

Basel III Capital Regulation and Bank Risk: Evidence from Chinese Banking Industry

Ying Zhang

2023

Table of contents

Preface	5
1 Introduction	6
1.1 Background of the Study	6
1.1.1 Bank Regulation and Supervision in the Post-Global Financial Crisis Era	6
1.1.2 China's Banking Landscape	6
1.2 Research Motivation and Research Questions	7
1.3 Overview of Chapters	9
1.3.1 Chapter 2. The Landscape Review of China's Banking Industry	9
1.3.2 Chapter 3. Ownership dynamics, risk and regulation in Chinese banking: New evidence	10
1.3.3 Chapter 4. Does stringent capital regulation affect persistent or transient Chinese bank efficiency-A four-component model analysis	10
1.3.4 Chapter 5. Assessing Systemic Risk Dynamics in Chinese Banking: The Impact of Basel III and Ownership Structures	11
2 The Landscape Review of China's Banking Industry	12
2.1 Part I: Chinese Banking Sector Reforms	12
2.1.1 The era from 1978 to early 1990s	13
2.1.2 Early-1990s to End-2001	15
2.1.3 WTO accession (2001) - 2010	17
2.1.4 2010 onward	20
2.2 Part II: the Chinese banking regulatory framework	23
2.2.1 Historical overview of the Chinese banking regulators	23
2.2.2 The current main regulators in banking regulation and supervision . . .	24
2.2.3 Other relevant regulators	27
2.2.4 Regulated financial institutions and regulated businesses	28
2.2.5 Adoption of Basel III framework and rules issued to regulate the shadow- banking system	30
2.3 Part III: Ratio analysis	31
2.3.1 Data	31
2.3.2 Total Assets	32
2.3.3 3. Financial Ratios of CAMELS rating system	34

2.4	Appendices	52
2.4.1	Key regulation and regulatory documents in the adoption of Basel III framework	52
2.4.2	CAMEL variable definition and data source	52
2.4.3	Total Assets of the Banking Sector	54
2.4.4	Information of Basel Accords	55
3	Ownership dynamics, risk and regulation in Chinese banking: New evidence	65
3.1	Introduction	65
3.2	Literature	67
3.2.1	Bank capital and risk	68
3.2.2	Owership structure and risk	69
3.2.3	State ownership	70
3.2.4	The evolution of ownership structure of commercial banks in China . .	71
3.2.5	The evolution of the regulation framework in China's financial sector . .	72
3.2.6	Ownership structure and regulation	72
3.3	Data and forensic accounting anaysis	73
3.4	Methodology	74
3.4.1	Bank Credit Risk	75
3.4.2	Capital Adequacy Requirements	75
3.4.3	Bank-level Predictors	77
3.4.4	Industry and Macroeconomic variables	77
3.4.5	Ownership Structure	78
3.5	Main Results	80
3.5.1	Impact on bank credit risk – Risk-based total capital ratio	82
3.5.2	Impact on bank credit risk – Ownership structure	84
3.5.3	Impact on bank credit risk – Interaction between regulation and owner- ship structure	86
3.6	Conclusion	88
4	Does stringent capital regulation affect persistent or transient Chinese bank efficiency-A four-component model analysis	90
4.1	Introduction	90
4.2	Literature review	92
4.2.1	Two approaches to bank regulation	93
4.2.2	Bank Capital and Efficiency	94
4.2.3	Ownership Structure and bank efficiency	96
4.3	Data and methodology	99
4.3.1	Data	99
4.3.2	Methodology	100
4.4	Results	104
4.4.1	Descriptive statistics and variable correlations	104
4.4.2	Main results	105

4.4.3	Inefficiency effects	111
4.5	Conclusion	115
4.5.1	Bias and Further Directions	116
4.6	Appendix	117
4.6.1	The Variable Definition Table for Efficiency Analysis	117
5	Assessing Systemic Risk Dynamics in Chinese Banking: The Impact of Basel III and Ownership Structures	119
5.1	Introduction	119
5.2	Literature Review	121
5.2.1	Capital Regulation and Bank Risk	121
5.2.2	Ownership Structure and Bank Risk	124
5.2.3	State Ownership	125
5.2.4	The evolution of ownership structure of commercial banks in China . .	126
5.3	Data and Empirical Methodology	127
5.3.1	Data Sample	127
5.3.2	The Empirical Model	128
5.3.3	The Measure of Systemic Stability	128
5.3.4	Capital Adequacy Requirement	130
5.3.5	Bank-Level Control Variables	130
5.4	Empirical Results	131
5.4.1	Descriptive Statistics and Correlation Matrix	131
5.4.2	Relationship between Capital and Systemic Risk	132
5.4.3	Bank Characteristics and Systemic Risk	135
5.5	Conclusion	137
5.6	Appendix	137
5.6.1	Correlation Matrix	137
6	Conclusion	139
6.1	Research Summary	139
6.1.1	Contribution	141
6.1.2	Limitations	142
	Bibliography	143

Preface

1 Introduction

1.1 Background of the Study

1.1.1 Bank Regulation and Supervision in the Post-Global Financial Crisis Era

The repercussion of the Global Financial Crisis (GFC) over 2007-2009 mandated a redesign of the global financial regulatory architecture. The GFC had caused such extensive disruption in financial markets and abrupt and persistent impact on economic growth that require a comprehensive and globally coordinated response from the public sector. The regulatory reform agenda agreed by Group of Twenty (G20) leaders in 2009 elevated the overhaul of the Basel regulatory and supervisory framework. The Basel III framework enhances capital buffers, improves the quality of bank capital, reduces leverage and incorporates macroprudential the liquidity risk elements, aiming at strengthening the resilience of the global banking system. Implementation of the Basel III capital regulation has advanced largely as planned. As one of the member jurisdictions of the Basel Committee on Banking Supervision (BCBS), China embraced and fully adopted the Basel III framework in 2012. According to the latest report of the Regulatory Consistency Assessment Program (RCAP) by BCBS, China was found largely compliant with the standards for imposing more intense supervision and surcharges for capital.

1.1.2 China's Banking Landscape

China's banking sector is a vital component of the national financial system; and its effective functioning is crucial to the country's economic health and development. China's banking sector has evolved and made notable progress through the financial reform over the last forty years, although developed much later than those of development economies.

The financial reform has been carried out since 1978, as an integral part of the country's overall economic reform and structural adjustments, encompassing almost all aspects of the Chinese banking sector including institutions, regulations and market conditions. The literature commonly identifies three main stages/waves of the financial reform in the times before 2010: since 1978 to the early 1990s; during the 1990s until 2001 China's accession to the World Trade Organization (WTO); and since the entry of the WTO, through five years of transitional time until 2010 (see Berger et al., 2009; Dong et al., 2017; Wang et al., 2014).

Between 1979 and 1992, China's banking sector underwent a comprehensive institutional restructuring including the creation of the "Big Four"¹ State-Owned Commercial Banks (1979-1984), establishment of national banks and diversification of ownership (1986-1987), diversification of financial institution types (1980s), and transition of the People's Bank of China (PBOC) to a central bank (1984). This initial wave served as a significant milestone in China's reform process as new players entered the financial markets. the government exhibited a conservative stance regarding the entry of foreign banks and ownership diversification.

The second stage (1990s-2001) witnessed a decline in the loan quality of major state-owned banks and the establishment of assets management companies to address the issues. Ownership structures of national banks transitioned to joint-stock models, with private ownership notably emerging in China. The commercialization of banks makes a distinctive feature of this period.

From 2001 to 2010, China underwent comprehensive economic reforms following its entry into the WTO. Alongside the transformation of commercial banks, legislative efforts and the opening of domestic financial markets to foreign banks, marketization emerged as a distinctive feature of this stage. Public offering enrich shareholder profiles and promotes modern corporate governance frameworks in banks.

Since 2010, rather than pursuing structural overhaul, China's financial sector has witnessed nuanced improvements and refinements. The ownership landscape has diversified, embracing models such as state-owned, joint-stock with local government participation, and joint-stock with private company shareholders in financial institutions.

Over four decades, the financial reform in China's banking sector transformed the landscape, fostering marketization, securitization, and globalization. Diversified ownership structures, modern corporate governance, and market competition emerged as outcomes. The reforms indicate a gradual receding of direct government intervention in banking decisions. Seizing the opportunity presented by the GFC, China's financial reform is propelled towards establishing a sound and competitive banking sector dedicated to supporting the real economy.

1.2 Research Motivation and Research Questions

The GFC uncovered weaknesses in design and implementation of the pre-crisis regulatory framework that it failed to "contain the buildup of vulnerabilities and tame the incentives of market participants to take excessive risks" ("A decade after the global financial crisis," 2019). Shortly after the GFC began, regulatory consensus was reached by G20 that it is necessary for financial institutions to be subject to more robust and effective regulations and supervision. More stringent capital adequacy requirements including enhanced capital buffers and reduced

¹The "Big Four": Bank of China, China Construction Bank, Agricultural Bank of China, and Industrial and Commercial Bank of China

leverage are one of the overhauls addressed to the prevailing Basel framework. Another important regulatory development in post-crisis era has been a greater emphasis on systemic stability and macroprudential regulatory framework. While regulatory consensus has been made on more stringent capital regulation, there is continued contentious debate regarding the role of Basel III capital adequacy requirements. Proponents of more stringent capital requirements state that increased capital requirements provide social value and facilitate banks to make “more economically appropriate” decisions (Admati et al., 2014). On the other hand, opponents of higher capital requirements argue that these would hinder economic growth (De Angelo and Stulz, 2013).

As presented in the previous section, the Chinese banking sector has experienced several rounds of financial reform over the past few decades. China’s financial authorities fully adopted and localized the Basel III framework in 2012. The landscape of China’s banking sector has been dramatically transformed. Chinese banks actively participate in global financial markets and contribute to the interconnectedness of the international financial system. These notable achievements have not only laid a solid foundation for the future development of China’s financial system; but also made the Chinese banking sector as an unique context to investigate the role of the Basel III capital regulation.

There is a body of literature that examine the relationship between capital, risk, and efficiency of Chinese commercial banks. Tan and Floros (2013) examine the relationship between capital, risk and bank efficiency following the hypotheses proposed by Berger and Humphrey (1997). They report a negative relationship between capitalization and bank risk. Lee et al. (2015) find that capital has a negative impact on bank profitability, supporting the “risk-return hypothesis” (see Altunbas et al., 2007); and a negative relationship between capital and risk in favor of the “moral hazard hypothesis” (see Demirguc-Kunt and Kane, 2002). Pessarossi and Weill (2015) suggest that capital adequacy requirements have a positive impact on cost efficiency of Chinese banks. These studies focus on the period before 2011.

Regarding the ownership structure and its impact on bank risk-taking and performance, research interest remains focused on state ownership. Two alternative theories regarding state ownership in banks have been proposed in the literature: the social view and the political view. The social view, rooted in the economic theory of institutions, posits that state ownership serves as a form of government intervention aimed at addressing market failures, improving market functions, and enhancing economic performance (Stiglitz, 1993). On the other hand, the political view contends that state ownership primarily generates political benefits for politicians rather than promoting social welfare (Shleifer and Vishny, 1997; see Shleifer and Vishny, 1994). The empirical studies provides mixed results in favor of both views (see Andrianova et al., 2012; Beck and Levine, 2002; La Porta et al., 2002). Most of the aforementioned studies on the Chinese banks consider bank size instead of bank ownership. Berger et al. (2009) investigate the efficiency of Chinese banks over 1994-2003 and find the Big Four banks are the least efficient and the Foreign-owned banks are the most efficiency in China’s banking industry.

Following the global financial crisis of 2007-2009, there has been a shift in research focus towards investigating systemic risk and the macroprudential regulation of financial systems.

However, there is a scarcity of literature examining the connection between capital regulation and systemic risk in the Chinese banking industry. Several studies explored various aspects of systemic risk in the Chinese banking industry. Gang and Qian (2015) observed an increase in systemic risk due to monetary policy shocks. Huang et al. (2019) utilized multiple measures to assess systemic risk in Chinese banks. Zhang et al. (2021) concentrated on the relationship between liquidity creation and systemic risk, identifying a “U shape” pattern in the Chinese banking sector.

Therefore, the lack of consistent results over the period after the GFC and the unique context of the Chinese banking sector provide a strong motivation to examine the role of Basel III capital regulation and the impact on individual banks’ credit risk-taking, efficiency and systemic risk contribution.

This study aims to examine the interplay among the comprehensive implementation of Basel III capital regulation, the credit risk-taking behavior of individual banks, cost efficiency, and their contribution to systemic risk. This investigation takes into consideration the diverse ownership structure, predominantly characterized by state ownership, within China’s banking industry.

Utilizing the latest panel data of Chinese banks spanning from 2010 to the present, this study contributes to the investigation of three research questions. The first research question explores the impact of Basel III capital regulation on bank credit risk-taking, considering the interplay between capital regulation and ownership structure. The second research question, employing a sophisticated four-component stochastic frontier approach (SFA), examine whether stringent capital regulation affect persistent or transitional Chinese bank efficiency. The third research question evaluates the dynamics of systemic risk in the Chinese banking sector, assessing the influence of Basel III and ownership structures.

1.3 Overview of Chapters

1.3.1 Chapter 2. The Landscape Review of China’s Banking Industry

Chapter 2 offers a comprehensive examination of China’s banking landscape, beginning by reviewing the evolutionary trajectory of financial reforms and the regulatory framework in Part I, followed by a detailed analysis of crucial financial indicators in Part II. Chapter 2 provides the reasons and the drivers of the distinctive context of China’s banking industry, assesses the alignment of China’s financial regulatory framework with the Basel III framework, and explores the involvement of Chinese banks in the global financial system. This initiative laid a groundwork for the subsequent chapters which focus on empirical analyses. Part I uncovers the diversified ownership structure in China’s banking sector, as a direct consequence of China’s financial reform and legislative progressions, alongside transformation initiatives. Contemporary corporate governance frameworks were established in commercial banks at the second stage of the reform. Heightened market competition increased market efficiency and

encouraged market access, as well as improved the resilience of China’s financial markets. The full adoption and integration of the Basel III framework into China’s banking regulatory framework is evident by China’s regulatory authorities issuing localized Basel III regulations. Employing CAMELS rating system, Part II examines the main financial indicators aiming at evaluating the safety and soundness of Chinese banks. China’s commercial banks have the average regulatory capital ratio exceeding 10% which is higher than the Basel III standards, and maintain a lower average NPL ratio compared to G20 peers. Notably, Chinese commercial banks enjoy a competitive advantage with lower cost-to-income ratios and an average return on equity exceeding 14%. While credit risk and liquidity risk are generally well-managed, especially in the largest banks, medium-sized banks, especially those historically tied to local government shareholders, may face elevated credit risk and liquidity risks due to the higher average NPL ratio and wholesale funding dependence.

1.3.2 Chapter 3. Ownership dynamics, risk and regulation in Chinese banking: New evidence

The first empirical chapter appraises the impact of Basel III capital regulation on Chinese banks’ credit risk-taking, taking into account the interaction between Basel III capital ratio with ownership structure. This study employs the data on 231 Chinese banks over the period 2010-2019. We also refined the data by manually collecting the missing data from the individual banks’ financial reports. Our results shows that higher regulatory capital decreases credit risk, supporting the regulatory expectations that regulatory capital serves as a protective buffer against economic shocks and mitigates banks’ proclivity for risk, aligned with the theory proposed by Mehran et al. (2011). In this chapter, we provide evidence that the impact of Basel III capital regulation on credit risk-taking is influenced by ownership structure, which echo the empirical conclusion drawn by Laeven and Levine (2009). Moreover, this chapter emphasizes how ownership structure affects credit risk, revealing that state-owned banks generally exhibit higher credit risk compared to foreign-owned banks and other ownership types. This aligns with the findings of Zhu and Yang (2016) and is consistent with Laeven and Levine (2009), indicating that banks with significant cash flow rights held by large owners are prone to higher credit risk. Explanation and analysis on the reasons are provided in Chapter 3.

1.3.3 Chpater 4. Does stringent capital regulation affect persistent or transient Chinese bank efficiency-A four-component model analysis

The second empirical study, Chapter 4, conducts an investigation regarding the impact of Basel III capital regulation on cost efficiency in the unique context of China’s banking industry, using an advanced four-component Stochastic Frontier Approach (SFA) model. We ask the question: does higher capital adequacy requirements affect persistent or transient cost efficiency of Chinese banks? With an unbalanced panel data of 233 China’s commercial banks

over the period 2010-2020, we employ the most recent four-component SFA cost model developed by Colombi et al. (2011), Colombi et al. (2014), Filippini and Greene (2016), and Badunenko and Kumbhakar (2017) to explore and explain Chinese banks' performance. This sophisticated methodology empowers our study to break down overall efficiency into two components: transient (subject to time variations) and persistent (time-invariant). Our results imply that overall inefficiency is almost evenly distributed between the two components. Notably, state-owned banks occupy a mid-tier position in the overall efficiency rankings compared to other ownership types, showcasing higher transient efficiency but markedly lower persistent efficiency. This aligns with the conclusions drawn by Fungáčová et al. (2020). In exploring the impact of regulatory capital requirements on bank cost efficiency, our investigation reveals no statistically significant relationship. Regarding the association between ownership structure and bank cost efficiency, the results suggest that state ownership is statistically significant but inconclusive.

1.3.4 Chapter 5. Assessing Systemic Risk Dynamics in Chinese Banking: The Impact of Basel III and Ownership Structures

The final empirical chapter, Chapter 5, plays a pivotal role in the comprehensive narrative, merging the micro-prudential insights from the initial two studies into the macro-prudential framework. Aligned with the regulatory priorities post-crisis, which address systemic financial stability, this chapter investigates how Basel III risk-based capital regulation influences the individual contributions of banks to systemic risk. This study utilizes the conditional value at risk (CoVaR) methodology proposed by Adrian and Brunnermeier (2016). Our dataset comprises 376 Chinese financial institutions, encompassing 236 Chinese commercial banks, spanning the period from 2010 to 2022. In alignment with previous research (Demirgüç-Kunt et al., 2018; see Laeven et al., 2016), our results affirm that higher regulatory capital exerts a negative influence on the individual banks' systemic risk contributions. Notably, we observe an increase in systemic risk with larger bank size. Furthermore, our study reveals that state-ownership structures exhibit a higher contribution to systemic risk compared to joint-stock and local government-holding structures, corroborating existing evidence.

