, respectively. Robust standard errors in parentheses. Time and Country dummies are not reported.
Source: Author's calculations.

Table 4.12 FEM Regression Results with Different Sets of Explanatory Variables

	(1)	(2)	(3)	(4)	(5)	(6)
L.CAR	0.391***	0.390***	0.391***	0.326***	0.326***	0.362***
	(0.037)	(0.037)	(0.037)	(0.039)	(0.039)	(0.036)
SIZE	-3.995***	-3.991***	-4.007***	-4.267***	-4.268***	-2.203***
	(0.843)	(0.837)	(0.839)	(0.832)	(0.832)	(0.583)
ROA	1.434***	1.452***	1.438***	1.645***	1.647***	1.507***
	(0.247)	(0.247)	(0.245)	(0.262)	(0.262)	(0.267)
LOAN_RATIO	-0.093***	-0.098***	-0.097***	-0.113***	-0.113***	-0.079***
	(0.019)	(0.019)	(0.019)	(0.022)	(0.022)	(0.021)
LLP_TO_TA	-0.506	-0.499	-0.512	-0.885	-0.884	-1.079*
	(0.531)	(0.528)	(0.532)	(0.557)	(0.558)	(0.586)
FA_RATIO	0.614***	0.608***	0.601***	0.784***	0.785***	0.721***
	(0.138)	(0.138)	(0.136)	(0.167)	(0.167)	(0.171)
DEPOSIT_RATIO	-0.092***	-0.093***	-0.093***	-0.086***	-0.085***	-0.088***
	(0.034)	(0.034)	(0.034)	(0.030)	(0.030)	(0.031)
REG		-0.132***	-0.130***	-0.078	-0.079	0.209***
		(0.050)	(0.050)	(0.055)	(0.055)	(0.047)
GDP_GROWTH			-0.068	-0.079	-0.081	-0.126**
			(0.044)	(0.054)	(0.054)	(0.055)
MARKET_CAP				0.011	0.011	0.030***
				(0.008)	(0.008)	(0.008)
COMP					0.239	0.015
					(0.567)	(0.488)
Time Dummies	Yes	Yes	Yes	Yes	Yes	No
Observations	3,989	3,989	3,989	3,119	3,119	3,119
Banks	545	545	545	458	458	458
R-square	0.459	0.461	0.461	0.502	0.502	0.465

Notes: *, **, *** represent significance levels at 0.1, 0.05 and 0.01, respectively. Robust standard errors in parentheses. Source: Author’s calculations.

Table 4.13 Two-step system GMM regression on capital ratio considering Indonesia and Japan banks

	Full sample	Indonesia	Others (ex. Indonesia)	Japan	Other (ex. Indonesia and Japan)
L.CAR	0.372***	0.372***	0.441***	0.125	0.438***
	-0.071	-0.075	-0.067	-0.439	-0.066
L.EQTA					
L.TIER1					
ACRI	0.061***	0.446***	0.052***	0.200*	0.050***
	-0.019	-0.133	-0.014	-0.103	-0.015
SIZE	-0.681***	-1.585***	-0.305***	-0.154	-0.399***
	-0.100	-0.328	-0.082	-0.219	-0.091
ROA	1.487***	2.040***	0.677***	1.999	0.722***
	-0.201	-0.260	-0.127	-1.312	-0.134
LOAN_RATIO	-0.055***	-0.157***	-0.040***	-0.092**	-0.035***
	-0.012	-0.04	-0.009	-0.043	-0.009
LLP_TO_TA	-0.905**	-0.961*	0.296**	0.804	0.337**
	-0.401	-0.527	-0.149	-0.855	-0.145
FA_RATIO	0.605***	1.138***	0.162*	-1.463*	0.182**
	-0.140	-0.237	-0.087	-0.829	-0.088
DEPOSIT_RATIO	-0.044***	-0.386***	-0.007	0.019	-0.004
	-0.013	-0.078	-0.007	-0.016	-0.008
GDP_GROWTH	-0.191***	-0.420	-0.099***	0.054	-0.083***
	-0.033	-0.516	-0.023	-0.085	-0.025
MARKET_CAP	0.017***	0.115**	0.014***	-0.022*	0.015***
	-0.003	-0.049	-0.003	-0.012	-0.003
COMP	0.720*	-74.643***	0.285	-0.061	0.330
	-0.389	-27.023	-0.277	-10.658	-0.277
Constant	20.162***	57.281***	11.874***	17.654**	12.034***
	-2.476	-8.897	-1.738	-8.363	-1.759

Observations	3,119	787		2,332	276			2,056
Banks	458	82		376	38			338
Instruments	18	13		18	26			18
AR(2) test	0.225	0.768		0.339	0.533			0.34
Hansen test	0.354	0.499		0.614	0.25			0.548

Notes: This table reports regression results of equation (3.12) for sub-samples with and without Indonesian and Japanese banks. Forward-orthogonal-deviation is applied in transforming data for differences equation. The dependent variable is *CAR*. The endogenous variable is *L.CAR*, instrumented by lags 2 to 7 periods of *CAR* and collapsed. *, **, *** represent significance levels at 0.1, 0.05 and 0.01, respectively. Robust standard errors in parentheses.

4.6 Chapter Summary

This chapter has examined the effects of capital regulation on bank capital ratios using a sample of banks in 20 Asian countries during the period of 2001-2016. The empirical results have shown that capital regulation has been strengthened over the period despite disparities among the jurisdictions. Asian banks in the sample also raise their capital ratios and keep these ratios much higher than the minimum requirements.

Employing two-step SYS-GMM regression on bank capital ratios using the PAM model, we confirm that capital regulation is effective in inducing banks to raise capital ratio. The conclusion holds for different measurements of capital ratios; that is Total Regulatory Capital ratio, Equity ratio and Tier 1 capital ratio. The results show that bank capital ratios are additionally impacted by bank characteristics and country-specific factors. Specifically, size, lending, deposit ratios, economic growth and competition have a negative influence on bank capital ratios, while profitability, asset quality, tangibility and stock market development exert a positive effect. However, the effects of these factors, particularly lending, asset quality, tangibility, deposit ratios and competition, change substantially when capital ratios are referred to as Leverage ratios or Tier 1 capital ratios. These results are robust to the choice of estimation methods, although SYS-GMM seems to outperform the others.

Our results also reveal that country groups and BCBS membership play an important role in studying bank capital ratios. These different groups of countries provide different market characteristics and regulatory environments that can affect bank capital ratios differently. However, such effects are prominent for bank characteristics and country-specific factors only. The impact of capital regulation on capital ratios is not significantly different across these country groups and BCBS members.

Chapter 5

Capital Regulation, Bank Capital and Risk Behavior

5.1 Introduction

This chapter examines the effect of capital regulation on bank capital and risk behavior; the second research objective. The study sample covers 19 Asian countries during the period of 2002-2016. The preliminary analysis is provided in section 5.2. The effects of capital regulation on changes in bank capital and risk are examined and presented in section 5.3. Section 5.4 analyzes the effects of capital regulation on bank capital and risk levels. We also conduct further analyses to investigate whether these findings about capital regulation differ across banks in different country groups, BCBS members, and capitalization levels. The results of these effects are reported in section 5.5. While section 5.6 presents the robustness checks to ensure the inference of the results, section 5.7 concludes the chapter.

5.2 Preliminary Analysis

Figure 5.1 depicts the average changes in bank capital and risk in Asia during the period of 2002 - 2016, using the regulatory definition of capital and risk. The result shows that banks changed their risk quickly and at a greater extent than capital. Changes in capital varied around 0%, while changes in risk ranged from approximately -6% to 3%. This supports the idea that adjusting risk is easier than adjusting capital, particularly in immature capital markets like Asia. On average, banks increase their regulatory capital over assets after 2004 (positive value of changes). Despite several reductions throughout the remaining period, capital increases dominate bank behavior. The average change in regulatory capital over assets is 0.08%. Against expectations, banks in Asia do not reduce risk over the year. Risk reduction (negative value of changes) is not frequent, except for large decreases in 2004 and 2009. On average, banks increase risk by 0.12%.

This behavior can be attributed to higher capital ratios in relation to the regulatory requirements of Asian banks. Since banks are already safe from regulatory intervention, they tend to increase risk to enjoy higher profits. Furthermore, with the fast growth of the Asian economy, and the banking sector, banks have more opportunities to maximize the use of their money and funds. However, the relationship between changes in bank capital and risk are not clear, as displayed in Figure 5.1.

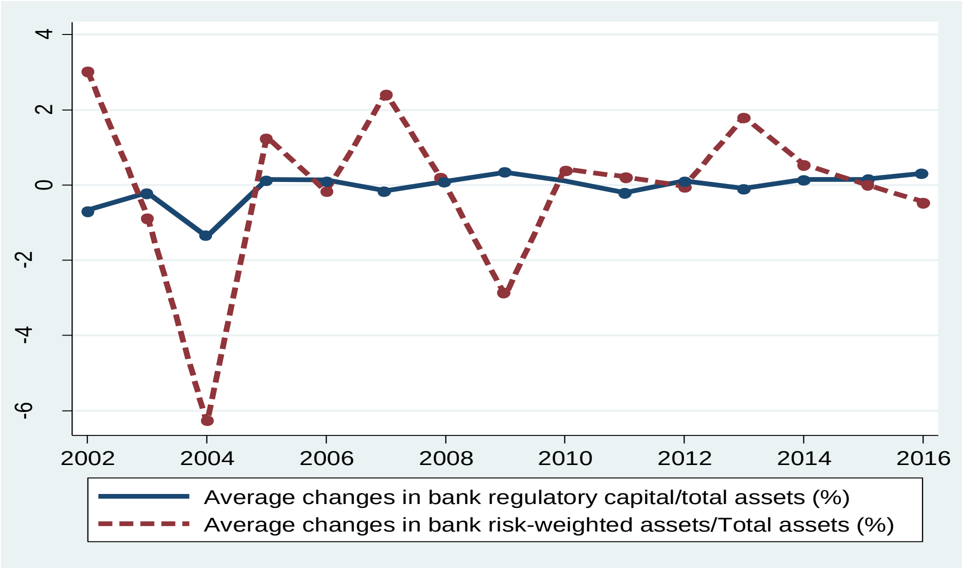

Figure 5.1 Average Changes in Bank Capital and Bank Risk in Asia (2002-2016)

Figure 5.2 shows that changes in bank capital and risk are positively correlated. The pairwise correlation coefficient is 0.3122 and is significant at the 0.1 level. The figure also suggests a positive effect of capital regulation on changes in bank capital and risk, although the effect is quite small.

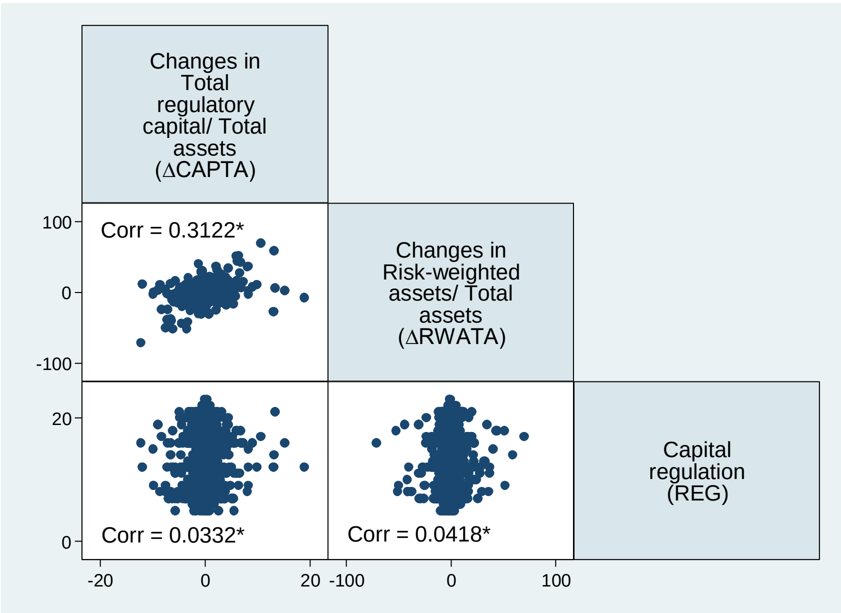

Figure 5.2 Relationship among Changes in Bank Capital, Changes in Bank Risk and Capital regulation

Notes: This figure displays a matrix of scatterplots of changes in bank capital, changes in bank risk and capital regulation. The x and y axes show the values of these variables. Measurements are in percentage for $\Delta CAPTA$, $\Delta RWATA$ and unit for REG. "Corr" represents the pairwise correlation coefficient, * denotes the 0.1 significance level.

Figure 5.3 examines the relationships between different definitions of bank capital and risk. Apparently, there is not much difference when defining bank capital as Tier 1 ratio or total regulatory capital ratio. The correlation between these two definitions is very high (0.9043). However, the correlations between equity ratio and the regulatory capital ratios are slightly weaker. Similarly, the association of bank capital and regulatory risk (measured as risk-weighted assets/total assets), is not significantly different between the two regulatory definitions, but is much smaller for the equity ratio. This suggests that Tier 1 capital plays a significant role in banks' total regulatory capital and the increase in total regulatory capital is primarily from Tier 1 capital. In addition, banks focus more on regulatory capital to cover their regulatory risks.

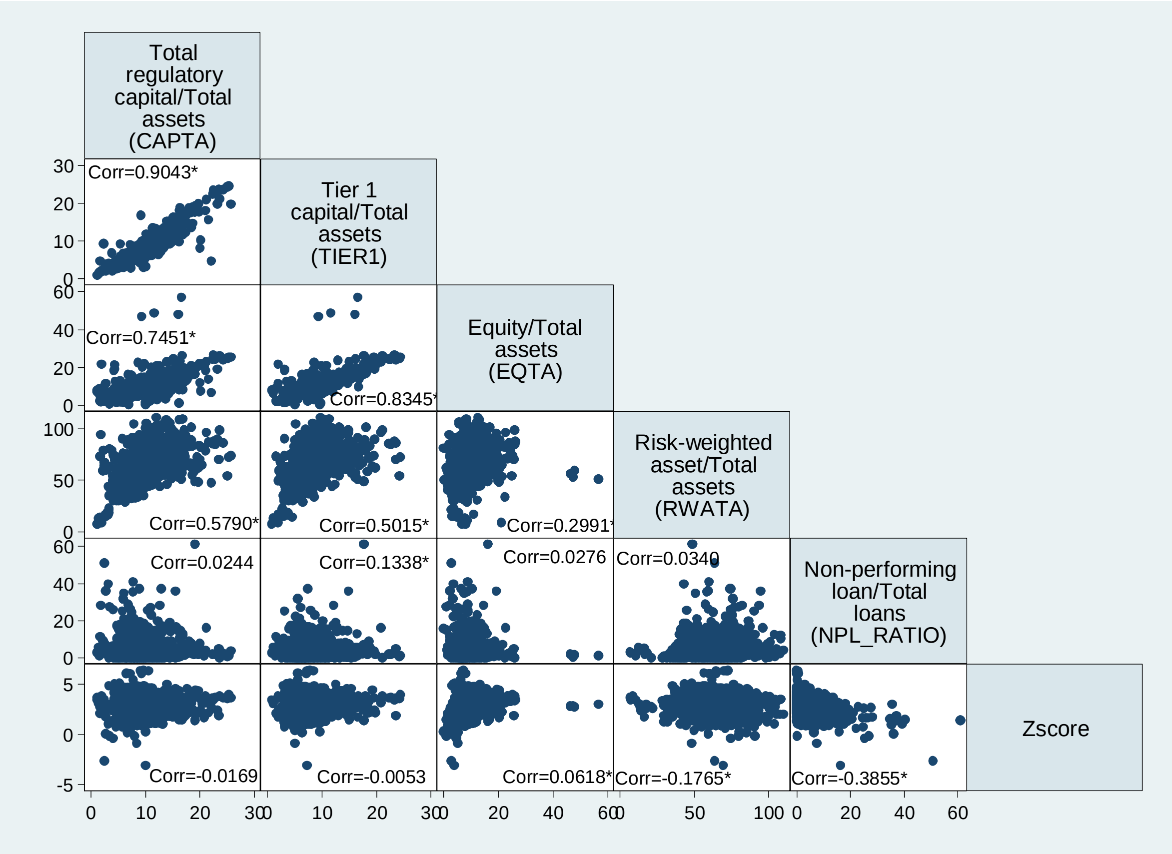

Figure 5.3 Relationship among Different Capital and Risk Definitions

Notes: This figure displays a matrix of scatterplots of different capital and risk definitions. The x and y axes show the values of these variables. Measurements are in percentages for *CAPTA*, *TIER1*, *EQTA*, *RWATA* and *NPL_RATIO*. *ZSCORE* has no measurement unit. "Corr" represents the pairwise correlation coefficient, * denotes the 0.1 significance level.

Figure 5.3 also shows the non-performing loan ratio is uncorrelated with total regulatory capital and equity ratios, but has weak correlation (0.1338) with Tier 1 capital ratios. This implies that banks cover the higher risk of loans with high quality capital. In addition, the non-performing loan ratio has no correlation with the risk-weighted assets ratio, but has a moderate correlation with Z-scores. This raises an important implication; that is, that the regulatory risk measurement fails to capture bank credit risks and the Z-score seems to outperform the risk-weight measurement. Given the primary role of lending in Asian bank activities, the failure to reflect bank credit risks in risk-based measurements is quite problematic.

5.3 Effect of Capital Regulation on Changes in Bank Capital and Risk

Table 5.1 reports the results of equations (3.16) and (3.17) using both 2SLS-FE and Two-Stage Least Squares with Random Effects regressions (2SLS-RE). The estimations are basically the same in the two regressions, with some exceptions. These include the estimation of *LOAN_RATIO, FA_RATIO* and *GDP_GROWTH* in the capital equation, and *ΔCAPTA, ROA* and *LLP_TO_TA* in the risk equation. Diagnostic tests at the end of Table 5.1 show that both the F-test for joint-significance of bank-fixed effects and the Durbin-Wu-Hausman test for the endogeneity of *ΔRWATA* and *ΔCAPTA* have p-values smaller than the 0.01 significance level. Therefore, fixed effects and the inter-relationship between *ΔRWATA* and *ΔCAPTA* need to be controlled in our model. Regarding fixed effects, the Hausman test confirms the consistency of 2SLS-FE over 2SLS-RE with large chi-square statistic. It is significant at the 0.01 level. Therefore, we rely on the 2SLS-FE regression results to explain the effect of capital regulation on changes in bank capital and risk, as well as for further analysis. Further, in terms of the relevance of instruments, the F-statistics are much larger than the rule-of-thumb value, which is 10, and support the relevance of the instruments.

Table 5.1 shows that against the prediction in preliminary analysis, after controlling for other factors affecting changes in bank capital and risk, capital regulation has a negative effect on changes in bank capital and no influence on changes in bank risk. This suggests that strengthening capital regulation is not an effective way to induce banks to increase their capital and reduce risk. Instead, banks increase capital more if they are smaller (*SIZE*), have higher profits (*ROA*), lower loan quality (*LLP_TO_TA*), a higher ratio of fixed assets (*FA_RATIO*), and in economic downturns (*GDP_GROWTH*). Similarly, banks reduce their risk more if they are smaller (*SIZE*), have lower lending (*LOAN_RATIO*), and in times of economic upturn (*GDP_GROWTH*).

Table 5.1 Regressions of Changes in Bank Capital and Risk

	Capital Equation (ΔCAPTA)		Risk Equation (ΔRWATA)	
	2SLS-FE	**2SLS-RE**	**2SLS-FE**	**2SLS-RE**
REG	-0.052**	0.038*	0.053	0.112
	(0.022)	(0.020)	(0.075)	(0.083)
ΔRWATA	-0.037*	-0.041*		
	(0.020)	(0.023)		
L.CAPTA	-0.653***	-0.330***		
	(0.054)	(0.027)		
ΔCAPTA			-0.182	-0.413**
			(0.134)	(0.164)
L.RWATA			-0.558***	-0.372***
			(0.040)	(0.027)
SIZE	-1.002***	-0.170***	2.108*	-0.473***
	(0.330)	(0.033)	(1.103)	(0.126)
ROA	0.497***	0.424***	0.566	0.965***
	(0.087)	(0.060)	(0.361)	(0.220)
LOAN_RATIO	-0.009	0.013***	0.460***	0.235***
	(0.013)	(0.005)	(0.045)	(0.023)
LLP_TO_TA	0.543***	0.465***	0.450	0.599*
	(0.141)	(0.124)	(0.428)	(0.352)
FA_RATIO	0.294***	0.060	0.031	0.099
	(0.092)	(0.049)	(0.250)	(0.180)
DEPOSIT_RATIO	0.008	0.001	0.014	-0.030
	(0.014)	(0.004)	(0.064)	(0.024)
GDP_GROWTH	-0.052**	-0.014	-0.252***	0.211***
	(0.021)	(0.015)	(0.091)	(0.063)
Constant	14.269***	2.740***	-3.140	19.408***
	(4.173)	(0.862)	(16.026)	(5.597)
Time Dummies	Yes	Yes	Yes	Yes
Observations	2,765	2,765	2,765	2,765
Banks	440	440	440	440
F-test for Bank Fixed Effects	F(439,2301) = 2.13***		F(439,2301) = 3.09***	
Durbin-Wu-Hausman Test	Chi-square(1)=34.559***		Chi-square(1)=48.918***	
F-statistic for Relevance of Instruments	218.471		143.071	
Hausman Test	Chi-square(24)=134.24***		Chi-square(24)= 72.74***	

Notes: Standard errors adjusted for bank clusters in parentheses. *, **, *** represent significance levels at 0.1, 0.05 and 0.01 levels, respectively. Endogenous variables: *ΔRWATA, ΔCAPTA*.
Source: Author's estimations.

Table 5.1 also shows that capital and risk in the previous year (*L.CAPTA* and *L.RWATA*) negatively affect changes in capital and risk. These coefficients are significant at the 0.01 level and thus, suggest the appropriateness of the PAM model. The *L.CAPTA* and *L.RWATA* coefficients are -0.653 and -0.558. Removing the negative sign of these coefficients, we have the adjustment speed of capital and risk (α and β) in equations (3.14) and (3.15). Correspondingly, these adjustment speeds are quite high at

0.653 for capital, and 0.558 for risk. On average, Asian banks need more than one and a half years to close the gaps toward their target capital and risk levels.[21] Capital adjustment (toward the target level) is slightly faster than risk adjustment. These adjustment speeds are consistent with Godlewski (2005) findings for banks in emerging countries, which are 0.518 for capital adjustment, and 0.517 for risk adjustment. These figures are much higher than banks in the U.S and European countries (see Cannata and Quagliariello (2006); Rime (2001); Teply and Matejasák (2007)).

In terms of the relationship between changes in capital and changes in risk, the *ΔRWATA* coefficient in the capital equation and *ΔCAPTA* coefficient in the risk equation are all negative (see Table 5.1). However, only the *ΔRWATA* coefficient is significant, despite its relatively small magnitude (0.037%). This finding is not surprising as most of the banks in our study have capital ratios higher than the minimum requirement. As long as the capital does not fall below this restriction, banks can reduce capital to maximize profits from higher risk assets. The negative effect of changes in bank risk on changes in bank capital is evident in earlier studies of Asian banks (Hussain and Hassan (2005); Nachane and Saibal (2001); Zhang et al. (2008). However, these studies also found a negative effect of changes in bank capital on changes in bank risk. We obtain the same results when regressing equations (3.16) and (3.17) using Pooled-2SLS regression (see Table D. 1) and conclude that the difference arises from bank fixed-effects.

5.4 Effect of Capital Regulation on Bank Capital and Risk Levels

The efficiency of SYS-GMM estimation is sensitive to the specification of endogenous variables, exogenous variables, and the instruments. Therefore, we rely on three criteria, which are the AR(2) test, the Hansen test, and the C-test to determine these variables and instruments in estimating equations (3.20) and (3.21). Table 5.2 reports the p-values of these tests for different combinations of endogenous variables, exogenous variables, and instruments. The results show that *RWATA* is exogenous. Treating *RWATA* as endogenous will result in model mis-specification, as evidenced by the rejection of the AR(2) test and/or the Hansen test. Instruments for *CAPTA* should not exceed lag 4 of *CAPTA* since they will become invalid (evidenced by a rejection of the Hansen test in specification 4). For the risk equation, Table 5.2 indicates that *CAPTA* is endogenous (the C-test in specification 1 and 2 is rejected). In addition, instruments from lags 2 to 9 of *RWATA* or from lags 2 to 8 of *CAPTA* are valid instruments (the p-values of the AR(2) tests and the Hansen tests in specifications 4 to 8 are larger than the 0.1 significance level). Therefore, to estimate the capital equation (equation (3.20)) with system GMM, we treat *RWATA* as an exogenous variable and instrument lagged dependent variable (*L.CAPTA*) by lags 2 to 4 of *CAPTA*. For the risk equation (equation (3.21)), *CAPTA* is endogenous and is

[21] Time to close the gap equals 1 divided by speed of adjustment, and equals 1.53 years for capital, and 1.79 years for risk.

instrumented by its second lag. The lagged dependent variable (*L.RWATA*) is instrumented by lags 2 to 9 of *RWATA*.[22]

Table 5.3 presents the two-step SYS-GMM regression results of equations (3.20) and (3.21). The estimation shows that capital regulation does not affect both bank capital and risk levels. *REG* coefficients are insignificant in both capital and risk equations. Similar results were also obtained by Heid et al. (2003) for German banks, and Bougatef and Mgadmi (2016) for banks in MENA countries. Together with the significant effect of capital regulation on changes in bank capital, as shown in Table 5.1, this explains why changes in capital and risk, rather than their levels, are used to study the effects of capital regulation. In addition, bank capital and risk levels are driven primarily by their own incentives. The coefficients of bank characteristics and macro-environment are all significant, except for deposit ratios in the capital equation.

However, it is unfair to conclude that capital regulation is not effective at all, based solely on the capital regulation variable (*REG*). In a broader sense, one of the objectives of capital regulation is to induce banks to hold adequate capital to cover all of their risks, particularly with higher quality capital. However, the *RWATA* and *ROA* coefficients show that these coefficients are positive at the 0.01 significance level (see Table 5.3). This suggests that banks actually do increase capital to cover higher risks and accumulate their capital with retained earnings. Therefore, capital regulation achieves its purpose, to a certain extent. Nevertheless, higher capital does not create enough incentive for banks to reduce their risk-taking (the *CAPTA* coefficient is negative but insignificant). Interestingly, the *DEPOSIT_RATIO* coefficient is negative and significant, which implies that depositors create some market discipline on bank risk.

Since *CAPTA* does not impact *RWATA*, including *CAPTA* and treating it as an endogenous variable in the risk equation, may complicate and distort the results. We also estimate equation (3.21) without *CAPTA* in the set of explanatory variables. The estimators are likely to be the same but the AR(2) test has a p-value < 0.1, which suggests the mis-specification of the model (see estimation (3) in Table 5.3). Therefore, it is important to consider the inter-relationship between capital and risk levels.

Both lags of *CAPTA* and *RWATA* are significant in the capital and risk equations, respectively and suggest the appropriateness of the partial adjustment model. The adjustment speeds derived from these coefficients for *CAPTA* and *RWATA* are 0.700 and 0.589 (calculated by subtracting these coefficients from 1) and are consistent with the findings in Table 5.1, which are 0.653 and 0.558, respectively (see Table 5.3).

[22] Regressions with other qualified specifications yield similar results.

Table 5.2 Model Choice and Lag Lengths for SYS-GMM Estimation of Bank Capital and Risk Levels

	Capital Equation (CAPTA)					Risk Equation (RWATA)				
Specification	**CAPTA**	**RWATA**	**AR(2) test**	**Hansen test**	**C-test**	**RWATA**	**CAPTA**	**AR(2) test**	**Hansen test**	**C-test**
(1)	2 – 2	0 – 0	0.713	0.105	0.105	2 – 2	0 – 0	0.166	0.019	0.019
(2)	2 – 3	0 – 0	0.171	0.268	0.138	2 – 3	0 – 0	0.180	0.015	0.004
(3)	2 – 4	0 – 0	0.147	0.404	0.205	2 – 2	1 – 1	0.205	0.014	N/A
(4)	2 – 5	0 – 0	0.264	0.006	0.327	2 – 2	2 – 2	0.114	0.329	N/A
(5)	2 – 2	1 – 1	0.041	< 0.001	N/A	2 – 2	2 – 8	0.118	0.541	N/A
(6)	2 – 2	2 – 2	0.016	0.498	N/A	2 – 3	2 – 2	0.122	0.195	N/A
(7)	3 – 3	1 – 1	0.195	< 0.001	N/A	2 – 9	2 – 2	0.115	0.444	N/A
(8)	3 – 3	2 – 2	0.032	0.010	N/A	2 – 3	2 – 3	0.114	0.180	N/A
(9)	3 – 3	3 – 3	0.064	0.012	N/A	2 – 4	2 – 4	0.114	0.018	N/A

Notes: The estimations are for equations (3.20) and (3.21). Two-step SYS-GMM with standard errors corrected for small sample bias and collapsed instruments are used. Lag (0, 0) of a variable (for example, *RWATA*) represents the treatment of the respective variable as exogenous. The first number in the pair specifies the start of the lag length and the second number specifies the end. Given the dynamic of equations (3.20) and (3.21), variables from lag 2 of the dependent variable can be valid instruments for the lagged dependent variables. Therefore, lags for *CAPTA* (and *RWATA*) in the capital (and risk) equation begin from 2. N/A represents "Not applicable" because the suspicious endogenous variable has been treated as endogenous.
Source: Author's calculations.

Table 5.3 SYS-GMM Estimation of Bank Capital and Risk Levels

	Capital Equation (CAPTA)		Risk Equation (RWATA)			
	(1)		(2)		(3)	
	Coefficient	Robust S.E	Coefficient	Robust S.E	Coefficient	Robust S.E
REG	0.0104	0.53	0.103	1.04	0.102	1.08
RWATA	0.0823***	10.40				
L.CAPTA	0.300***	4.83				
CAPTA			-0.160	-0.49		
LRWATA			0.411***	5.87	0.415***	5.38
SIZE	-0.271***	-7.32	-0.761***	-3.45	-0.685***	-4.39
ROA	0.575***	7.27	1.510***	3.67	1.360***	5.03
LOAN_RATIO	-0.0243***	-4.33	0.326***	8.28	0.321***	7.62
LLP_TO_TA	0.466***	3.61	1.358***	2.85	1.260***	3.04
FA_RATIO	0.131**	2.05	0.446*	1.86	0.395*	1.92
DEPOSIT_RATIO	-0.000309	-0.05	-0.0809***	-3.14	-0.0797***	-3.18
GDP_GROWTH	-0.0842***	-4.77	0.337***	4.32	0.349***	4.71
Constant	4.066***	4.27	34.79***	4.22	32.97***	4.36
Time Dummies	Yes		Yes		Yes	
Observations	2765		2765		2765	
Banks	440		440		440	
Instruments	28		34		32	
AR(2) Test	0.147		0.115		0.068	
Hansen Test	0.404		0.444		0.343	

Notes: This table reports the regression results of equations (3.20) and (3.21), using two-step SYS-GMM, with robust standard errors corrected for the small sample bias. Forward orthogonal deviation is employed in transforming data for differences equation. In the capital equation, *CAPTA* is the dependent variable, *L.CAPTA* is the endogenous variable and instrumented by lags 2 to 4 of *CAPTA, RWATA* is treated as an exogenous variable and instrumented by itself. In the risk equation (estimation 2), RWATA is the dependent variable, *L.RWATA* and *CAPTA* are endogenous variables and instrumented by lags 2 to 9 of *RWATA* and lag 2 of *CAPTA*, respectively. Estimation (3) is similar to estimation (2) with the exception of the inclusion of *CAPTA* in the set of explanatory variables. All instruments are collapsed. *, **, *** indicate significance levels at 0.1, 0.05 and 0.01, respectively. Source: Author's calculations.

5.5 Further Analysis

5.5.1 Moderating Effect of Country Groups

The study sample covers a wide range of countries that are different from each other in terms of economic development, financial development and regulatory environments. Therefore, we examine the moderating effect of country group by introducing dummy variables for each group (that is, *Developed*, *Emerging* and *Frontier*) and interact them with the capital regulation variable (*REG*) in equations (3.16), (3.17), (3.20) and (3.21).

Estimation (1) in Table 5.4 reports the moderating effect of country group for changes in bank capital. The negative effect of capital regulation on changes in bank capital, reported in Table 5.1, is also observed for banks in developed (*REG* coefficient is negative and significant at the 0.01 level) and emerging markets (estimation for the total effect of *REG + REG*Emerging* is negative and significant at the 0.1 level). Nevertheless, capital regulation does not affect changes in capital in frontier markets (estimation for the total effect of *REG + REG*Frontier* is insignificant).

However, the insignificance of capital regulation on changes in bank risk, reported in Table 5.1, is applied to banks in frontier markets only (estimation for the total effect of *REG + REG*Frontier* is insignificant) (see estimation (2) in Table 5.4). Banks in developed markets adjust their risks by 0.203% less to respond to stricter capital regulations. Notably, banks in emerging markets make greater changes in risk (by 0.210%).

Estimations with changes in capital and risk (*ΔCAPTA* and *ΔRWATA*) do not tell us exactly whether banks increase or reduce capital and risk in response to stricter capital regulation. Estimations (3) and (4) in Table 5.4 for bank capital and risk levels indicate that banks in developed markets reduce both capital levels (by 0.047%) and risk levels (by 0.259%), while banks in emerging markets reduce capital levels (by 0.091%) and increase risk levels (by 0.325%). Similar to the findings for the effects of capital regulation on changes in bank capital and risk in frontier markets, estimations (3) and (4) in Table 5.4, also show that capital regulation has no significant influence on bank capital and risk levels in these countries. Therefore, the insignificance of capital regulation on bank capital and risk levels, reported in Table 5.2, are caused by the crowding out of contrasting effects among banks in developed, emerging and frontier markets. The Wald test in Panel C (Table 5.4) confirms that the moderating effect of country groups on the relationship between capital regulation and bank capital is substantial (the p-values of the Wald tests are less than the 0.01 significance level).

Table 5.4 Effects of Capital Regulation on Bank Capital and Risk Considering Country Groups

	ΔCAPTA	**ΔRWATA**	**CAPTA**	**RWATA**
	(1)	**(2)**	**(3)**	**(4)**
Panel A: Estimators				
REG	-0.111***	-0.203**	-0.047**	-0.259**
	(0.027)	(0.097)	(0.022)	(0.122)
*REG*Emerging*	0.072***	0.414***	-0.044***	0.584***
	(0.019)	(0.094)	(0.013)	(0.109)
*REG*Frontier*	0.093***	0.175	0.064**	0.225
	(0.036)	(0.127)	(0.030)	(0.143)
L.CAPTA	-0.653***		0.316***	
	(0.054)		(0.059)	
ΔRWATA	-0.034*			
	(0.019)			
RWATA			0.082***	
			(0.008)	
L.RWATA		-0.574***		0.359***
		(0.041)		(0.071)

	ΔCAPTA	ΔRWATA	CAPTA	RWATA
	(1)	**(2)**	**(3)**	**(4)**
ΔCAPTA		-0.175		
		(0.133)		
CAPTA				-0.257
				(0.318)
SIZE	-1.124***	1.456	-0.364***	-0.769***
	(0.334)	(1.122)	(0.043)	(0.267)
ROA	0.496***	0.554	0.649***	1.567***
	(0.086)	(0.350)	(0.080)	(0.463)
LOAN_RATIO	-0.011	0.449***	-0.029***	0.341***
	(0.013)	(0.045)	(0.006)	(0.041)
LLP_TO_TA	0.546***	0.405	0.605***	1.332***
	(0.140)	(0.428)	(0.110)	(0.502)
FA_RATIO	0.302***	0.019	0.187***	0.604**
	(0.089)	(0.245)	(0.061)	(0.273)
DEPOSIT_ RATIO	0.006	0.013	-0.006	-0.098***
	(0.014)	(0.065)	(0.006)	(0.030)
GDP_GROWTH	-0.062***	-0.250***	-0.078***	0.117
	(0.020)	(0.086)	(0.018)	(0.076)
Emerging			-0.103	-3.259**
			(0.251)	(1.533)
Frontier			-3.227***	-1.476
			(0.544)	(2.789)
Constant	15.300***	3.319	5.856***	43.415***
	(4.191)	(16.326)	(1.046)	(9.708)
Panel B: Full Effect of REG				
*REG + REG*Emerging*	-0.039*	0.210**	-0.091***	0.325***
*REG + REG*Frontier*	-0.018	-0.028	0.018	-0.034
Panel C: Moderating Effect of Country Group				
Wald test (chi-square(2))	15.89***	19.25***	23.90***	29.98***
Time Dummies	Yes	Yes	Yes	Yes
Observations	2,765	2,765	2,765	2,765
Banks	440	440	440	440
Instruments			32	38
AR(2) Test			0.195	0.118
Hansen Test			0.769	0.425

Notes: This table reports the 2SLS-FE regression of equations (3.16), (3.17) and two-step SYS-GMM regression of equations (3.20) and (3.21), with consideration for country-group effects. Panel A presents the coefficients estimation. Panel B presents the full effect of the interaction variable for each country group. The estimation is based on a linear combination of coefficients of capital regulation variables (*REG*) and interaction variables with *REG* for each country group. Panel C displays the chi-square of the Wald test for the joint-significance of interaction variables (*REG*Emerging* and *REG*Frontier*). The endogenous variables are *ΔRWATA* (estimation 1, instrumented by *L.RWATA*), *ΔCAPTA* (estimation 2, instrumented by *L.CAPTA*), *L.CAPTA* (estimation 3, instrumented by lags 2 to 4 periods of *CAPTA*), *CAPTA* and *L.RWATA* (estimation 4, instrumented by lag 2 periods of *CAPTA* and lags 2 to 9 periods of *RWATA*, respectively). *Emerging* and *Frontier* are dummy variables and equal 1 if the country is an emerging or frontier market, respectively. Developed market is set as the reference group to avoid multicollinearity problems. Time dummies are not reported. Robust standard errors are in parentheses. *, **, *** indicate significance levels at 0.1, 0.05 and 0.01, respectively.
Source: Author's calculations.

5.5.2 Moderating Effect of Basel Committee Membership

BCBS members are required to follow Basel capital standards, while other countries are not. Therefore, those countries with BCBS membership are expected to behave more prudentially. This effect is examined by including a dummy variable for BCBS members *(BCBS)* and interacting it with capital regulation (REG) in equations (3.16), (3.17), (3.20) and (3.21).

Estimations (1) and (2) in Table 5.5, reveal that the effect of capital regulation on changes in bank capital and risk do not depend on Basel Committee membership (*REG*BCBS* coefficients are insignificant). The negative effect of capital regulation on changes in bank capital is observed for both banks in BCBS and non-BCBS members. Although there is a significant difference in the effect of capital regulation on bank capital levels between BCBS and non-BCBS members (*REG*BCBS* coefficient in estimation (3) in Table 5.5 is negative and significant at the 0.01 level), the difference is in the opposite sign. Consequently, capital regulation exerts no influence on capital levels of banks in non-BCBS members. Similarly, capital regulation does not affect the risk levels of non-BCBS members. Therefore, BCBS membership has no moderation effect on changes in bank capital and risk.

Table 5.5 Effects of Capital Regulation on Bank Capital and Risk Considering Basel Committee Membership

	ΔCAPTA	**ΔRWATA**	**CAPTA**	**RWATA**
	(1)	**(2)**	**(3)**	**(4)**
Panel A: Estimators				
REG	-0.052**	0.023	0.028	0.143
	(0.026)	(0.082)	(0.023)	(0.108)
*REG*BCBS*	-0.004	0.034	-0.043***	-0.082
	(0.019)	(0.081)	(0.015)	(0.079)
CAPTA	-0.654***		0.305***	
	(0.054)		(0.062)	
ΔRWATA	-0.033*			
	(0.019)			
RWATA			0.081***	
			(0.008)	
L.RWATA		-0.572***		0.413***
		(0.040)		(0.070)
ΔCAPTA		-0.175		
		(0.130)		
CAPTA				-0.138
				(0.314)
SIZE	-1.122***	1.430	-0.280***	-0.753***
	(0.332)	(1.103)	(0.037)	(0.229)
ROA	0.504***	0.618*	0.579***	1.490***
	(0.087)	(0.359)	(0.078)	(0.412)
LOAN_RATIO	-0.014	0.445***	-0.024***	0.324***

	ΔCAPTA	ΔRWATA	CAPTA	RWATA
	(1)	**(2)**	**(3)**	**(4)**
	(0.013)	(0.045)	(0.006)	(0.039)
LLP_TO_TA	0.534***	0.394	0.474***	1.347***
	(0.142)	(0.430)	(0.127)	(0.476)
FA_RATIO	0.291***	0.002	0.140**	0.448*
	(0.091)	(0.252)	(0.064)	(0.245)
DEPOSIT_ RATIO	0.008	0.016	-0.001	-0.082***
	(0.014)	(0.065)	(0.006)	(0.026)
GDP_GROWTH	-0.050**	-0.235***	-0.091***	0.333***
	(0.020)	(0.086)	(0.017)	(0.081)
BCBS	0.574*	2.650**	0.874***	1.270
	(0.316)	(1.217)	(0.257)	(1.330)
Constant	15.514***	4.456	4.100***	34.511***
	(4.231)	(16.217)	(0.952)	(8.419)
Panel B: Full Effect of REG				
*REG + REG*BCBS*	-0.057**	0.057	-0.015	0.062
Time Dummies	Yes	Yes	Yes	Yes
Observations	2,765	2,765	2,765	2,765
Banks	440	440	440	440
Instruments			30	36
AR(2) Test			0.139	0.113
Hansen Test			0.487	0.405

Notes: This table reports the 2SLS-FE regression of equations (3.16), (3.17) and two-step SYS-GMM regression of equations (3.20) and (3.21), with consideration for Basel Committee membership effects. Panel A presents the coefficients estimation. Panel B presents the full effect of capital regulation for BCBS members. The estimation is based on a linear combination of REG and interaction variable with REG. The endogenous variables are *ΔRWATA* (estimation 1, instrumented by *L.RWATA*), *ΔCAPTA* (estimation 2, instrumented by *L.CAPTA*), *L.CAPTA* (estimation 3, instrumented by lags 2 to 4 periods of *CAPTA*), *CAPTA* and *L.RWATA* (estimation 4, instrumented by lag 2 periods of *CAPTA* and lags 2 to 9 periods of *RWATA*, respectively. *BCBS* is a dummy variable and equals 1 if the country is a Basel Committee member. Time Dummies are not reported. Robust standard errors in parentheses. *, **, *** indicate significance levels at 0.1, 0.05 and 0.01, respectively.
Source: Author's calculations.

5.5.3 Moderating Effects of Bank Capitalization Levels

Previous studies suggest that banks increase their capital and reduce risk more when they are undercapitalized and thus, the effect of capital regulation on bank capital and risk depends on the level of bank capitalization (Calem & Rob, 1999; Zhang et al., 2008). We examine this effect by introducing dummy variables to capture undercapitalized banks and interact them with capital regulation. We use different thresholds to identify undercapitalized banks. Accordingly, banks are considered as undercapitalized if their total regulatory capital ratios are below the minimum regulatory requirement ($UNDER\_MIN$=1) (Godlewski, 2005; Shrieves & Dahl, 1992), or below the median of capital ratio of banks in the country ($UNDER\_MEDIAN$=1) (Heid et al., 2003). We also classify the level of undercapitalization by defining banks with capital ratios below the 25th percentile of capital ratios of banks in the country as extremely undercapitalized ($EXTREME$ =1) and those with a capital ratio between the 25th and 50th percentile of capital ratios of banks in the country as modestly undercapitalized ($MODEST$ = 1) (Cannata & Quagliariello, 2006).

Table 5.6 reports the regression results considering these bank capitalization levels and their moderating effects on changes in bank capital and risk. Accordingly, capital regulation has a negative effect on changes in bank capital and no effect on changes in bank risk if banks are not undercapitalized (*REG* coefficients are negative and significant in the capital equation but are insignificant in the risk equation). The effects of capital regulation on changes in bank capital and risk are not significantly different between undercapitalized and adequately capitalized banks (the coefficients of interacted variables are insignificant). One exception is banks with capital ratios below the median capital ratio of the country in the capital equation (the *REG* UNDER_MEDIAN* coefficient in estimation (2) is positive and significant at the 0.05 level). Nevertheless, the full effect of capital regulation for undercapitalized banks is insignificant, regardless of the thresholds (see Panel B in Table 5.6). In short, bank capitalization levels do not moderate the effect of capital regulation on bank capital and risk adjustments. In addition, our conclusions about the negative effect of capital regulation on changes in capital and its ineffectiveness on changes in bank risk are mainly driven by adequately capitalized banks.

Table 5.7 reports the moderating effect of bank capitalization levels for bank capital and risk levels. Interestingly, we found no significant effect of capital regulation on capital and risk levels of adequately capitalized banks (*REG* coefficients are insignificant in all estimations). Nevertheless, the effect of capital regulation changes significantly for undercapitalized banks. Specifically, banks with capital ratios below the median capital ratio of banks in the country will increase their capital (by 0.046%). The increase is greater if banks are extremely undercapitalized (0.061%) and lesser if banks are modestly undercapitalized (0.044%). Bank capitalization levels do not moderate the effect of capital regulation on bank risk.

Table 5.6 2SLS-FE Regression of Changes in Bank Capital and Risk Considering Bank Capitalization Levels Effects

	ΔCAPTA		ΔCAPTA		ΔCAPTA		ΔRWATA		ΔRWATA		ΔRWATA	
	(1)		(2)		(3)		(4)		(5)		(6)	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Panel A: Estimators												
REG	-0.044*	0.023	-0.054**	0.024	-0.034	0.025	0.052	0.075	0.064	0.084	0.030	0.085
*REG*UNDER_MIN*	-0.140	0.118					0.263	0.298				
*REG*UNDER_MEDIAN*			0.032**	0.015					-0.053	0.065		
*REG*EXTREME*					0.024	0.023					-0.019	0.090
*REG*MODEST*					0.019	0.016					-0.050	0.069
L.CAPTA	-0.675***	0.046	-0.719***	0.049	-0.736***	0.048						
ΔRWATA	-0.042**	0.019	-0.058***	0.019	-0.064***	0.019						
L.RWATA							-0.558***	0.040	-0.566***	0.041	-0.570***	0.042
ΔCAPTA							-0.190	0.130	-0.268**	0.121	-0.307***	0.118
SIZE	-1.087***	0.313	-0.492	0.322	-0.370	0.321	2.085*	1.095	1.636	1.155	1.433	1.181
ROA	0.475***	0.087	0.419***	0.081	0.404***	0.082	0.565	0.360	0.682*	0.362	0.727**	0.362
LOAN_RATIO	0.000	0.012	0.024*	0.013	0.030**	0.013	0.460***	0.045	0.438***	0.045	0.434***	0.045
LLP_TO_TA	0.503***	0.142	0.495***	0.136	0.486***	0.138	0.451	0.421	0.541	0.428	0.578	0.425
FA_RATIO	0.353***	0.067	0.205**	0.097	0.201**	0.096	0.031	0.248	0.126	0.256	0.146	0.259
DEPOSIT_ RATIO	0.012	0.014	0.002	0.014	0.003	0.014	0.014	0.065	0.019	0.065	0.018	0.067
GDP_GROWTH	-0.060***	0.021	-0.045**	0.021	-0.040*	0.022	-0.256***	0.091	-0.267***	0.091	-0.277***	0.091
UNDER_MIN	-2.238*	1.280					-2.732	3.150				
UNDER_MEDIAN			-1.971***	0.242					1.967*	1.077		
EXTREME					-2.386***	0.324					2.304	1.458
MODEST					-1.523***	0.264					1.434	1.109
Constant	14.085***	4.106	10.289**	4.077	9.039**	4.049	-2.982	16.058	1.197	16.740	3.544	17.091
Panel B: Full Effect of REG												
*REG + REG*UNDER_MIN*	-0.183						0.315					
*REG + REG*UNDER_MEDIAN*			-0.022						0.011			

	ΔCAPTA	ΔCAPTA	ΔCAPTA	ΔRWATA	ΔRWATA	ΔRWATA
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
*REG + REG*EXTREME*			-0.010			0.011
*REG + REG*MODEST*			-0.015			-0.020
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,765	2,765	2,765	2,765	2,765	2,765
Banks	440	440	440	440	440	440

Notes: Panel A reports the 2SLS-FE estimations of equations (3.16) and (3.17) considering the effect of bank capitalization levels. Panel B presents the full effect of capital regulation for different bank capitalization levels. The estimation is based on a linear combination of *REG* coefficients and interaction variables with *REG*. The endogenous variables are *ΔRWATA* (in estimations 1, 2, 3 and instrumented by *L.RWATA*) and *ΔCAPTA* (in estimations 4, 5, 6 and instrumented by *L.CAPTA*). Time Dummies are not reported. Standard errors (SE) are robust to heteroscedasticity. *, **, *** indicate significance levels at 0.1, 0.05 and 0.01, respectively.
Source: Authors' calculations.

Table 5.7 Two-step SYS-GMM Regression of Bank Capital and Risk Considering Bank Capitalization Levels Effects

	CAPTA		CAPTA		CAPTA		RWATA		RWATA		RWATA	
	(1)		(2)		(3)		(4)		(5)		(6)	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Panel A: Estimators												
REG	0.013	0.020	-0.031	0.019	-0.011	0.019	0.102	0.099	0.119	0.101	0.095	0.097
*REG*UNDER_MIN*	-0.137*	0.082					0.082	0.285				
*REG*UNDER_MEDIAN*			0.077***	0.014					-0.047	0.073		
*REG*EXTREME*					0.073***	0.018					-0.032	0.087
*REG*MODEST*					0.056***	0.013					-0.052	0.076
L.CAPTA	0.227***	0.061	0.204***	0.056	0.173***	0.056						
ΔRWATA	0.091***	0.008	0.102***	0.007	0.109***	0.007						
L.RWATA							0.411***	0.070	0.383***	0.070	0.377***	0.070
ΔCAPTA							-0.158	0.342	0.304	0.442	0.571	0.469
SIZE	-0.305***	0.038	-0.273***	0.031	-0.294***	0.032	-0.760***	0.224	-0.573**	0.243	-0.439*	0.251
ROA	0.580***	0.071	0.432***	0.062	0.395***	0.061	1.510***	0.421	1.302***	0.407	1.184***	0.396
LOAN_RATIO	-0.022***	0.006	-0.009**	0.005	-0.009*	0.005	0.326***	0.040	0.304***	0.040	0.288***	0.039
LLP_TO_TA	0.450***	0.121	0.422***	0.107	0.422***	0.104	1.356***	0.483	1.099**	0.487	0.935*	0.491
FA_RATIO	0.235***	0.055	0.104*	0.062	0.108*	0.059	0.437*	0.254	0.406*	0.220	0.338	0.217
DEPOSIT_ RATIO	-0.002	0.006	-0.002	0.005	-0.001	0.005	-0.081***	0.026	-0.078***	0.025	-0.074***	0.024
GDP_GROWTH	-0.078***	0.017	-0.073***	0.015	-0.066***	0.015	0.335***	0.078	0.346***	0.076	0.336***	0.073
UNDER_MIN	-3.502***	0.997					-0.215	3.592				
UNDER_MEDIAN			-3.225***	0.238					3.174*	1.703		
EXTREME					-3.946***	0.291					4.906**	2.161
MODEST					-2.459***	0.220					2.824*	1.590
Constant	3.997***	1.042	4.526***	0.835	4.496***	0.812	34.841***	8.249	31.635***	8.362	28.891***	8.244
Panel B: Full Effect of REG												
*REG + REG*UNDER_MIN*	-0.125						0.184					
*REG + REG*UNDER_MEDIAN*			0.046**						0.072			

	CAPTA	CAPTA	CAPTA	RWATA	RWATA	RWATA
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
*REG + REG*EXTREME*			0.061***			0.063
*REG + REG*MODEST*			0.044**			0.042
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,765	2,765	2,765	2,765	2,765	2,765
Banks	440	440	440	440	440	440
Instruments	30	30	32	36	36	38
AR(2) Test	0.503	0.630	0.917	0.117	0.111	0.102
Hansen Test	0.151	0.359	0.346	0.437	0.502	0.491

Notes: Panel A reports the two-step SYS-GMM regression of equations (3.20) and (3.21) considering the effect of bank capitalization levels. Panel B presents the full effect of capital regulation for different bank capitalization levels. The estimation is based on a linear combination of *REG* coefficients and interaction variables with *REG*. The endogenous variables are *L.CAPTA* (estimation 1, 2, 3, instrumented by lags 2 to 4 periods of *CAPTA*), *CAPTA* and *L.RWATA* (estimation 4, 5, 6, instrumented by lag 2 periods of *CAPTA* and lags 2 to 9 periods of *RWATA*, respectively). Time Dummies are not reported. Standard errors (SE) are robust to heteroscedasticity and corrected for finite sample bias. *, **, *** indicate significance levels at 0.1, 0.05 and 0.01, respectively.
Source: Author's calculations.