2 The Landscape Review of China's Banking Industry

China's banking sector plays an essential role in the country's economic development. According to National Bureau of Statistics, the growth of the banking sector contributes 5.4% in the increase of the GDP in 2018.¹ The total added value of the financial sector is RMB7,707.7 billion Yuan (around \$1,100 billion USD) in 2019, increased by 7.2% compared to 2018.² Therefore, the performance of China's banks attracts the increasing attention from both academics and practitioners. China's banking sector has evolved over the last forty years. The reform implementation in all aspects of banking industry, the evolution of financial legislation, and the adoptions of advanced regulatory guidelines all dramatically influence the ecosystem of China's banking sector. Therefore, a review of China's banking sector is useful to aid understanding of this complex financial landscape. For example, Berger et al. (2009) and Huang et al. (2019), among others, discuss the financial reforms to help understand the whole picture.

This section also provides quantitative information about bank performance through an analysis of key financial ratios. Part I reviews China's banking sector, mainly focusing on China's financial reforms, and providing a foundation for the mechanism of current China's banking industry. Part II provides an overview of the regulatory framework of China's banking sector. Part III displays and investigates some essential financial ratios of China's banks, supplementing the review of China's banking industry from the quantitative angle.

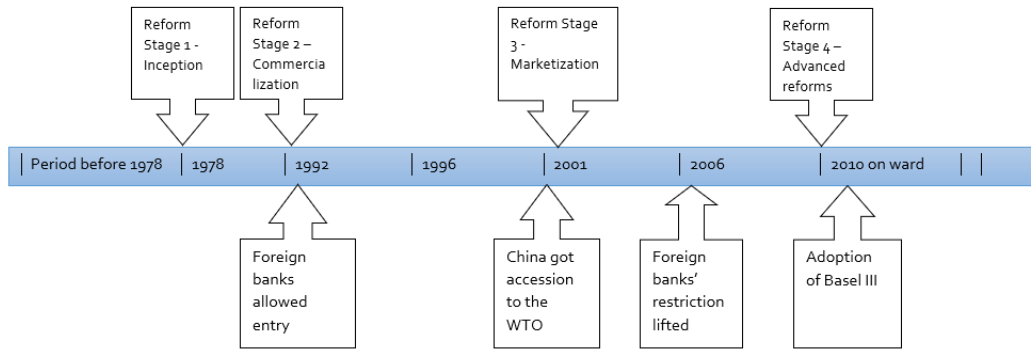
2.1 Part I: Chinese Banking Sector Reforms

The Chinese banking system has been reformed as part of the country's overall economic reform and structural adjustments since 1978. During this period, almost all aspects of the Chinese banking industry have transformed and matured, from ownership structures to marketization, to product diversification, and to new technology. The literature commonly identifies three stages/waves of the financial system reform in the times before 2010: since 1978 to the early 1990s; during the 1990s until 2001 China's accession to the World Trade Organization (WTO); and since the entry of the WTO, through five years of transitional time until 2010 (Berger et al., 2009; Dong et al., 2017; Wang et al., 2014). In 2010 China became the world's second large

¹See China Statistical Yearbook(2019) <http://www.stats.gov.cn/sj/ndsj/2019/indexeh.htm>

²See Statistical Communique of the People's Republic of China on 2019 National Economic and Social Development http://www.stats.gov.cn/english/PressRelease/202002/t20200228_1728917.html

economy based on the Gross Domestic Product (GDP) of \$6,078 billion USD.³ Since then, the reforms of China's banking sector have led to an in-depth transformation which is generally considered as the fourth phase of the financial reforms. In Part I of this review, we present an overview of the structural and regulatory changes of China's banking sector. The timeline and some of the milestones concerning China's financial reforms can be found in Figure 2.1.



Source: People's Bank of China (PBOC), China Banking and Insurance Regulatory Commission (CBIRC), and the State government

Figure 2.1: The Financial Reform Timeline

2.1.1 The era from 1978 to early 1990s

China's central bank, the People's Bank of China (PBOC)⁴ was founded in 1948 with the merging of the North China Bank, Beihai Bank, and the Northwest Peasant Bank. In 1949, the Chinese People's Political Consultative Conference designated the PBOC as the central bank and its national financial functions. The responsibilities of the PBOC included: issuing and circulating the unified currency – the Renminbi (RMB), controlling inflation, managing exchange rates, and centralizing, allocating, as well as utilizing credit endowment to support and accelerate national economic recovery.

Before 1978, China's banking system took the form of the 'mono-bank' structure, the idea referencing the financial system of the former Soviet Union. (Berger et al., 2009) The reason

³See GDP ranking on the World Bank Database https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?end=2010&most_recent_value_desc=true&start=1960&view=chart

⁴For detailed history of the People's Bank of China, see the official webpage of the PBOC <http://www.pbc.gov.cn/en/3688066/3688089/index.html>

behind this choice relies upon the fragile social and economic environment China was facing by that time. After World War II and the civil war, China's economy was extremely weakened and the social situation was rather severe, with high level of poverty, unemployment, and inflation. Under these circumstances, the PBOC established a rudimentary banking system, aiming at building up people's faith to the government and to their communities, as well as boosting the national recovery in all aspects.

From 1979, the national strategies have shifted to developing and strengthening the economy from economic recovery. A series of relative national strategies created and executed by the Chinese government are usually labeled 'Reform-Open' strategies. The essence of the 'Reform-Open' strategies involve: 1) lifting the restriction of accession to China's domestic markets; 2) loosening the constraints of foreign shareholding; 3) establishing and fortifying legislation upon markets, competition, corporate governance, and intellectual property protection. The reform of financial system is a critical part in the chain of China's industrial reforms.

During the period between 1979 and 1992, China's banking sector reconstructed its institutional structure. First, the commercial-banking function of the People's Bank of China was delegated to four state-owned commercial banks: Bank of China, China Construction Bank, Agricultural Bank of China, and Industrial and Commercial Bank of China. These four commercial banks are traditionally called 'the Big Four'. By the time they were founded or resumed⁵, their business was limited in a specified sector of economy, namely foreign trade, construction, agriculture, and industrial and commercial sectors (see Berger et al., 2009; Jiang et al., 2009). Second, national banks came into existence from 1986 (Hsiao et al., 2015). The first national bank is Bank of Communications which was resumed in 1987⁶. Apart from the biggest shareholder- the Finance Ministry, state-owned enterprises were allowed to invest in banks for the first time. Third, other types of financial institutions were set up or resumed to complete the financial system. For instance, the State Administration of Foreign Exchange (SAFE) was founded as the authority administrating foreign Exchange issues. The People's Insurance company was re-established.⁷ Trust companies and urban credit cooperatives, as new players, entered China's financial system. Foreign banks were allowed to enter China's financial market by operating in Special Economic Zones⁸ (Berger et al., 2009). Lastly, starting from 1984, the PBOC performs solely as a central bank, a decision made by the State Council the previous year.

⁵Bank of Communications

⁶Bank of Communications was founded in 1908 during the Qing Dynasty. The bank was dismantled and its business was taken over by the Big Four after 1949. In 1987, Bank of Communication was resumed and performed banking business again.

⁷The People's Insurance Company was existed before 1949. Therefore, the company was re-established in the early 1990's.

⁸Special Economic Zones: a form of Free Ports in China where companies may benefit from tariff allowances and exemption. Chinese government designated the first four Special Economic Zones – Shenzhen, Xiamen, Shantou, and Hainan Province – in order to encourage foreign investments and improve economy and technology by the end of 1980's. More details may be found in http://www.npc.gov.cn/npc/c12434/c234/201905/t20190522_64495.html

A key feature of China’s financial reform during this period is the restructuring at the institutional level, making the first wave of China’s financial reform. At this stage, new types of players began to operate in China’s financial markets. However, the government still controlled the ownership of all layers of financial institutions. Apart from the Big Four banks, city credit cooperatives, emerged in this period, were still wholly owned by local Bureau of Finance, because the capital used to establish those financial institutions was originated from the Treasury system (i.e. tax payers). This initial phase of financial reorganization serve as a significant milestone in China’s reform process. It has to be admitted that the chances for the further changes and development were provided at this stage; nevertheless, Chinese government exhibited a conservative stance regarding the entry of foreign banks.

2.1.2 Early-1990s to End-2001

Besides the financial reforms, the industrial reform took place in industries during the same period. The first wave of China’s industrial reform, which occurred concurrently with the financial changes, not only granted the state-owned enterprises greater autonomy in decision-making but also introduced the ‘Contract Responsibility System’ (CRS) to take a tentative attempt in separation of ownership and management (Lin et al., 2020). The CRS resembles corporate governance structures in advanced nations. However, the CRS, functioning within the framework of state-owned ownership, had certain constraints and led to both positive outcomes. The CRS boosted the incentives of management of the state-owned enterprises at the same time caused some issues such as superfluous supply and moral hazard problems due to the leeway of the CRS system.

One of the results was the severe deterioration of loan quality of the Big Four, since the Big Four played a main role in the state-owned enterprises’ financing which were involved directly with the government before 1990’s. Concerning the Big Four, several initiatives were adopted. In 1994, three policy banks (China Development Bank, Agricultural Development Bank of China, Export-Import Bank of China) were established to undertake the policy-lending function performed by the Big Four. In 1998, Ministry of Finance issued 270 billion RMB of long-term special Treasury bonds as the supplement capital invested into the Big Four. In 1999, four state-owned asset management companies (AMCs) were founded and bought in total 1.4 trillion RMB of Non-performing Loans from the Big Four⁹.

Regulatory legislation surrounding financial reforms made a breakthrough during this period. In 1995, Central Bank Law (the People’s Bank of China Law of the People’s Republic of China) and Commercial Bank Law (Commercial Bank Law of the People’s Republic of China) were enacted by the National People’s Congress. Central Bank Law authorizes the People’s Bank of China as the central banks of China to perform regulation and supervision over China’s financial system. Commercial Bank Law clarifies banks should conduct their business as

⁹Four state-owned asset management companies: China Huarong Asset Management Co., Ltd., China Great Wall Asset Management Co., Ltd., China Cinda Asset Management Co., Ltd., and China Orient Asset Management Co., Ltd.

commercial entities. Commercial Bank Law also, for the first time, stipulates the requirement of the capital adequacy towards commercial banks. It requires that commercial banks must remain the capital adequacy ratios over 8%.

National banks¹⁰ transitioned to a joint-stock ownership structure¹¹. In 1996, China Minsheng Bank was established and jointly owned by private companies instead of having state-owned institutions and/or Ministry of Finance as its shareholders. Required by the State Council, and abiding the guidance document ‘State Council Decisions on Financial System Reform’ issued in 1993, urban credit cooperatives located in cities embarked on merge and consolidation to establish the new type of joint-stock financial institutions – city banks. In principle, there would be one city bank located in one city and provide financial services focusing on that geographic area. Like city banks, the establishment of rural commercial banks was also started out on the basis of the associations of rural credit cooperatives which take private company-individual shareholding structure. Rural commercial banks primarily focus their business in rural areas surrounded a city.

The year 1994 marked a significant shift with the ‘Regulation of the People’s Republic of China governing foreign financial institutions,’ allowing foreign banks to enter China’s financial markets. Subsequently, in 1996, foreign banks were licensed to conduct business in the local currency in Shanghai Pudong¹² and further expanded to neighboring areas (Berger et al., 2009; Hsiao et al., 2015). Since 1998, foreign banks have been authorized entry to China’s inter-bank market.

A distinguishing feature of the financial reforms during this period is commercialization of banks. They evolved into genuine commercial entities, departing from their previous role as ‘policy-lending ‘conduit’ (Berger et al., 2009). The 1995 Commercial Bank Law had a profound impact upon banking industry in the aftermath of its introduction. During this period, shareholders of banks diversified compared to the direct government shareholders and the state-owned shareholders in the first stage of the financial reforms. Alongside with the government (Ministry of Finance), state-owned enterprises, private companies even individuals were allowed to invest in banking industry. The act of embracing foreign financial institutions also improved the speed of Chinese banks’ commercialization, to some extent, regarding learning from the advanced countries. This period, from the perspective of ownership structures, marked the beginning of reduced direct government intervention in banks’ operations, owing to the inclusion of diversified shareholders.

¹⁰National banks: commercial banks which have nationwide branches with no geographical constraints.

¹¹Joint-Stock banks: commercial banks which shares are held by institutional investors, mainly local treasury bureaus and other enterprises.

¹²Shanghai Pudong District: an area similar to the Special Trade Zones where foreign companies have tariff and other benefits; officially designated as China (Shanghai) Pilot Free Trade Zone in 2013.

2.1.3 WTO accession (2001) - 2010

China gained entry into the WTO in 2001. The WTO agreement deepened and broadened China's overall economic Reform in terms of the extent and fields covered. China committed to put much more effort in legislation, commercial banks' transformation, opening domestic financial markets to foreign banks, among others. China got a five-year transition period to fulfill the commitment in stages.

Since 2003, several laws have been changed and new institutions have been founded to be aligned with the WTO agreement and the environment of the ongoing reforms. The 1995 Central Bank Law was amended to reinforce the People's Bank of China as the central bank performing monetary policies and macro-prudential administration. A new regulatory department – China Banking Regulatory Commission (CBRC)¹³ was established. Most of regulatory duties performed by the People's Bank of China (PBOC) during the initial stages of the economic recovery and reform were transferred to the CBRC since the end of 2003. By the time the CBRC was established, its founding law 'the Law of the People's Republic of China on Banking Supervision' also has taken effect and empowered the CBRC as the main regulatory body in banking sector. The 1995 Commercial Bank Law also was amended to satisfy the new market environment by broadening the business scope of commercial banks and adding more articles in terms of governance, disclosure, and supervision. In the end of 2006, the amendment of 'Regulation of the People's Republic of China governing foreign financial institutions' was executed with the new definitions of foreign financial institutions and new articles in terms of regulation and supervision.

Since 2003, aiming at Initial Public Offering and becoming market-oriented institutions, the transformation of the state-owned banks, i.e. the Big Four, have started. At the end of 2003, Central Huijin Investment Ltd. ('Central Huijin') was established by the People's Republic of China ('the State'). Since then, Central Huijin has been acting as a shareholding representative of the State in those state-owned financial firms including banks, insurance companies, securities firms, and other financial firms.¹⁴ Between 2003 and 2008, Central Huijin injected around 125 billion US dollars in total as supplement capital into the Big Four. During the same period, the NPLs were bought by the four asset management companies (AMCs) on market prices again. After the aforementioned preparation for listing, during 2005-2007, three of the Big Four went public on Shanghai Stock Exchange and Hong Kong Stock Exchange. Other national banks such as Bank of Communications, China Minsheng Bank and China Merchants Bank had been listed on the domestic stock market before that time. In 2006, Post Savings Bank of China was founded by China Post Group. The Big Four, Bank of Communications and Post Savings Bank of China have become the six Systemically Important Banks in China,

¹³In 2018, the China Banking Regulatory Commission (CBRC) consolidated the China Insurance Regulatory Commission (CIRC) into a new regulatory authority - The China Banking and Insurance Regulatory Commission (CBIRC).

¹⁴For detailed information, see Central Huijin website http://www.huijin-inv.cn/huijineng/About_Us/index.shtml

i.e. the Big Six, since 2019. The assets of the Big Six account for 40.27% of the total assets of the banking sector.¹⁵

The reforms in city credit cooperatives took further steps following the WTO agreement. City/urban credit cooperatives¹⁶ are a primary financial institutional form in cities during the 1990s, apart from the Big Four and the national banks. The ownership structure of city/urban credit cooperatives is joint-investment, the legitimate shareholders include individual investors and private companies. The cooperatives mainly provide financial services to the members. In 2005, the CBRC issued ‘guidance on development of city credit cooperatives’, proposing that city credit cooperatives should be transformed into joint-stock banks within 3 years. In 2006, city commercial banks were permitted to set up branches and operate in regions other than the host cities. By the end of 2006, there were 113 city commercial banks and 78 city credit cooperatives in China. The numbers of city commercial banks increased to 143 by the end of 2009. In 2007, three city banks Nanjing Bank, Ningbo Bank and Beijing Bank went public and listed in Shanghai or Shenzhen Stock Exchange.

Similar to city credit cooperatives, rural credit cooperatives provide financial services to their members in rural areas. Their primary shareholders are rural private investors. The reform in rural credit cooperatives, i.e. the establishment of rural commercial banks, has also speeded up since 2003. In 2003, the CBRC issued the regulatory documents ‘Transitional Regulation on the Administration of Rural Commercial Banks’ and ‘Transitional Regulation on the Administration of Rural Cooperative Banks’ aiming at regulating those new rural commercial/cooperative banks¹⁷. In 2004, the State Council also issued a policy document seeking to accelerate the reform. By the end of 2009, there were already 43 rural commercial banks and 196 rural cooperative banks in China’s banking sector.

China fulfilled WTO commitments by allowing foreign institutions to conduct business in its financial markets and permitting them to hold shares of Chinese banks as strategic investors. The taxonomy ‘Strategic Investors’ is firstly used by the China Securities Regulatory Commission (CSRC), referring to those institutional investors which invest in listed companies for long-term/strategic purposes rather than short-term financial returns. In the banking sector, strategic investors are mostly those foreign large financial conglomerates (including foreign banks and non-banking institutions) which invest in Chinese commercial banks. A single foreign strategic investor is allowed to hold no more than 20% of shares of a Chinese bank; and multiple foreign strategic investors are allowed to hold in total no more than 25% of shares of a Chinese bank.

In 2006, the amendment of ‘Regulation of the People’s Republic of China governing foreign financial institutions’ was issued and took effect. The restrictions over business region and clientele have been relaxed. By the end of 2006, there were 312 foreign banking entities¹⁸

¹⁵<<http://www.cbirc.gov.cn/cn/view/pages/ItemDetail.html?docId=890465&itemId=954&generaltype=0> >

¹⁶See regulatory document <http://www.pbc.gov.cn/bangongting/135485/135495/135499/2833472/index.html>

¹⁷A rural cooperative bank is a transitional structure of a rural financial institution which are smaller than a rural commercial bank in size and has the similar membership feature as a rural credit cooperative.

¹⁸Foreign banking entities entail foreign bank branches, foreign bank subsidiaries and foreign joint-stock banks.

conducting business in China's financial markets, compared to only 192 foreign financial entities in 2003. During this period, foreign banks also actively investing in Chinese banks as strategic investors. By the end of 2006, foreign banks and institutional investors were holding investments in three of the Big Four, Bank of Communications and several national banks. The Royal Bank of Scotland Group (RBS Group), Temasek Holdings Private Ltd., and UBS Group AG totally held 16.85% of the listed shares of Bank of China. The Goldman Sachs Group Inc., Allianz Group, and American Express held 10% of the listed shares of Industrial and Commercial Bank of China. Bank of America and Temasek Holdings Private Ltd. (also through Asia Financial Holding Group and other subsidiaries) held almost 20% of the listed shares of China Construction Bank. HSBC Group held 19.9% of the listed shares of Bank of Communications.¹⁹ Apart from investing in the state-owned banks and national banks, foreign financial institutions, as strategic investors, also invested in city banks such as Xi'an Bank, Nanjing Bank, Ningbo Bank, Beijing Bank, etc. The period of 2005-2006 is the heyday of foreign investment into domestic banks, expanding from the biggest cities such as Beijing and Shanghai, to the medium sized cities such as Nanjing. By the end of 2006, the amount of foreign investment in Chinese banks were around 19 billion US dollars, accounting for 0.3% of the total assets of the whole banking sector, and 14% of the total assets of the foreign banks in China.²⁰

In terms of banking regulation, on the basis of the adoption of Basel I²¹ (1995 Commercial Bank Law stipulated the capital adequacy.) and the incorporation of Basel II, the CBRC issued the regulation of 'Measures of the Capital Adequacy Ratio of Commercial Banks' in 2004 and its amendment in 2006. This regulation can be regarded as the China version of Basel II.

Corresponding to the rapid transformation of commercial banks and aiming at corporate risk management, the CBRC issued a regulatory document 'Regulatory Guidelines of Corporate Governance in State-owned Commercial Banks' in 2006.

Marketization was a distinctive feature of this reform period. This period is a crucial stage of China's financial reform during which almost all influential events and policies concerning regulation and supervision, ownership structures, corporate governance, among others, happened.

With regard to ownership structure, the establishment of Central Huijin is one of the crucial milestones in China's reform of state-owned financial enterprises. Since the end of 2003, Central Huijin, as a shareholder, has gradually replaced the direct role of the State government in those state-owned financial firms. Central Huijin acts as a representative of the State government which is the shareholder of the state-owned firms. The momentum of this fundamental change could stem from China's commitment to the WTO and the upcoming pressure of the competition with foreign financial firms. In 2007, the founding of China's sovereign wealth

¹⁹The data come from the individual banks' annual financial reports.

²⁰The data come from the CBIRC annual report in 2006 and manual computation.

²¹See *appendix* Table 2.2 for detailed information

fund – China Investment Corporation (CIC) took the abovementioned reform a step forward. Central Huijin became a wholly-controlled subsidiary of CIC. The establishment of Central Huijin played a crucial role in reforming state-owned financial enterprises, representing a shift from direct government intervention to indirect control through shareholding.

Getting listed is also an imperative strategy in China’s financial reforms. It dramatically enriches the shareholder profiles: transforming government shareholding, accepting private enterprises, embracing foreign investors, and partially privatizing (individual investors). More importantly, it promotes the establishment of modern corporate governance frameworks in banks, both listed and non-listed; which reciprocally validates and strengthens the reform. It was in this period that multiple categories of banks’ ownership structure rose and became the foundation and the consensus in the future development of China’s banking sector.

2.1.4 2010 onward

The literature does not, generally, define the time since 2010 as part of the ‘reform period’. This may be because: 1) during 1990s and 2009, substantial and fundamental reforms were successfully performed and the infrastructure of financial industry in terms of legislation, regulation, and corporate governance were founded; 2) 2007-2008 the worldwide financial crisis drastically changed the landscape of the financial industry; 3) reforms implemented after 2010 are usually considered as improvements or advanced changes on the basis of the achievements of the previous reforms. Nonetheless, there are still important changes in China’s banking sector during this period.

Since 2009, further changes concerning the corporate governance framework were implemented in state-owned banks including policy banks and state-owned commercial banks. Notably, in 2010, Agricultural Bank of China listed on both Shanghai Stock Exchange and Hong Kong Stock Exchange. After the introduction of 10 foreign and domestic strategic investors including UBS Group AG, JP Morgan Chase, Temasek Holdings Private Ltd., China Life Insurance Group, and etc. in 2015, Post Savings Bank of China finished its Initial Public Offering (IPO) on Hong Kong Stock Exchange in 2016, and also listed on Shanghai Stock Exchange at the end of 2019.

From 2010 onward, comprehensive reforms targeted city banks, or more generally, small-middle sized banks, focusing on ownership structures and target markets. Regulatory measures were introduced to diversify ownership profiles. In 2010, the CBRC issued the regulatory document ‘Notice on the Examination of Qualification of Major Shareholders of Small and Medium-sized Commercial Banks’ to restrain the share of a single major shareholder (the shareholder which have controlling shares or voting rights) within 20% of the shares of a small and medium-sized commercial bank. This regulatory document aims at constructing city banks as the financial institutions jointly owned by shareholders with a diversified ownership profile. In 2019, the China Banking and Insurance Regulatory Commission (CBIRC) issued a regulatory document ‘Measures of License Issues in Rural Small and Medium-sized Banking institutions’,

stipulating that non-financial institutions and their related parties as shareholders are not allowed to hold more than 10% of the total shares of a rural commercial bank. Since 2013, private enterprises have been permitted to invest in small and medium-sized commercial banks as founding shareholders. In 2014, 5 private joint-stock commercial banks were founded.²² By 2017, private institutional shareholding accounted for 43% in national banks, 55% in city banks, and 87% in rural financial institutions. In 2016, 7 city banks got listed in Shanghai or Shenzhen Stock Exchange, and 8 city banks finished their IPO in Hong Kong Stock Exchange. By the end of 2019, there a total of 20 city banks listed. Regarding the target market, in 2011, the CBRC issued guidance documents to encourage small and medium-sized banks to target small and micro enterprises²³ as their clientele.

Qualified rural credit cooperatives have continued to be transformed into rural commercial banks and the modern corporate governance framework was established as early as 2010. Those unqualified were designated as town-village banks or credit cooperatives as supplemental financial organizations to serve their local rural community. By the end of 2017, there have been in total 1351 rural commercial banks. As an example of the success in the ownership structure reforms, Chongqing Rural Bank finished its IPO in Hong Kong Stock Exchange in 2010. There were 10 listed rural commercial banks by the end of 2019.

Foreign banking entities continue to increase by volume and by total assets year on year since 2009, given that the Chinese government took the opening-strategy a step further. In 2014, the State Council issued the amendment of the 2006 ‘Regulation of the People’s Republic of China governing foreign financial institutions’,²⁴ lifting more restrictions regarding founding and operating foreign banking entities in China’s domestic financial markets. Since 2009, new foreign banking entities began emerging in the north-east and the central-west provinces and medium-to-small sized cities where the economy is rather under-developed. By the end of 2016, 1031 foreign banking entities have been founded and are operating in over 70 cities in 27 provinces (including the province-level municipalities).

A parallel strategy to opening financial markets and embracing foreign companies is known as ‘going-abroad’ strategy. Those qualified commercial banks and policy banks have started to go abroad and set up branches and/or subsidiaries in foreign countries after they established the corporate governance frameworks and control systems. By 2017, 23 banks (commercial banks and policy banks) have set up 238 subsidiaries/branches/representatives in 65 foreign countries (regions).

²²Five private joint-stock commercial banks: Kincheng Bank of Tianjin Co., Ltd., Shanghai Huarui Bank Co., Ltd., Zhejiang E-Commerce Bank Co., Ltd., Myshare Bank of Wenzhou Co., Ltd., Shenzhen Qianhai WeBank Co., Ltd.

²³According to ‘the Law of the People’s Republic of China on the Promotion of Small and Medium Enterprises’, small and medium enterprises should submit application to the government to define whether they are small and medium enterprises. Generally, enterprises which have revenue under USD70,000 (RMB 500,000 Yuan) can be defined as micro enterprises. Enterprises which have revenue between USD70,000 - USD700,000 can be defined as Small enterprises.

²⁴The 2006 ‘Regulation of the People’s Republic of China governing foreign financial institutions’ itself was an amended version of the original 1994 ‘Regulation of the People’s Republic of China governing foreign financial institutions.

Aligning with the Basel III framework, the CBRC issued ‘Commercial Bank Capital Management Measures’, – the China version of Basel III in 2012. China’s regulatory authorities fully adopted Basel III ²⁵, incorporating it into the domestic regulations and setting up the transition period matching the requirement of Basel Committee. Targeting regulatory arbitrage and shadow banking, the CBRC issued regulatory documents to rule and rectify the thriving wealth management products and inter-bank market in 2014 and 2015. Also as a complement to corporate governance guidance, the regulatory document ‘Guidelines of Administration and Supervision on Consolidation of Commercial Banks’ requires commercial banks to consolidate domestic and foreign subsidiaries and conduct comprehensive risk management.

Instead of structural overhaul, more nuanced improvements and adjustments have happened since 2010 based on the implementation in previous stages. The ownership structure evolved, with diversified models becoming mainstream including state-owned, joint-stock with local government holding, joint-stock with private company shareholders in China’s financial institutions. Among others, establishment of modern corporate governance framework is considered as a safeguard against direct government interference in banks’ decision-making; although the evidence of the recedes of direct government in practice need to be investigated further. The last forty years’ reform substantially changed the role that the State government and local government played in the economy: from directly designing economic development plans and managing enterprises to fostering a conducive market environment for competition and upholding macroeconomic stability (Atherton and Newman, 2016).

One of the most salient reforms in banking regulation is the issuance of ‘Commercial Bank Capital Management Measures’ – the China version of Basel III by the CBRC in 2012. It not only changes the way of China’s regulatory authorities regulating and supervising banks, but also requires commercial banks to be accountable for their business decisions. To some extent, this new regulation also can be viewed as the withdrawal of implicit government resort as presented in the early years of the financial reforms.

As part of the significant systemic industrial Reform in China’s economy, the financial reform in the banking sector transformed the landscape forstoring marketization, securitization, and globalization. The reform and development in legislation and transformation resulted in diversified ownership structures, modern corporate governance, and market competition. From the perspective of corporate governance, the direct government intervenes can be considered receding step by step in rounds of the reform. The further deepening overhaul, taking the global financial crisis as an opportunity, is taking place in a fast pace and contribute to the further growth of China’s financial system.

²⁵See appendix Table 2.2 for detailed information

2.2 Part II: the Chinese banking regulatory framework

Along with the overall banking sector reforms, the banking regulatory framework has also experienced considerable changes. In this section, we will briefly review the evolution of the banking regulatory framework, then introduce the main factors of the framework as follows: the regulatory authorities, the regulated institutions, and the regulated fields.

2.2.1 Historical overview of the Chinese banking regulators

We begin with a brief history of the evolution of banking regulators in China.

Until 1978, the Chinese banking system was following the mono-bank model. The only bank, - the People's Bank of China (PBOC), which acted as a unit of the State Council and was appointed as 'a National Bank', undertook functions including 'issuing national currency, managing national treasury, managing national finance, stabilizing financial markets and supporting economic recovery'²⁶ following its establishment. Following the incorporation of private financial institutions into the financial system, the PBOC played a dual role in the financial system: a central bank as well as a commercial bank. The PBOC performed its supervisory function through directly controlling permission for the establishment of financial institutions, approval of their key operational decisions, and senior management appointments in financial institutions.

The national economic reform began in 1979, which necessitates the function transformation of the PBOC and establishment of a diverse financial system. Since 1984, the PBOC perform solely as a central bank, which was decided by the State Council the year before. In 1995, 'the People's Bank of China Law of the People's Republic of China' reinforced the PBOC's status as a central bank through legislation.

In 2003 the regulatory function was officially separated from the PBOC and transferred to the newly founded supervisory body, - the China Banking Regulatory Commission (CBRC). Since then, the CBRC has been regulating banks and financial institutions other than insurance companies and securities firms. In 2018, the CBRC was merged with the China Insurance Regulatory Commission into a new regulatory body, - the China Banking and Insurance Regulatory Commission (CBIRC) which is responsible for regulating banking and insurance sectors.²⁷

²⁶See the website of the People's Bank of China <http://www.pbc.gov.cn/rmyh/105226/105433/index.html>

²⁷See the official document of the Chinese Government 'The Central Committee of the Communist Party of China issued the 'Deepening Party and State Institution Reform Plan' http://www.gov.cn/zhengce/2018-03/21/content_5276191.htm#2.

2.2.2 The current main regulators in banking regulation and supervision

Authorized by its founding laws, the China Banking and Insurance Regulatory Commission (CBIRC) and the People's Bank of China (PBOC) are the two main regulators in bank regulation and supervision in China. These two regulators have the authority to issue regulatory documents in forms of rules, decrees, notices, etc. to regulate and oversee financial institutions. A chart of the structure of the framework of regulation and supervision in China can be found in Figure 2.2.

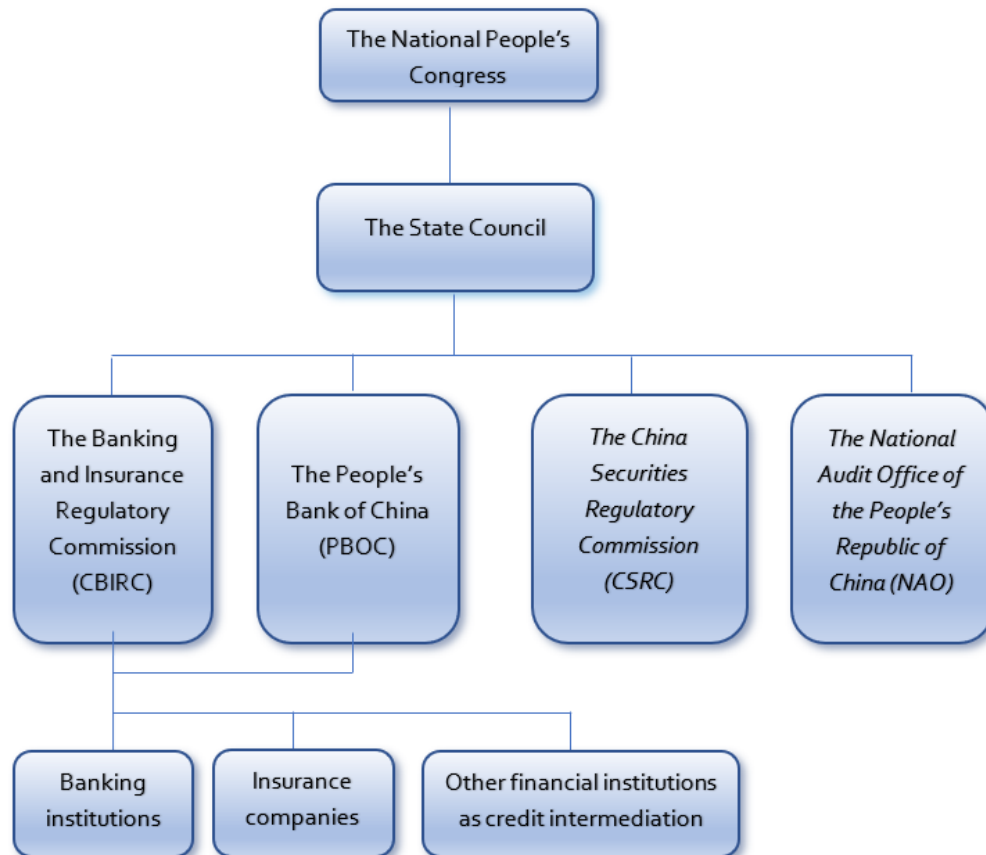


Figure 2.2: The Structure of The Banking Regulatory and Supervisory Framework in China

2.2.2.1 The China Banking and Insurance Regulatory Commission (CBIRC)

The China Banking and Insurance Regulatory Commission (CBIRC) was established in 2018 combining two previously separated regulatory commissions, – the China Banking Regulatory Commission (CBRC) and the China Insurance Regulatory Commission (CIRC). The theory behind the combination of these two regulatory commissions is that there were supervision gaps between banking and insurance sectors as well as the imbalance of supervisory resource. The aims of the merger are to eliminate the supervisory gaps and to clarify the supervisory responsibilities as well as optimizing allocation of supervisory resource.²⁸

The CBIRC is the major player in the Chinese banking regulatory framework. Besides the official document issued by the Chinese Government, the CBIRC is empowered by the Law of the People's Republic of China on Banking Supervision, the Law of the People's Republic of China on Commercial Banks, and other relevant laws and administrative documents such as the Law of the People's Republic of China on the People's Bank of China and the state government document 'China Banking Insurance Regulatory Commission's functional configuration, internal institutions and staffing regulations'.

The mandates listed in the above central document and its official website of the CBIRC include:

I) Rule-making and enforcement

The CBIRC is authorized by the People's Congress to issue two types of regulatory rules: regulations and regulatory documents.²⁹ Most of these rules are issued in the forms of Notices or Decrees by the CBIRC. The regulatory rules are legally bound and the breaches would be subject to the commensurate legal punishment according to the legal force of the regulations or the regulatory documents.

II) Oversight and supervision

The CBIRC ensures that the regulatory rules are adhered through their oversight and supervision on financial institutions' behavior and disclosure. The CBIRC may conduct on-site inspection and compliance assessments as well as supervise banks (and insurance companies) on corporate governance, risk management and internal control. The CBIRC also establishes risk monitoring and evaluation systems on banks (and insurance companies) in terms of capital adequacy, solvency and other stability and soundness requirements.