5.6 Robustness Checks

In order to ensure the robustness and comparison of our results to previous studies, we conduct some robustness checks. These analyses involve re-estimating equations (3.16) and (3.17): (i) disregarding the simultaneity between changes in capital and risk; (ii) using alternative measurements of capital regulation; and (iii) using different definitions of capital (Tier 1 ratios and Leverage ratios) and risk (non-performing loan ratios and Z-scores). We do not check the simultaneity of equations (3.20) and (3.21) since these analyses have been examined when testing the mis-specification of these equations. There are also no robustness checks for alternative measurements of capital regulation and dependent variables for equations (3.20) and (3.21), since there are few studies which employ estimations with capital and risk levels.

5.6.1 Simultaneity of Changes in Bank Capital and Risk

The insignificance of capital on changes in bank risks, reported in Table 5.1, casts doubts on the simultaneity in capital and risk adjustments. Therefore, we re-estimate equations (3.16) and (3.17) without such simultaneity. Since there is no simultaneity concern, the estimation estimated out FEM regression. The results in Table 5.8 reveal no substantial changes in estimations compared to Table 5.1 results. The only differences are the relationship between changes in risk ($\Delta RWATA$) and changes in capital ($\Delta CAPTA$). While the $\Delta RWATA$ coefficient is negative and significant at the 0.1 level in Table 5.1, the coefficient is positive and significant at the 0.01 level in Table 5.8. Similarly, the $\Delta CAPTA$ coefficient becomes significant and positive in the risk equation. The coefficient is large (0.922) and indicates a nearly perfect correlation between these two variables, which seems impractical. Therefore, it is necessary to consider the simultaneous relationship between changes in bank capital and risk.

Table 5.8 FEM Regression of Changes in Bank Capital and Risk

	Capital Equation (ΔCAPTA)		Risk Equation (ΔRWATA)	
	Coefficient	**Robust SE**	**Coefficient**	**Robust SE**
REG	-0.068***	0.021	0.083	0.067
ΔRWATA	0.060***	0.010		
ΔCAPTA			0.922***	0.192
L.CAPTA	-0.569***	0.052		
L.RWATA			-0.514***	0.035
SIZE	-1.026***	0.321	3.167***	1.050
ROA	0.460***	0.087	0.207	0.383
LOAN_RATIO	-0.031**	0.012	0.452***	0.044
LLP_TO_TA	0.615***	0.132	-0.263	0.451
FA_RATIO	0.323***	0.071	-0.266	0.206
DEPOSIT_RATIO	-0.000	0.011	0.007	0.056
GDP_GROWTH	-0.039**	0.019	-0.205**	0.090
Constant	15.175***	4.035	-13.440	14.296
Time Dummies	Yes		Yes	
Observations	2,765		2,765	
Banks	440		440	
R-square	0.424		0.469	

Notes: This table reports the FEM regression of equations (3.16) and (3.17). Robust standard errors (SE) adjusted for bank clusters in parentheses. *, **, *** indicate significance levels at 0.1, 0.05 and 0.01, respectively.
Source: Author's calculations.

5.6.2 Different Measurements of Capital Regulation

Most previous studies (using the same dependent variables as $\Delta CAPTA$ and $\Delta RWATA$), suggest a positive relationship between capital regulation and changes in bank capital, while supporting the ineffectiveness of capital regulation on changes in bank risk (see for example, Cannata and Quagliariello (2006); Rime (2001); Van Roy (2005); Zhang et al. (2008)). Apart from the consideration of bank fixed effects, another possible explanation for the difference of our study is the use of the ACRI index for capital regulation measurement, instead of regulatory pressure. Therefore, we regress equations (3.16) and (3.17) with 2SLS-FE using traditional measurements of capital regulation similar to these studies.

Two alternative capital regulation measurements are employed. The first measurement applies the probabilistic approach (also known as the capital volatility approach) following Rime (2001); Van Roy (2005) and Teply and Matejasák (2007). Accordingly, capital regulation is measured as a dummy variable (*REG_1*) that equals 1 if the banks' capital ratio is less than the minimum regulatory requirement, plus one standard deviation of its capital ratio, and 0 otherwise. This measurement examines whether there is a difference between a bank with and without regulatory pressure. The second measurement uses a gap approach and employs two variables, which are *REG_LOW* and

REG_HIGH, to distinguish the behavior of banks with capital ratios below and above the minimum requirements. Specifically, *REG_LOW* equals the difference between the inverse of bank capital ratios and minimum capital requirements if the banks' capital ratio is less than the minimum requirement, and 0 otherwise whereas *REG_HIGH* equals the difference between the inverse of minimum capital requirements and bank capital ratio if the banks' capital ratio exceeds the minimum requirement, and 0 otherwise (Teply & Matejasák, 2007; Zhang et al., 2008).

The results for capital equation (columns (1) and (2) in Table 5.9) show a significant difference in capital adjustments between banks with and without regulatory pressure. The REG_1 coefficient is -2.194 and indicates that banks under regulatory pressure will reduce their capital adjustment by 2.194% more than banks without such pressure. The REG_LOW coefficient is also negative and significant at the 0.01 level. Therefore, the further banks' capital ratio is below the minimum capital ratio requirement, the greater the reduction in capital adjustment will be. In contrast, banks with capital ratios above the minimum requirement increase their capital adjustments depending on the difference between their capital ratio and the minimum requirement (the REG_HIGH coefficient is positive and significant at the 0.01 level).

In term of the risk adjustment (columns (3) and (4) in Table 5.9), banks under regulatory pressure (REG_1) will increase the risk adjustments by 1.636% more than those without regulatory pressure. Although the degree of regulatory pressure has no effect on the risk adjustments of banks with capital ratios below the minimum requirement (the REG_LOW coefficient is not significant), it induces banks with capital ratios above the minimum requirement to reduce their risk adjustments (the REG_HIGH coefficient is significant and positive).

Among the different measurements of capital regulation, only the results which employ the REG_LOW variable resemble our findings using the advanced capital regulation index. It is worth re-emphasizing that the Advanced Capital Regulation Index (as a measurement of capital regulation) differs from traditional measurements by reflecting both qualitative and quantitative aspects of capital regulation. The minimum capital requirement, despite being the core of capital regulation, is insufficient to capture the effects of stricter capital regulation. In addition, the REG_1 coefficient in the capital equation reinforces the negative effect of capital regulation on capital adjustment. Besides, the effect of REG_HIGH on capital and risk adjustments supports the franchise value theory. Accordingly, banks below the minimum requirement have little to lose in the case of bankruptcy. They reduce their capital and increase risk to maximize future profits. However, banks that have successfully built up their franchise value will try to protect this value. They increase their capital and operate safely (Demsetz et al., 1996).

Table 5.9 2SLS-FE Regression with Different Proxies for Capital Regulation

	Capital Equation (ΔCAPTA)		Risk Equation (ΔRWATA)	
	(1)	(2)	(3)	(4)
REG_1	-2.194***		1.636***	
	(0.257)		(0.632)	
REG_HIGH		0.975***		-0.582***
		(0.068)		(0.187)
REG_LOW		-0.130***		0.135
		(0.031)		(0.171)
ΔRWATA	-0.050***	-0.079***		
	(0.018)	(0.018)		
L.CAPTA	-0.720***	-0.833***		
	(0.048)	(0.033)		
ΔCAPTA			-0.259**	-0.350***
			(0.122)	(0.108)
L.RWATA			-0.562***	-0.569***
			(0.041)	(0.042)
SIZE	-0.737**	-0.196	1.848	1.534
	(0.305)	(0.327)	(1.163)	(1.197)
ROA	0.466***	0.278***	0.632*	0.790**
	(0.087)	(0.082)	(0.359)	(0.354)
LOAN_RATIO	0.013	0.059***	0.446***	0.424***
	(0.012)	(0.011)	(0.044)	(0.044)
LLP_TO_TA	0.497***	0.360***	0.527	0.643
	(0.138)	(0.123)	(0.421)	(0.415)
FA_RATIO	0.241***	0.168**	0.093	0.155
	(0.092)	(0.083)	(0.256)	(0.263)
DEPOSIT_RATIO	0.012	0.013	0.011	0.011
	(0.014)	(0.015)	(0.066)	(0.066)
GDP_GROWTH	-0.051**	0.007	-0.259***	-0.300***
	(0.021)	(0.023)	(0.091)	(0.091)
Constant	11.453***	0.442	0.123	7.404
	(3.912)	(4.447)	(16.723)	(17.414)
Year dummies	Yes	Yes	Yes	Yes
Observations	2,765	2,765	2,765	2,765
Banks	440	440	440	440

Notes: Robust standard errors adjusted for bank clusters in parentheses. *, **, *** indicate significance levels at 0.1, 0.05 and 0.01, respectively. Endogenous variables: *ΔRWATA, ΔCAPTA*.
Source: Author's calculations.

5.6.3 Different Definitions of Capital and Risk

Table 5.10 reports the 2SLS-FE regression of equation (3.16) using different definitions of capital and risk. The REG coefficients, in estimations (1) and (2) of Panel A, are negative and significant at 0.01 and 0.05 levels, respectively. This confirms the negative effect of capital regulation on changes in total regulatory capital ratio, as reported in Table 5.1. In addition, in all of the remaining estimations (see

Panels B and C), the REG coefficients, are negative and significant at a 0.01 level. Thus, we can conclude that capital regulation has a negative impact on changes in bank capital regardless of whether it is total regulatory capital ratio, Tier 1 ratio, or equity ratio. The result supports findings in Abreu and Gulamhussen (2010); Hussain and Hassan (2005) studies, which also employed Tier 1 ratio, and Godlewski (2005) study, which used equity ratio.

Table 5.11 presents the 2SLS-FE regression of equation (3.17), using different definitions of capital and risk. Replacing the Tier 1 ratio and equity ratio with total regulatory capital ratio results in no changes in the effect of capital regulation on changes in bank risk-weighted assets (the REG coefficients in Panel A are insignificant). Similarly, capital regulation has no influence on changes in non-performing loan ratios, but only when capital is measured as total regulatory capital ratio or equity ratio (see Panel B). This result is consistent with Ghosh (2014); Godlewski (2005); Saadaoui (2011); Shrieves and Dahl (1992) findings. However, when risk is measured as a Z-score, the coefficient of capital regulation is negative and significant at the 0.01 level (see Panel C). This suggests that stricter capital regulation increases changes in banks' probability of default (a high Z-score means higher stability and lower risk). Collectively, these results indicate that Asian banks do not reduce their risk to respond to stricter capital regulations.

Table 5.10 2SLS-FE Regression of Changes in Capital with Different Capital and Risk Definitions

	Panel A: ΔCAPTA		Panel B: ΔTIERTA			Panel C: ΔEQTA		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
REG	-0.068***	-0.054**	-0.067***	-0.100***	-0.078***	-0.094***	-0.116***	-0.085***
	(0.026)	(0.021)	(0.024)	(0.029)	(0.023)	(0.023)	(0.025)	(0.019)
ΔRWATA			-0.032**			-0.037***		
			(0.016)			(0.012)		
ΔNPL	0.037			0.045			0.070**	
	(0.027)			(0.027)			(0.029)	
ΔZSCORE		0.653*			0.432			0.641
		(0.362)			(0.281)			(0.449)
L.CAPTA	-0.638***	-0.579***						
	(0.057)	(0.051)						
L.TIER1TA			-0.638***	-0.591***	-0.579***			
			(0.045)	(0.044)	(0.041)			
L.EQTA						-0.612***	-0.590***	-0.554***
						(0.031)	(0.033)	(0.038)
SIZE	-1.297***	-0.752***	-1.102***	-1.260***	-0.840***	-0.953***	-1.059**	-0.862***
	(0.341)	(0.290)	(0.338)	(0.391)	(0.286)	(0.323)	(0.413)	(0.320)
ROA	0.505***	0.400***	0.386***	0.333***	0.368***	0.491***	0.367***	0.341***
	(0.100)	(0.098)	(0.078)	(0.093)	(0.083)	(0.092)	(0.132)	(0.126)
LOAN_RATIO	-0.028*	-0.002	-0.007	-0.018	-0.004	-0.015	-0.028**	-0.011
	(0.015)	(0.010)	(0.013)	(0.014)	(0.011)	(0.010)	(0.012)	(0.009)
LLP_TO_TA	0.503***	0.535***	0.657***	0.641***	0.612***	0.456***	0.375**	0.484***
	(0.162)	(0.126)	(0.122)	(0.135)	(0.114)	(0.130)	(0.184)	(0.110)
FA_RATIO	0.378***	0.195**	0.383**	0.333*	0.176	0.612***	0.446***	0.568***
	(0.113)	(0.085)	(0.163)	(0.177)	(0.168)	(0.089)	(0.091)	(0.101)
DEPOSIT_RATIO	0.005	0.005	0.017	0.013	0.016	0.021**	0.018	0.015
	(0.014)	(0.012)	(0.014)	(0.015)	(0.012)	(0.010)	(0.013)	(0.009)

	Panel A: ΔCAPTA		**Panel B: ΔTIERTA**			**Panel C: ΔEQTA**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
GDP_GROWTH	-0.059***	-0.038**	-0.045**	-0.039*	-0.034*	-0.047**	-0.058**	-0.030
	(0.020)	(0.018)	(0.021)	(0.023)	(0.019)	(0.023)	(0.024)	(0.020)
Constant	18.393***	11.397***	13.899***	16.216***	11.210***	10.961***	13.146***	9.814***
	(3.934)	(3.530)	(3.985)	(4.535)	(3.423)	(3.414)	(4.415)	(3.279)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,207	2,753	2,356	1,886	2,351	2,765	2,207	2,753
Banks	367	440	398	326	398	440	367	440

Notes: This table reports the 2SLS-FE estimations of equation (3.16) with different measurement of capital as the dependent variable. The estimations in columns of each panel are different in term of risk measurement. The endogenous variables are changes in risk (that is, *ΔRWATA, ΔNPL, ΔZSCORE*). Time Dummies are not reported. Robust standard errors adjusted for bank clusters in parentheses. *, **, *** indicate significance levels at 0.1, 0.05 and 0.01, respectively.
Source: Author’s calculations.

Table 5.11 2SLS-FE Regression of Changes in Risk with Different Capital and Risk Definitions

	Panel A: ΔRWATA		Panel B: ΔNPL			Panel C: ΔZSCORE		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
REG	0.050	0.058	0.031	0.113**	0.041	-0.007***	-0.008***	-0.009***
	(0.089)	(0.073)	(0.042)	(0.053)	(0.047)	(0.002)	(0.003)	(0.003)
ΔCAPTA			0.264*			-0.017**		
			(0.139)			(0.007)		
ΔTIER1	-0.241*			0.377**			-0.024***	
	(0.134)			(0.174)			(0.009)	
ΔEQTA		0.004			0.336*			-0.048***
		(0.176)			(0.187)			(0.010)
L.RWATA	-0.580***	-0.551***						
	(0.036)	(0.039)						
L.NPL			-0.549***	-0.593***	-0.542***			
			(0.039)	(0.044)	(0.035)			
L.ZSCORE						-0.819***	-0.824***	-0.962***
						(0.058)	(0.071)	(0.055)
SIZE	2.951***	2.286*	-2.136***	-2.430***	-2.050***	-0.114***	-0.143***	-0.137***
	(1.036)	(1.177)	(0.672)	(0.814)	(0.619)	(0.040)	(0.052)	(0.048)
ROA	0.479	0.506	0.100	0.333	0.147	0.154***	0.140***	0.170***
	(0.362)	(0.372)	(0.231)	(0.255)	(0.262)	(0.028)	(0.034)	(0.028)
LOAN_RATIO	0.438***	0.459***	-0.056**	-0.068**	-0.053**	-0.002	-0.002	-0.002
	(0.042)	(0.045)	(0.025)	(0.029)	(0.022)	(0.002)	(0.002)	(0.002)
LLP_TO_TA	0.190	0.330	1.362***	1.330***	1.368***	0.042*	0.040*	0.056**
	(0.452)	(0.421)	(0.501)	(0.490)	(0.513)	(0.022)	(0.024)	(0.024)
FA_RATIO	0.154	-0.020	0.538***	0.871***	0.506***	0.063***	0.045***	0.083***
	(0.368)	(0.263)	(0.193)	(0.262)	(0.192)	(0.009)	(0.011)	(0.014)
DEPOSIT_ RATIO	0.028	0.012	-0.024	-0.044*	-0.024	0.001	0.001	0.002
	(0.068)	(0.062)	(0.018)	(0.024)	(0.018)	(0.001)	(0.001)	(0.001)

	Panel A: ΔRWATA		Panel B: ΔNPL			Panel C: ΔZSCORE		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
GDP_GROWTH	-0.273***	-0.244***	-0.090***	-0.050*	-0.082***	-0.003	-0.004	-0.003
	(0.096)	(0.092)	(0.030)	(0.028)	(0.032)	(0.002)	(0.003)	(0.003)
Constant	-2.337	-4.860	24.107***	31.569***	23.013***	3.087***	3.461***	3.614***
	(13.757)	(16.324)	(7.298)	(9.540)	(6.638)	(0.508)	(0.678)	(0.535)
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,356	2,765	2,207	1,886	2,207	2,753	2,351	2,753
Banks	398	440	367	326	367	440	398	440

Notes: This table reports 2SLS-FE estimations of equation (3.17) with different measurement of risk as the dependent variable. The estimations in columns of each panel are different in term of capital measurement. The endogenous variables are changes in capital (that is, *ΔCAPTA, ΔTIER1TA, ΔEQTA*). Time Dummies are not reported. Robust standard errors adjusted for bank clusters in parentheses. *, **, *** indicate significance levels at 0.1, 0.05 and 0.01, respectively.
Source: Author’s calculations.

5.7 Chapter Summary

This chapter has examined the effects of capital regulation on capital and risk behaviors of Asian banks during the period of 2002 - 2016. Employing a simultaneous equation model with partial adjustment, we found that capital regulation has a negative effect on changes in bank capital and no influence on changes in bank risk. This suggests that strengthening capital regulation by imposing stricter rules is not an effective way to induce banks to increase their capital and reduce risk. Instead, banks increased capital more if they were smaller in size, had higher levels of profitability, lower loan quality, a higher ratio of fixed assets, and during periods of economic downturn. Similarly, banks reduced their risks more if they were smaller, had lower rates of lending, and during periods of economic upturn. The results were robust to different capital, risk and capital regulation measurements.

However, such a negative effect of capital regulation on changes in bank capital was found for developed and emerging markets only, while its ineffectiveness on changes in bank risk was only applied to frontier markets. Banks in developed markets made less changes to their risk levels, while those in emerging markets made greater changes when capital regulation became stricter. Basel Committee membership and bank capitalization levels also did not impact the relationship between capital regulation and bank capital and risk adjustments.

The chapter has highlighted the importance of taking into account bank fixed effects in modelling bank capital and risk behavior. Given the existence of fixed effects, this study has also examined the effect of capital regulation on bank capital and risk levels using the simultaneous equations model with partial adjustment. While studying changes in bank capital and risk reveals little about the direction of adjustments (that is, whether banks increase or reduce capital and risk), modelling capital and risk levels addresses this concern. Our results indicated no influence of capital regulation on capital and risk levels. Nevertheless, further analysis showed that stricter capital regulation induced banks in developed countries to reduce both capital and risk. It created unexpected effects by inducing banks in emerging countries to reduce capital and increase risk. In contrast, banks in frontier countries were unaffected by capital regulation. Although banks in BCBS member countries were expected to behave more prudentially, we found no difference in capital and risk behavior between banks in these countries and non-BCBS members. In addition, if banks had capital ratios below the median levels of the country, they would raise their capital levels. Particularly, the increase in capital level was greater among the least capitalized banks in the country. Nevertheless, the effect of capital regulation on bank risk did not depend on bank capitalization levels.

Chapter 6

Capital Regulation and Balance Sheet Adjustments

6.1 Introduction

This chapter investigates the effects of capital regulation on balance sheets adjustments of banks in 15 Asian countries during the period of 2004 – 2016 (research objective 3). First, we analyze trends in balance sheet adjustments to discover how they have changed over the study period. Employing the normalization method, we show which strategy Asian banks apply to adjust their risk-based capital ratios, that is, via the asset side and/or the liability side. These analyses are presented in section 6.2. Next, we determine whether capital regulation causes these changes. We utilize a dynamic model and take into account the inter-relationship among balance sheet components. The regression results are reported in section 6.3. The effects of country group and BCBS membership are examined in section 6.4. Section 6.5 outlines the robustness checks used to substantiate the results, and section 6.6 concludes the chapter.

6.2 Changes in Bank Balance Sheet Components

Figure 6.1 illustrates the average capital components of all banks in the sample, during the period of 2004-2016. The figure shows that banks gradually increase their regulatory capital over assets by increasing both retained earnings and shareholder capital. The ratio of regulatory capital over assets is set relatively high, around 9%, in which, retained earnings play an important part and, on average, contribute up to 50% of the total regulatory capital over assets. Next is the increasing role of shareholder capital, particularly during the period of 2007-2009 when banks greatly suffered from losses and could not rely on the internal sources of capital. Other forms of capitals, including subordinated debts and other Tier 2 capital, are important for banks as an additional source of capital before 2006. However, these fell dramatically from 2008. This is against the increasing trend in retained earnings and shareholder capital. The fact suggests that Asian banks made great efforts to strengthen their regulatory capital base, with a focus on Tier 1 capital. However, the increase in retained earnings and shareholder capital slowed after 2011, while other forms of capital experienced growth. This period coincides with the introduction of Basel III at the end of 2010 which was implemented in many Asian countries from 2013 onwards.[23] This behavior is interesting as banks are expected to raise more Tier 1 capital following the implementation of the new requirements.

[23] In the sample, only Sri Lanka did not implement Basel III requirements during the study period. The implementation began in July 2017 (Banking Act Directions No.1 of 2016, Central Bank of Sri Lanka https://www.cbsl.gov.lk/en/laws/directions-circulars-guidelines-for-banks.

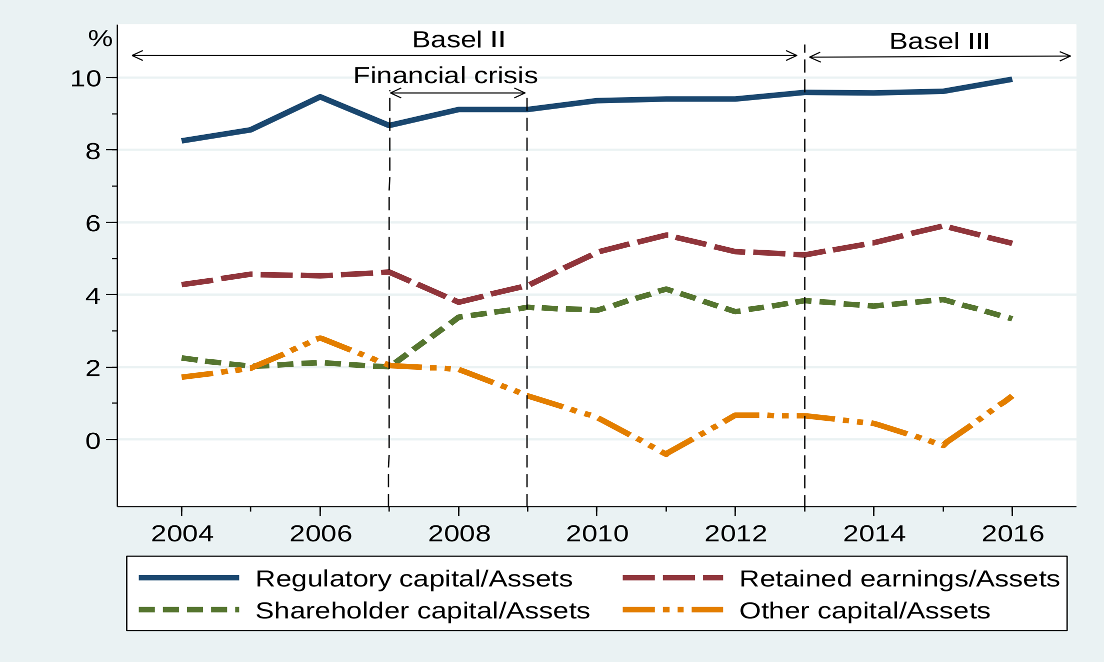

Figure 6.1 Average Regulatory Capital and Capital Components (2004-2016)

In terms of asset components on the balance sheet, Figure 6.2 shows that banks reduced their ratios of risk-weighted assets after 2004 but raised this again after 2009. This risk-weighted asset ratio was the lowest during the global financial crisis period of 2007-2009 (approximately 61%), despite an increase in loan ratios (by 1.71%) and investments (by 0.89%). This suggests that banks re-allocated their asset portfolios to safer investment. However, this seems to be impractical since most banks took on very high risk during this time. Based on loan loss provisions and non-performing loan ratios data during the 2007-2009 period, we found that the average loan loss provision ratio increased from 0.40% to 0.58% and non-performing loan ratios increased from 2.74% to 3.24%. This reveals the failure of the risk-weighting system at that time. The movement of risk-weighted assets is in line with bank lending. In addition, lending contributes the most to total risk-weighted assets (about 90%). Another important component of bank risk is investment, which is maintained around 20% in total assets. It should be noted that the direction of changes in loans and investments move against each other, which suggests a negative correlation between them. Since investment is an alternative source of making high profits with lower risk-weights secondary to loans, banks can reduce lending and invest more to lower the risk-weighted assets.

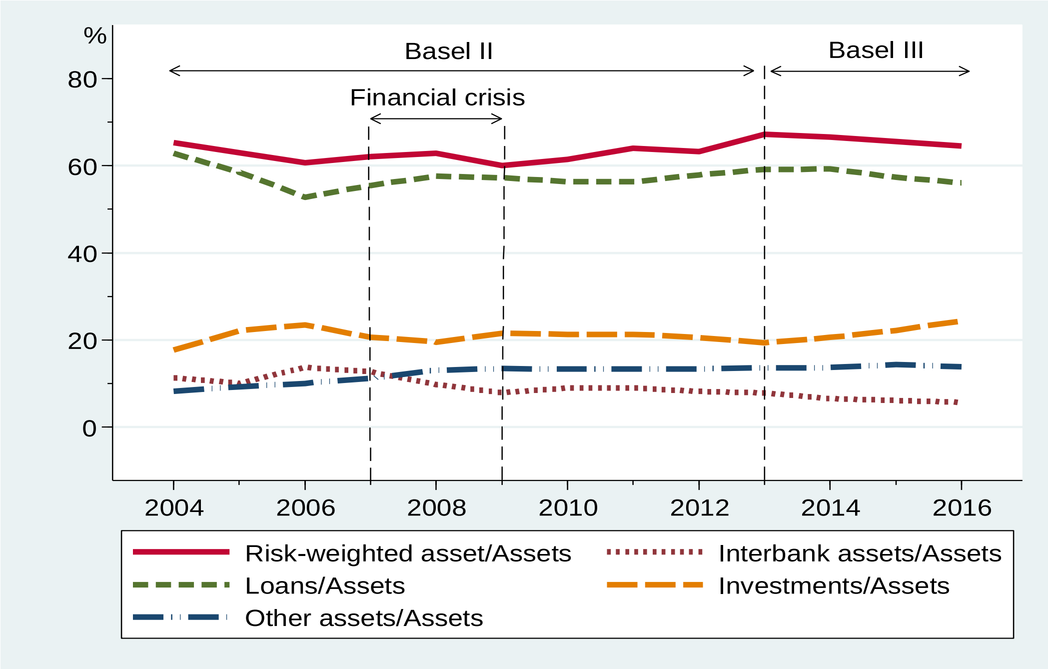

Figure 6.2 Average Risk-weighted Assets and Asset Components (2004-2016)

Panel A in Table 6.1 shows that banks make the greatest changes to their retained earnings and interbank assets. The annual growth rates of these components are 27.79% and 36.44%, respectively. These changes vary greatly among banks. Besides retained earnings, changes in other capital differ substantially across banks, with a standard deviation of up to 160.47%. Although there are banks, which reduce either their assets or capital components, most banks increase them. This is evidenced by the negative growth rate of all components in the 5th percentile, but a positive growth rate on average and the median.

Given large variations in balance sheet adjustments, we look at the sub-samples to see if these adjustments differ. Interestingly, banks in developed, emerging and frontier countries (Panel B in Table 6.1 adjust their retained earnings, shareholder capital, loans and other assets differently. Banks in developed countries have substantially lower growth rates in retained earnings than banks in emerging countries, and lower shareholder capital growth rates than banks in frontier countries. However, they have the highest growth rates in lending and other assets, among the three country groups. In contrast, banks in BCBS members countries differ significantly from those in non-member countries, in term of shareholder capital, other capital, investments and loan adjustments (Panel C in Table 6.1).

Table 6.1 Changes in Balance Sheet Components

	Capital Components			Asset Components			
	ΔRE	**ΔSHC**	**ΔOC**	**ΔIA**	**ΔINV**	**ΔLOAN**	**ΔOA**
Panel A: Full Sample							
Mean	26.788	5.794	15.904	36.441	18.957	11.225	15.687
Standard Deviation	59.825	21.854	160.467	134.883	43.884	15.265	39.034
Median	15.983	1.615	3.487	5.362	10.116	9.825	8.997
5^{th} percentile	-28.283	-14.286	-120.776	-67.351	-28.157	-10.435	-30.186
95^{th} percentile	104.027	37.906	211.866	247.477	95.132	37.178	74.23
Panel B: Country Groups							
Developed	14.159	6.39	22.707	12.632	15.585	12.311	25.251
Emerging	27.831	5.066	17.826	37.598	18.479	11.928	15.185
Frontier	27.157	9.486	2.124	41.57	23.195	6.859	13.831
Mean difference (F-statistic)	*2.43**	*3.69***	*0.95*	*1.77*	*1.35*	*10.19****	*3.38***
Panel C: BCBS Members							
No	24.729	7.321	9.045	35.081	16.215	9.917	14.442
Yes	28.971	4.174	23.18	37.884	21.867	12.611	17.008
Mean Difference (t-statistic)	*-1.36*	*2.775****	*-1.68**	*-0.396*	*-2.451***	*-3.371****	*-1.260*
Panel D: Capital Shortfall							
No	32.094	7.371	20.269	31.66	15.658	10.32	16.15
Yes	22.722	4.585	12.558	40.105	21.486	11.918	15.332
Mean Difference (t-statistic)	*2.876****	*2.394***	*0.930*	*-1.212*	*-2.566***	*-1.978***	*0.388*

Note: Mean difference in Panel B is tested using ANOVA with the Bonferroni adjustment for multiple-comparisons. Mean differences in Panels C and D are tested using the t-test. *, **, *** represent significance levels at 0.1, 0.05, and 0.01, respectively. N=1,459.
Source: Author’s calculations.

Following Francis and Osborne (2012) suggestion that banks adjust their balance sheets depending on their capitalization levels, we also consider whether there is any difference between banks facing, and not facing, capital shortfalls. We estimate the target capital ratio from equation (3.9) using long-term coefficients derived from equations (3.12) and (3.13), similar to Francis and Osborne (2012). Next, the estimated target capital ratio is compared with bank actual capital ratios. A bank is said to have a capital shortfall if it has a lower actual capital ratio than target ratio. The results in Panel D in Table 6.1 reveal that banks with capital shortfalls have significantly lower growth rates in both retained earnings and shareholder capital, while increase investments and lending significantly more than banks without a capital shortfall. These adjustments, surprisingly, contrast with Francis and Osborne (2012) suggestion that banks would decrease their assets and loan growth and increase Tier 1 capital.

Table 6.2 and Figure 6.3 report the normalized changes in capital and risk components to the percentage-point (hereafter, pp) change in capital ratio, calculated from equation (3.3). Over the study period, on average, banks increase their capital ratios by 0.026%. The increase is caused primarily by a strengthening of regulatory capital (by 1.545 pp). Although banks increase risk (by 0.054 pp) and expand total assets (by 1.465 pp), the magnitude is smaller than the increase in capital. This strategy (that is, strengthening capital base and expanding assets) is observed for all banks across different samples. However, their risk adjustments are not homogenous and consequently, their capital ratios might increase or decrease. Risk reduction is observed for banks in developed (by 0.111 pp) and frontier countries (by 0.518 pp), in countries without BCBS membership (by 0.107 pp), and banks without capital shortfall (by 0.098 pp). In contrast, banks in emerging, BCBS member countries and banks with capital shortfall increase their risk by 0.173 pp, 0.224 pp and 0.170 pp, respectively.

Table 6.2 Normalized Changes in Capital Ratio Components

	Capital Ratio (CAR)	**Regulatory Capital (CAP)**	**Risk-weighted Assets (RWA)**	**Risk (RWA/TA)**	**Total Assets (TA)**
	(a) = (b) – (c)	*(b)*	*(c) = (d) + (e)*	*(d)*	*(e)*
Full Sample	0.026	1.545	1.519	0.054	1.465
Country Groups					
Developed	0.092	1.623	1.531	-0.111	1.642
Emerging	-0.052	1.598	1.650	0.173	1.477
Frontier	0.427	1.223	0.796	-0.518	1.314
BCBS-Member					
No	0.137	1.311	1.174	-0.107	1.281
Yes	-0.091	1.795	1.886	0.224	1.662
Capital Shortfall					
No	0.848	2.208	1.360	-0.098	1.458
Yes	-0.603	1.038	1.641	0.170	1.471

Notes: This table reports the normalized changes in capital and risk components to a percentage-point change in total capital ratio, calculated from equation (3.3).
Source: Author's calculations.

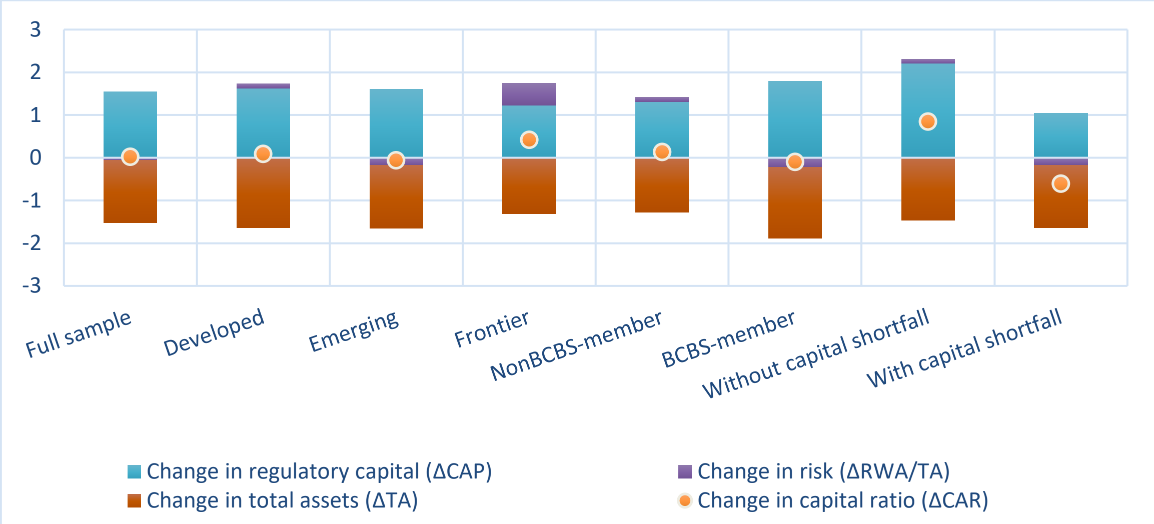

Figure 6.3 Normalized Changes in Total Capital Ratio

Notes: This figure reports the normalized changes in capital and risk components to a percentage-point change in total capital ratio, calculated from equations (3.3).

Table 6.3 Normalized Changes in Regulatory Capital Components

	Regulatory Capital (CAP)	Retained Earnings (RE)	Shareholder Capital (SHC)	Other Capital (OC)
	(a) = (b) + (c) + (d)	*(b)*	*(c)*	*(d)*
Full Sample	1.545	0.678	0.415	0.452
Country Groups				
Developed	1.623	1.093	0.316	0.214
Emerging	1.598	0.605	0.412	0.581
Frontier	1.223	0.884	0.480	-0.141
BCBS-Member				
No	1.311	0.644	0.474	0.193
Yes	1.795	0.716	0.353	0.726
Capital Shortfall				
No	2.208	0.950	0.505	0.753
Yes	1.038	0.471	0.346	0.221

Notes: This table reports the normalized changes in retained earnings, shareholder capital and other capital to a percentage-point change in total capital ratio, based on the breakdown in equation (3.5).
Source: Author's calculations.

Table 6.3 and Figure 6.4 describe how much percentage-point change in total capital ratio is caused by retained earnings, shareholder capital and other capital, based on the breakdown in equation (3.5). The results show that Asian banks strengthen their regulatory capital primarily through retained earnings. Out of 1.545 pp change in capital ratio made by regulatory capital, approximately 40% is obtained from changes in retained earnings. The use of retained earnings in improving capital base is the most significant for banks in developed and frontier countries, which are 67.34% and 72.28%, respectively.[24] Shareholder capital and other capital play equal roles in improving capital ratios. However, increasing shareholder capital is more dominant in frontier and non-BCBS member countries, while increasing other capital is more prevalent for banks in BCBS member countries and those without capital shortfalls.

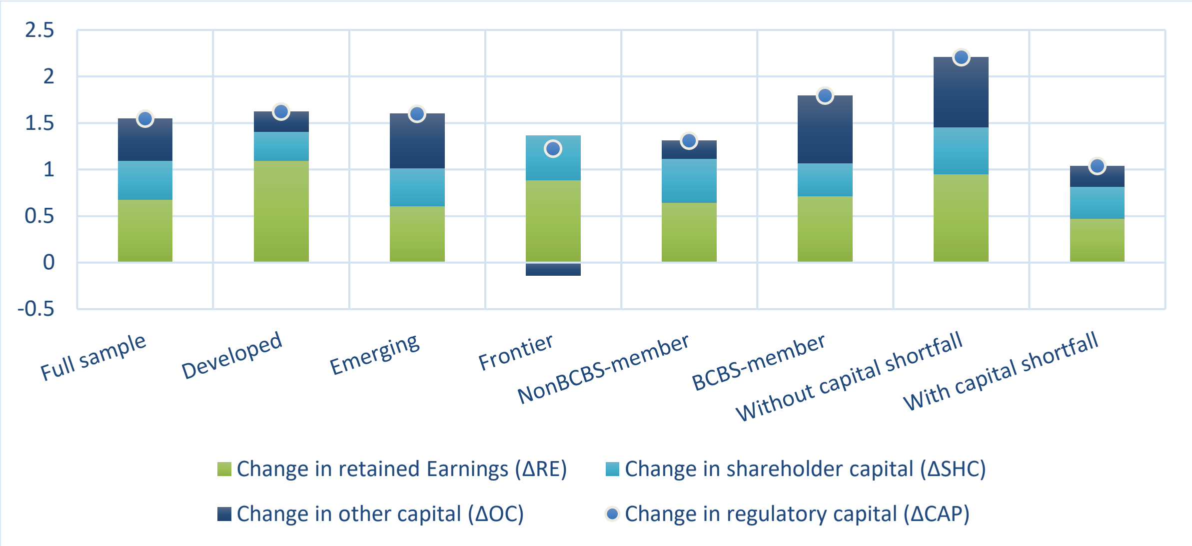

Figure 6.4 Normalized Changes in Regulatory Capital Components

Notes: This figure reports the normalized changes in retained earnings, shareholder capital and other capital to a percentage-point change in total capital ratio, based on the breakdown in equation (3.5).

Table 6.4 Normalized Changes in Risk-weighted Assets Components

	Risk-weighted Assets (*RWA*)	Interbank Assets (*IA*)	Investments (*INV*)	Loans (*LOAN*)	Other Assets (*OA*)
	(a) = (b) + (c) + (d) + (e)	*(b)*	*(c)*	*(d)*	*(e)*
Full Sample	1.519	0.160	0.310	0.834	0.215
Country Groups					
Developed	1.531	0.229	0.265	0.826	0.211
Emerging	1.650	0.178	0.316	0.909	0.247
Frontier	0.796	0.032	0.295	0.427	0.042
BCBS-Member					
No	1.174	0.095	0.289	0.630	0.160
Yes	1.886	0.230	0.332	1.051	0.273
Capital Shortfall					
No	1.360	0.152	0.252	0.775	0.181
Yes	1.641	0.167	0.354	0.879	0.241

Notes: This table reports the normalized changes in interbank assets, investments, loans, and other assets to a percentage-point change in total capital ratio, based on the breakdown in equation (3.6).
Source: Authors' calculations.

[24] Calculated as percentage point change in retained earnings, divided by percentage point change in total regulatory capital.

Table 6.4 and Figure 6.5 show the role of asset adjustments to the change in total capital ratios, following the breakdown in equation (3.6), On average, out of 1.519 pp change in capital ratio results from risk-weighted assets, half of it comes from increases in loans (0.834 pp). The second important contribution to change in capital ratio is investment (0.31 pp). This strategy is persistent across sub-samples. Particularly, changes in capital ratio, caused by loans and investments in developed, frontier, non-BCBS countries and in banks without capital shortfall, are less than the other countries and in the full sample. This is consistent with the reduction of risk, shown in Table 6.2. Interbank assets and other assets play less important roles.

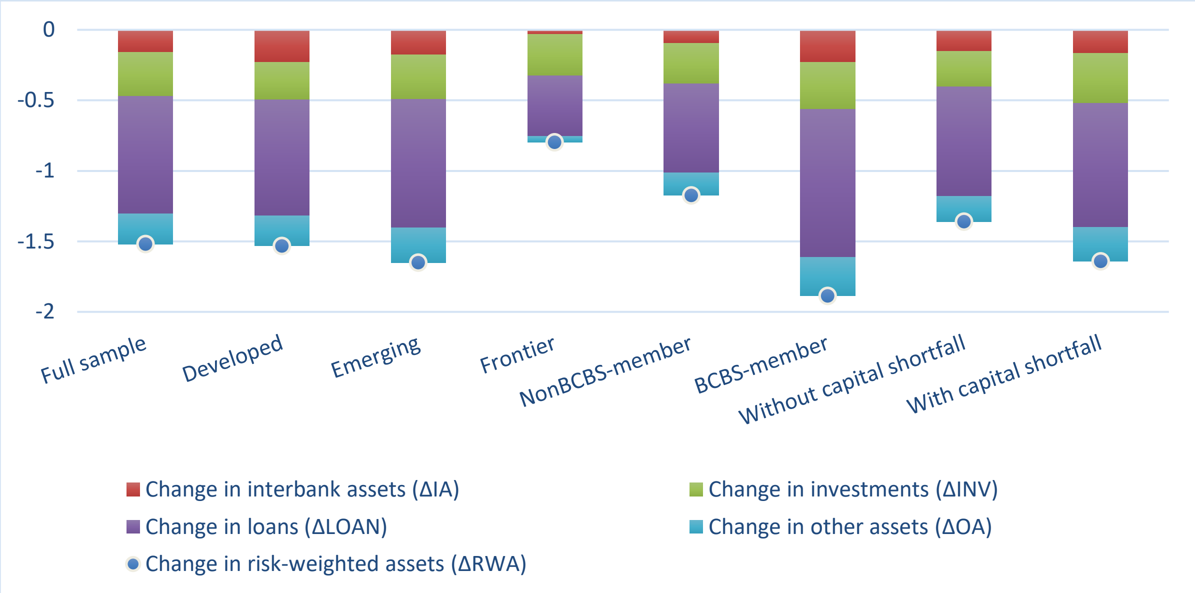

Figure 6.5 Normalized Changes in Risk-weighted Asset Components

Notes: This figure reports the normalized changes in interbank assets, investments, loans, and other assets to a percentage-point change in total capital ratio, based on the breakdown in equation (3.6).

6.3 Effect of Capital Regulation on Balance Sheet Adjustments

Before examining the effect of capital regulation on bank balance sheet adjustments, we check the appropriateness of the specification proposed in equation (3.24) in terms of: (i) the presence of fixed effects; (ii) the dynamic of balance sheet component adjustments; and (iii) the inter-relationship of balance sheet adjustments. Equation (3.24) is estimated using FEM regression for each balance sheet component.[25]

[25] We also run the model with REM regression but the Hausman tests rejects the null hypothesis that there is no correlation between individual effects and regressors in the model, which implies the efficiency of FEM over REM.

Table 6.5 FEM Regression of Balance Sheet Adjustments

	ΔRE	ΔSHC	ΔOC	ΔIA	ΔINV	ΔLOAN	ΔOA
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Panel A: Presence of Fixed Effects							
F-test for Fixed Effects (p-value)	<0.001	0.0003	0.0025	0.0937	<0.001	<0.001	0.0154
Panel B: Dynamic of Balance Sheet Components							
One-year lag of dependent variable	-0.008	-0.206***	-0.134***	-0.289***	-0.206***	0.162***	-0.217***
	(0.069)	(0.038)	(0.041)	(0.050)	(0.043)	(0.039)	(0.042)
Two-year lag of dependent variable	-0.173***	-0.077***	-0.228***	-0.068**	-0.056*	-0.010	-0.083***
	(0.056)	(0.025)	(0.055)	(0.031)	(0.032)	(0.033)	(0.031)
Panel C: Inter-relationship of Balance Sheet Components							
Δ*RE*		0.038*	-0.061	0.011	0.057	0.011	0.038
		(0.019)	(0.102)	(0.105)	(0.047)	(0.007)	(0.027)
Δ*SHC*	0.254*		-0.264	0.547***	0.126*	0.121***	0.028
	(0.143)		(0.294)	(0.186)	(0.069)	(0.022)	(0.072)
Δ*OC*	-0.003	-0.002		0.022	-0.001	0.005*	-0.000
	(0.012)	(0.005)		(0.026)	(0.009)	(0.003)	(0.006)
Δ*IA*	-0.011	0.007**	0.044		-0.033***	0.003	-0.014*
	(0.012)	(0.003)	(0.038)		(0.009)	(0.003)	(0.008)
Δ*INV*	0.143	0.027	-0.166	-0.487***		0.020**	-0.097***
	(0.095)	(0.018)	(0.127)	(0.124)		(0.008)	(0.029)
Δ*LOAN*	0.240	0.392***	1.750***	0.631*	0.300**		0.562***
	(0.174)	(0.047)	(0.580)	(0.376)	(0.123)		(0.164)
Δ*OA*	0.097	0.025	0.094	-0.197*	-0.131***	0.042***	
	(0.059)	(0.020)	(0.120)	(0.101)	(0.037)	(0.016)	
Panel D: Other Variables							
L.REG	-0.982	-0.137	1.933	-0.652	-0.435	0.285	-0.262
	(0.949)	(0.275)	(3.098)	(1.253)	(0.691)	(0.225)	(0.516)
L.CAR	-6.993	3.279	42.936	-15.683	-3.014	-16.380***	-10.852

	ΔRE	ΔSHC	ΔOC	ΔIA	ΔINV	ΔLOAN	ΔOA
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
	(13.289)	(3.585)	(29.859)	(21.354)	(9.087)	(2.259)	(9.214)
Panel D: Other Variables (cont'd)							
L.SIZE	-15.129***	-5.179**	-19.271	-2.745	2.205	2.119*	4.782
	(5.319)	(2.322)	(13.095)	(7.456)	(3.805)	(1.281)	(4.288)
L.ROA	0.153	-0.112	4.841***	1.246	1.380***	-0.633***	1.185***
	(0.313)	(0.147)	(1.356)	(1.282)	(0.356)	(0.091)	(0.297)
L.LOAN_RATIO	-10.972**	0.590	27.486*	-1.935	4.086	-1.197	7.190
	(5.390)	(2.743)	(14.999)	(9.281)	(4.027)	(1.418)	(5.095)
L.LLP_TO_TA	-2.879	0.799	-17.008	-5.994	5.641*	-1.145	0.458
	(4.814)	(1.272)	(12.429)	(5.495)	(3.138)	(1.098)	(2.124)
L.FA_RATIO	0.134	-0.118	1.168	2.233	-0.442	0.020	0.779***
	(0.345)	(0.184)	(1.361)	(1.428)	(0.388)	(0.088)	(0.296)
L.DEPOSIT_RATIO	-0.974	-0.685*	-1.625	3.346*	2.951***	-0.118	1.026
	(0.889)	(0.367)	(2.637)	(1.987)	(0.738)	(0.197)	(0.634)
L.GDP_GROWTH	1.220	-0.684	5.287*	5.723*	-1.736**	-0.001	-0.009
	(1.027)	(0.448)	(2.862)	(2.997)	(0.736)	(0.216)	(0.602)
Constant	126.116	0.470	-820.531**	43.550	-7.368	187.826***	-36.562
	(133.751)	(39.476)	(352.948)	(243.769)	(99.011)	(24.420)	(100.622)
Observations	1,400	1,375	1,197	1,413	1,411	1,393	1,383
Banks	279	276	256	279	279	275	273
R-square	0.151	0.191	0.132	0.151	0.187	0.409	0.196

Notes: This table reports FEM regression of equation (3.24) for balance sheet components. Panel A presents the p-value of the F-test for the joint-significance of all fixed effects. Panel B presents the estimation for dynamic effects of balance sheet components. Two-year lag of asset components are also included. Panel C presents the estimation results of other balance sheet components. Panel D presents the estimation of other remaining variables in the model. Robust standard errors in parentheses. *, **, *** represent significance levels at 0.1, 0.05, and 0.01, respectively.
Source: Author's calculations.

The results in Table 6.5 show the F-test for joint-significance of fixed effects has a p-value smaller than the 0.1 significance level for all components and confirms the presence of fixed effects in the model (see Panel A). The coefficients of one- and two-year lags of the dependent variables are significant for all of the components, except for the one-year lag of retained earnings and the two-year lag of loans. This confirms the dynamic of balance sheet components (see Panel B). The adjustment of a bank balance sheet component depends on other components and there is an inter-relationship between them (see Panel C).

Table 6.6 further shows that including adjustments of other balance sheet components provides better explanatory power for the dependent variable and increases the model's goodness of fit. Information criteria (both AIC and BIC) are the lowest and the R-square is the highest in the full model, which takes into account the dynamic effect and other balance sheet components. Therefore, we estimate equation (3.24) using SYS-GMM for each balance sheet components. The regression results for adjustment in the liability and asset side of the balance sheet are reported in Table 6.7 and Table 6.8, respectively.