III) Licensing, chartering, and registration

²⁸See the official document of the Chinese Government 'The Central Committee of the Communist Party of China issued the 'Deepening Party and State Institution Reform Plan' http://www.gov.cn/zhengce/2018-03/21/content_5276191.htm#2.

²⁹According to CBIRC, the regulations have more powerful authority than regulatory documents.

The CBIRC issues licenses and charters to banks (and insurance companies) in term of the access to financial markets and the business scopes. It also has the authority to influence the appointment of senior management in the regulated financial institutions.

The banking regulatory framework in China is a ‘CBIRC centric’ framework. The CBIRC has established its dispatched agencies and affiliates in all provinces and eight key cities such as Beijing, Shanghai, and Shenzhen on the mainland. These affiliates in different regions are called ‘Supervision Bureaus’ which directly report to the CBIRC headquarter. This two-tier structure facilitates the effective execution of regulations and supervision.

2.2.2.2 The central bank – the People’s Bank of China (PBOC)

Most of regulatory duties performed by the People’s Bank of China (PBOC) during the initial stages of the economic recovery and reform has been transferred to the CBIRC since 2003. The legal status of the PBOC as the central bank of the People’s Republic of China was established by the Law of the People’s Republic of China on the People’s Bank of China in 2003. As the central bank, the PBOC conducts monetary policies, targeting short-term interest rates through open market operations.³⁰ The PBOC also may provide loans to commercial banks, acting as a ‘lender of last resort’.

The PBOC is still closely tied to the stability and soundness of the financial system in China. The regulatory functions of the PBOC focus on regulating bank behavior in interbank markets involving repurchase agreements (Repo), interbank foreign exchanges, and interbank bonds. The PBOC also issues regulatory rules on the payment system cooperating with the CBIRC.

China takes the form of the dual-regulator architecture on banking supervision. The PBOC acts as the monetary authority of China, and performs supervisory responsibility on payment systems. The CBIRC acts as the primary regulatory authority of the banking sector. The adoption of a single regulator has been a common feature of banking during the last three decades (Herring and Carmassi, 2008). For example, the European Central Bank has direct supervisory responsibilities over banks in the Eurozone and the Federal Reserve in the United States strengthened its supervisory power by Dodd-Frank Act. The advantages of the single regulator structure include economies of scale and scope, reduction of potential regulatory arbitrage, the ability to supervise the complicated financial conglomerates, among others (Doumpos et al., 2015). Internationally, the Reserve Bank of Australia and the Bank of Japan do not perform the direct supervision over the domestic banking sectors (Berger et al., 2017). China takes the dual-regulator architecture which might avoid the disadvantages of the single-regulator structure, such as potential conflict within a single regulator, the monopoly power and the moral hazard issues, as reported in (Doumpos et al., 2015).

³⁰Open market operations refer to the PBOC buys and sell Treasury Bonds on the open market in order to control the money supply.

2.2.3 Other relevant regulators

Chinese banks are also subject to other regulators in the regulatory framework other than those two major players discussed before. These regulators, as components of the whole regulatory framework, have specific regulatory functions and regulatory objectives. The following regulators involved in banking regulation and supervision usually do not issue specific regulatory documents targeting financial institutions; rather, financial institutions are required to comply with the regulation issued by these regulators. Therefore, the duties of the following regulators complement the regulation and supervision performed by the two major regulators.

The China Securities Regulatory Commission (CSRC) was founded to regulate the areas over the following: (i) participants in securities markets; (ii) securities markets; and (iii) securities products. The CSRC is primarily concerned with transparency and fairness of the securities markets and investor protection. According to the CSRC, by the end of 2019 there were 37 banking firms³¹ publicly traded in the domestic market and they are subject to supervision by the CSRC in terms of financial information disclosures, securities issuance, and other publicly trading information.

Unlike banking regulators, the CSRC does not have regulatory force directly on banking firms and may not be able to intervene or prevent banks from taking excessive risks. However, under the supervision of the CSRC, listed banking firms are required to truthfully and thoroughly disclose their financial information which may indicate potential risks to investors. Banks that intend to list in the near future must submit their financial and internal control reports to the CSRC.

The National Audit Office of the People's Republic of China (NAO) is a department of the State Council and has the authorized duty to audit the firms controlled or dominated by the State-owned capital.³² Differing from banking firms in most advanced countries, the five biggest banks in China are controlled or dominated by either Central Huijin Investment Co., Ltd or directly by the Ministry of Finance of the People's Republic of China. These State-owned banks are also under the supervision of the NAO in terms of financial information and corporate governance. Similar to the CSRC, bank stability and soundness might be an indirect concern of the NAO over banking firms. As an auditor recruited by the State government, the NAO mainly concerns about the truthful disclosure of the employment of the state capital and there are no illegal activities that may harm the state capital in banks. However, banks are bound by the regular reports and inspections by the NAO and need to present their safety and soundness.

³¹See 'Industry classification results of listed companies in the fourth quarter of 2019' by the CSRC <http://www.csrc.gov.cn/csrc/c100103/c1451996/content.shtml>.

³²See the website of the National Audit Office of the People's Republic of China <https://www.audit.gov.cn/en/n744/index.html>.

2.2.4 Regulated financial institutions and regulated businesses

According to its founding laws, the CBRC has the authority to regulate and supervise all institutions in the financial sector including ‘commercial banks, urban credit cooperatives, rural credit cooperatives and other financial institutions and policy banks that absorb public deposits’. Besides these depository institutions, the CBRC extends its regulatory authority to asset management companies, trust and investment companies, internal financial intermediaries in corporations, financial lease companies, and other financial institutions permitted by law. These financial institutions are also legally bound by the Law of the People’s Republic of China on Banking Supervision. After the combination of the CBRC and the CIRC, the regulatory authority of the CBIRC extends to all insurance companies including insurance brokers.

Foreign banks (including Chinese-foreign joint-stock banks) are also subject to the regulation and supervision of the authorized regulators such as the CBIRC and the People’s Bank of China. The ‘Regulation of the People’s Republic of China on the Administration of Foreign Banks’, which has the highest legal force on foreign banks’ operating in financial markets in China, was issued in 2008 as a decree of the State Council and has been revised twice since then.³³ Responding to this legal document, the CBIRC issued ‘People’s Republic of China Foreign Banks Regulations Implementation Rules’ in 2015.³⁴ This implementation document provides more detailed guidance to foreign banks in all aspects of their operation in China.

It is noticeable that in the 2nd amendment of the ‘Regulation of the People’s Republic of China on the Administration of Foreign Banks’, the requirements on the regulatory capital adequacy ratio has been underlined and included into legal articles.

According to the statistics from the CBIRC, by October 2019, the six largest banks³⁵ have a combined share of about 47.9% of the total assets of commercial banks. Four of these six largest banks (the Industrial and Commercial Bank of China, China Construction Bank, Agricultural Bank of China, Bank of China) have been listed as Global Systemically Important Banks (G-SIBs) by the Financial Stability Board (FSB) in 2019.³⁶

There two main areas of banking business are under the oversight of the CBIRC and the central bank. Apart from the expansion of regular banking business, the rapid growth of shadow banking has become a new concern and a key area that attracts regulation and supervision.

a) Regular banking business

³³See the website of the central government, https://www.gov.cn/zhengce/content/2008-03/28/content_1958.htm.

³⁴See the website of the CBIRC <http://www.cbirc.gov.cn/cn/doc/9103/910303/91030302/020943393088424EBD4670788398111B.html>.

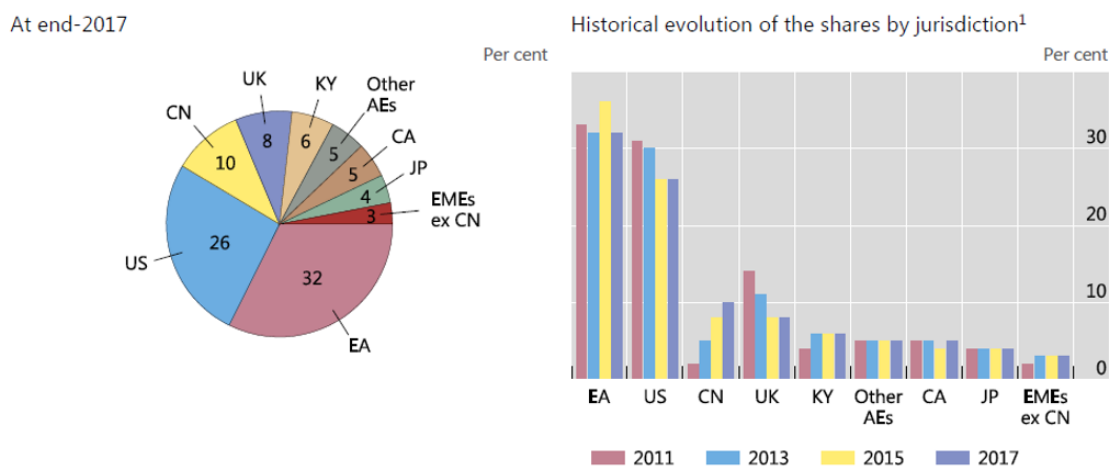
³⁵The six largest banks, also called the State-controlled large commercial banks, include the Industrial and Commercial Bank of China, China Construction Bank, Agricultural Bank of China, Bank of China, Bank of Communications, and Postal Savings Bank of China.

³⁶See the FSB website <https://www.fsb.org/2019/11/2019-list-of-global-systemically-important-banks-g-sibs/>.

According to the ‘Law of the People’s Republic of China on Banking Supervision’ and the ‘Commercial Bank Law of the People’s Republic of China’, all businesses and products within the business scopes of the domestic and foreign commercial banks should be either approved by or filed to the CBIRC and/or the People’s Bank of China. The regular banking business encompasses a broad range of products and transactions such as absorbing deposits and issuing loans, issuing financial bonds, interbank lending, buying, and selling bonds, credit/debit card business, among others.

b) Shadow banking

It is believed that the emergence of a large amount of Wealth Management Products (WMPs) indicates the rapid rise of shadow banking in China. As it is shown in Figure 2.3, China’s other financial institution (OFI) assets have increased to 11.8 trillion US dollars in 2017, accounting for 10% of the global OFI asset shares and becoming the third-largest jurisdiction (FSB, 2019). FSB also reported that the shares of China’s shadow banking have been monotonously increasing from 2011 to 2017 (as shown in the right histogram of Figure 2.3).



Source: FSB Global Monitoring Report on Non-Bank Financial Intermediation 2018

Figure 2.3: China’s Other Financial Institution Assets Share

Banks dominate the Chinese financial sector. It is understandable that commercial banks act as the largest and direct intermediaries in shadow banking in China (Berger et al., 2019). Banks participating in shadow banking could be considered as a way of regulatory arbitrage. The risks involved in shadow banking such as liquidity risk, high leverage, and operational risk might also be imposed on the whole financial system and the real economy and cause the systematic breakdown. Shadow banking now has become one of the key areas which needs to be supervised by the national regulators through stricter regulatory initiatives.

2.2.5 Adoption of Basel III framework and rules issued to regulate the shadow-banking system

As a member of the G20³⁷ and Basel Committee on Banking Supervision (BCBS, or Basel Committee), China has been fully supporting and participating in the global regulatory reform after the Great Financial Crisis³⁸. In June 2012, the CBRC³⁹ issued the regulation ‘Commercial Bank Capital Management Measure (Trial)’, which means that Basel III framework has been adopted and incorporated into the banking regulatory framework in China.⁴⁰ The BCBS also assessed the adoption as ‘compliant’ and ‘largely compliant’ in their assessment report in the Regulatory Consistency Assessment Program (RCAP) in 2013 (BCBS, 2013).

Following 2012, the CBRC issued or updated supplementary regulatory documents involving requirements covering all aspects of Basel III framework to improve the banking regulatory framework in China. Key regulatory documents can be found in the Appendix Table 2.2.

Besides the full adoption of Basel III framework, the Chinese banking regulatory authorities have noticed the rapid growth of shadow banking (as shown in Figure 2.3). As a member of G20, China commits to the annual monitoring exercise conducted by the Financial Stability Board (FSB). The authorities also have started taking initiatives in order to regulate this particular area to avoid the damage it would possibly cause. As early as in 2011, the CBRC issued the regulatory document ‘Measures for the Administration of Sales of Wealth Management Products (WMPs) of Commercial Banks’, requiring commercial banks to reveal the risk associated with the WMPs which they are selling to their customers. Also, in the same year, the CBRC issued a notice which is linked to a regulatory document targeted at the joint Wealth Management Products between banks and trusts. In this notice the CBRC further required that the amount of the WMPs should be reduced gradually. In 2017, the CBRC announced another notice addressing to stricter regulation on the WMPs joint business between banks and trusts.

In 2018, the CBIRC issued the regulation ‘Measures for the Supervision and Administration of Wealth Management Business of Commercial Banks’ which particularly addresses to commercial banks, the largest and direct intermediaries in shadow banking. As to those Special Purpose Vehicles (SPVs) founded by commercial banks to buying and selling WMPs, the CBIRC issued regulations ‘Measures for the Management of Wealth Management Subsidiaries of Commercial Banks’ and ‘Measures for the Management of Net Capital of Wealth Management Subsidiaries of Commercial Banks’ in 2018 and 2019 respectively. These regulations intend to impose more stringent regulation and supervision on the business line of WMPs.

Centering the two main regulators – the CBIRC and the PBOC, supplemented by other related regulated bodies such as the China Securities Regulatory Commission (CSRC), the banking

³⁷G20: An international forum for the governments and central bank governors from 19 countries and the European Union (EU) in order to promote international cooperation.

³⁸the financial crisis from 2007 to 2009

³⁹The CBRC and the CIRC were combined into the CBIRC in 2018.

⁴⁰China also adopted and implemented Basel II and Basel II.5 in previous years.

regulatory framework was established and evolved in the past four decades. Financial institutions involved with banking business, not only banks, are monitored and supervised under this regulatory framework. The full adoption of Basel III framework not only symbolizes China’s support for the global regulatory reform, but also represents the further growth of China’s banking sector in terms of regulation and supervision. After the adoption of Basel III framework, China’s two main regulators the CBIRC and the PBOC have switched their focus to macroprudential supervision, as instructed by the Bank for International Settlement (BIS). Because of the rapid growth of shadow banking globally as well as domestically and its potential influence on the stability of the whole banking system, shadow banking has become a focusing regulated area in China’s banking sector. As shown in (FSB, 2020), the growth rate and the value of shadow banking already started to decelerate in terms of total financial assets, compared to the last year.

2.3 Part III: Ratio analysis

2.3.1 Data

We use the SNL database (a service provided by S&P Global Inc.) as our main data source. Our sample is unbalanced. In the analysis of total assets, our sample entails the data of 5 banking sub-sectors - banks, insurance companies, securities firms (broker-dealers), trust companies and specialty lending companies- in total 342 financial institutions over the period 2010-2019. In the CAMEL system ratio analysis, we use the data of 231 commercial banks over the period 2010-2019, totaling 2097 observations. In case the SNL database does not provided enough information or has doubtful values, we hand-collect data from other official sources including the annual issues of China’s Statistical Yearbook, press releases and the annual reports of the China Banking and Insurance Regulatory Commission (CBIRC), and the annual reports of individual banks and other types of financial institutions. The categories of financial institutions of the banking sector and their ownership structures can be found in Table 2.1.

Table 2.1: Ownership structure information of the banking sector

Description	Number of Institutions(by 2019)
Total number	231
Banks-Border	
Chinese banks	198
Foreign bank subsidiaries	33
Public Offering(Chinese Banks)	
Listed banks	50
Non-listed banks	148
Place Listed(Chinese Banks)	
Listed-Mainland	36
Listed-Hong Kong	15
Bank Ownership	

(continued)

Description	Number of Institutions(by 2019)
State-owned_Big Six	6
State-owned_Non-BigSix	8
Local government-holding	58
Joint-stock	114
Foreign joint-stock	12
Foreign-owned	33
Bank Type	
Big Six	6
National bank	12
City bank	110
Rural commercial	70
Foreign-owned	33
Insurance Companies	
Total number	37
State-owned	19
Joint-stock	14
Foreign joint-stock	4
Securities Firms	
Total number	44
State-owned	7
Local government-holding	15
Joint-stock	20
Foreign joint-stock	2
Trust Companies	
Total number	23
State-owned	5
Local government-holding	7
Joint-stock	7
Foreign joint-stock	3
Foreign-owned	1
Specialty Lending Companies	
Total number	6
State-owned	2
Joint-stock	4

Data source:

the SNL database, the China Banking and Insurance Regulatory Commission (CBIRC) and manual calculation.

2.3.2 Total Assets

Figure 2.4 shows the shares of the total assets of the subsectors (including banks, insurance companies, securities companies, trust companies and special lending companies) to the total assets of banking sector between 2010-2018, based on the categories by the China Banking and Insurance Regulatory Commission (CBIRC).

The total assets of the whole banking sector (including banking and non-banking financial institutions) and of the banking institutions have been increasing between 2010-2019. The total assets of the whole banking sector amount to RMB 2,825 trillion (approximate USD 403.5 trillion) at the end of 2019. Figure 2.4 shows that the banks are the biggest subsector

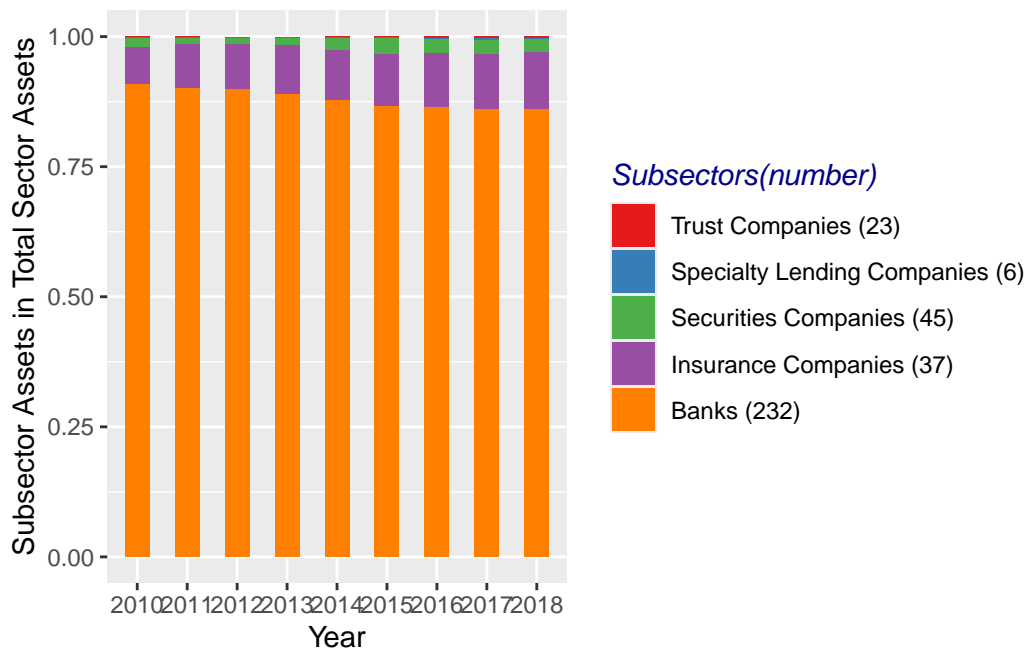


Figure 2.4: Banking Sector Assets Total Shares - Overview(2010-2018)

of the banking sector, in terms of the numbers of the institutions and their total assets. It also shows that the proportion of the total assets of the bank subsector have been virtually decreasing between 2010 to 2018, whereas other subsectors being increasing. The reasons that the shares of the banks have been remaining steady or even decreasing in recent three or four years could be the rising of the shares of other financial institutions, including securities firms, insurance companies, FinTech companies etc., which also are incorporated into the whole banking sector (see Berger et al., 2019). This trend represents that more financial services and functions have been put into China's financial service system.

From the perspective of ownership structure, the total assets of the state-owned banks, although there are only 14 of them out of total 231 banks, account for over 50% of the total assets of the subsector. This means that the state-owned, big banks dominate the subsector. However, it is not the case in other subsectors. The state-owned insurance companies account for over 70% of total assets of the subsector and over 50% of total number of the institutions, which might be considered roughly proportionate. In the subsectors of securities companies and trust companies, the total assets of the state-owned institutions do not outnumber other ownership structures.

In the appendix (Table 2.4), the total assets of the state-owned banks show the absolute decrease pattern (from 67.18% to 51.99%); in other subsectors, due to their overall increase in the total assets, the state-owned institutions in those subsectors exhibit a relative decrease tendency. The same descending tendency can be found in Hsiao et al. (2015) where the share

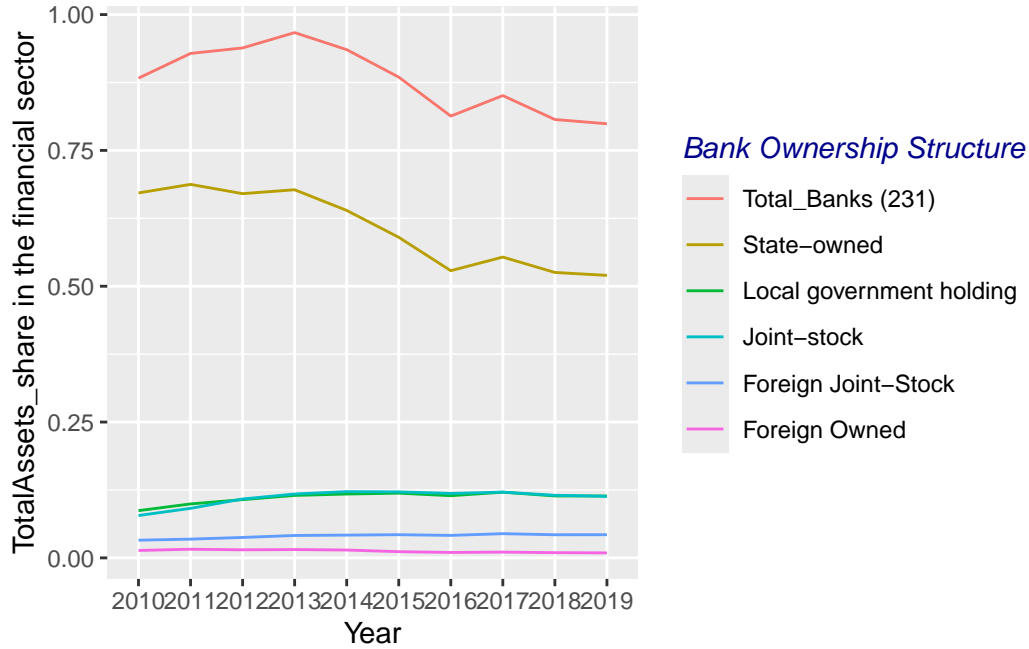


Figure 2.5: Banks' Total Assets - by Ownership Structure (2010-2019)

of total assets of the biggest five banks (the state-owned banks) decreased from 61.83% to 52.76% during 2007-2012; and the joint-stock banks increased gradually. Other ownership structures, especially local-government holding, joint-stock and foreign joint-stock, all reveal an obvious increase trend. For example, the total assets of the joint-stock insurance companies have leaped from 0.45% in 2010 to 1.7% in 2019.

Figure 2.5 demonstrates the change of the banks' total assets by different ownership structures. Apart from the clear decrease of the portion of the state-owned, the total assets of the joint-stock and the local-government holding banks gradually increased. Another type of ownership structure – foreign joint-stock banks show similar tendency to the local-government holding banks, with the share going up from 3.26%% in 2010 to 4.27% in 2015 and remaining steady since then. However, the foreign-owned banks' share has slightly dropped from 1.38% in 2010 to 0.92%% in 2019. The reasons behind the patterns exhibited in Figure 2.5 might be closely related to a series of strategies of Chinese government and the regulatory authorities after China's accession to the WTO in 2001 such as regulations concerning the diversifying the shareholders of commercial banks.

2.3.3 3. Financial Ratios of CAMELS rating system

Following the ratio classification used by the CAMELS rating system, we analyze the financial ratios of 233 sample banks, in terms of their ownership structures and the bank types.

CAMELS rating system is the common name for the Uniform Financial Institutions Rating System (UFIRS) which was first adopted by the Federal Reserve U.S. in 1979 as a methodology to evaluate the soundness and safety of depository institutions. The ‘CAMELS’ is an acronym of the six assessment components: Capital adequacy, Asset quality, Management, Earnings, Liquidity and Sensitivity to Market Risk. The Sensitivity to Market Risk was added into the UFIRS in 1996 as an evaluation component.⁴¹ In this sector, we use the CAMEL ratios to assess the safety and soundness of the sample banks on the ground that the Sensitivity component requires market data which are not available for those non-listed banks. Due to the fact that the CAMELS rating system guidance only gives the principle guidelines of the above assessment factors instead of the exact financial ratios, we take the following financial ratios as the factors for evaluating the safety and soundness of the sample banks, by reference to the relevant literature such as Gunther and Moore (2003), Arena (2008), and Bitar et al. (2018). Variable definitions and the definition source are listed in appendix Table 2.3.

2.3.3.1 CAMEL Ratios of Commercial banks – Capital Adequacy

We examine two capital adequacy ratios: Tier 1 capital ratio and Total equity to total assets ratio. Except for the foreign banks, the means of Tier 1 capital ratio of other different types of banks are quite close, from 10.64% to 12.21%. The state-owned banks have the mean of 10.65%. The joint-stock banks have the highest mean of Tier 1 capital ratio which is 12.21% and have the highest standard deviation of 15.51%. This might be due to that joint-stock banks are quite different from each other in sizes, performance, and risk management competence, as well as the abnormal maximum value of 447.46%. These results are corroborated by the Table 3-2 categorized by bank types. Apart from the state-owned Big Six being consistent with the mean of the state-owned banks, national banks show a mean of the state-owned banks, the local government holding banks, and the joint-stock banks, since there are 12 national banks and comprised with the abovementioned ownership structure. Most regional banks are involved with local government shareholders, city banks and rural commercial banks are mostly joint-stock banks, therefore their means are close to the means of those ownership structures. Corporation banks⁴² are the banks which were funded initially by some corporations or companies in order to provide financial services for the specific industries, and emerged after 2015. Therefore, these banks are similar to the joint-stock banks in terms of sizes and geographic areas. There are 13 corporation banks by the end of 2019, including those founded by the private companies. The China Banking Regulatory Commission (CBRC) issued ‘Commercial Bank Capital Management Measures (Trial)’ in 2012, which is the sign of the adoption of Basel III, demanding that all commercial banks in China would have to apply the new capital adequacy requirements under Basel III since 2013. As a result, the value of Tier 1 ratio of all

⁴¹For more detailed information, see Federal Reserve website and the Commercial Bank Examination Manual <https://www.federalreserve.gov/publications/files/cbem.pdf>.

⁴²Regional banks and Corporation banks will be combined with the category of “City bank” in the following chapters because of their similar sizes, business lines, and the places where the banks operate.

Ownership Structures	CAMEL Ratios - Capital Adequacy									
	<u>Tier 1 Capital Ratio</u>					<u>Total Equity / Total Assets</u>				
	Mean	Median	Std. Dev.	Max.	Min.	Mean	Median	Std. Dev.	Max.	Min.
State-owned	10.65%	10.11%	2.30%	20.21%	6.65%	6.75%	6.76%	1.57%	10.33%	1.65%
Local government-holding	11.09%	10.68%	2.50%	39.15%	0.82%	7.08%	6.90%	1.89%	23.59%	3.66%
Joint-stock	12.21%	11.13%	15.51%	447.46%	-13.65%	7.94%	7.48%	4.51%	91.42%	-1.31%
Foreign Joint-stock	10.38%	10.11%	1.49%	16.21%	7.74%	6.67%	6.32%	1.44%	11.18%	3.55%
Foreign-owned	44.06%	19.90%	84.74%	676.75%	10.14%	18.78%	12.52%	15.64%	80.94%	6.06%

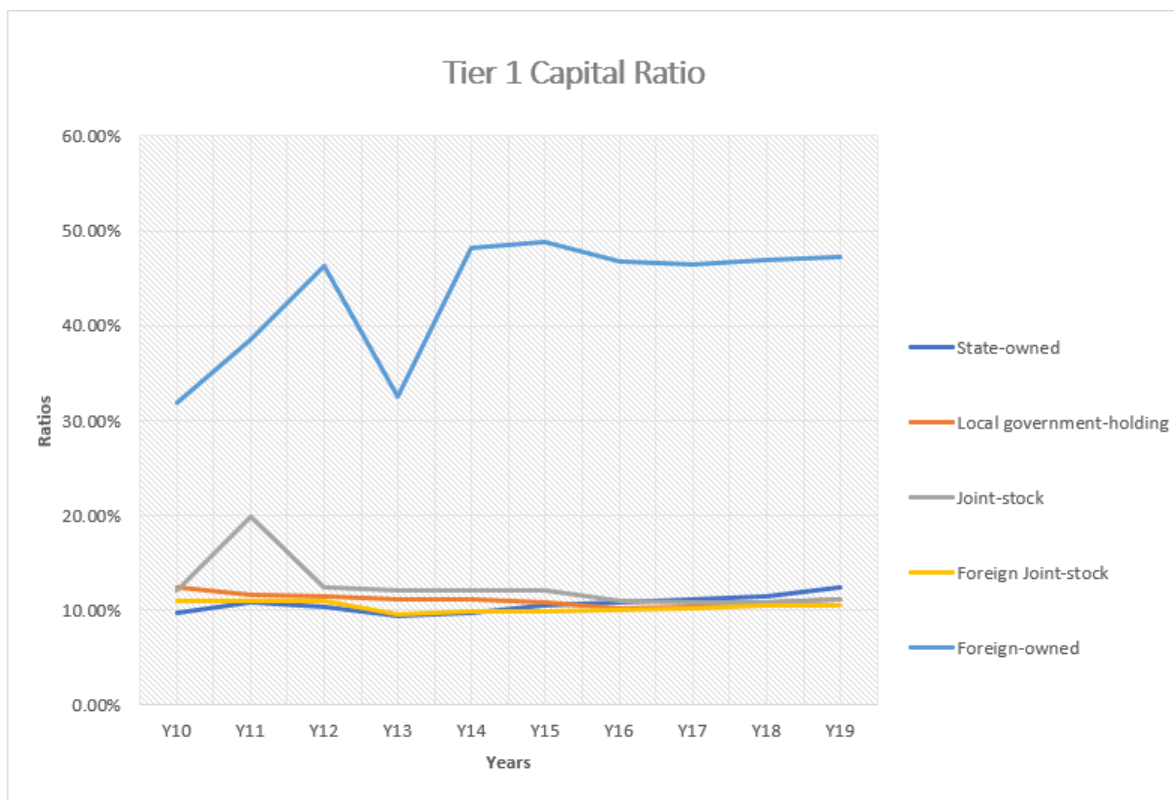
Table *-1: CAMEL Ratios – Capital Adequacy (Ownership Structures)

Bank Types	CAMEL Ratios - Capital Adequacy									
	<u>Tier 1 Capital Ratio</u>					<u>Total Equity / Total Assets</u>				
	Mean	Median	Std. Dev.	Max.	Min.	Mean	Median	Std. Dev.	Max.	Min.
Big Six	10.69%	10.81%	1.71%	14.68%	7.37%	6.60%	6.87%	1.73%	8.94%	1.65%
National bank	9.12%	9.19%	2.40%	13.25%	-13.65%	6.05%	5.98%	1.31%	8.92%	-1.31%
Regional bank	11.10%	10.60%	2.40%	22.00%	7.74%	7.41%	7.10%	2.26%	23.60%	4.16%
City bank	11.57%	10.50%	16.19%	447.46%	3.25%	7.14%	6.89%	2.21%	41.96%	3.34%
Corporation bank	13.85%	11.17%	9.76%	81.98%	8.63%	9.76%	7.30%	11.47%	91.42%	3.64%
Rural commercial	11.96%	11.66%	2.60%	30.00%	0.82%	7.94%	7.77%	1.89%	16.20%	3.28%
Foreign bank subsidiary	44.06%	19.90%	84.74%	676.75%	10.14%	18.78%	12.52%	15.64%	80.94%	6.06%

Table *-2: CAMEL Ratios – Capital Adequacy (Bank Types)

Data source: the SNL database, the release of the China Banking and Insurance Regulatory Commission (CBIRC) and manual calculation

Figure 2.6: CAMEL Ratios-Capital Adequacy



Data source: the SNL database, the release of the China Banking and Insurance Regulatory Commission (CBIRC) and manual calculation

Figure 2.7: The Yearly Mean of Tier1 Capital Ratios (Ownership Structure)

ownership structure decreased compared to the previous year. As shown in Figure 2.7, since 2013, the Tier 1 capital ratio of all types of banks have been increasing gradually.

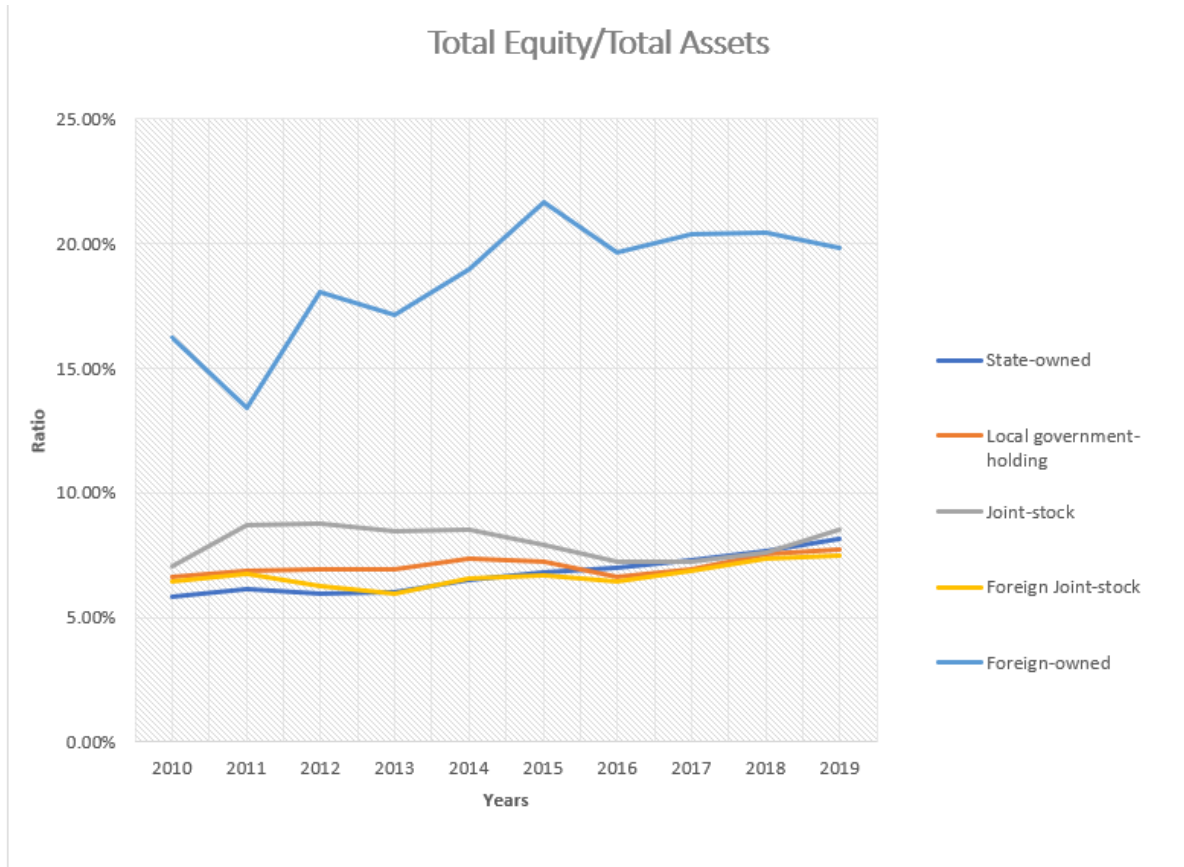
The ratio of total equity/total assets represents the book value leverage of a bank. The majority of means of total equity/total assets of banks with different ownership are below 8% yet over 6.50%, such as local government holding banks at 7.08%, slightly higher than the state-owned banks (6.76%). However, the mean of the ratio of joint-stock banks are almost 13% higher than other types of banks. A higher of standard deviation of the ratio (4.51%) might reveal the cause of a higher mean of the joint-stock banks. The peer group of Bank Types provides the corresponding results. As presented in Figure 2.8, The yearly mean of the ratio of total equity/total assets have shown different trends between different types of ownership. Except that the state-owned banks have been following gradual growth year by year, other bank types have exhibited the tendency of increase-decrease-increase again. The yearly mean of the ratio of all banks are over 7% in 2019.