Table 6.6 Information Criteria and R-square of Different Models

Models	**AIC**	**BIC**	**R-square**
Dependent Variable: Δ*RE*			
Without lagged dependent variables & adjustments of other balance sheet components	15585	15696	0.100
Without lagged dependent variables	15554	15697	0.125
With adjustments of other balance sheet components	14801	14922	0.122
Full model	14766	14918	0.151
Dependent Variable: Δ*SHC*			
Without lagged dependent variables & adjustments of other balance sheet components	12586	12697	0.093
Without lagged dependent variables	12489	12632	0.158
With adjustments of other balance sheet components	11737	11857	0.122
Full model	11637	11789	0.191
Dependent Variable: Δ*OC*			
Without lagged dependent variables & adjustments of other balance sheet components	18679	18790	0.039
Without lagged dependent variables	18676	18819	0.048
With adjustments of other balance sheet components	15011	15128	0.114
Full model	14997	15145	0.132
Dependent Variable: Δ*IA*			
Without lagged dependent variables & adjustments of other balance sheet components	18168	18279	0.044
Without lagged dependent variables	18130	18273	0.076
With adjustments of other balance sheet components	18064	18180	0.111
Full model	17471	17623	0.151
Dependent Variable: Δ*INV*			
Without lagged dependent variables & adjustments of other balance sheet components	14661	14772	0.116

Models	AIC	BIC	R-square
Without lagged dependent variables	14592	14734	0.164
With adjustments of other balance sheet components	14616	14733	0.144
Full model	14032	14184	0.187
Dependent Variable: Δ*LOAN*			
Without lagged dependent variables & adjustments of other balance sheet components	10901	11012	0.318
Without lagged dependent variables	10768	10911	0.383
With adjustments of other balance sheet components	10842	10958	0.346
Full model	10227	10379	0.409
Dependent Variable: Δ*OA*			
Without lagged dependent variables & adjustments of other balance sheet components	14375	14486	0.099
Without lagged dependent variables	14312	14454	0.144
With adjustments of other balance sheet components	14296	14413	0.147
Full model	13441	13593	0.196

Notes: Estimations of equation (3.24) using FEM regression with robust standard errors.
Source: Author's calculations.

6.3.1 Adjustments on the Liability Side

Table 6.7 reports the SYS-GMM regression of equation (3.24) for the liability side. The results in columns 1 and 2 show that the retained earnings adjustment (*ΔRE*) is positively correlated with its adjustment in the previous year. This relationship for shareholder capital adjustment (*ΔSHC*) is negative. This suggests that banks maintain their retained earnings strategy for two years, but change the shareholder capital adjustment after one year. This is consistent with the perception that raising shareholder capital is expensive so that banks cannot keep issuing new capital every year. Retaining earnings is more feasible if banks want to strengthen their capital base.

Table 6.7 SYS-GMM Regression of Balance Sheet Adjustments on the Liability Side

	ΔRE	**ΔSHC**	**ΔSHC**	**ΔOC**
	(1)	**(2)**	**(3)**	**(4)**
One-year lag of dependent variable	0.145**	-0.164**	-0.055	0.016
	(0.070)	(0.071)	(0.071)	(0.036)
Two-year lag of dependent variable	-0.027	-0.020		-0.071
	(0.056)	(0.028)		(0.044)
Δ*RE*		0.140***	0.109***	-0.081
		(0.035)	(0.035)	(0.085)
Δ*SHC*	0.249*			0.334
	(0.133)			(0.327)
Δ*OC*	-0.011	0.009	0.001	
	(0.013)	(0.012)	(0.012)	
Δ*IA*	0.002	-0.010	-0.008	0.057***
	(0.010)	(0.009)	(0.012)	(0.021)
Δ*INV*	0.029	0.101*	0.110**	-0.213**

	ΔRE	ΔSHC	ΔSHC	ΔOC
	(1)	**(2)**	**(3)**	**(4)**
	(0.089)	(0.061)	(0.053)	(0.107)
ΔLOAN	0.554***	0.578***	0.553***	-0.254
	(0.189)	(0.147)	(0.159)	(0.497)
ΔOA	0.130**	0.111**	0.110***	0.249**
	(0.054)	(0.043)	(0.037)	(0.122)
L.REG	-0.756	-0.749***	-0.609**	0.895
	(0.519)	(0.267)	(0.271)	(1.568)
L.CAR	-0.977**	-0.195	-0.515**	-0.389
	(0.429)	(0.198)	(0.224)	(1.141)
L.SIZE	-2.494**	-0.042	-0.274	1.628
	(1.094)	(0.419)	(0.418)	(2.996)
L.ROA	-5.901***	-3.491***	-2.440**	-15.619**
	(2.234)	(1.311)	(0.999)	(6.364)
L.LOAN_RATIO	-0.051	-0.027	-0.057	0.001
	(0.117)	(0.068)	(0.066)	(0.361)
L.LLP_TO_TA	-2.687	-1.172	-1.118	6.693
	(3.035)	(1.642)	(1.351)	(4.310)
L.FA_RATIO	0.442	0.060	-0.739	-0.179
	(2.402)	(0.789)	(0.711)	(3.821)
L.DEPOSIT_RATIO	-0.056	-0.116	-0.094	0.602
	(0.110)	(0.092)	(0.076)	(0.462)
L.GDP_GROWTH	0.555	-0.828***	-1.086***	6.045***
	(0.771)	(0.298)	(0.336)	(1.751)
Constant	68.144***	24.253*	30.426***	-114.082
	(22.205)	(13.564)	(11.602)	(73.942)
Time Dummies	Yes	Yes	Yes	Yes
Observations	1,400	1,375	1,459	1,197
Banks	279	276	290	256
Instruments	45	116	106	59
AR(2) Test (p-value)	0.993	0.097	0.311	0.527
Hansen Test (p-value)	0.118	0.288	0.115	0.189

Notes: This table reports two-step SYS-GMM of equation (3.24) for the adjustments of regulatory capital components. Columns 2 and 3 are different in the use of the lagged dependent variable. The endogenous variables are lagged dependent variables and balance sheet components adjustments. Column 1 uses lags 1 to 2 periods of endogenous variables as instruments in differences equation. Columns 2 and 3 use lags 2 to 12 periods. Column 4 uses lags 1 to 4 periods. The instruments in levels equation are lagged first-differences of endogenous variables. All instruments are collapsed. Forward-orthogonal-deviation is used to transform data in differences equation. Robust standard errors in parentheses. *, **, *** represent significance levels at 0.1, 0.05, and 0.01, respectively. Time dummies are not reported.
Source: Author's calculations.

Since the shareholder capital adjustment changes more frequently, we re-estimate equation (3.24) for *ΔSHC*, controlling only for a one-year lag of the dependent variable. The results in column 3 in Table 6.7 show the estimation is not significantly different from that in column 2, except for the coefficient of one-year lag of *ΔSHC*, which becomes insignificant. The *L.CAR* coefficient also becomes significant at the 0.01

level. The AR(2) test for second-order serial correlation in differences of residuals has a p-value larger than the 0.1 significance level and suggests the exogeneity of the instruments used, which is not the case when controlling for the two-year lag of *ΔSHC* (column 2). Therefore, we rely on estimations in Column 3 to interpret the *ΔSHC* estimations.

The decision in retaining earnings and adjusting shareholder capital positively affect each other. A 1% increase in the shareholder capital adjustment will induce banks to increase retained earnings by 0.249% more, everything being equal. In contrast, a 1% increase in retained earnings growth rate will increase the shareholder capital growth rate by 0.109% (columns 1 and 3 in Table 6.7). This suggests that a bank that wants to improve its capital will increase both its retained earnings and shareholder capital. The positive effect of retained earnings adjustment on shareholder capital adjustment also implies the risk of being under-priced of equity issuance. Increasing retained earnings can help signal the market about bank strength, reducing the cost of issuing equity and facilitating the equity issuance (Myers, 1984; Myers & Majluf, 1984). In addition, this positive relationship indicates the active capital ratio management of Asian banks is similar to Berger et al. (2008) finding for the U.S banks.

Adjustments in retained earnings, and shareholder capital are positively affected by adjustments in loans (*ΔLOAN*) and other assets (*ΔOA*) (columns 1 and 3 in Table 6.7). Shareholder capital adjustment is further positively affected by investment adjustment (*ΔINV*), while other capital adjustment is negatively impacted by investment adjustment (ΔINV), but positively impacted by interbank asset adjustment (*ΔIA*) and other asset adjustments *(ΔOA)* (column 4 in Table 6.7). This suggests that banks increase regulatory capital together with asset expansion. In addition, high quality capital (that is, retained earnings and shareholder capital) is used primarily to finance loans. The *ΔLOAN* coefficients are also the largest among the balance sheet components, 0.554 for retained earnings adjustment and 0.553 for shareholder capital adjustments.

Capital regulation (*L.REG)* does not affect either banks' retained earnings or other capital adjustments (columns 1 and 4 in Table 6.7). Stricter capital regulation even reduces banks' shareholder capital growth (column 3 in Table 6.7). This indicates that the increase in bank regulatory capital is not the result of greater capital regulation stringency. Instead, banks raise their retained earnings and shareholder capital more if they have lower capital adequacy ratios. This finding highlights the importance of distinguishing between the effects of capital regulation and capital ratio, when making claims about the effect of capital regulation on bank balance sheet adjustments. A low capitalized bank might strengthen its capital base not purely to avoid regulatory breaches, but also to gain the confidence of market participants. Nevertheless, capital regulation is important in the way it sets standards to determine bank capital adequacy ratios.

The adjustment of retained earnings is also affected by bank size and profitability (column 1 in Table 6.7), while adjustments of shareholder capital and other capital are affected by profitability and economic growth (columns 3 and 4 in Table 6.7). Small banks tend to rely more on retained earnings to increase their capital because they have less access to the capital market and more difficulty in issuing equity, compared to large banks. Surprisingly, profitable banks have lower growth rates in all regulatory capital components. These banks might have little need to strengthen their capital base. In addition, banks in countries with high economic growth focus more on increasing other capital. Conversely, banks in countries with slow economic growth increase shareholder capital instead.

6.3.2 Adjustments on the Asset Side

Table 6.8 reports the regression results of equation (3.24) for adjustments on the asset side of the balance sheets. All estimations are efficient given the AR(2) test for second-order correlation of residuals. The Hansen test for the validity of over-identifying instruments cannot reject the null hypothesis at the 0.05 significance level. Nevertheless, the estimation for interbank asset adjustments (column 1) shows the Hansen test rejects the null hypothesis at the 0.1 significance level. Therefore, we additionally control for the two-year lag of the dependent variable, bearing in mind that interbank asset adjustments may be dynamic for up to two years (as shown in Table 6.5). The estimation in column 2 of Table 6.8 is consistent with column 1 and suggests the robustness of estimations in column 1.

Table 6.8 SYS-GMM Regression of Balance Sheet Adjustments on the Asset Side

	ΔIA	**ΔIA**	**ΔINV**	**ΔLOAN**	**ΔOA**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
One-year lag of dependent variable	-0.145***	-0.158***	-0.098**	0.198*	-0.098
	(0.035)	(0.035)	(0.042)	(0.107)	(0.140)
Two-year lag of dependent variable		-0.008			
		(0.032)			
Δ*RE*	-0.026	-0.021	0.035	-0.071***	0.228***
	(0.084)	(0.062)	(0.047)	(0.024)	(0.077)
Δ*SHC*	0.440**	0.535***	0.074	0.177**	-0.160
	(0.190)	(0.179)	(0.068)	(0.069)	(0.242)
Δ*OC*	0.030	0.033	0.001	0.016**	-0.024
	(0.031)	(0.030)	(0.009)	(0.008)	(0.027)
Δ*IA*			-0.031***	0.024***	-0.015
			(0.008)	(0.007)	(0.032)
Δ*INV*	-0.452***	-0.361***		0.064*	-0.135
	(0.100)	(0.088)		(0.033)	(0.115)
Δ*LOAN*	0.749	0.704	0.142		1.616***
	(0.517)	(0.466)	(0.126)		(0.334)
Δ*OA*	-0.272**	-0.230*	-0.102***	0.048	

	ΔIA	ΔIA	ΔINV	ΔLOAN	ΔOA
	(1)	(2)	(3)	(4)	(5)
	(0.119)	(0.118)	(0.034)	(0.041)	
L.REG	1.288	0.967	1.749***	-0.326*	1.574**
	(1.279)	(1.221)	(0.501)	(0.188)	(0.687)
L.CAR	-0.798	-0.687	-0.987***	0.581***	-0.917**
	(0.747)	(0.785)	(0.277)	(0.147)	(0.427)
L.SIZE	-4.284*	-4.322*	-2.304***	0.073	-0.664
	(2.195)	(2.409)	(0.726)	(0.248)	(0.751)
L.ROA	1.284	1.420	4.083**	0.228	2.128
	(5.190)	(4.837)	(1.843)	(0.704)	(1.638)
L.LOAN_RATIO	1.305***	1.369***	0.177	-0.252***	0.625***
	(0.335)	(0.327)	(0.133)	(0.044)	(0.158)
L.LLP_TO_TA	-5.867	-4.076	5.475***	-1.675**	1.555
	(6.363)	(6.120)	(1.775)	(0.770)	(2.484)
L.FA_RATIO	1.899	2.307	2.482**	-0.595	1.167
	(2.633)	(2.788)	(1.127)	(0.531)	(1.283)
L.DEPOSIT_RATIO	0.361	0.259	-0.168*	0.094***	-0.284**
	(0.423)	(0.442)	(0.097)	(0.035)	(0.134)
L.GDP_GROWTH	5.404***	4.015**	0.641	0.646**	-0.357
	(1.753)	(1.628)	(0.545)	(0.262)	(0.559)
Constant	54.678	79.746	28.839*	9.959	-21.962
	(62.314)	(60.843)	(16.170)	(6.805)	(24.493)
Time Dummies	Yes	Yes	Yes	Yes	Yes
Observations	1,459	1,413	1,459	1,459	1,459
Banks	290	279	290	290	290
Instruments	36	45	43	78	57
AR(2) Test (p-value)	0.210	0.416	0.175	0.407	0.397
Hansen Test (p-value)	0.082	0.129	0.329	0.191	0.278

Notes: This table reports two-step SYS-GMM of equation (3.24) for the adjustments of asset components. Columns 1 and 2 are different in the use of the lagged dependent variable. The endogenous variables are lagged dependent variables and balance sheet component adjustments. Column 1 uses lag 1 period of endogenous variables as instruments in the differences equation. Columns 2 and 3 use lags 1 to 2 periods. Column 4 uses lags 2 to 8 periods. Column 5 uses lags 2 to 5 periods. The instruments in levels equation are lagged first-differences of endogenous variables. All instruments are collapsed. Forward-orthogonal-deviation is used to transform data in differences equation. Robust standard errors in parentheses. *, **, *** represent significance levels at 0.1, 0.05, and 0.01, respectively. Time dummies are not reported.
Source: Authors' estimations.

Table 6.8 estimations show that all asset components have a dynamic pattern, except for other assets (*ΔOA*). Adjustments to interbank assets (*ΔIA*) and investments (*ΔINV*) are negatively correlated with their adjustments in the previous year, but this relationship for loan adjustment (*ΔLOAN*) is positive. The coefficient of the one-year lag for the dependent variable is also the largest for loan adjustments, which is 0.198. This behavior indicates Asian banks' focus on lending and their strategy to expand lending every year.

Adjustments in asset components depend on bank decisions on capital adjustment and other asset components. Specifically, a 1% increase in retained earnings adjustment will be accompanied by a 0.071% reduction in loan adjustments and a 0.228% increase in other asset adjustments. Meanwhile, a 1% increase in shareholder capital adjustment will induce banks to adjust their interbank assets and loans by 0.44% and 0.177% more. In addition, adjustments in interbank assets, investments, and other assets negatively affect each other. In contrast, these adjustments positively affect loans adjustments and vice versa (see Table 6.8). This suggests the competing role of interbank assets, investments and other assets and the supplement role between these assets and loans. In order to ensure this assumption, we regress bank risk-weighted asset growth rates on asset component adjustments. As displayed in Table 6.9, loan adjustments contribute the most to the changes in bank risk-weighted assets. The *ΔLOAN* coefficient is 0.788, whereas, interbank assets, investments, and other asset adjustments share a similar degree of influence. The *ΔIA, ΔINV, ΔOA* coefficients are each less than 0.05.

Table 6.9 Riskiness of Asset Components

Dependent: Δ*RWA*	**Coefficient**	**S.E**	**t-statistic**	**P>t**	**[95% Confidence**	**Interval]**
Δ*IA*	0.012	0.003	4.750	<0.001	0.007	0.017
Δ*LOAN*	0.788	0.037	21.350	<0.001	0.715	0.861
Δ*INV*	0.038	0.007	5.600	<0.001	0.025	0.051
Δ*OA*	0.049	0.013	3.800	<0.001	0.023	0.074
Observations (Banks)	1,459 (290)					
Bank Fixed Effects	Yes					
Time Dummies	Yes					
F (16,345) (Prob>F)	92.95 (<0.001)					
R-square	0.5269					

Notes: This table presents the FEM regression of risk-weighted assets growth rate on asset component adjustments. Standard errors are robust to heteroscedasticity. Time dummies are not reported.
Source: Author's calculations.

Stricter capital regulations (*L.REG)* induce banks to increase their adjustments in investments and other assets, and reduce adjustments in lending (see Table 6.8). These results confirm the findings of Cumming and Nel (2005); Furfine (2001); Hall (1993); Peek and Rosengren (1995). In addition, banks with low capital ratios (*L.CAR)* will focus more on investments and other asset adjustments, and have lower adjustments in loans, as suggested by Catalan et al. (2017); Haubrich and Wachtel (1993). This provides evidence of a capital crunch in Asia. A slow-down in bank lending is necessary if the soundness of the banking system is maintained. Nevertheless, Lee and Hsieh (2013) show that increasing capital requirements increase the risk (measured as volatility of return on equity) of Asian banks. Fu, Lin, and Molyneux (2014) reveal no effect of capital requirements on bank risk (either measured by probability of default or probability of banks' insolvency) in Asia Pacific. However, in a cross-country analysis that included Asia, Laeven and

Levine (2009) discover a negative effect of capital regulation on bank risk. While there are still debates around the role of capital regulation on disciplining bank risk, reducing lending levels is obviously an unfavorable consequence of capital regulation. Thus, it is necessary to find a way to properly determine risk-weighted assets that does not penalize loans with so high risk-weights.

Smaller banks (*L.SIZE)* focus more on interbank assets (by 4.284) and investments (by 2.304) adjustments, while profitable banks (*L.ROA)* increase investment adjustments (by 4.083). Banks also promote interbank assets (by 1.305) and other asset adjustments (by 0.625), and reduce loan adjustments (by 0.252) when their loan ratios (*L.LOAN_RATIO*) are already high. However, banks with higher loan quality (*L.LLP_TO_TA*) will increase loans (by 1.675) and reduce investments adjustments (by 5.475). Banks with higher deposit ratios (*L.DEPOSIT_RATIO*) additionally reduce other asset adjustments (by 0.284). In countries with high economic growth or during economic upturns (*L.GDP_GROWTH*), banks expand their assets, particularly interbank assets (by 5.404) and lending (by 0.646) (see Table 6.8).

6.4 Moderating Effect of Country Group

Comparision of mean balance sheet adjustments in Table 6.1 suggests potential differences in balance sheet adjustments of banks in developed, emerging and frontier markets. We examine the effect of country group by regressing equation (3.24) with country group dummy variables and interacting these dummy variables with capital regulation (*L.REG*). The regression is conducted for four main capital and asset variables, which are retained earnings, shareholder capital, loans and investments. Two-step SYS-GMM is employed to estimate the results.

The regression results in Table 6.10 confirm the differences in balance sheet adjustments of banks in developed, emerging and frontier markets. Specifically, banks located in emerging markets (*Emerging*) have higher retained earnings (by 27.60%) and loan (by 7.64%) growth rates than those in developed markets while banks in frontier markets (*Frontier*) adjust shareholder capital by 22.63% more than those in developed countries.

Capital regulation (*L.REG*) does not affect capital (that is, retained earnings and shareholder capital) and loan adjustments of banks in developed markets. However, it induces these banks to increase their investments. The effect of capital regulation on investment adjustments is almost similar across different country groups (*L.REG*Emerging* and *L.REG*Frontier* coefficients are insignificant). However, there are significant differences in the effects of capital regulation on adjustments in retained earnings and loans between developed and emerging markets. Shareholder capital adjustments, between banks in frontier and developed markets, are also dissimilar (see Panel A in Table 6.10). The Wald tests in Panel C in Table 6.10 have large F-statistics for adjustments in retained earnings, shareholder capital and loans. This suggests that there is a significant effect of country group on the relationship between capital regulation and these balance sheet adjustments.

Panel B in Table 6.10 estimations show that an increase in capital regulation causes banks in emerging markets to reduce adjustments in retained earnings by 1.41% and in loans by 0.70%. These banks also increase investment growth rates by 1.79%. For banks in frontier markets, an increase in capital regulation causes a 1.32% reduction in shareholder capital growth rates and a 2.55% increase in investment growth rates.

Table 6.10 Effects of Capital Regulation on Balance Sheet Adjustments Considering Country Groups

	ΔRE	**ΔSHC**	**ΔINV**	**ΔLOAN**
	(1)	**(2)**	**(3)**	**(4)**
Panel A: Estimators				
L.REG	0.163	0.108	1.131*	-0.216
	(0.844)	(0.351)	(0.677)	(0.287)
*L.REG*Emerging*	-1.570**	-0.424	0.662	-0.486*
	(0.681)	(0.373)	(0.680)	(0.251)
*L.REG*Frontier*	0.285	-1.432**	1.421	0.350
	(1.304)	(0.575)	(1.009)	(0.395)
Emerging	27.598**	3.929	-8.677	7.639*
	(10.943)	(5.456)	(8.919)	(3.927)
Frontier	0.165	22.632***	-14.751	-8.453
	(19.145)	(7.465)	(13.062)	(5.922)
One-year lag of dependent variable	0.148*	-0.044	-0.092**	0.183*
	(0.076)	(0.074)	(0.041)	(0.111)
Two-year lag of dependent variable	-0.021			
	(0.059)			
ΔRE		0.108***	0.032	-0.066***
		(0.036)	(0.047)	(0.024)
ΔSHC	0.257*		0.075	0.194***
	(0.134)		(0.067)	(0.070)
ΔOC	-0.011	-0.001	0.001	0.015*
	(0.013)	(0.012)	(0.009)	(0.008)
ΔIA	-0.001	-0.006	-0.032***	0.022***
	(0.010)	(0.013)	(0.008)	(0.008)
ΔINV	0.019	0.123**		0.052
	(0.090)	(0.055)		(0.034)
ΔLOAN	0.544***	0.525***	0.120	
	(0.180)	(0.152)	(0.129)	
ΔOA	0.134**	0.113***	-0.105***	0.052
	(0.055)	(0.040)	(0.034)	(0.045)
L.CAR	-1.079**	-0.396*	-0.919***	0.470***
	(0.461)	(0.216)	(0.281)	(0.150)

	ΔRE	ΔSHC	ΔINV	ΔLOAN
	(1)	(2)	(3)	(4)
L.SIZE	-2.608**	-0.074	-1.977**	-0.173
	(1.190)	(0.430)	(0.764)	(0.299)
L.ROA	-4.846**	-2.852***	3.773**	0.958
	(2.172)	(0.964)	(1.909)	(0.726)
L.LOAN_ RATIO	-0.066	-0.047	0.191	-0.276***
	(0.137)	(0.072)	(0.139)	(0.045)
L.LLP_TO_TA	-1.988	-2.008	5.239***	-0.714
	(3.004)	(1.232)	(1.905)	(0.806)
L.FA_RATIO	0.706	-1.443*	2.359*	-0.102
	(2.670)	(0.736)	(1.204)	(0.538)
L.DEPOSIT_RATIO	-0.094	-0.047	-0.153	0.076**
	(0.107)	(0.072)	(0.098)	(0.037)
L.GDP_GROWTH	0.454	-0.735**	0.517	0.492*
	(0.814)	(0.353)	(0.552)	(0.258)
Constant	52.740**	17.214	32.237*	11.210
	(25.733)	(11.971)	(18.594)	(7.927)
Panel B: Full Effect of REG for:				
Emerging Countries *(L.REG+L.REG*Emerging)*	-1.407**	-0.316	1.793***	-0.702***
Frontier Countries *(L.REG+L.REG*Frontier)*	0.448	-1.324**	2.551**	0.134
Panel C: Moderating Effect of Country Group				
Wald Test (*F-statistic*)	3.51**	3.23**	1.01	6.77***
Time Dummies	Yes	Yes	Yes	Yes
Observations	1,400	1,459	1,459	1,459
Banks	279	290	290	290
Instruments	49	110	47	82
AR(2) Test (p-value)	0.955	0.388	0.191	0.537
Hansen Test (p-value)	0.080	0.092	0.286	0.084

Notes: This table presents the two-step SYS-GMM regression results of equation (3.24) but considering the effect of country group. Panel A presents the coefficients estimation. Panel B presents the full effect of the interacted variable for each country group. The estimation is based on a linear combination of coefficients of capital regulation variables (*L.REG*) and interaction variables with *L.REG* for each country group. Panel C displays the F-statistics of the Wald test for the joint-significance of interaction variables. Developed is set as the reference group to avoid multicollinearity. The endogenous variables are lagged dependent variables and balance sheet components adjustments. Estimation 1 uses lags 1 to 2 periods of endogenous variables as instruments in the differences equation. Estimation 2 uses lags 2 to 12 periods. Estimation 3 uses lags 1 to 2 periods. Estimation 4 uses lags 2 to 8 periods. The instruments in the levels equation are lagged first-differences of endogenous variables. All instruments are collapsed. Forward-orthogonal-deviation is used to transform data in differences equation. Robust standard errors in parentheses. *, **, *** represent significance levels at 0.1, 0.05, and 0.01, respectively. Time Dummies are not reported.
Source: Author's calculations.

6.5 Moderating Effect of BCBS Membership

The t-tests for mean difference in balance sheet adjustments in Table 6.1 also suggest substantial differences in adjustments in retained earnings, shareholder capital, investments and bank loans in countries with and without Basel Committee membership. Thus, we examine the effect of BCBS membership on these balance sheet adjustments by regressing equation (3.24) with the BCBS dummy variable (*BCBS*) and interacting this dummy variable with capital regulation (*L.REG*). Two-step SYS-GMM is employed to estimate the results.

The regression results in Table 6.11 indicate that banks in BCBS-member countries (*BCBS*) have lower shareholder capital adjustment rates (by 8.37%) and higher loan adjustment rates (by 6.66%) than those in non-member countries. Capital regulation (*L.REG*) does not affect retained earnings and loan adjustments of banks in non-BCBS member countries. However, it marginally induces these banks to reduce shareholder capital adjustments by 0.69%, but also increase investment adjustments by 1.19%. The effects of capital regulation on balance sheet adjustments are almost similar between banks in BCBS member and non-member countries (*L.REG*Emerging* and *L.REG*Frontier* coefficients are insignificant*)* except for the loan adjustment. Specifically, banks in BCBS-member countries reduce loan adjustments by 0.49% for each unit increase in capital regulation. These banks additionally reduce retained earning adjustments by 1.02% (see Panel B in Table 6.11). Since Basel Committee member countries closely follow Basel Committee standards on capital regulation, they are expected to enforce stricter capital regulations and supervision than non-member countries. Therefore, such results further support the findings about the effects of stricter capital regulations on shareholder capital and investment adjustments in Table 6.7 and Table 6.8.

Table 6.11 Effects of Capital Regulation on Balance Sheet Adjustments Considering BCBS Membership

	ΔRE	**ΔSHC**	**ΔINV**	**ΔLOAN**
	(1)	**(2)**	**(3)**	**(4)**
Panel A: Estimators				
L.REG	-0.628	-0.693**	1.188**	-0.147
	(0.666)	(0.320)	(0.603)	(0.235)
*L.REG*BCBS*	-0.389	0.303	0.835	-0.346**
	(0.613)	(0.273)	(0.591)	(0.174)
BCBS	8.010	-8.373*	-8.042	6.659**
	(10.133)	(4.534)	(9.034)	(2.972)
One-year lag of dependent variable	0.149**	-0.058	-0.103**	0.197*
	(0.070)	(0.072)	(0.041)	(0.108)
Two-year lag of dependent variable	-0.025			
	(0.057)			
ΔRE		0.107***	0.037	-0.067***
		(0.035)	(0.048)	(0.024)
ΔSHC	0.256*		0.074	0.183***
	(0.132)		(0.070)	(0.069)
ΔOC	-0.011	0.002	0.000	0.016**
	(0.013)	(0.012)	(0.009)	(0.008)

	ΔRE	ΔSHC	ΔINV	ΔLOAN
	(1)	**(2)**	**(3)**	**(4)**
ΔIA	0.002	-0.008	-0.030***	0.022***
	(0.010)	(0.012)	(0.008)	(0.007)
ΔINV	0.028	0.105**		0.059*
	(0.089)	(0.051)		(0.032)
ΔLOAN	0.557***	0.562***	0.177	
	(0.184)	(0.157)	(0.128)	
ΔOA	0.132**	0.106***	-0.101***	0.048
	(0.054)	(0.037)	(0.034)	(0.040)
L.CAR	-1.003**	-0.445**	-1.032***	0.543***
	(0.436)	(0.211)	(0.289)	(0.143)
L.SIZE	-2.536**	-0.083	-2.431***	0.009
	(1.120)	(0.424)	(0.726)	(0.251)
L.ROA	-5.718**	-2.697***	4.263**	0.388
	(2.219)	(0.984)	(1.880)	(0.681)
L.LOAN_ RATIO	-0.063	-0.040	0.165	-0.257***
	(0.121)	(0.065)	(0.133)	(0.042)
L.LLP_TO_TA	-2.568	-1.215	5.243***	-1.500*
	(3.047)	(1.312)	(1.800)	(0.789)
L.FA_RATIO	0.622	-0.974	2.654**	-0.475
	(2.390)	(0.690)	(1.113)	(0.532)
L.DEPOSIT_RATIO	-0.068	-0.081	-0.157	0.097***
	(0.112)	(0.076)	(0.096)	(0.035)
L.GDP_GROWTH	0.351	-0.801**	0.524	0.469*
	(0.800)	(0.324)	(0.575)	(0.247)
Constant	69.580***	25.180**	34.703**	9.966
	(23.293)	(11.850)	(16.405)	(6.782)
Panel B: Full Effect of REG for BCBS members				
*L.REG + L.REG*BCBS*	-1.017*	-0.390	2.023***	-0.493***
Time Dummies	Yes	Yes	Yes	Yes
Observations	1,400	1,459	1,459	1,459
Banks	279	290	290	290
Instruments	47	108	45	80
AR(2) Test (p-value)	1.000	0.328	0.146	0.465
Hansen Test (p-value)	0.109	0.108	0.293	0.181

Notes: This table presents the two-step SYS-GMM regression results of equation (3.24) but considering the effect of BCBS membership. Panel A presents the coefficients estimation. Panel B presents the full effect of capital regulation for BCBS members. The estimation is based on a linear combination of capital regulation variable and the interaction variable. The endogenous variables are lagged dependent variables and balance sheet component adjustments. Estimation 1 uses lags 1 to 2 periods of endogenous variables as instruments in differences equation. Estimation 2 uses lags 2 to 12 periods. Estimation 3 uses lags 1 to 2 periods. Estimation 4 uses lags 2 to 8 periods. The instruments in the levels equation are lagged first-differences of endogenous variables. All instruments are collapsed. Forward-orthogonal-deviation is used to transform data in the differences equation. Robust standard errors in parentheses. *, **, *** represent significance levels at 0.1, 0.05, and 0.01, respectively. Time Dummies are not reported.
Source: Author's calculations.

6.6 Robustness Checks

To substantiate our conclusions, we conduct some robustness checks. We estimate equation (3.24) using two-step SYS-GMM for three cases: (1) excluding other balance sheet components; (2) including other balance sheet components, but treating them as exogenous; (3) considering only retained earnings, shareholder capital, loan, and investment adjustments. The main concern is the effect of capital regulation (*L.REG*) and capital ratios (*L.CAR*) on balance sheet adjustments, particularly retained earnings (*ΔRE*), shareholder capital (*ΔSHC*), loans (*ΔLOAN*), and investments (*ΔINV*). These estimations are compared to the regression results in Table 6.5 when the endogeneity of lagged dependent variables is not considered, and results in Table 6.7 and Table 6.8 when both the endogeneity of lagged dependent variables and balance sheet components are considered. For convenience, these estimations are re-displayed in columns (1) and (3), respectively, in Table 6.12.

Table 6.12 Robustness Checks for Balance Sheet Adjustment Specifications

	FEM	SYS-GMM	SYS-GMM	SYS-GMM	SYS-GMM
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Panel A: Retained Earnings Adjustments					
L.REG	-0.974	-0.804	-0.756	-0.173	-0.598
	(0.889)	(0.500)	(0.519)	(0.532)	(0.620)
L.CAR	-0.982	-0.984**	-0.977**	-1.240***	-1.136***
	(0.949)	(0.392)	(0.429)	(0.390)	(0.429)
Control Variables	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes
Endogeneity of Lagged Dependent Variables	No	Yes	Yes	Yes	Yes
Endogeneity of *ΔSHC, ΔINV, ΔLOAN*	No	No	Yes	No	Yes
Endogeneity of *ΔOC, ΔIA, ΔOC*	No	No	Yes	No	No
Observations	1,400	1,400	1,400	1,400	1,400
Banks	279	279	279	279	279
Instruments		34	45	29	32
AR(2) Test (p-value)		0.960	0.993	0.449	0.634
Hansen Test (p-value)		0.580	0.118	0.213	0.828
Panel B: Shareholder Capital Adjustments					
L.REG	-0.685*	-0.616**	-0.609**	-0.651**	-0.651**
	(0.367)	(0.249)	(0.271)	(0.272)	(0.258)
L.CAR	-0.137	-0.601***	-0.515**	-0.491***	-0.567***
	(0.275)	(0.173)	(0.224)	(0.181)	(0.171)
Control Variables	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes
Endogeneity of Lagged Dependent Variables	No	Yes	Yes	Yes	Yes
Endogeneity of *ΔRE, ΔINV, ΔLOAN*	No	No	Yes	No	Yes
Endogeneity of *ΔOC, ΔIA, ΔOC*	No	No	Yes	No	No
Observations	1,375	1,459	1,459	1,459	1,459

	FEM	SYS-GMM	SYS-GMM	SYS-GMM	SYS-GMM
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Banks	276	290	290	290	290
Instruments		33	106	27	42
AR(2) Test (p-value)		0.198	0.311	0.240	0.251
Hansen Test (p-value)		0.841	0.115	0.318	0.209
Panel C: Investment Adjustments					
L.REG	2.951***	2.198***	1.749***	1.905***	1.790***
	(0.738)	(0.509)	(0.501)	(0.603)	(0.492)
L.CAR	-0.435	-1.047***	-0.987***	-1.501***	-1.043***
	(0.691)	(0.290)	(0.277)	(0.454)	(0.295)
Control Variables	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes
Endogeneity of Lagged Dependent Variables	No	Yes	Yes	Yes	Yes
Endogeneity of *ΔRE, ΔSHC, ΔLOAN*	No	No	Yes	No	Yes
Endogeneity of *ΔOC, ΔIA, ΔOC*	No	No	Yes	No	No
Observations	1,411	1,459	1,459	1,459	1,459
Banks	279	290	290	290	290
Instruments		31	43	26	42
AR(2) Test (p-value)		0.474	0.175	0.239	0.198
Hansen Test (p-value)		0.511	0.329	0.149	0.332
Panel D: Loan Adjustments					
L.REG	-0.118	-0.026	-0.326*	-0.082	-0.082
	(0.197)	(0.153)	(0.188)	(0.156)	(0.159)
L.CAR	0.285	0.442***	0.581***	0.312**	0.405**
	(0.225)	(0.151)	(0.147)	(0.152)	(0.164)
Control Variables	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes
Endogeneity of Lagged Dependent Variables	No	Yes	Yes	Yes	Yes
Endogeneity of *ΔRE, ΔSHC, ΔINV*	No	No	Yes	No	Yes
Endogeneity of *ΔOC, ΔIA, ΔOC*	No	No	Yes	No	No
Observations	1,393	1,459	1,459	1,459	1,459
Banks	275	290	290	290	290
Instruments		33	78	27	42
AR(2) Test (p-value)		0.423	0.407	0.235	0.929
Hansen Test (p-value)		0.604	0.191	0.359	0.034

Notes: This table presents the regression results of equation (3.24). The dependent variables are retained earning adjustments (Panel A), shareholder capital adjustments (Panel B), investment adjustments (Panel C), and loan adjustments (panel D). The instruments in estimations (2) and (4) are lags 1 to 3 periods of lagged dependent variables for Panel A, lags 1 to 3 periods for Panels B and C, and lags 1 to 2 periods for Panel D. The instruments in estimation (3) are lags 1 to 2 periods of endogenous variables for Panel A and C, lags 2 to 12 periods for Panel B, lags 2 to 8 periods for Panel D. The instruments in estimation (5) are lags 1 of endogenous variables for Panel A, lags 1 to 4 periods for Panel B, C and D. Robust standard errors in parentheses. *, **, *** represent significance levels at 0.1, 0.05, and 0.01, respectively. Control variables and Time dummies are not reported.
Source: Author’s calculations.

The results in Table 6.12 show that the effects of capital regulation on the adjustment of retained earnings, shareholder capital, and investments are quite similar in all estimations, in terms of sign and significance. However, the effect on loan adjustment is no more significant. This suggests that ignoring the inter-relationship of balance sheet component adjustments, when assessing the effect of capital regulation on lending, can bias the estimation and distort the conclusion. Specifically, while an increase in capital regulation causes a reduction in loan growth, ignoring the inter-relationship of balance sheet component adjustments can lead to a conclusion of no effect of capital regulation on loan adjustment. Such a conclusion lowers the economic cost of capital regulation and probably affects the design of capital regulation. The estimations in Table 6.12 additionally indicate that *L.CAR* coefficients are insignificant when the endogeneity of lagged dependent variables are not concerned, but are significant otherwise. Therefore, the dynamic of balance sheet components should be considered and properly addressed.

6.7 Chapter Summary

This chapter has examined balance sheet adjustments of banks in 15 Asian countries during the period of 2004-2016. Employing both descriptive analyses, through normalizing changes in balance sheet components, and formal regression analysis, using two-step SYS-GMM, the chapter arrives at several important conclusions.

During the study period (2004 - 2016), Asian banks not only strengthened their capital base, primarily through retained earnings, but also expanded their asset levels. However, their risk adjustments were not homogenous. Among asset categories, loans made up the highest contribution in total asset growth, as well as overall bank riskiness. The study also found a competing role of interbank assets, investments and other assets, and a supplement role between these assets and loans.

Surprisingly, the capital enhancement through retained earnings and shareholder capital was not a result of the stricter capital regulation, but due to bank capital ratio. In addition, stricter capital regulation induced banks to increase adjustments in investments and other assets and reduce adjustments in lending. In particular, banks with low capital ratios focused more on investments and other asset adjustments and had lower adjustments in loans. Stricter capital regulation even induced banks in emerging and BCBS-member countries to reduce retained earning adjustments. In contrast, banks in frontier and non BCBS-member countries reduced shareholder capital adjustments. Investment increases were observed for banks in all countries, but loan reductions were only detected for banks in emerging and BCBS-member countries.

The chapter has also raised concerns about the inter-relationship between balance sheet component adjustments, which have been ignored in prior studies. Our study has shown that banks, which aim to improve their capital base, increase both retained earnings and shareholder capital. The strengthening of regulatory capital is accompanied by asset expansion and banks use high quality capital (that is, retained earnings and shareholder capital) primarily to finance loans. Conversely, adjustments in asset components of bank balance sheets were affected by each other, as well as capital adjustments. Ignoring such inter-relationship, particularly when assessing the effects of capital regulation on lending, can bias estimations and distort conclusions.

Chapter 7

Conclusion

7.1 Introduction

This chapter summarizes the study and draw conclusions about the effects of capital regulation on bank behavior in Asia. While section 7.2 briefly reviews the study, section 7.3 discusses the main findings and implications according to each of the three research objectives. Section 7.4 raises some policy implications and recommendations based on the research findings. Section 7.5 states the limitations of the study and section 7.6 suggests directions for future research.

7.2 Overview of the Study

Capital regulation is one of the primary focus of regulators in regulating and assessing banks' operations. Together with other prudential instruments such as interbank exposure limits, concentration limits, loan-to-value ratio limits, and reserve requirements, capital regulation aims to maintain the stability and credibility of the financial system. The Basel Accord, which was first introduced by the Basel Committee in 1988 and revised regularly since then, has established international standards for capital regulation worldwide. However, the effects of capital regulation, particularly Basel Accord, are still widely debated.

This study has investigated bank responses to capital regulation to discover whether it encourages banks to operate safely or not. Specifically, we have examined how capital regulation affects bank capital ratios (Research Objective 1), how banks adjust their capital and risk in response to capital regulations (Research Objective 2), and how capital regulation affects bank balance sheet adjustments (Research Objective 3). This study has focused on Asian banks, which have received limited attention in empirical studies compared to the U.S and European countries. Given more convergence in implementing Basel III among Asian countries, understanding the effects of capital regulation on bank behavior in these countries is of great importance.

In order to explore the effect of capital regulation on bank capital ratio, this study employed the PAM model, which considers the existence of a target capital ratio and the adjustment cost in reaching this target level. A sample of 545 banks in 20 Asian countries during the period 2001-2016 was used. Due to the dynamic nature of the model, data was analyzed using SYS-GMM.

The effects of capital regulation on bank capital and risk behavior were investigated using the SEM-PAM model. The emphasis was on the existence of fixed effects, which are usually ignored in prior studies.

Therefore, two models – one that considered adjustments in capital and risk, and the other that considered capital and risk levels – were used. The first model was analyzed using the 2SLS method for panel data while the latter employed the SYS-GMM method. Due to the unavailability of data on regulatory capital and risk-weighted assets for certain observations, primarily due to public disclosure requirements, the sample for analysis reduced to 440 banks across 19 countries.

In order to detect effects of capital regulation on bank balance sheet adjustments, this study modified Francis and Osborne (2012) model by accounting for the dynamics of balance sheet adjustments, as well as the inter-relationship between them. The model was then estimated with SYS-GMM for a sample of 290 banks in 15 countries during the period of 2004-2016. The reduction of the sample size was caused by the unavailability of data before 2004 and the treatment of outliers.

Our dataset covered a relatively wide range of countries that differentiate themselves in terms of levels of economic, financial, and regulatory development. We considered these factors by investigating bank behavior in countries with similar market characteristics (that is, based on classifications of the country as a developed, emerging or frontier market), and bank capital regulatory environment (that is, based on whether the country was a BCBS member or not). Furthermore, we acknowledged the importance of a proper measurement of capital regulation that could capture both quantitative and qualitative aspect of capital regulation. Therefore, we developed a new measurement of capital regulation, namely the Advanced Capital Regulation Index and applied this index as a proxy for capital regulation. The research results were substantiated by a number of descriptive, empirical analyses, and robustness checks.

7.3 Summary of Main Findings and Implications

This section summarizes the main findings of chapters 4, 5, and 6, which correspond to the three research objectives. We compare and contrast these findings to previous studies and identify key implications of the empirical results.

7.3.1 Effects of Capital Regulation on Capital Ratios of Asian Banks

Our study has confirmed that capital regulation is effective in inducing banks to raise capital ratios. This conclusion holds for different measurements of capital ratio; Total Regulatory Capital ratios, Leverage ratios and Tier 1 ratios. In term of total regulatory capital ratios, our finding supports several earlier studies which measured capital regulation as individual capital requirements set by national authorities ((Alfon et al., 2005; Francis & Osborne, 2010; Wong et al., 2005). It also aligns with Ahmad et al. (2008) study which used a time dummy to indicate increases in capital adequacy standards in Malaysia, and Zahid et al. (2015) study (for Pakistani banks), which measured capital regulation using distance from minimum capital requirements. However, Ahmad et al. (2008) study which used the two other variables of capital regulation, the industry capital ratio as a threshold, and a time dummy to reflect the amendment in capital regulation, respectively, showed a negative/no effect of capital regulation.

The Leverage ratio result is consistent with Brewer III et al. (2008) study, which used Barth et al. (2001) CRI index. However, the result contrasts with Kleff and Weber (2008) study of German banks, Bouheni and Rachdi (2015) work on Tunisia banks, and De Jonghe and Öztekin (2015) investigation of banks in 64 countries, which found a negative impact of capital regulation. Bougatef and Mgadmi (2016) even suggest that capital regulation has no influence on the Leverage ratio. Brewer III et al. (2008); Saibal et al. (2004) examined the effect of capital regulation on Tier 1 ratios but showed negative and no effect of capital regulation. The difference in our conclusion with most previous studies can be attributed to the measurement of capital regulation. Since capital regulation measurements in these studies primarily reflect the total capital adequacy ratio, there should be little explanation for variation in Leverage and Tier 1 capital ratios.

Together, these results have two major implications. First, if quantitatively regulating bank capital induces banks to have higher capital ratios, regulators need to focus on raising the minimum capital requirement. However, the Basel Committee has kept this minimum capital requirement at 8% since 1988. Instead, they have strengthened the regulation about regulatory capital qualifications and risk determinations and complemented total adequacy capital ratios with other requirements, such as leverage ratios or capital buffers. In addition, not many national jurisdictions raise minimum capital ratio requirements. Some even lower this ratio, like Azerbaijan and Kazakhstan. This is partly because the higher minimum capital requirement is not only associated with better stability, but also lowers banks' intermediation role. Regulators try to raise the minimum capital requirement indirectly through other regulations. Second, it emphasizes that capital regulation is a multi-faceted issue and that quantitative measurement alone cannot fully reflect the regulation effect. Failure to measure different aspects of capital regulation in previous studies frustrates conclusions about the effects of capital regulation.

Despite the positive effect of capital regulation on bank capital ratios, the effect is relatively small, and ranges from 0.06 to 0.10 for different capital ratio measurements. In addition, banks in frontier and non-BCBS member countries have higher average total regulatory capital ratios than those in other countries, despite less strict capital regulation. The capital ratios of these banks are also not affected by capital regulation. These results suggest that the positive effect of capital regulation is still not large enough to override the negative impact of bank characteristics and other country-specific factors, in particular, bank size, loan ratios, and economic growth. Therefore, we expect that new rules under Basel III, including additional capital requirements and enhanced supervision for G-SIBs and domestic systemically important banks (D-SIBs), and countercyclical buffers, can help address these issues.

Table 7.1 summarizes the main findings for research objective 1.

Table 7.1 Summary of Main Findings for Research Objective 1

	Full Sample	Country Group			Basel Committee Member	
		Developed	Emerging	Frontier	BCBS	Non-BCBS
REG - CAR	(+)***	(+)***	(+)**	0	(+)**	0

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

7.3.2 Effects of Capital Regulation on the Adjustments of Capital and Risk of Asian Banks

Under the force of capital regulation, banks are expected to increase their capital and reduce their risk. However, our study has shown that stricter capital regulation induced banks to change capital less (by 0.052% marginally), while having no influence on changes in bank risk. The finding for changes in capital is not supported by prior literature, despite evidence on the ineffectiveness of capital regulation on changes in bank risk (see for example, Rime (2001); Teply and Matejasák (2007); Van Roy (2005); Zhang et al. (2008)). Two possible reasons are our different measurement of capital regulation, which was ACRI index, and modelling of capital and risk behaviors considering bank fixed effects.

First, regarding the capital regulation measurement, our estimation using a probabilistic approach produced similar results to the aforementioned studies for undercapitalized banks (those which have capital ratios below the minimum requirement). However, it showed cautious behavior (positive changes in capital and negative changes in risk) for adequately capitalized banks (those with capital ratios above the minimum requirement). Estimations using the dummy approach, however, revealed a positive effect of capital regulation on the risk adjustment of undercapitalized banks (those with capital ratios below the minimum requirement). The differences between these results and our findings using the ACRI index raise an important point. Specifically, traditional measurements rely primarily on bank capital ratios and a threshold, usually the minimum capital requirement. These measurements reflect the quantitative aspect of capital regulation only. In addition, the minimum capital requirement, despite being the core of capital regulation, is insufficient to capture the effects of stricter capital regulation. Therefore, the Advanced Capital Regulation Index, which reflects both qualitative and quantitative aspects of capital regulation, is superior in measuring the effects of capital regulation.

Second, concerning bank fixed effects, our estimation which used pooled-2SLS, yielded positive effects of capital regulation on changes in bank capital. This result is consistent with most previous studies (see for example, Cannata and Quagliariello (2006); Pereira and Saito (2015); Rime (2001); Teply and Matejasák (2007); Zhang et al. (2008)). These studies also suggest a significant and negative relationship between changes in bank capital and risk. Conversely, our estimation, which considers bank fixed effects, found a negative effect of changes in risk on changes in capital only. Therefore, we conclude that studies on bank capital and risk behavior should take into account bank fixed effects. Omitting such effects can distort conclusions about the effect of capital regulation.

Given the existence of bank fixed effects, our study has also examined the effects of capital regulation on bank capital and risk levels using the simultaneous equations model with partial adjustment. However, we found no effect of capital regulation on both bank capital and risk levels. The results confirm Heid et al. (2003) work on German banks, and Bougatef and Mgadmi (2016) study of banks in MENA countries. Together with the significant effect of capital regulation on changes in bank capital, it explains why changes in capital and risk rather than their levels are commonly used in studying the effects of capital regulation. In addition, these results suggest that strengthening capital regulations are not an effective way to promote bank soundness and discipline bank behavior.

Collectively, the results have shown that capital regulation plays a limited role in the management of bank capital and, particularly, risk. Instead, these decisions are largely driven by bank characteristics such as size, profitability, lending, loan quality, tangibility, and deposit ratios, as well as macro-factors such as economic growth. Specifically, banks will increase their capital if they are smaller, have higher levels of profitability, lower rates of lending, lower asset quality, high tangibility and in during periods of economic downturn. In addition, they will lower theirs risk when they are larger, have lower levels of profitability, lower rates of lending, higher quality assets, lower tangibility, higher deposit ratios and in periods of economic downturn.

Interestingly, our study has found that bank capital and risk behavior are not homogeneous across countries. Capital regulation induces banks in developed markets to marginally reduce their changes in risk by 0.203% and lower risk levels by 0.259%. Although these banks reduce capital adjustments and lower capital levels at the same time, the effect is much smaller than that on bank risk. This behavior contrasts with the U.S and European banks which have made greater changes in bank capital and less changes in bank risk (see for example, Jacques and Nigro (1997); Shrieves and Dahl (1992); Teply and Matejasák (2007)). One possible explanation might be the stricter regulatory environment in the U.S and EU. The regulatory framework in Asia is more rule-based and focused on compliance with these principles. Asia also has less independence and a weaker power of supervisory agencies compared to other regions (Sahay et al., 2015). In contrast, U.S banks are under the regulation and supervision of multiple agencies. Specifically, national banks are regulated by the Comptroller of the Currency, the Federal Reserve and

FDIC, while state banks are regulated by respective state agencies, the Federal Reserve (if they are members) and the FDIC (if they are insured) (Madura, 2010). European banks are under the regulation and supervision of national authorities, in addition to the European Central Bank (for Euro member countries and participating non-euro area Member States), and the European Banking Authority (previously the Committee of European Banking Supervisors) (Kawai & Morgan, 2014).