The foreign-owned banks have displayed abnormally high capital adequacy ratios. We cannot trace the values back to its sources due to the data availability. Speculatively, this might be caused by a relatively small size of the assets of the foreign-owned banks in China.

The ratio of return on average assets (ROAA), the ratios associated with Non-performing Loans (NPLs to total loans, problem loans/total loans, loan loss reserves/problem loans and loan loss reserves/gross loans) and the ratio of net loans/total assets constitute the assessment of asset quality of banks.

The means and medians of ROAA of different ownership structure are centered around 1%, with the exception of the foreign owned banks at 0.48%, almost only as half of the other types of banks. This might be due to the high costs of the foreign-owned banks' operation in China's financial markets and could also collaborate with the ratio of Cost to Income in the later part of analysis. In the peer group of Bank Types, the Big Six has the highest ROAA ratio, which might reveal the economies of scale. Figure 2.11 displays that the yearly means have a trend of decline since 2012/2013, which could reveal the disproportionate growth of return and the total assets of banks in recent years and could also reveal the competition rising in the banking industry.

The ratios associated with Non-Performing Loans (NPLs) can be divided into two groups with regards to their indications, like two sides of a coin. The group of the ratio of NPLs to total loans and the ratio of problem loans/total loans indicates the issue of problematic loans. Intuitively the lower the ratios are, the better the asset quality is. The group of the ratios of loan loss reserves/problem loans and loan loss reserves/gross loans means the safeguards a bank puts into its dubious loans, the higher the better. The results are consistent with the country NPL results from the IMF Financial Soundness Indicators for Global Financial Stability Report (2019) that China's commercial banks have a relatively low rate of NPL. The reason attributed will be explained later. In the above table, the state-owned banks exhibit the lowest means of NPLs to total loans and problem loans/total loans (1.28% and 1.27%, respectively) amongst all ownership structures. In terms of bank types, the rural commercial



Data source: the SNL database, the release of the China Banking and Insurance Regulatory Commission (CBIRC) and manual calculation

Figure 2.8: The Yearly Mean of Total Equity/Total Assets (Ownership Structure)

CAMEL Ratios - Asset Quality										
Ownership Structures	<u>ROAA</u>					<u>Total Net Loans/ Assets</u>				
	Mean	Median	Std. Dev.	Max.	Min.	Mean	Median	Std. Dev.	Max.	Min.
State-owned	1.01%	1.04%	0.28%	1.61%	0.05%	46.79%	49.49%	9.95%	62.56%	14.38%
Local government-holding	1.00%	0.97%	0.39%	2.33%	0.02%	42.05%	42.40%	9.29%	62.53%	15.49%
Joint-stock	1.02%	0.97%	0.44%	2.70%	-0.77%	46.63%	47.83%	9.85%	74.22%	0.00%
Foreign Joint-stock	0.91%	0.95%	0.31%	1.78%	-0.45%	42.34%	40.96%	8.36%	64.63%	28.90%
Foreign-owned	0.48%	0.46%	0.67%	2.96%	-5.12%	37.33%	39.84%	14.24%	72.72%	0.00%
	<u>NPL to Gross Total Loans</u>					<u>Problem Loans/Gross Total Loans</u>				
	Mean	Median	Std. Dev.	Max.	Min.	Mean	Median	Std. Dev.	Max.	Min.
State-owned	1.28%	1.19%	0.70%	5.59%	0.00%	1.27%	1.19%	0.70%	5.59%	0.00%
Local government-holding	1.48%	1.41%	1.16%	13.97%	0.00%	1.43%	1.30%	1.18%	13.99%	0.00%
Joint-stock	1.72%	1.56%	1.60%	28.44%	0.00%	1.61%	1.47%	1.27%	20.44%	0.00%
Foreign Joint-stock	1.32%	1.17%	0.68%	4.31%	0.11%	1.33%	1.19%	0.67%	4.31%	0.11%
Foreign-owned	0.98%	0.86%	0.95%	5.97%	0.00%	0.82%	0.60%	0.95%	5.97%	0.00%
	<u>Loan Loss Reserves/ Problem Loans</u>					<u>Loan Loss Reserves/ Gross Loans</u>				
	Mean	Median	Std. Dev.	Max.	Min.	Mean	Median	Std. Dev.	Max.	Min.
State-owned	244.72%	219.25%	117.02%	830.70%	93.38%	2.69%	2.49%	0.82%	5.22%	0.85%
Local government-holding	278.24%	224.12%	146.32%	965.95%	44.26%	3.28%	3.09%	1.04%	8.58%	1.10%
Joint-stock	262.53%	221.91%	123.92%	950.69%	30.46%	3.57%	3.30%	1.46%	15.88%	0.12%
Foreign Joint-stock	270.44%	203.33%	173.83%	943.94%	63.63%	3.13%	3.05%	0.76%	5.30%	1.36%
Foreign-owned	266.56%	243.04%	106.69%	852.28%	102.44%	2.17%	2.05%	1.40%	9.06%	0.00%

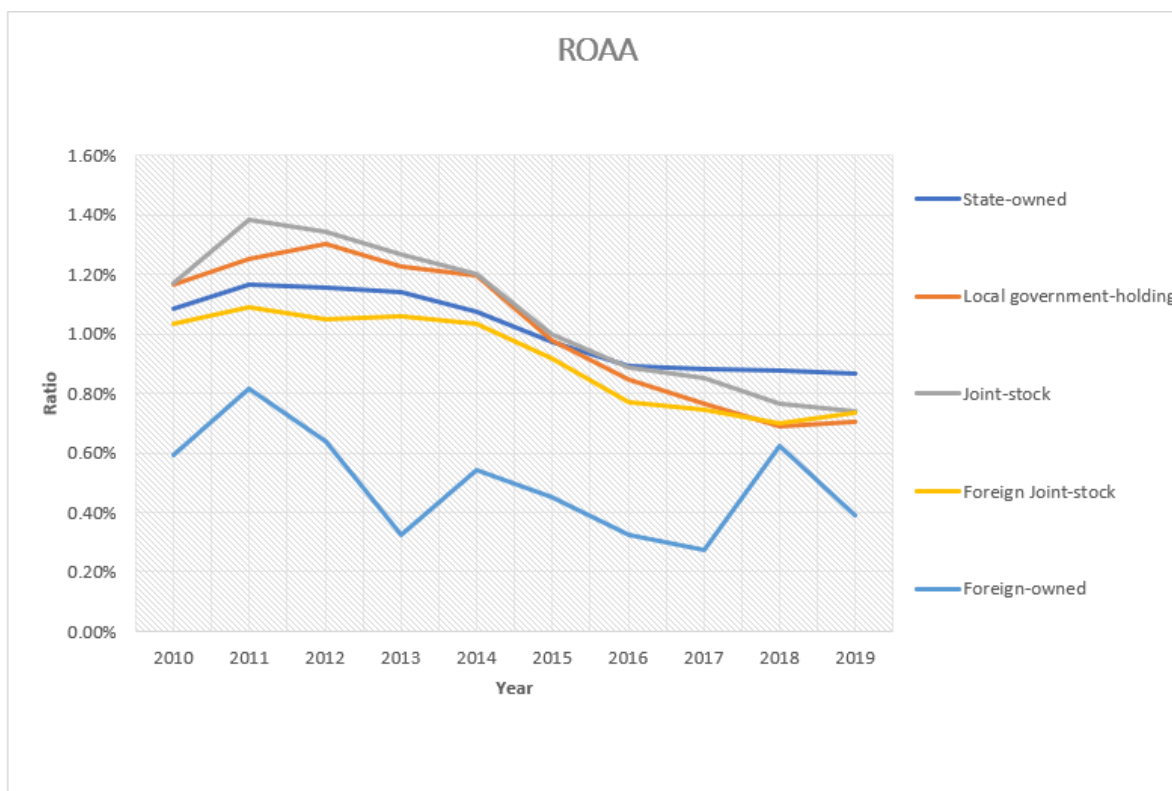
Data source: the SNL database, the release of the China Banking and Insurance Regulatory Commission (CBIRC) and manual calculation

Figure 2.9: CAMEL Ratios-Asset Quality (Ownership Structure)

Bank Types	CAMEL Ratios - Asset Quality									
	<u>ROAA</u>					<u>Total Net Loans/Assets</u>				
	Mean	Median	Std. Dev.	Max.	Min.	Mean	Median	Std. Dev.	Max.	Min.
Big Six	1.06%	1.10%	0.27%	1.48%	0.49%	49.05%	52.28%	8.46%	57.55%	24.64%
National bank	0.95%	0.93%	0.23%	1.45%	0.06%	47.51%	48.30%	8.34%	61.74%	25.97%
Regional bank	0.98%	0.95%	0.39%	2.14%	0.15%	41.94%	42.41%	8.46%	64.63%	16.42%
City bank	1.00%	0.96%	0.45%	2.70%	-0.77%	42.88%	42.76%	9.88%	74.22%	15.49%
Corporation bank	0.84%	0.88%	0.38%	1.66%	-0.17%	36.51%	38.38%	10.62%	62.56%	0.00%
Rural commercial	1.07%	1.04%	0.38%	2.42%	-0.24%	49.01%	49.88%	8.11%	66.06%	22.88%
Foreign bank subsidiary	0.48%	0.46%	0.67%	2.96%	-5.12%	37.33%	39.84%	14.24%	72.72%	0.00%
	<u>NPL to Gross Total Loans</u>					<u>Problem Loans/Gross Total Loans</u>				
	Mean	Median	Std. Dev.	Max.	Min.	Mean	Median	Std. Dev.	Max.	Min.
Big Six	1.23%	1.19%	0.41%	2.39%	0.22%	1.23%	1.22%	0.43%	2.39%	0.16%
National bank	1.45%	1.33%	2.60%	28.44%	0.11%	1.19%	1.22%	0.53%	3.38%	0.11%
Regional bank	1.50%	1.38%	0.75%	4.31%	0.27%	1.46%	1.32%	0.78%	4.31%	0.01%
City bank	1.42%	1.34%	0.92%	13.25%	0.00%	1.35%	1.23%	0.93%	13.25%	0.00%
Corporation bank	1.19%	1.15%	0.77%	4.25%	0.00%	1.05%	0.98%	0.85%	4.49%	0.00%
Rural commercial	1.96%	1.72%	1.58%	20.44%	0.34%	1.90%	1.67%	1.59%	20.44%	0.00%
Foreign bank subsidiary	0.98%	0.86%	0.95%	5.97%	0.00%	0.82%	0.60%	0.95%	5.97%	0.00%
	<u>Loan Loss Reserves/ Problem Loans</u>					<u>Loan Loss Reserves/ Gross Loans</u>				
	Mean	Median	Std. Dev.	Max.	Min.	Mean	Median	Std. Dev.	Max.	Min.
Big Six	251.30%	220.94%	127.68%	830.70%	136.69%	2.69%	2.43%	0.73%	4.53%	1.33%
National bank	248.82%	208.48%	118.26%	852.28%	120.83%	2.66%	2.52%	1.38%	15.88%	1.25%
Regional bank	251.01%	232.18%	92.59%	533.33%	102.44%	3.22%	3.14%	0.88%	6.36%	1.10%
City bank	276.66%	231.11%	140.78%	965.95%	30.46%	3.08%	2.91%	0.98%	8.77%	0.12%
Corporation bank	283.17%	218.76%	175.22%	950.69%	55.67%	2.70%	2.52%	1.18%	7.99%	0.85%
Rural commercial	258.68%	220.23%	114.67%	912.54%	40.81%	4.15%	3.82%	1.39%	11.20%	1.22%
Foreign bank subsidiary	270.44%	203.33%	173.83%	943.94%	63.63%	2.17%	2.05%	1.40%	9.06%	0.00%

Data source: the SNL database, the release of the China Banking and Insurance Regulatory Commission (CBIRC) and manual calculation

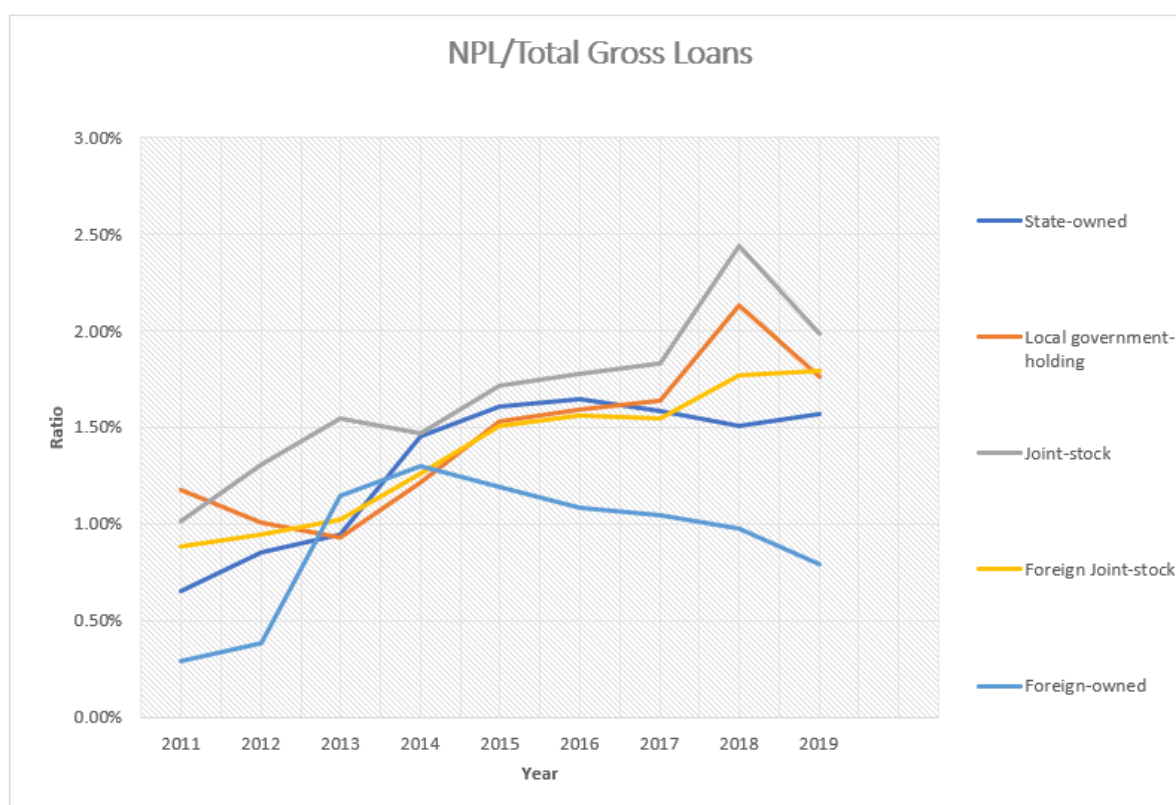
Figure 2.10: CAMEL Ratios-Asset Quality (Bank Type)



Data source: the SNL database, the release of the China Banking and Insurance Regulatory Commission (CBIRC) and manual calculation

Figure 2.11: The Yearly Means of ROAA (Ownership Structure)

banks have the highest NPL to Gross Loan rate and the ratio of Problem Loans/Gross Total Loans, being 1.96% and 1.9% respectively, which is consistent with the higher credit risk that small and medium banks are facing. Although rural commercial banks also have the highest Loan Loss Reserves/Gross Loans rate as 4.51%, the relatively low ratio of Loan Loss Reserves/Problem Loans, being 258.65%, potentially means that rural commercial banks might not have enough safeguards against the default risk. The yearly mean of NPLs to total loans (Figure 2.12) exhibit total increase during 2010-2018 in all ownership structures except for foreign-owned banks, revealing the highest mean of NPLs to total loans by 2.44% of the joint-stock banks. The foreign owned banks demonstrate the descending trend since 2013, the reason possibly relates to their business focus differing from other domestic banks.

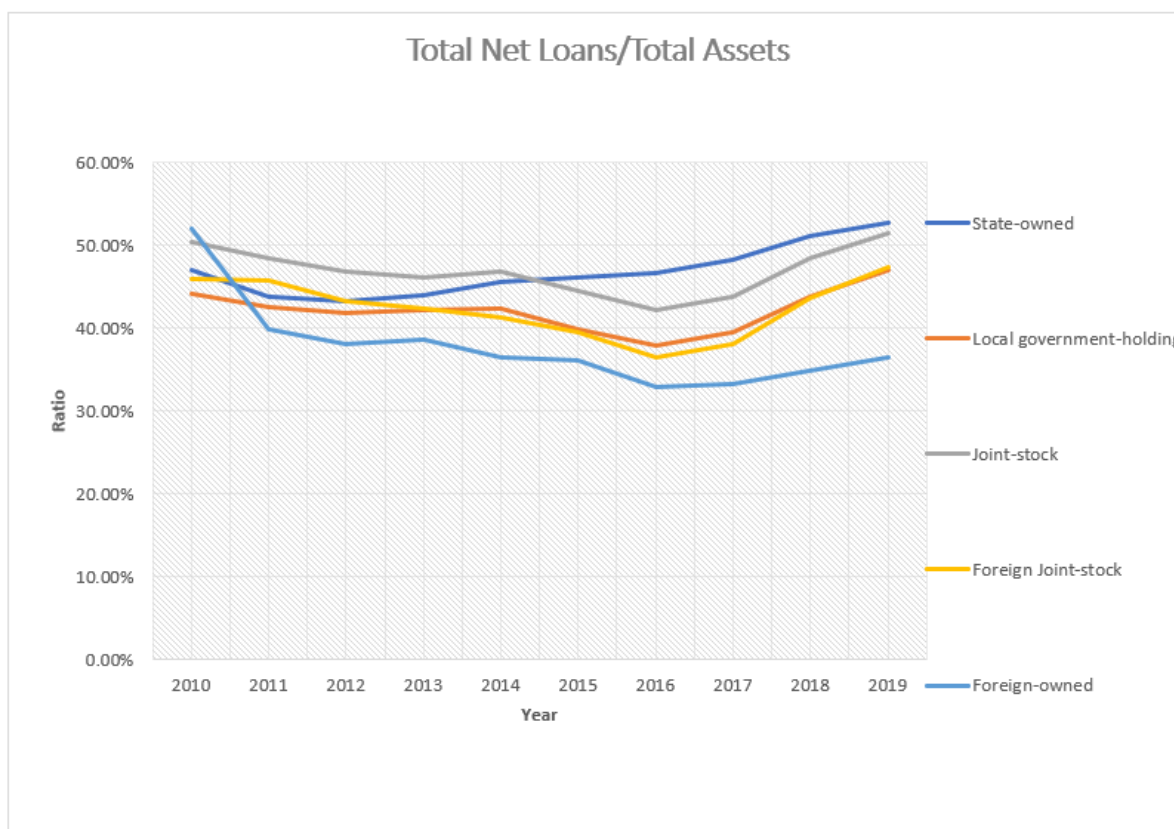


Data source: the SNL database, the release of the China Banking and Insurance Regulatory Commission (CBIRC) and manual calculation

Figure 2.12: The Yearly Means of NPL/Total Gross Loans (Ownership Structure)

The IMF Financial Soundness Indicators for Global Financial Stability Report (2019) reveals that China has a relatively lower NPL ratio (NPLs to total loans) than most members of G20 countries, especially lower than those developing countries, despite increasing overall since 2010 (See Part II, Figure 2.3). One reason could be attributed to China's financial reform. During the transformations of the Big Six and the city banks, the asset management companies,

including the four national ones and those local asset management institutions bought a great amount of NPLs of banks and move them off the banks' balance sheets. Another effective solution is that the mergers and consolidations of formal city cooperatives after China's accession to the WTO in 2001. The NPLs which might have been held by city cooperative reciprocally could be restructured and deducted from the consolidated balance sheets when the new city banks were established. Besides, the NPLs might have been reduced or restructured in the process of introducing new non-financial institutional shareholders such as private companies. Along with the business solutions for NPLs, the stringent regulation and supervision upon the NPLs quotas by the CBIRC also help restraining the ratio under limits. The Law of the People's Republic of China on Banking Supervision and Administration stipulates that banks' violation by covering up NPLs or inaccurate classification of NPLs would face official censure. Zhang et al. (2016) provides evidence that the restrictions on NPLs by the CBIRC and the capital injection by the government in order to control the NPL level.



Data source: the SNL database, the release of the China Banking and Insurance Regulatory Commission (CBIRC) and manual calculation

Figure 2.13: The Yearly Means of Total Net Loans/Total Assets (Ownership Structure)

The last ratio in assessing asset quality is net loans/total assets. The state-owned banks and the

joint-stock banks have the close means of this ratio at 46.79% and 46.63% respectively; while the similar means are held by the local government holding banks and the foreign joint-stock banks around 42%. The foreign owned banks, however, have a lower mean of net loans/total assets by 37.33%, which is probably due to the smaller size of loans of the foreign owned banks compared to domestic banks, although the restriction upon local currency banking business had been lifted entirely since 2006. Figure 2.13 discloses that the yearly variance of net loans/total assets of all ownership structures are not significant from a long-term perspective, which might indicate that the relatively proportional changes between net loans and the total assets of banks.

2.3.3.2 CAMEL Ratios of commercial banks – Management Quality

Ownership Structures	CAMEL Ratios - Management Quality				
	<u>Cost-to-Income Ratio</u>				
	Mean	Median	Std. Dev.	Max.	Min.
State-owned	37.97%	36.77%	11.68%	76.22%	15.63%
Local government-holding	39.01%	38.38%	8.07%	75.60%	19.91%
Joint-stock	39.97%	38.41%	12.21%	218.75%	11.41%
Foreign Joint-stock	38.17%	37.57%	7.77%	58.59%	21.01%
Foreign-owned	70.17%	65.16%	26.69%	274.25%	36.65%

Table *-3: CAMEL Ratios – Management Quality (Ownership Structures)

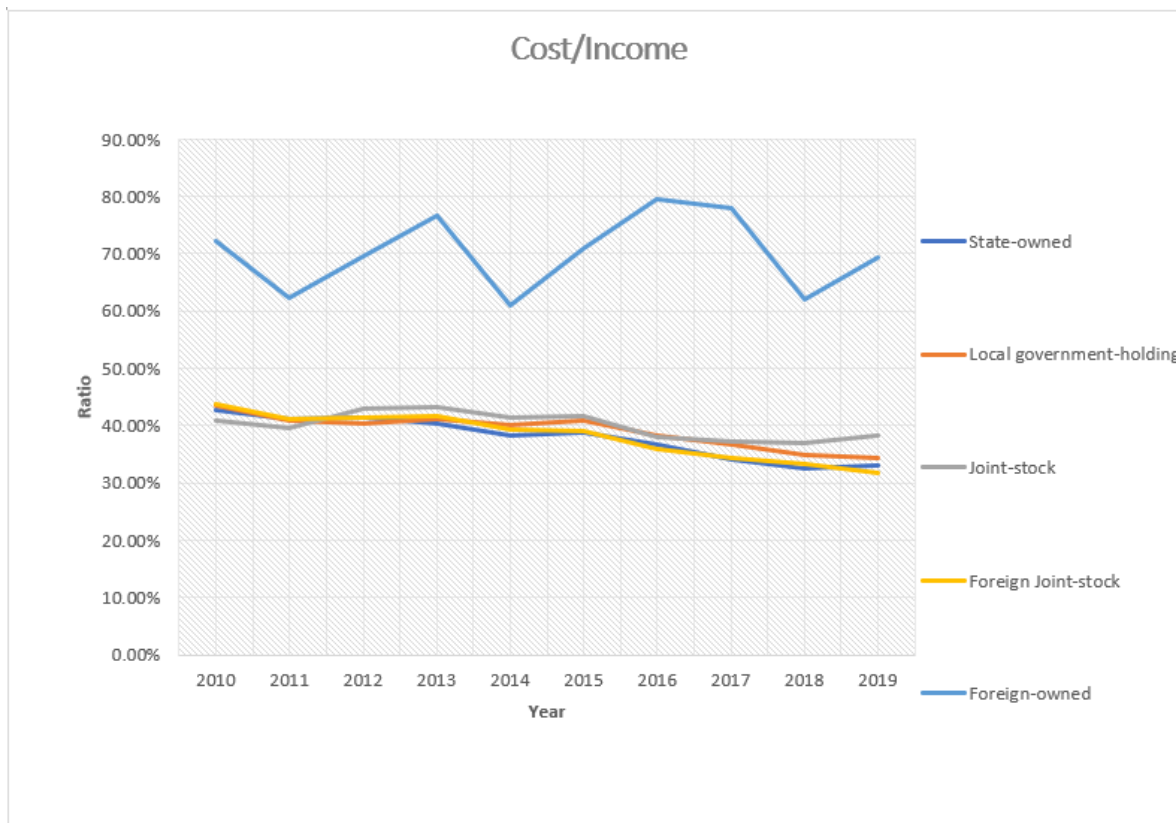
Bank Types	CAMEL Ratios - Management Quality				
	<u>Cost-to-Income Ratio</u>				
	Mean	Median	Std. Dev.	Max.	Min.
Big Six	40.90%	37.19%	12.41%	76.22%	26.67%
National bank	37.43%	36.77%	7.17%	58.59%	25.31%
Regional bank	37.94%	37.12%	8.75%	61.11%	19.15%
City bank	39.45%	38.78%	10.10%	156.14%	11.41%
Corporation bank	43.51%	39.57%	24.44%	218.75%	15.63%
Rural commercial	39.09%	38.12%	7.54%	79.33%	25.25%
Foreign bank subsidiary	70.17%	65.16%	26.69%	274.25%	36.65%

Table *-4: CAMEL Ratios – Management Quality (Bank Types)

Data source: the SNL database, the release of the China Banking and Insurance Regulatory Commission (CBIRC) and manual calculation

Figure 2.14: CAMEL Ratios – Management Quality

In the CAMEL rating system, management quality is evaluated by the ratio of cost-to-income. Domestic banks have the similar cost-to-income ratios in the range of over 37.9% to nearly 40%, with the state-owned banks having the lowest at 37.97% and the joint-stock banks having the



Data source: the SNL database, the release of the China Banking and Insurance Regulatory Commission (CBIRC) and manual calculation

Figure 2.15: The Yearly Means of Cost/Income (Ownership Structure)

highest at 39.97%. However, the foreign owned banks have almost twice cost-to-income ratio as the domestic banks, presenting the number as 70.17%. Bitar et al. (2018) examine 1992 banks in 39 OECD countries and found the mean of cost-to-income ratio as 70.8%. Comparing the value of the cost-to-income ratio with the existing literature, it may imply that the Chinese banks have a lower cost while the foreign owned banks have the normal cost in their business. The results of the peer group of Bank Types are consistent with that of Ownership Structures. The corporation banks have the highest mean of this ratio as 43.51%, which might due to the facts that most of these banks are relatively new banks and have specific geographic and/or industrial focuses. Apart from the foreign-owned banks, the overall decreasing tendency of the movement of the ratio has been displayed for all ownership structures through the past 10 years (Figure 2.15). The fact that Chinese banks have a lower cost might due to two main reasons. First, interest rates including deposit and loan interest rates have been under the stringent guidance, to a great extent, by the regulatory authorities (mainly the central bank) for many years. This almost secures a certain amount of cost and income of banks. Only by the recent years, the financial reform initiatives concerning interest rates have been taking steps. It was only since 2013 that the Loan Prime Rate (LPR)⁴³ has been set up and since 2019 put into effect. Second, the increase of income, including interest income and non-interest income, is faster than the increase of costs of banks through the past 10 years, which matches the fast pace of China's economic development.

2.3.3.3 CAMEL Ratios of commercial banks – Earnings

Usually Return on Average Equity (ROAE) and net interest margin are used to measure the quality of banks' earnings. The ratios are expected to be positively associated with banks' profitability, as the higher the better, intuitively.

The means of ROAE of the state-owned banks and the local-government holding banks are higher, being 15.85% and 14.81% respectively; while the joint-stock banks are 2% lower than their aforementioned counterparties. The foreign owned banks have a mean of 4.02% of ROAE. Although the state-owned banks have the highest ROAE, their net interest margin is not the highest. The local government holding and the joint-stock banks have the highest means of net interest margin at 2.63%. As for the bank types, the Big Six definitely have the highest ROAE rate as 16.9%, while a relatively lower net interest margin ratio as 2.36% than regional banks, city banks, and rural commercial banks. Considering these two ratios together, the reason that the foreign owned banks are lagged by the domestic banks could be due to the small size of their interest-bearing business in China's financial markets. The fact that the state-owned banks have a higher ROAE and a lower net interest margin could be attributed to their clientele and business diversification. Most state-owned banks are national banks which target national state-owned and private corporations and conglomerates as their clientele. However, local

⁴³Loan Prime Rate (LPR) is one of the essential initiatives of interest rate reform in China's financial markets. It resembles the Libor, as a basic interest rate in loan markets, quoted by 18 major commercial banks on monthly basis.

Ownership Structures	CAMEL Ratios - Earnings									
	<i>ROAE</i>					<i>Net Interest Margin</i>				
	Mean	Median	Std. Dev.	Max.	Min.	Mean	Median	Std. Dev.	Max.	Min.
State-owned	15.85%	15.86%	4.80%	31.79%	0.81%	2.24%	2.30%	0.46%	3.06%	1.02%
Local government-holding	14.81%	14.04%	6.10%	37.11%	0.27%	2.63%	2.62%	0.96%	7.15%	0.08%
Joint-stock	13.86%	13.09%	6.08%	46.61%	-10.44%	2.63%	2.58%	1.07%	6.03%	-0.44%
Foreign Joint-stock	14.27%	14.98%	5.10%	24.55%	-5.31%	1.77%	1.66%	0.57%	3.59%	0.33%
Foreign-owned	4.02%	3.33%	4.13%	21.05%	-11.95%	2.42%	2.24%	0.67%	4.53%	1.02%

Table *-5: CAMEL Ratios – Earnings (Ownership Structures)

Bank Types	CAMEL Ratios - Earnings									
	<i>ROAE</i>					<i>Net Interest Margin</i>				
	Mean	Median	Std. Dev.	Max.	Min.	Mean	Median	Std. Dev.	Max.	Min.
Big Six	17.48%	17.13%	4.50%	31.79%	10.80%	2.40%	2.44%	0.34%	2.92%	1.51%
National bank	17.11%	17.04%	4.19%	25.98%	7.86%	2.30%	2.39%	0.44%	3.16%	1.11%
Regional bank	14.38%	14.24%	5.17%	24.46%	2.94%	2.70%	2.72%	0.86%	4.78%	0.46%
City bank	15.41%	14.94%	6.69%	46.61%	-10.44%	2.66%	2.62%	1.06%	7.15%	-0.07%
Rural commercial	14.18%	13.72%	4.69%	29.02%	-3.63%	2.79%	2.74%	1.07%	6.03%	0.09%
Foreign bank subsidiary	4.11%	3.33%	4.16%	21.05%	-11.95%	1.81%	1.70%	0.58%	3.59%	0.54%
Corporation bank	12.15%	11.73%	6.67%	38.08%	-0.37%	2.32%	2.27%	0.71%	3.93%	1.02%

Table *-6: CAMEL Ratios – Earnings (Bank Types)

Data source: the SNL database, the release of the China Banking and Insurance Regulatory Commission (CBIRC) and manual calculation

Figure 2.16: CAMEL Ratios – Earnings

government holding banks, joint-stock banks and foreign joint-stock banks are mostly regional banks, city banks or rural commercial banks which act as the major finance provider for the regional, small and medium sized business and individuals within their local communities. It is a consensus opinion that big companies usually have more power in negotiation with banks than those small and medium sized companies and individuals. Therefore, the (loan) interest income of the state-owned banks probably could be lower than those local community banks. Business diversification of Chinese banks emerged around the end of the last century when China was making progress on the commitment to the WTO agreement. The People's Bank of China (PBOC) issued regulatory documents lifting the restrictions on market entry for domestic banks in 2002. Berger et al. (2010) illustrate Big Six established their branches across all the regions in China during this period. Alongside with the regional expansion, non-interest-bearing business started to be prospective during this period in China's financial reform. The PBOC also released regulatory documents about easing the restriction on fee-based banking business and allowed banks to cooperate with insurance companies and other banking institutions such as trust companies. Yuan (2006) and Berger et al. (2010) both mentioned national banks embarked on non-interest bearing business including cash management, wealth management, trading services etc. Business diversification of those state-owned, national banks caused the proportion of interest-bearing business to assets relatively to decrease, which can explain why the state-owned banks have a lower net interest margin compared to their peers. As for local banks including local government holding, joint-stock and foreign joint-stock banks, their business diversification started later than the national banks. Taking account of their clientele and their service region, it might be reasonable to assume that their business still relies more on interest-bearing assets than the state-owned banks.

2.3.3.4 CAMEL Ratios of commercial banks – Liquidity

The CAMELS rating system concerning liquidity evaluates the competence of banks in asset and liability management (ALM) which encompasses interest rate risk and liquidity risk. Here we choose to focus on liquidity risk since interest rate risk of China's banks might be relatively under control guided by the regulatory authorities. The ratios of wholesale funding/total liabilities and retail deposits/total deposits can represent the current level of liquidity and the volatility of the funding sources. Demirgüç-Kunt and Huizinga (2010) present evidence that wholesale funding may increase banks' risk, such as stock volatility, although it supports large banks' fast expansion. As to retail deposits, Hirtle and Stiroh (2007) state that retail deposits may provide a more stale business line for banks, although they may have lower returns.

The state-owned banks, foreign joint-stock banks and foreign owned banks have higher means of the ratio of wholesale funding/total liabilities, with 24.59%, 27.54% and 24.88% respectively. While the means of the local government holding banks and the joint-stock banks are almost 3-4% lower than the state-owned banks, with 20.83% and 19.34% respectively. The lower means mostly belong to those city banks and rural commercial banks whose ownership structure are local government holding and joint-stock. These small and medium sized banks, consistent

Ownership Structures	CAMEL Ratios - Liquidity									
	<u>Wholesale Funding/Total Liabilities</u>					<u>Retail Deposits/ Total Deposits</u>				
	Mean	Median	Std. Dev.	Max.	Min.	Mean	Median	Std. Dev.	Max.	Min.
State-owned	24.59%	22.29%	13.35%	72.22%	1.92%	36.12%	33.23%	18.50%	87.86%	4.25%
Local government-holding	20.83%	22.41%	12.16%	56.26%	0.00%	35.74%	32.76%	14.66%	75.97%	12.24%
Joint-stock	19.34%	17.97%	12.68%	58.85%	0.00%	32.20%	25.89%	16.76%	68.27%	4.20%
Foreign Joint-stock	27.54%	29.93%	11.88%	49.74%	0.03%	26.60%	22.37%	12.60%	58.80%	4.40%
Foreign-owned	24.88%	22.73%	14.32%	83.62%	0.00%	13.56%	14.08%	10.58%	33.69%	0.01%

Table *-7: CAMEL Ratios – Liquidity (Ownership Structures)

Bank Types	CAMEL Ratios - Liquidity									
	<u>Wholesale Funding/Total Liabilities</u>					<u>Retail Deposits/ Total Deposits</u>				
	Mean	Median	Std. Dev.	Max.	Min.	Mean	Median	Std. Dev.	Max.	Min.
Big Six	15.24%	15.31%	7.80%	36.41%	1.92%	50.12%	45.56%	15.81%	87.86%	30.40%
National bank	31.83%	31.63%	9.37%	51.16%	10.16%	17.56%	17.25%	6.98%	37.09%	4.20%
Regional bank	24.74%	24.69%	10.83%	49.41%	1.34%	30.64%	27.86%	9.29%	54.32%	18.48%
City bank	21.30%	22.56%	12.13%	56.89%	0.00%	30.12%	28.89%	11.52%	68.08%	11.33%
Corporation bank	31.93%	30.45%	13.01%	72.22%	0.00%	21.11%	21.01%	6.87%	37.29%	4.25%
Rural commercial	15.28%	13.30%	11.37%	58.85%	0.00%	54.63%	54.24%	9.68%	75.97%	37.76%
Foreign bank subsidiary	24.88%	22.73%	14.32%	83.62%	0.00%	13.56%	14.08%	10.58%	33.69%	0.01%

Table *-8: CAMEL Ratios – Liquidity (Bank Types)

Data source: the SNL database, the release of the China Banking and Insurance Regulatory Commission (CBIRC) and manual calculation

Figure 2.17: CAMEL Ratios – Liquidity

with the statement of the existing literature, focus on serving their local communities and might have more conservative strategy of business expansion. The results presented in Table 7-2 confirmed this assumption. The city banks and the rural commercial banks have the means of the ratio of wholesale funding/total liabilities of 15.28% and 21.31% respectively, the lowest value in the peers. On the other hand, the national banks and regional banks have the highest values of 31.83% and 24.74% respectively, which means that these banks might face more liquidity risk than the rest of their peers.