Conversely, stricter capital regulation induces banks in emerging markets to change their capital less and change their risk more. These banks also have lower levels of capital and higher risk levels. Although a negative effect of capital regulation on bank capital has also been found for banks in Turkey, Korea, Malaysia, Thailand (Hussain & Hassan, 2005) and Indonesia (Parinduri & Riyanto, 2011), these banks made less changes in bank risk at the same time. Banks that made greater changes in their risk levels also changed their capital more (Saadaoui, 2011). Nevertheless, these studies suggest that there is at least some evidence of either a negative effect of capital regulation on changes in bank capital or a positive effect on changes in bank risk. Asian banks generally have stronger balance sheets and do not necessarily recapitalize to improve them (Freshfields Bruckhaus Deringer, 2008).

Our findings on the ineffectiveness of capital regulation on capital and risk behavior of banks in frontier countries are consistent with prior literature (see Bougatef and Mgadmi (2016); Bouheni and Rachdi (2015); Ghosh (2014)). These countries lack adequate legal frameworks and face market constraints to facilitate the effectiveness of the capital regulation. In addition, frontier countries suffer from less financial development and an absence of competitive capital markets necessary for capital standards to be effective (Rojas-Suarez, 2002). Rojas-Suarez (2002), suggests two conditions crucial for the effectiveness of capital regulation in frontier markets. These are (i) the data and the overall supervisory framework, and (ii) the depth and efficiency of the markets.

Although BCBS members are bound to the Basel capital standards and banks in these countries should behave more prudentially, we did not find any differences in bank behavior between banks in member and non-member countries. Besides, we found no effect of bank capitalization levels on the relationship between capital regulation and bank behavior (both capital and risk), as suggested by Calem and Rob (1999); Zhang et al. (2008). However, if banks have capital ratios below the median levels of the country, they will raise their capital levels. The increase in capital levels is greater among the least capitalized banks in the country. Overall, our findings on the effects of capital regulation on bank capital and risk behavior are largely driven by adequately capitalized banks.

Table 7.2 summarizes the main findings for research objective 2.

Table 7.2 Summary of Main Findings for Research Objective 2

	Full sample	Country Group			Basel Committee Member	
		Developed	Emerging	Frontier	BCBS	Non-BCBS
REG – ΔCAPTA	(-)**	(-)***	(-)*	0	(-)**	(-)**
REG – ΔRWATA	0	(-)***	(+)**	0	0	0
REG-CAPTA	0	(-)**	(-)***	0	0	0
REG-RWATA	0	(-)**	(+)***	0	0	0
	Adequately Capitalized Banks		**Undercapitalized Banks**			
	CAR ≥ Min CAR	**CAR ≥ 50th pct.**	**CAR < Min CAR**	**CAR < 50th pct.**	**CAR < 25th pct.**	**25th pct. ≤ CAR < 50th pct.**
REG - ΔCAPTA	(-)*	(-)**	0	0	0	0
REG - ΔRWATA	0	0	0	0	0	0
REG-CAPTA	0	0	0	(+)**	(+)***	(+)**
REG-RWATA	0	0	0	0	0	0

Notes: The "pct." denotes percentile. *, **, *** indicate significance levels at 0.1, 0.05 and 0.01 levels, respectively.

7.3.3 Effects of Capital Regulation on Asian Bank Balance Sheet Adjustments

During the study period (2004 - 2016), Asian banks not only strengthened their capital base, primarily through retained earnings, but also expanded their assets. However, the strengthening of capital base, such as retained earnings and shareholder capital, was not the result of stricter capital regulation. Stricter capital regulation even induced banks in emerging and BCBS-member countries to reduce retained earnings adjustments. In contrast, banks in frontier and non BCBS-member countries reduced shareholder capital adjustments. These findings contradict previous studies which suggest that banks raise either Tier 1 capital or Tier 2 capital under the effect of capital regulation (see Aggarwal and Jacques (2001); De-Ramon et al. (2016); Francis and Osborne (2012); Horiuchi and Shimizu (1998); Ito and Sasaki (2002)). In contrast, we found a negative effect of bank capital ratios on adjustments in retained earnings and shareholder capital. The lower the capital ratio, the greater banks increase their retained earnings and shareholder capital. Therefore, the findings for bank capital ratios seem to be more consistent with prior studies. It is also worth noting that capital regulation in prior studies referred to banks' actual capital ratios (Horiuchi & Shimizu, 1998; Ito & Sasaki, 2002), a comparison between banks' actual capital ratio and different undercapitalization levels (Aggarwal & Jacques, 2001), or a comparison between banks' actual capital ratios and target capital levels (De-Ramon et al., 2016; Francis & Osborne, 2012). Thus, it is necessary to distinguish between the effects of capital regulation and capital ratios, when making claims about the effects of capital regulation on bank balance sheet adjustments. A low capitalized bank might strengthen its capital base not purely to avoid regulatory breaches, but also to gain the confidence of market participants. Nevertheless, capital regulation is important in the way it sets standards to determine bank capital adequacy ratios.

In addition, our study has found that stricter capital regulation induces banks to increase adjustments in investments and other assets and reduce adjustments in lending. These results confirm the findings of several prior studies (Cumming and Nel (2005); Furfine (2001); Hall (1993); Peek and Rosengren (1995). In addition, banks with low capital ratios focus more on investments and other asset adjustments, and have lower adjustments in loans, as suggested by Catalan et al. (2017); Haubrich and Wachtel (1993). Increases in investments was observed for banks in all of the sampled countries, while loan reductions were detected only for banks in emerging and BCBS-member countries. This provides evidence of a capital crunch in Asia. A slow-down in bank lending is necessary if the soundness of banking system is maintained. However, Lee and Hsieh (2013) show that increasing capital requirements increased Asian banks' risk (measured as volatility of return on equity). Fu et al. (2014) reveal no effect of capital requirements on bank risk (measured either by probability of default or probability of banks' insolvency) in the Asia Pacific. Conversely, in a cross-country analysis that included Asia, Laeven and Levine (2009) found a negative effect of capital regulation on bank risk. Although there are still debates around the role of capital regulation on disciplining bank risk, a reduction in lending is obviously an unfavorable consequence of capital regulation. Thus, further effort for a proper determination of risk-weighted assets that does not penalize loans with high risk-weights are required.

Table 7.3 summarizes the main findings for research objective 3.

Table 7.3 Summary of Main Findings for Research Objective 3

	Full Sample	**Country Group**			**Basel Committee Member**	
		Developed	**Emerging**	**Frontier**	**BCBS**	**Non-BCBS**
REG - ΔRE	0	0	(-)**	0	(-)*	0
REG - ΔSHC	(-)***	0	0	(-)**	0	(-)**
REG - ΔOC	0					
REG - ΔIA	0					
REG - ΔINV	(+)***	(+)*	(+)***	(+)**	(+)***	(+)**
REG - ΔLOAN	(-)*	0	(-)***	0	(-)***	0
REG - ΔOA	(+)***					

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

7.4 Policy Implications and Recommendations

Our research findings highlight the positive effect of capital regulation on banks' regulatory capital ratios and the usefulness of the regulatory capital ratio in inducing banks to strengthen their capital base. In section 7.4.1, we raise some additional concerns regarding the use of this capital ratio. In contrast, our study suggests a limited effect of capital regulation on bank risk mitigation, together with its negative effects on capital enhancement and lending. Section 7.4.2 indicates two possible causes of such effects, including the complexity of the capital regulation and the design of the risk-weighting system. On this basis, we make recommendations on potential reforms of capital regulation with an emphasis on its simplicity and comparability, and the risk-weighting requirements. These recommendations include a simplified leverage ratio, a greater emphasis on new equity raising, more national discretion, as well as an enhancement of risk-weights standards, risk level constraints, and reinforcements to the supervisor review process.

7.4.1 Capital Adequacy Ratio

Our study suggests that capital regulation has been successful in establishing a standard for capital ratio. Without such regulation, banks may not hold as high capital ratio as being observed. The capital ratio has now been among key indicators of bank solvency and widely used by regulatory and supervisory authorities, bank managers, and investors to assess bank soundness. However, the use of capital ratio should take into account two concerns, which are (i) the comparability of the ratio, and (ii) its measurement.

First, capital ratios are incomparable across countries and over time. This arises from different regulation of capital ratios in different countries, and the regular revision of capital regulation. Although the capital regulation in most countries follows the Basel capital standards, different implementation stages of Basel versions (Basel I, II or III), the national discretion in eligible capital instruments, asset risk weights determination, and risk measurement approaches give rise to the disparate nature of capital ratios. For these reasons, capital ratios should only be used to compare bank solvency in the same country at a specific time. For a longer period, comparison is possible as long as there are no changes in capital rules.

Second, when using capital ratios to assess bank solvency, it is necessary to understand the calculation involved. The resulting capital ratio is a mixture of capital components, asset portfolios, and different measurement approaches. Therefore, a similar capital ratio may conceal different information about capital and asset quality of the bank. For example, using a sample of 14 global banks in EU, Asia Pacific and North America, Le Leslé and Avramova (2012) show that a 9% core Tier 1 ratio in these banks corresponds to a variation between 3 and 7% leverage ratio, and a variation between 23 and 77% in risk weighted asset ratios. Although details about capital ratio calculations must be published (in countries adopting Pillar 2 of Basel II and Basel III), such information is frequently ignored or is not fully understood by market participants. The main reasons lie in the complexity of capital ratios determination, limited knowledge of the models used, as well as the observability and netting standards of off-balance sheet exposures (Fullenkamp & Rochon, 2017).

7.4.2 Design of Capital Regulation

Despite the positive effect of capital regulation on bank capital ratios, its limited effect on bank capital enhancement and risk mitigation suggest the need for a better design of capital regulation. Over the past thirty years, capital regulation has become increasingly complex. From a thirty-page length Basel I agreement, the standard has increased to 347 pages in Basel II, and up to 616 pages in Basel III. The parameters for risk-weighted capital ratio calculations have also seen a dramatic change; from single figures to several million (Haldane & Madouros, 2012). While the number of minimum requirements was limited to two ratios (Tier 1 and Total capital ratios) in Basel I, it increased to nine in Basel III, including five capital ratios, two liquidity ratios and two buffer ratios (BCBS, 1988, 2010a). Furthermore, U.S G-SIB banks are subject to 39 different regulatory capital requirements (Herring, 2018). Our average ACRI index also indicates an increase from 6.65 in 2001 to 17.65 in 2016. The country with the least strict capital regulation in the sample – Vietnam – has seen an index increase from 2 in 2001 to 7 in 2016. In contrast, the country with the strictest capital regulation – Singapore – has seen an index increase from 10 to 23 during the same period.

The evolving complexity of capital regulation has been criticized for imposing greater costs on banks. Banks have to maximise the profit while ensuring compliance with regulations (Herring, 2018). McKinsey report showed a 45 times increase in regulatory fees from 20 large U.S and EU universal banks during the period of 2009-2014 (Kaminski & Robu, 2016). There has also been a dramatic increase in the number of regulators and bank compliance personnel in the financial sector (Haldane & Madouros, 2012). The complexity provides banks with more scope for manipulation and arbitrages (Haldane & Madouros, 2012). This causes difficulties for external market participants to assess bank soundness and monitor bank operations. This also prevents supervisors from proper oversight and verification of capital ratios to enable prompt corrective actions. Consequently, the complex capital regulation undermines its own efficacy, particularly in promoting the safety and soundness of the banking system (Herring, 2018).

For such reasons, simplicity is recognized as an additional objective of the Basel capital framework, while ensuring its risk sensitivity and comparability (BCBS, 2013b). However, the challenge is how to simplify the standards while ensuring their risk sensitivity. These two objectives seem to contradict each other and suggest an acceptable level of simplicity and sensitivity. The Committee then proposed several potential considerations, including, enhancing levels of disclosure, developing a standardized set of resilience measures, making use of the leverage ratio, utilizing added floors and benchmarks, reconsidering the relationship between internal and regulatory models, limiting national discretion, consolidating the standards, and addressing factors driving complexity (BCBS, 2013b). Conversely, simplicity and comparability enhance each other. Therefore, we suggest that there should be a separation of risk sensitivity from simplicity and comparability.

Simplicity and Comparability of Capital Regulation

The simplicity and comparability of capital regulation can be achieved through a standard leverage ratio. The utilization of the leverage ratio gained substantial attention after the failure of the Basel standard during the 2007-2009 financial crisis. This non-risk-based ratio has three important benefits over the risk-based capital ratio. First, the leverage ratio is measured as the ratio of equity over assets (or possibly, as tangible equity over tangible assets). The simple calculation prevents the ratio from model risk and measurement errors, thus, reduces the possibility of capital arbitrage (Le Leslé & Avramova, 2012). Second, the leverage ratio can act as a standardized measure that enables bank stakeholders to properly compare and assess bank solvency (BCBS, 2013b). Third, it is a better predictor of bank failure than the risk-based capital ratio (Haldane & Madouros, 2012).

However, an important concern is how high this minimum leverage ratio should be set. The current 3% minimum requirement under Basel III framework has been criticized as being too low and may not create sufficient discipline for banks to operate safely (Admati, 2016). Different calculations using various methods yield different minimum levels, ranging from 5% (Carey, 2018) to as high as 20% (Admati & Hellwig, 2014). A higher leverage ratio is preferable since it internalizes bank losses and creates incentives for bank risk management (Admati, 2016). Admati (2016) also argues that a leverage ratio of 20% to 30% is minimal for a healthy firm and common among hedge funds, as well as the pre-safety net period. In addition, banks which are unable to raise equity to meet such minimum levels should be questioned about their healthiness. Therefore, the suggestion is that there should be a transition and progress toward a higher leverage ratio.

In addition, regulators should supplement the transition to the higher leverage ratio requirement by encouraging banks to raise new equity, rather than just maintain the leverage ratio. Since banks cannot expand their assets without raising new equity, when the leverage ratio reaches the minimum requirement, a planned and gradual accumulation of equity lessens the pressure on bank assets growth and allows banks to pursue growth strategies. To illustrate, consider a bank (bank A) with a 5% leverage ratio comprising of $5 billion equity and $100 billion assets. Assume the minimum leverage ratio is currently set at 5% and will increase to 6% after 3 years. In order to reach the new minimum requirement after 3 years, bank A has four options (see Figure 7.1). Option 2 shows that the bank has to shrink its assets unless it raises new equity. Increasing equity, however, reduces the amount of asset reductions (option 3), requires no asset reductions (option 1), or enables asset growth (option 4).

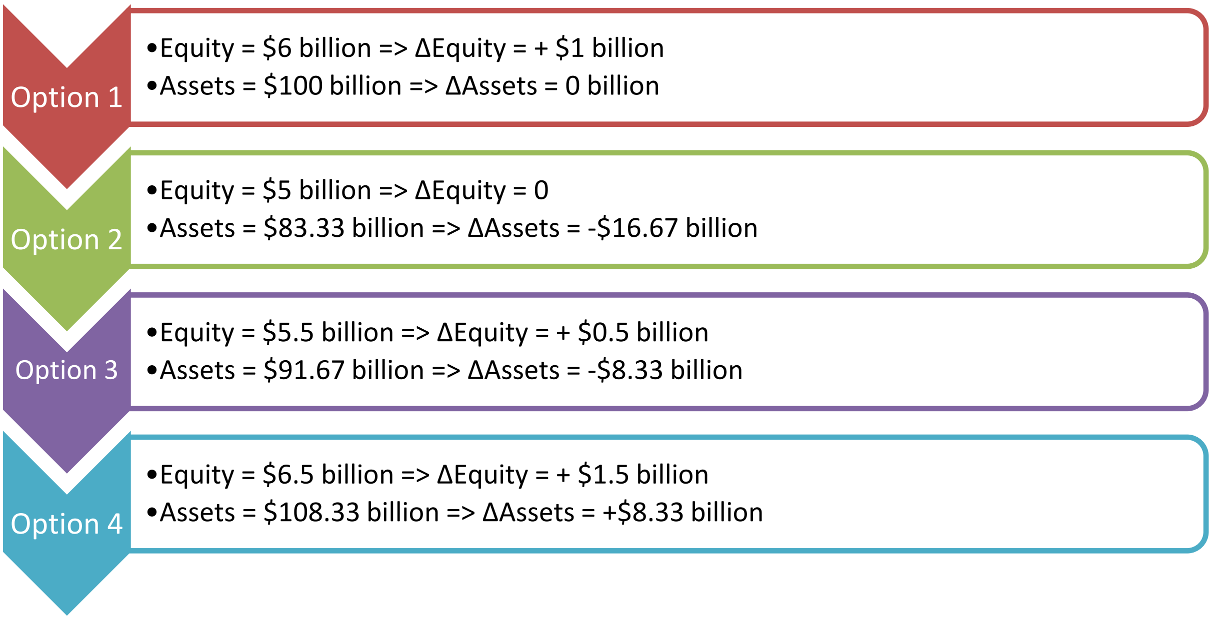

Figure 7.1 Bank Options in Reaching the Increase in Minimum Leverage Ratio Requirement

One may argue that this scheme causes disadvantages for large banks compared to small banks since they have to raise larger amounts of equity. For instance, choosing option 1, the aforementioned bank (bank A) has to raise $1 billion equity after 3 years while another bank (bank B), with the same 5% leverage ratio but only $10 billion assets, has to only raise $0.1 billion equity. However, our analysis showed that larger banks adjusted their capital less and had lower capital levels than smaller banks (see Chapter 5). Since these banks have better access to equity markets, they keep their capital as low as possible to maximize profits with the belief that they can raise capital easily when needed (Aggarwal & Jacques, 2001). In addition, the Basel Committee suggests the consideration of a buffer structure for the leverage ratio, similar to the risk-based capital ratio and a stronger requirement for G-SIBs. Therefore, the same leverage ratio requirement for banks of different sizes can offset banks' unwillingness to raise equity and acts as a buffer requirement for large banks.

Another concern is whether the minimum leverage ratio should be the same for every country, or whether national jurisdictions can be allowed to determine their own ratios? Based on our analysis, the latter option is preferred. Given differences in macroeconomic conditions, national jurisdictions have a better understanding about their financial system. Therefore, the minimum leverage ratio can be set in consideration of historical levels of bank leverage ratios in the country, the development of capital markets, particularly the equity market, as well as economic growth. Obviously, when most banks in the country have a leverage ratio higher than 6%, for example, a 5% minimum leverage ratio will not be binding and will create no incentive for banks to strengthen their capital. In addition, in countries where the equity market is less developed, such as frontier countries, enforcing a high leverage ratio and fast transition period can place inevitable pressure on banks and even impair banking development as well as economic growth. Although such national discretion challenges the objectives of the Basel capital framework in creating a level playing field for banks across countries (BCBS, 2013b), we should keep in mind that this objective has not been reached since the first version of Basel standards (Basel I) and seems to be far from realization.

Risk Sensitivity

Our empirical results suggest the ineffectiveness of the current capital regulation in constraining bank risk-taking, at least for Asian emerging and frontier countries. In addition, it initiates a reduction in lending to favour less risk-weighted assets, such as securities and derivatives. Although the risk-weighting system is an innovation in measuring bank risk, it cannot avoid certain limitations in accurately reflecting bank riskiness. Le Leslé and Avramova (2012) note that the current risk-weight design (Basel III) faces considerable subjectivity and different interpretations. The flexibility in calculating risk-weighted assets induces bank innovation to avoid constraints caused by the risk-weighted capital requirements. It is also the main source of capital arbitrage, particularly with the existence of non-capital regulated entities (Masera, 2012). Consequently, there has been growing concern about the credibility and reliability of the reported risk-weighted capital ratio (Le Leslé & Avramova, 2012).

Recognizing the importance of a reliable and credible risk-weight system, in its latest efforts, the Basel Committee, has reformed the Basel framework with a focus on restoring market confidence in the calculation of risk-weighted assets (BCBS, 2017). Specifically, the reform enhances the robustness and risk sensitivity of the standardized approaches for credit and operational risks. In addition, it limits the use of internally modelled approaches, which have been identified as the primary source of complexity in the capital framework (BCBS, 2013b). Nevertheless, once risk is a denominator of the capital ratio and the limitation is on this ratio, there is still scope for capital arbitrage.

Our suggestion is to establish constraints in term of the maximum risk levels (risk ceiling), which is a ratio of total risk-weighted assets over total assets. In our study, Asian banks have an average risk level of 64% and most banks (99%) have a ratio less than 100%. Camara et al. (2013) report a 67% risk level among European banks for highly capitalized banks and 75.5% for strongly undercapitalized banks. In Albaity and Toobaee (2017) study, large listed banks in 30 countries have an average risk level of 64.6%. Banks in the

US maintain an average risk level of 71.6%, with a maximum up to 241.7% (Abreu & Gulamhussen, 2015). Determining the acceptable maximum risk level requires further research. In addition, the 12.5 multiplier of market and operational risks also needs further consideration since the minimum capital requirement is no longer the risk-based capital ratio and 8%.

Risk is multi-faceted and measuring risk is not easy. In addition, every measurement are associated with errors. Therefore, there needs to be more focus on risk management. This is similar to Pillar 2 in the current Basel framework. However, the emphasis is on banks' risk profile and management rather than capital adequacy. Banks should conduct a comprehensive self-assessment of all their risks and ensure that they have a proper process in place for controlling and mitigating these risks. To be effective, banks should keep identifying and updating all potential risks related to their businesses. Emerging risks include data-related risks, industry disruptions due to new technologies, geopolitical risks, global regulatory fragmentation, model risks, industry disruptions due to regulatory arbitrage, and social risks (EY, 2017). In addition, it is also necessary to continually upgrade risk management tools and techniques, as well as having proper investment into personnel and IT infrastructures. In such process, supervisors must play a supporting role by reviewing bank risk profiles and the risk management adequacy. Stress testing should be a part of this process. In principle, banks and supervisors should follow the Basel Committee standards and guidelines for risk management, including the management of credit risks, liquidity risks, interest rate risks, and operational risks. Other guidelines on corporate governance and stress testing are of equal importance.[26]

7.5 Limitations

Despite our greatest efforts, this study cannot avoid certain limitations. First, the study was subject to data availability for regulatory measures, such as total regulatory capital ratios, total regulatory capital, and risk-weighted assets. This data is not reported in many Asian countries in the sample, particularly frontier countries. This led to a large amount of missing data. Compared to the original sample (without these regulatory data), which comprised of more than 10,000 observations for 1,110 banks, the final sample of more than 3,000 observations with 545 banks is quite modest. In addition, data on types of capital and risk components are also limited. Therefore, we were unable to investigate further the effect

[26] These guidelines and standards are documented in the Principles for the Management of Credit Risk, Principles for Sound Liquidity Risk Management and Supervision, Interest Rate Risk in the Banking Book, Principles for the Sound Management of Operational Risk, Corporate Governance Principles for Banks, and Principles for Sound Stress Testing Practices and Supervision, which are available at the Basel Committee website (https://www.bis.org/bcbs/publications.htm?m=5%7C28%7C427).

of capital regulation on types of regulatory capital, such as Common Equity Tier 1, Tier 1, and Tier 2 capital, as well as types of bank risk, such as credit risk, market risk, and operational risk.

Second, this study did not include unlisted banks, since data for these banks is not available from the Bloomberg database. Listed and unlisted banks may differ in many aspects, such as their access to the capital markets, the risk and capital-holding incentives, and market pressure. Although these differences may affect the generalization of our results, such limitation is unavoidable given our access to the Bloomberg database only. In the future, when there is access to alternative sources of data, such as Fitch Connect, Orbis Bank Focus (previously Bankscope), this limitation can be overcome.

Third, our study did not distinguish between different types of banks, such as commercial banks, investment banks, and saving banks. It also did not consider types of ownership, such as private, foreign, and state ownership. These features relate to bank objectives, which can subsequently affect their capital structures, capital and risk behavior, as well as their balance sheets. While this data is available for developed countries, such as those in the U.S and Europe (from the Bloomberg database), they are not adequately reported for most Asian banks in our sample. Hand collecting such data requires considerable time and effort. Therefore, we have left these examinations for future research.

Fourth, we currently use an equal weight for each component to construct the ACRI index. This means that each component will contribute to the ACRI in the same way and will have an equivalent effect on bank behavior. But in fact, it is not necessarily the case. Depending on banks' characteristics, some may find some rules less strict and conversely, some may find them difficult to satisfy. However, these rules are qualitative and different banks may respond to each rule differently. Therefore, it is not easy to assign a correct weight and wrong weight-assignment may even lead to more spurious conclusion than the standard approach. In addition, the CRI index also applies an equal weight and we found no references to set a different weight for each rule. Thus, we use the equal weight and recognize its limitation.

7.6 Directions for Future Research

Our study has recognized the importance of a proper measurement for capital regulation and developed the ACRI index to serve this purpose. This index has proved to work well using the sample of Asian banks. Therefore, there is promising opportunity to construct this index for other countries and apply this index as a proxy for capital regulation. Especially, for countries where Barth et al. (2001) CRI index is available, comparative studies which employ two indices can produce interesting results and provide further evidence on the usefulness of the ACRI index.

During the beginning of the global financial crisis 2007-2009, many banks experienced severe stress, despite adequate capital levels. Liquidity risk and the negligence of liquidity risk management were among the key drivers of this crisis (Allen & Carletti, 2008; Brunnermeier, 2009). The Basel Committee has recognized the importance of liquidity management and introduced liquidity requirements under Basel III to strengthen existing capital regulation (BCBS, 2010b). The liquidity requirements, comprising of a liquidity coverage ratio (LCR) and a net stable funding ratio (NSFR), have undergone an observation period from 2011 to 2014. Minimum LCR standards were introduced in 2015 and minimum NSFR standards were introduced in 2018 (BCBS, 2013a). Since these liquidity requirements are relatively new, and their implementation is still in an early phase, the linkage between capital and liquidity requirements, in conjunction with their joint-effects on bank behavior and macro-economy are of possible interest.[27]

Beside lapses in liquidity management, weak governance was also a major cause of the recent crisis (Berger, Imbierowicz, & Rauch, 2016; Kirkpatrick, 2009). Corporate governance is "a set of relationships between a company's management, its board, its shareholders and other stakeholders, which provides the structure through which the objectives of the company are set, and the means of attaining those objectives and monitoring performance" (BCBS, 2015, p. 1). Previous studies have shown that corporate governance has a significant effect on bank capitalization strategies (Anginer, Demirguc-Kunt, Huizinga, & Ma, 2016) and risk-taking (see Srivastav and Hagendorff (2016) for a comprehensive review). In addition, while empirical research on the effects of corporate governance on the capital structure of non-financial firms is vast (for example, see Chang, Chou, and Huang (2014); Kieschnick and Moussawi (2018); Liao, Mukherjee, and Wang (2015)), yet, there are no such studies on banks.[28] Therefore, the interplay between corporate governance, capital regulation, and bank behavior could be an interesting topic for future research. To the best of our knowledge, this relationship has only been examined by Laeven and Levine (2009). The authors have shown that ownership concentration affects the relationship between bank risk and capital regulation. Therefore, there is scope for further studies on other mechanisms of corporate governance, such as board characteristics and compensation schemes.

[27] At the time of the thesis writing, there are few studies on this topic. These include Roger and Vlček (2011) study on macroeconomic costs of higher capital and liquidity requirements; Varotto (2011) study on the effect of capital regulation, accounting for the new requirement for liquidity risk on trading portfolios of twelve U.S bond indices; Distinguin et al. (2013) study on the relationship between regulatory capital and liquidity for the U.S and European publicly traded banks; and Hasman and Samartín (2017) theoretical study on the combined effect of capital and compensated reserves on reducing bank moral hazard.

[28] Most studies focus on the corporate governance effect on bank performance (such as Aebi, Sabato, and Schmid (2012); Bokpin (2013)). See also Molyneux (2018) for a brief review of studies on corporate governance in banking.

In addition, franchise value is another interesting variable that worth further investigation. Future researcher can work on a topic that investigates the role of franchise value in the relationship between capital regulation and bank behaviors.

Appendix A

International Capital Standards – BASEL Accords

A.1 Basel I

The Basel Committee on Banking Supervision introduced Basel I in 1988. The Accord required banks to hold an adequate amount of capital to cover their credit risks related to different categories of on- and off-balance sheet assets. Specifically, bank capital comprised of two main components, which were Core capital (Tier 1) and Supplementary capital (Tier 2), and Deductions from capital. Tier 1 capital included equity capital and disclosed reserves while Tier 2 capital consisted of undisclosed reserves, revaluation reserves, general loan-loss reserves, hybrid debt capital instruments, and subordinated term debt. For on-balance sheet assets, the Accord assigned a risk weight ranging from 0, 10, 20, 50 to 100% on different asset categories. For off-balance sheet exposures, credit conversion factors were applied to different types of off-balance-sheet instruments or transactions based on their estimated size, the likely occurrence of the credit exposure, and the relative degree of credit risk. These credit conversion factors were then multiplied by the weights applicable to the category of the counterparty for an on-balance-sheet transaction to determine the amount of risk-weighted assets (BCBS, 1988). The capital ratio (CAR) was calculated as follow:

$$CAR = \frac{Tier\ 1\ capital + Tier\ 2\ capital - Deductions\ from\ capital}{Risk - weighted\ assets}$$

The minimum CAR requirement was 7.25% at the end of 1990 and 8% at the end of 1992. Tier 2 was limited to 100% of Tier 1, which was equivalent to a minimum Tier 1 ratio requirement at 3.625% at the end of 1990 and 4% at the end of 1992 (BCBS, 1988).

A.2 Basel II

The Committee amended the Basel I framework several times during the period of 1991-1998. Among the amendments, the January 1996 version, which incorporates the market risk arising from bank exposure is the most important. Consequently, the Committee revised the Basel capital framework in 2004. This is commonly referred to as the Basel II Accord. Basel II includes three pillars, namely the minimum capital requirements (Pillar 1), the supervisory review process (Pillar 2), and market discipline (Pillar 3) (BIS, 2018).

Under the first pillar, the Committee revised its calculations of the total minimum CAR requirements to additionally cover market and operational risk. The Committee also revised the eligible regulatory capital in terms of the deductions of capital and excluded general loan loss reserves from eligible Tier 2 capital. The total risk-weighted assets were determined as the sum of credit risk and capital requirements for market risk and operational risk multiplied by 12.5. In determining risk-weighted assets for credit risk, banks could choose either Standardized or Internal Rating-Based (IRB) approach, depending on which approach was more appropriate for their operations and financial market infrastructure. For market risk capital requirements, banks could choose either Standardized approach or Internal Model approach (IMA), subject to the approval of national authorities. Regarding capital requirements for operational risk, Basel II provided three available methods; the Basic Indicator approach (BA), Standardized approach, and Advanced Measurement approach (AMA). The use of Standardized approach and AMA approach was subject to supervisory approval. The minimum CAR requirement was maintained at 8% and Tier 2 capital was still limited to 100% of Tier 1 capital (BCBS, 2004).

The Pillar 2 aimed to treat risks that were not fully included or considered in Pillar 1. These included credit concentration risks, interest rate risks in the banking book, business and strategic risks, and factors external to the bank such as business cycle effects. Besides ensuring that banks had adequate capital to support their risks, Pillar 2 encouraged banks to develop and use better risk management techniques. Therefore, Pillar 2 required banks to have an overall capital adequacy assessment process according to their risk profile and a capital maintaining strategy. Supervisors played an important role by reviewing and evaluating banks' self-assessment (BCBS, 2004).

The Pillar 3 complemented the other two pillars by requiring banks to disclose information about their scope of applications, capital, risk exposures, risk assessment processes, and the capital adequacy. The aim of disclosure was to inform the market about the banks' risk exposures and provide a consistent and understandable framework that enhances the comparability among banks (BCBS, 2004).

In close cooperation with the International Organization of Securities Commissions, the Committee released a consensus document on the application of Basel II to trading activities. This document was then incorporated into the existing Basel II framework in June 2006 and being referred to as the comprehensive version (BIS, 2018).

A.3 Basel III

The massive failure of the banking system during the global financial crisis of 2007-2009 forced the revision of Basel II. Consequently, the Committee released Basel III in mid-December 2010 and revised it in June 2011 (BIS, 2018). The new framework enhanced the risk coverage in the three pillars by strengthening the regulatory capital base in both quality and quantity, as well as the risk coverage of the capital framework. The Committee also introduced several new minimum capital requirements, including leverage ratios, CET1 ratios, capital conservation buffers, G-SIB surcharges in addition to existing minimum Tier 1 ratios and CAR requirements. Besides, the Basel standards, for the first time, developed two minimum standards for funding, namely Liquidity Coverage Ratio and the Net Stable Funding Ratio to address bank's liquidity risk. These two standards aimed to promote both short-term and long-term resilience of banks' liquidity risk profile. The regulation on liquidity risk was revised in January 2013 (for the Liquidity Coverage Ratio) and in October 2014 (for the Net Stable Funding Ratio) (BIS, 2018). Figure A. 1 summarizes these requirements.

	2011	2012	2013	2014	2015	2016	2017	2018	As of 1 January 2019
Leverage Ratio	Supervisory monitoring		Parallel run 1 Jan 2013 – 1 Jan 2017 Disclosure starts 1 Jan 2015					Migration to Pillar 1	
Minimum Common Equity Capital Ratio			3.5%	4.0%	4.5%	4.5%	4.5%	4.5%	4.5%
Capital Conservation Buffer						0.625%	1.25%	1.875%	2.50%
Minimum common equity plus capital conservation buffer			3.5%	4.0%	4.5%	5.125%	5.75%	6.375%	7.0%
Phase-in of deductions from CET1 (including amounts exceeding the limit for DTAs, MSRs and financials)				20%	40%	60%	80%	100%	100%
Minimum Tier 1 Capital			4.5%	5.5%	6.0%	6.0%	6.0%	6.0%	6.0%
Minimum Total Capital			8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Minimum Total Capital plus conservation buffer			8.0%	8.0%	8.0%	8.625%	9.125%	9.875%	10.5%
Capital instruments that no longer qualify as non-core Tier 1 capital or Tier 2 capital			Phased out over 10 year horizon beginning 2013						
Liquidity coverage ratio	Observation period begins				Introduce minimum standard				
Net stable funding ratio		Observation period begins						Introduce minimum standard	

Figure A. 1 Basel III Phase-in Arrangements

Note: Shading indicates transition periods. All dates are as the 1st of January
(Source: BCBS (2011))

In December 2017, the Basel Committee completed its Basel III post-crisis reforms. Accordingly, the revised framework enhanced the robustness and risk sensitivity of the standardized approaches for credit risk and reduced the reliance of its external credit ratings. The use of internally modelled approaches was more constrained. For operational risk, the framework replaced the advanced measurement approaches and the existing three standardized approaches with a single risk-sensitive standardized approach. The new standardized approach was determined based on banks' income and historical losses. The new implementation date was extended to 01 January 2022 (BCBS, 2017).

Appendix B

Asian Countries Key Statistics

Table B. 1 Key Economic and Financial Statistics of Selected Asian Countries (as of 2016)

Country	GDP (bil.USD)	Market Capitalization (bil.USD)	Financial Development Index	Financial Institutions Index	Financial Markets Index
Azerbaijan	37.85	N.A	0.18	0.29	0.08
Bangladesh	221.42	N.A	0.18	0.32	0.04
China	1,199.15	7,320.74	0.65	0.62	0.68
Georgia	14.33	N.A	0.33	0.59	0.07
Hong Kong	320.91	3,193.24	0.73	0.77	0.69
India	2,263.52	1,566.68	0.41	0.39	0.42
Indonesia	932.26	425.77	0.36	0.43	0.29
Israel	318.74	213.98	0.57	0.77	0.36
Japan	4,939.38	4,955.30	0.87	0.93	0.79
Kazakhstan	133.66	40.16	0.34	0.38	0.29
Korea	1,411.25	1,254.54	0.86	0.84	0.86
Malaysia	296.36	359.79	0.66	0.71	0.6
Pakistan	283.66	91.86	0.23	0.32	0.14
Philippines	304.91	239.74	0.38	0.39	0.36
Singapore	296.97	640.43	0.71	0.74	0.68
Sri Lanka	81.32	18.68	0.28	0.4	0.16
Taiwan	530.61	885.58	N.A	N.A	N.A
Thailand	406.84	432.96	0.73	0.74	0.7
Turkey	857.75	171.76	0.5	0.48	0.52
Vietnam	202.62	66.4	0.32	0.43	0.21
East Asia & Pacific	22,512.17	65.59	0.36	0.46	0.26
South Asia	2,903.12	46.35			
Europe & Central Asia	20,280.71	17.6	0.51	0.64	0.38
North America	20,166.31	38.37			

Notes: N.A = Not available.
Source: CEIC (2018); IMF (2018); World Bank (2018b)

Table B. 2 Key Banking Statistics of Selected Asian Countries

Country	Domestic Credit to GDP [a] (%)	Bank Non-interest Income to Total Income [a] (%)	Financial Stability [a] (Z-score)	Total Banks [b]	Total Banking Assets [b] (bil.USD)
Azerbaijan	38.92	21.77	8.85	30	20.58
Bangladesh	61.44	33.07	7.52	57	148.17
China	215.18	20.47	20.15	3,747	30,002.36
Georgia	65.44	31.72	6.24	24	14.62
Hong Kong	210.62	69.36	14.57	195	2,660.83
India	75.03	28.20	17.12	1,749	514.21
Indonesia	47.94	22.05	5.36	221	2,110.96
Israel	81.11	38.31	28.41	21	403.00
Japan	345.15	25.52	15.81	173	9,918.88
Kazakhstan	43.30	34.02	3.75	33	74.71
Korea	169.63	20.49	11.02	59	1,244.36
Malaysia	145.26	24.59	17.89	32	72.65
Pakistan	52.36	26.27	11.95	58	589.05
Philippines	63.49	27.45	17.28	34	215.92
Singapore	129.55	34.48	21.59	602	286.17
Sri Lanka	71.86	27.61	11.09	158	829.70
Taiwan	183.65	40.48	15.75	30	502.08
Thailand	167.35	29.59	6.88	65	1,415.62
Turkey	80.60	25.15	8.13	51	984.07
Vietnam	140.06	19.27	14.30	44	387.51
East Asia & Pacific [c]	225.43	23.21	6.15		
South Asia	71.28	28.86	10.58		
Europe & Central Asia [c]	146.68	29.56	6.23		
Latin America & Caribbean [c]	241.89	27.50	13.76		

Notes: [a] Data is as of 2014.
[b] Data is as of 2016.
[c] Developing only

Source: World Bank (2018a) and author's compilation from national central bank statistics.

Table B. 3 Two-step system GMM estimation on different measurements of capital ratio for different samples

	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
	CAR	**CAR**	**CAR**	**EQTA**	**EQTA**	**EQTA**	**TIER1_RATIO**	**TIER1_RATIO**	**TIER1_RATIO**
L.CAR	0.372***	0.205***	0.319***						
	-0.071	-0.070	-0.091						
L.EQTA				0.414***	0.492***	0.678***			
				-0.080	-0.081	-0.087			
L.TIER1_RATIO							0.377***	0.316***	0.188
							-0.056	-0.046	-0.168
ACRI	0.061***	0.032**	0.006	0.096***	0.052***	0.041***	0.100***	0.040**	0.036
	-0.019	-0.016	-0.021	-0.017	-0.011	-0.010	-0.018	-0.017	-0.026
SIZE	-0.681***	-0.517***	-0.525***	-0.495***	-0.337***	-0.152**	-0.519***	-0.676***	-0.705***
	-0.100	-0.075	-0.101	-0.086	-0.076	-0.075	-0.088	-0.085	-0.214
ROA	1.487***	0.864***	1.134***	1.031***	0.825***	0.674***	0.752***	0.568***	1.412***
	-0.201	-0.103	-0.166	-0.145	-0.130	-0.129	-0.119	-0.094	-0.336
LOAN_RATIO	-0.055***	-0.065***	-0.058***	0.016***	0.010	0.023***	-0.056***	-0.092***	-0.057***
	-0.012	-0.012	-0.012	-0.005	-0.008	-0.006	-0.013	-0.014	-0.021
LLP_TO_TA	-0.905**	0.556***	0.460***	-0.158	0.294	-0.139	0.655***	0.980***	0.151
	-0.401	-0.186	-0.147	-0.218	-0.223	-0.148	-0.186	-0.246	-0.217
FA_RATIO	0.605***	0.320***	0.316***	0.628***	0.563***	0.434***	0.221	0.112	-0.361**
	-0.140	-0.089	-0.108	-0.090	-0.108	-0.136	-0.148	-0.137	-0.181
DEPOSIT_RATIO	-0.044***	0.000	0.013	-0.024***	-0.009	-0.012	0.007	0.007	0.022
	-0.013	-0.008	-0.012	-0.008	-0.008	-0.011	-0.009	-0.013	-0.021
GDP_GROWTH	-0.191***	-0.180***	-0.141***	-0.065***	-0.044***	-0.021	-0.112***	-0.170***	-0.225***
	-0.033	-0.03	-0.041	-0.018	-0.015	-0.024	-0.027	-0.027	-0.047
MARKET_CAP	0.017***	0.014***	0.015***	0.008***	0.008***	0.004*	0.010***	0.007**	0.004
	-0.003	-0.003	-0.003	-0.002	-0.002	-0.002	-0.003	-0.003	-0.004
COMP	0.720*	0.610**	1.193***	0.051	-0.062	-0.103	0.849***	0.435	2.015**
	-0.389	-0.273	-0.398	-0.219	-0.222	-0.246	-0.305	-0.295	-0.985
Constant	20.162***	18.896***	15.453***	7.712***	5.175***	2.010	12.483***	18.707***	17.753***
	-2.476	-2.099	-2.423	-1.505	-1.545	-1.360	-1.755	-2.006	-4.480

	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
	CAR	**CAR**	**CAR**	**EQTA**	**EQTA**	**EQTA**	**TIER1_RATIO**	**TIER1_RATIO**	**TIER1_RATIO**
Observations	3,119	2,005	951	3,119	2,005	951	2,379	1,718	798
Banks	458	351	215	458	351	215	387	318	192
Instruments	18	18	18	16	16	16	14	14	14
AR(2) test	0.225	0.344	0.296	0.118	0.831	0.893	0.927	0.646	0.295
Hansen test	0.354	0.109	0.701	0.956	<0.01	<0.01	0.462	0.519	0.497

Notes: This table reports regression results of equation (3.12) for different measurements of capital ratio on different samples. Estimation is carried out using two-step SYS-GMM, and robust standard errors are corrected for finite sample bias. Instruments in differences equation are lags 2 to 7 periods for *CAR*, lags 2 to 5 periods for *EQTA* and lags 2 to 3 periods for *TIER1*. All instruments are collapsed. Forward-orthogonal-deviation is applied in transforming variables for differences equation. Sample 1 covers 20 Asian countries (2001-2016); Sample 2 covers 19 Asian countries (2002-2016), and Sample 3 covers 15 Asian countries (2004-2016). Standard errors in parentheses. *, **, *** represent significance levels at 0.1, 0.05, and 0.01, respectively.
Source: Author's estimations.

Table B. 4 Two-stage least square with fixed-effect regression on changes in bank capital and bank risk for different samples

	Sample 2	Sample 3	Sample 2	Sample 3
	ΔCAPTA	**ΔCAPTA**	**ΔRWATA**	**ΔRWATA**
ACRI	-0.052**	-0.032	0.053	0.021
	-0.022	-0.022	-0.075	-0.090
ΔRWATA	-0.037*	0.008		
	-0.020	-0.015		
L.CAPTA	-0.653***		-0.540***	
	-0.054	-0.061		
ΔCAPTA			-0.182	-0.024
			-0.134	-0.212
L.RWATA			-0.558***	-0.590***
			-0.040	-0.039
SIZE	-1.002***	-0.656**	2.108*	0.534
	-0.33	-0.272	-1.103	-1.410
ROA	0.497***	0.342***	0.566	0.969**
	-0.087	-0.105	-0.361	-0.440
LOAN_RATIO	-0.009	-0.007	0.460***	0.391***
	-0.013	-0.012	-0.045	-0.050
LLP_TO_TA	0.543***	0.469***	0.45	1.207***
	-0.141	-0.164	-0.428	-0.458
FA_RATIO	0.294***	0.552***	0.031	0.649**
	-0.092	-0.107	-0.25	-0.304
DEPOSIT_RATIO	0.008	0.000	0.014	-0.061
	-0.014	-0.013	-0.064	-0.100
GDP_GROWTH	-0.052**	-0.042	-0.252***	-0.419***
	-0.021	-0.027	-0.091	-0.108
Constant	14.269***	11.977***	-3.140	14.038
	-4.173	-3.413	-16.026	-20.386
Observations	2,765	1,804	2,765	1,804
Banks	440	334	440	334

Notes: Sample 1 covers 20 Asian countries (2001-2016); Sample 2 covers 19 Asian countries (2002-2016), and Sample 3 covers 15 Asian countries (2004-2016). Standard errors adjusted for bank clusters in parentheses. Endogenous variables: *ΔRWATA, ΔCAPTA*. Time dummies are included but not reported. *, **, *** represent significance levels at 0.1, 0.05 and 0.01 levels, respectively.
Source: Author's estimations.

Appendix C

Table C. 1 Advanced Capital Regulation Index across Countries over Years

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Average
Azerbaijan	6	6	5	5	5	5	5	5	5	5	6	8	8	8	8	8	6.13
Bangladesh	3	3	3	3	3	3	3	3	5	13	13	13	13	13	20	21	8.44
China	8	8	8	9	9	9	9	9	9	9	9	10	21	21	21	21	11.88
Georgia	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8.00
Hong Kong	6	6	6	6	6	6	16	16	16	16	16	17	20	20	20	21	13.38
India	7	7	7	7	7	7	7	10	12	12	12	12	18	18	18	19	11.25
Indonesia	7	7	7	7	7	7	7	12	12	12	12	14	16	16	16	16	10.94
Israel	8	8	8	8	8	8	8	12	12	12	12	12	20	20	20	20	12.25
Japan	6	6	6	6	6	6	12	12	12	12	12	12	18	18	21	22	11.69
Kazakhstan	6	6	6	6	6	9	9	9	9	11	11	11	12	12	16	16	9.69
Korea	8	8	8	8	8	9	9	9	9	11	13	13	18	20	21	21	12.06
Malaysia	7	7	7	8	8	8	8	9	9	12	12	12	18	18	19	21	11.44
Pakistan	4	4	4	5	6	9	9	9	9	9	9	9	17	17	19	19	9.88
Philippines	10	10	10	10	10	10	15	15	15	15	17	17	17	20	20	20	14.44
Singapore	10	10	10	10	10	10	10	15	15	15	15	15	21	22	22	23	14.56
Sri Lanka	7	7	7	7	7	7	7	11	11	11	11	11	11	14	14	14	9.81
Taiwan	7	7	7	7	7	7	8	12	12	12	12	12	18	18	18	19	11.44
Thailand	5	5	5	5	5	5	5	9	11	11	11	11	18	18	18	19	10.06
Turkey	8	8	8	8	8	9	10	10	10	10	10	12	12	16	17	18	10.88
Vietnam	2	2	2	2	4	4	4	4	4	7	7	7	7	7	7	7	4.81
Average	**6.65**	**6.65**	**6.6**	**6.75**	**6.9**	**7.3**	**8.45**	**9.95**	**10.25**	**11.15**	**11.4**	**11.8**	**15.55**	**16.2**	**17.15**	**17.65**	**10.65**

Source: Author's calculations.

Table C. 2 Distribution of Total Regulatory Capital Ratio over Years

Year	Mean	Median	25th percentile	75th percentile	Inter-quantile range	Standard deviation
2001	15.472	12.460	10.420	17.900	7.480	7.686
2002	15.009	12.900	10.450	16.900	6.450	6.319
2003	15.990	13.680	11.285	18.150	6.865	7.070
2004	17.407	13.130	11.270	16.100	4.830	19.550
2005	15.157	13.760	11.300	16.990	5.690	7.011
2006	14.949	13.525	11.520	16.295	4.775	6.124
2007	14.419	13.000	11.440	16.015	4.575	5.248
2008	14.676	13.690	11.700	16.000	4.300	5.244
2009	15.551	14.360	12.415	16.915	4.500	7.205
2010	15.482	14.410	12.650	17.015	4.365	5.501
2011	15.460	14.010	12.690	16.160	3.470	6.172
2012	15.374	14.630	12.900	16.680	3.780	5.215
2013	15.062	14.365	12.400	16.030	3.630	5.937
2014	14.947	14.400	12.490	16.235	3.745	4.413
2015	15.164	14.637	12.830	16.815	3.985	3.908
2016	15.524	14.220	12.500	17.200	4.700	4.929
Total	**15.289**	**14.050**	**12.060**	**16.580**	**4.520**	**6.774**

Source: Author's calculations.

Table C. 3 Distribution of Total Regulatory Capital Ratio across Countries

Country	Mean	Median	25th percentile	75th percentile	Inter-quantile range	Standard deviation
Azerbaijan	18.561	17.380	13.800	20.000	6.200	7.400
Bangladesh	11.666	11.475	10.685	12.315	1.630	2.591
China	12.396	12.220	11.200	13.430	2.230	2.633
Georgia	18.431	15.930	14.100	25.000	10.900	5.855
Hong Kong	16.011	15.900	14.345	17.140	2.795	2.143
India	13.168	12.780	11.570	14.210	2.640	2.578
Indonesia	18.715	16.390	13.590	20.965	7.375	10.813
Israel	12.858	13.070	10.750	14.310	3.560	2.819
Japan	13.730	13.140	11.595	15.360	3.765	2.979
Kazakhstan	16.859	16.965	14.380	19.250	4.870	5.875
Korea	13.300	13.590	11.710	14.930	3.220	2.723
Malaysia	15.166	14.820	13.900	15.800	1.900	2.274
Pakistan	15.878	14.280	11.650	18.650	7.000	8.324
Philippines	19.733	17.000	14.670	20.530	5.860	10.479
Singapore	17.332	16.700	15.800	18.500	2.700	2.615
Sri Lanka	16.739	16.010	13.330	19.370	6.040	4.300
Taiwan	12.415	12.040	11.070	13.470	2.400	2.578
Thailand	15.771	15.420	14.010	17.300	3.290	3.237
Turkey	15.041	14.525	13.700	16.220	2.520	1.886
Vietnam	12.824	12.380	11.080	14.180	3.100	2.245
Total	**15.289**	**14.050**	**12.060**	**16.580**	**4.520**	**6.774**

Source: Author’s calculations.

Appendix D

Table D. 1 Pooled Two-stage Least Square Regression of Changes in Capital and Risk

	Capital equation (ΔCAPTA)		Risk equation (ΔRWATA)	
	Coefficient	**Robust SE.**	**Coefficient**	**Robust SE.**
REG	0.038*	0.020	0.162*	0.088
ΔRWATA	-0.041*	0.022		
L.CAPTA	-0.330***	0.027		
ΔCAPTA			-0.705***	0.205
L.RWATA			-0.277***	0.024
SIZE	-0.170***	0.033	-0.440***	0.102
ROA	0.424***	0.060	0.920***	0.201
LOAN_RATIO	0.013***	0.005	0.171***	0.020
LLP_TO_TA	0.465***	0.123	0.556*	0.335
FA_RATIO	0.060	0.049	0.058	0.165
DEPOSIT_RATIO	0.001	0.004	-0.017	0.017
GDP_GROWTH	-0.014	0.014	0.333***	0.058
Constant	2.740***	0.857	13.496***	4.496
Time Dummies	Yes	Yes	Yes	Yes
Observations	2,765	2,765	2,765	2,765
Banks	440	440	440	440

Notes: This table reports the regression results for equations (3.16) and (3.17) using pooled 2SLS regression. The endogenous variables are *ΔRWATA* and *ΔCAPTA*. Standard errors robust to heteroscedasticity. *, **, *** represent significance levels at 0.1, 0.05, and 0.01, respectively.
Source: Author's estimations.

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