The ratio of retail deposits/total deposits might be less indicative of banks' funding source reliance due to the fact that there are less observations available on this variable. However, the results may still corroborate the means of wholesale funding/total liabilities to the great extent. The local government holding banks and the joint-stock banks have a relatively high ratio of retail deposit/total deposit at 35.74% and 32.20%; while foreign joint-stock and foreign owned banks have a ratio of 5-10% lower. Foreign owned banks have the lowest ratio of 13.56%, which could imply that foreign owned banks might not take retail deposit strategy in China's financial markets. The state-owned banks, however, have the highest ratio of 36.12%; and the Big Six have the consistent value of 50.12%. The reasons could be traced to historical and diversification rationales. First, the state-owned banks, especially the Big Four, were the earliest commercial banks in China and entirely owned and controlled by the state government. Before legislation of deposit insurance was implemented in 2015, the state government in fact took the role of the implicit deposit insurer. As a long-term habit and due to trust, Chinese individuals, especially residents in cities, still consider these state-owned, large banks as their first choice for deposits and wealth management, even though there are numerous commercial banks. Second, the state-owned banks achieved more in geographical expansion and business diversification than city banks, in relation to time, scope and depth. Combined with the first reason, it is understandable that the state-owned banks have a higher ratio. The rural commercial banks have a rather higher ratio of 54.63% than the Big Six, which is in accordance with their lower reliability to the wholesale funding.

2.3.3.5 Conclusion

The CAMELS rating system is a popular methodology to assess the safety and soundness of individual banks in the banking industry. Guided by the CAMELS framework, this section presents an overview of China's banking industry a quantitative perspective. Commercial banks have a capital adequacy ratio over 10% which is higher than the standard of Basel III framework. The state-owned banks do not display the highest ratios. China's banking industry has a lower average NPL ratio than other members of G20 and has its own reasons. However, our analysis shows that those small and medium banks might not have enough safeguards against the relatively higher credit risk they are facing. China's commercial banks have a lower cost to income ratio than foreign banks and the average value in literature, mainly because of the stringent guidance on interest rates in China's financial markets. The slow progress of the reforms on market rates also have ensured, to a large degree of extent, commercial banks have

the ratio of return on equity over 14% on average. As for liquidity risk, the biggest and the smaller commercial banks averagely do not highly rely on wholesale funding. Nevertheless, the medium banks, especially those involved with local government shareholders in history, might have higher liquidity risk because they rely on wholesale funding channels more heavily.

2.4 Appendices

2.4.1 Key regulation and regulatory documents in the adoption of Basel III framework

Table 2.2: Key regulation and regulatory documents in the adoption of Basel III framework

Date	Regulation Documents	Regulatory Objectives
June 2012	Commercial Bank Capital Management Measure (Trial)	Fully adoption of the core elements of the Basel III framework
January 2014	Notice on Issuing the Guidelines for Disclosure of Global System Importance Assessment Indicators of Commercial Banks	Participation of the assessing process of the Globally Systemically Important Banks
January 2015	Commercial Banks' Leverage Management Measure (Revised)	Being consistent with the requirements on leverage ratios in the Basel III framework
December 2015	Commercial Bank's Liquidity Coverage Information Disclosure Measures	Adoption of the Pillar III - Market Discipline
April 2017	Commercial Bank Collateral Management Guidelines	Elaborating the detailed requirements on credit risk
January 2018	Derivative Counterparty Default Risk Exposure Measurement Rules	Focusing on Counterparty Risk
April 2018	Measurement of Large Exposure of Commercial Banks	Implementation of the large exposure framework
May 2018	Commercial Bank Liquidity Risk Management Measurement (Revised)	Updating the regulation on liquidity risk
March 2019	Commercial Banks' Net Stable Funding Ratio Information Disclosure Rules	Updating the regulation on liquidity risk

2.4.2 CAMEL variable definition and data source

Table 2.3: Summary of CAMEL Variable Definitions and Source

Variable	Definition	Definition Source
Capital Adequacy		
Tier 1 Ratio	Tier 1 capital as a percent of risk-weighted assets as defined by the latest regulatory guidelines	SNL database
Total Equity/Total Assets	Equity as a percent of assets	SNL database
Asset Quality		
ROAA	Return on average assets; net income as a percent of average assets	SNL database
NPL /Gross Total Loans	Nonperforming loans, net of guaranteed loans, as a percent of loans before reserves	SNL database
Problem Loans / Gross Total Loans	Problem loans as a percent of gross total loans	SNL database
Loan Loss Reserves / Problem Loans	Loan loss reserves as a percent of problem loans	SNL database
Loan Loss Reserves /Gross Loans	Loan loss reserves as a percent of gross loans. Gross loans are as reported on the balance sheet and may be derived from total gross loans or amortized gross customer loans	SNL database
Total Net Loans / Total Assets	Loans and finance leases, net of loan-loss reserves, as a percent of assets	SNL database
Management Quality		
Cost/Income	Expense as a percent of revenue; i.e. efficiency ratio - Noninterest expense before foreclosed property expense, amortization of intangibles, and goodwill impairments as a percent of net interest income (fully taxable equivalent, if available) and noninterest revenues, excluding only gains from securities transactions and nonrecurring items.	SNL database
Earnings		
ROAE	Return on average equity; net income as a percent of average equity	SNL database
Net Interest Margin	Net interest income, on a fully taxable-equivalent basis if available, as a percent of average earning assets. If average earning assets is not available, average financial assets may be used.	SNL database
Liquidity		

(continued)

Variable	Definition	Definition Source
Wholesale Funding / Liabilities (WF to Liabilities)	Wholesale funding including financial liabilities and repurchase agreements, excluding derivatives and customer deposits, as percentage of liabilities	SNL database
Retail Deposits / Deposits	Retail deposits as a percent of retail and corporate deposits	SNL database

2.4.3 Total Assets of the Banking Sector

Table 2.4: Total Assets Shares in the Financial Sector - detailed by Ownership Structure (2010-2019)

Ownership	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010
Banks										
Total_Banks (231)	0.7990	0.8068	0.8509	0.8132	0.8849	0.9355	0.9668	0.9386	0.9285	0.8830
State-owned	0.5199	0.5253	0.5537	0.5286	0.5901	0.6395	0.6776	0.6704	0.6874	0.6717
Local government holding	0.1139	0.1140	0.1209	0.1145	0.1192	0.1175	0.1150	0.1072	0.0994	0.0869
Joint-stock	0.1133	0.1152	0.1210	0.1187	0.1215	0.1219	0.1176	0.1084	0.0912	0.0780
Foreign Joint-Stock	0.0427	0.0426	0.0445	0.0414	0.0427	0.0420	0.0413	0.0376	0.0346	0.0326
Foreign Owned	0.0092	0.0097	0.0107	0.0100	0.0114	0.0145	0.0154	0.0149	0.0159	0.0137
Insurance Companies										
Total_Insurance (37)	0.0888	0.1008	0.1032	0.0957	0.1018	0.1017	0.1014	0.0911	0.0875	0.0698
State-owned	0.0647	0.0772	0.0782	0.0668	0.0740	0.0784	0.0797	0.0795	0.0768	0.0602
Joint-stock	0.0170	0.0167	0.0172	0.0152	0.0149	0.0146	0.0140	0.0049	0.0048	0.0044
Foreign Joint-Stock	0.0023	0.0022	0.0021	0.0081	0.0069	0.0028	0.0018	0.0015	0.0014	0.0013
Private	0.0048	0.0047	0.0057	0.0056	0.0059	0.0059	0.0059	0.0052	0.0045	0.0039
Securities Companies										
Total_Securities (44)	0.0252	0.0242	0.0270	0.0255	0.0304	0.0234	0.0134	0.0109	0.0117	0.0161
State-owned	0.0062	0.0059	0.0063	0.0049	0.0049	0.0037	0.0020	0.0017	0.0018	0.0029
Local government holding	0.0076	0.0074	0.0085	0.0086	0.0111	0.0087	0.0050	0.0039	0.0041	0.0057
Joint-stock	0.0101	0.0098	0.0110	0.0116	0.0139	0.0106	0.0062	0.0050	0.0053	0.0071
Foreign Joint-Stock	0.0012	0.0011	0.0011	0.0005	0.0005	0.0004	0.0003	0.0003	0.0004	0.0004
Private	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Trust Companies										
Total_Trust (23)	0.0016	0.0020	0.0022	0.0019	0.0021	0.0021	0.0019	0.0016	0.0014	0.0013
State-owned	0.0003	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003	0.0003
Local government holding	0.0003	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Joint-stock	0.0010	0.0010	0.0011	0.0009	0.0012	0.0011	0.0010	0.0008	0.0007	0.0007
Foreign Joint-Stock	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
Foreign Owned	0.0000	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001
Specialty Lending Companies										
Total_Specialty_Lending (6)	0.0010	0.0011	0.0028	0.0015	0.0000	0.0012	0.0012	0.0010	0.0008	0.0006
State-Owned	0.0010	0.0011	0.0019	0.0008	0.0000	0.0012	0.0012	0.0010	0.0008	0.0006
Joint-stock	0.0000	0.0000	0.0008	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Private	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

(continued)

Ownership	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010
-----------	------	------	------	------	------	------	------	------	------	------

Data source:

the SNL database, the release of the China Banking and Insurance Regulatory Commission (CBIRC) and manual calculation

2.4.4 Information of Basel Accords

Abstract and outlines:

This appendix is a description of relevant information about Basel Accords (or Basel Framework). This appendix includes five sections. Section I is the definition of Basel Accords and Basel Committee. Section II briefly describes the development of Basel Framework chronologically. Section III introduces the evolution of main parts of Basel Framework from the perspective of risk-based categories. Section IV describes the way of how Basel Framework functions. And section V is to look ahead.

2.4.4.1 What are Basel Accords?

Basel Accords are a series of financial regulations (including Basel I, II and III) for the banking sector set by Basel Committee on Bank Supervision (BCBS). Basel Accords, the prudential regulations reached by the consensus of the worldwide central banks and bank supervisors, aim to enhance the stability of the financial system as a whole. The risk spectrum covered by Basel Accords concerns credit risk, market risk, operational risk and other risks in banks and bank groups.

- Basel Committee on Bank Supervision (BCBS)

Basel Committee on Bank Supervision (thereafter BCBS, or Basel Committee), founded in 1974, is one of the standard-setting committees of the Bank for International Settlements (BIS). The BIS was established in 1930 and owned by 60 central banks worldwide. The BIS has missions to foster international cooperation in area of monetary and financial stability and ‘act as a bank for central banks’ (“About the BCBS,” 2018).

Under this premise, the BCBS was established to act as an international financial standard setter, as well as a provider of the forum for communication and cooperation on banking supervision between its 45 member institutions from 28 jurisdictions (“About the BCBS,” 2018).

2.4.4.2 The brief history of Basel Accords

Banks are highly leveraged institutions, which means that the banking industry is borne to be highly profitable at the same time highly fragile. The bank regulations have been existed since banks have been in their current institutional forms (Barth et al., 2004). For example, in the United States, the 1933 Banking Act not only imposed federal oversight on commercial banks for the first time, but also established a government corporation, the Federal Deposit Insurance Corporation (FDIC) to protect the benefits of depositors in the U.S. commercial banks and other saving institutions.

- Basel I

The highly unrestricted business expansion and the debacle of Latin American debt crisis in the early 1980's highlighted the necessity of building up a multinational accord to provide a 'level playing field' (Bank of England, 2001) for internationally active banks as well as to prevent bank capital adequacy condition deterioration. Endorsed and approved by the G10 Governors, Basel Capital Accord, also known as Basel I, was released in 1988.

The 1988 Basel Accord was 'a major milestone in the history of bank regulation.' (Bank of England, 2001) Basel I set the minimum capital standards for internationally active banks, using the approach that incorporates risk into the calculation of capital requirements. The minimum capital requirement in Basel I, which has been evolved and kept as the core value of Basel Accords, was that banks hold a capital equal to 8% of Risk-Weighted Assets (RWA). Basel I addressed to credit risk only.

In 1996, Basel Committee issued the Amendment to the Capital Accord to incorporate market risk. This Market Risk Amendment was designed to regulate the banks' trading-book activities which induced the rapid accumulation of risk exposure. In the 1996 Amendment, the internal models using the Value at Risk (VaR) methodology were allowed to measure the capital charges for the first time. The 1996 Amendment also set up a category of capital (Tier 3 capital) for mitigating only for market risk.

- Basel II

Basel I had been seen to lead the rebuilding of banks' capital adequacy standards. However, over time Basel I received more and more criticism due to its significant weaknesses. Basel I was criticized that it only differentiates credit risk based on the types of loans instead of the actual risk of the counterparties (Jackson, 2001); and that it ignores other types of risks. The 1996 Amendment also was accused that banks used the Internal Model Approach (IMA) to perform the regulatory capital arbitrage which might have been part of momentum of securitization boom at the end of 1990's (Jackson, 2001).

In 2006, Basel Committee issued a comprehensive version of 'International Convergence of Capital Measurement and Capital Standards: A Revised Framework'. The documentation is

usually called ‘Basel II’. It is also called ‘the new accord’ (Jackson, 2001). Several key features about Basel II might be worth to notify:

First, the capital accords which were built up by 1988 Basel Accord and the 1996 Amendment has been developed to a framework which aims at the stability and soundness of international banking system. This revised framework is comprised of three pillars – Pillar 1: Minimum Capital Requirements, Pillar 2: Supervisory Review, and Pillar 3: Market Discipline. The three-pillar approach has become the cornerstone of Basel Accords including Basel II and the sequent accords.

Second, Basel Committee stressed that the revised Framework was designed to establish minimum capital requirements for ‘internationally active banks’. Basel Committee encouraged national supervisory authorities to use their discretion to set supplementary requirements for other banking institutions they chartered.

Third, Basel II was deemed to be more risk sensitive than previous accords, which was addressed to the risk insensitivity of the 1988 Accord. Under the revised Framework, banks were allowed to use their own models to quantify and manage credit risk in the calculation of minimum capital requirements. This approach is called Internal Rating-Based (IRB) Approach which is definitely a conceptual leap in regulatory capital adequacy determination.

The operational risk capital charge was also introduced into Basel II Framework. The key elements of the least capital requirements (8%) of the 1988 Basel capital framework and the treatments of capital charge of market risk of 1996 Amendment were retained in this revised Framework.

- Basel II.5

It might be a misfortune for Basel II that its implementation date had hit the 2007-2009 financial crisis. Basel II had even been blamed for the crisis because it allowed banks to use internal risk assessments as inputs in the calculation of capital adequacy ratios.

In February 2011, the Basel Committee released a formal document ‘Revisions to the Basel II Market Risk Framework’ which was a series updates of changes to the Basel II Framework in terms of market risk. This documentation is often called Basel II.5.

Under the Basel II.5 Framework, the Basel Committee made several changes about market risk capital charge to the 1996 Amendment.

First, the Basel Committee introduced the stressed VaR measure into market risk capital charge calculation. Stressed VaR is calculated where the volatility of market variables is high, in other words, during a period of stressed market condition. As a result, two VaR were required in the calculation of market risk capital charge under the Basel II.5 Framework, one is usual VaR, the other is Stressed VaR.

Second, for banks that were allowed to use their internal models to assess market risk, the Basel Committee required an Incremental Risk Charge alongside the general market risk capital

charge (and a Specific Risk Charge). The Incremental Risk Charge was used to capture both default risk and migration risk of certain securitization exposures due to the fact that most losses during the 2007-2009 financial crisis were from the slump of credit rating.

Third, the Comprehensive Risk Measure (CRM) also had been introduced by the Basel Committee to measure the risk of tranchised securitized products such as Asset-Backed Securities (ABSs) and Collateralized Debt Obligations (CDOs). Yet the Basel Committee 'had not agreed that currently existing methodologies used by banks adequately capture incremental risks of all securitized products.' (BCBS, 2011)

- Basel III

The 2007-2009 financial crisis had revealed the weaknesses of the existing Basel II Framework. After the crisis, the Basel Committee realized that an overhaul of the existing regulation architecture was necessary. Since the end of 2010, the Basel Committee started a set of phase-in arrangements to review and revise the Basel II Framework.

In December 2017, the Basel Committee released the document 'Basel III: Finalizing post-crisis reforms' summarizing the main features of the changed Basel Framework. In 2019, the Basel Committee issued 'Full Version of the Basel Framework', a document which includes regulation versions effective as of January 1, 2019. Most regulations are now still under the transition arrangements and will have further changes.

Basel III is usually called 'Reforms'. The Basel Committee aims to build up resilience in the banking sector and avoid the systemic vulnerabilities through the regulatory reforms. According to the 2017 document 'Basel III: Finalising post-crisis reforms', the main features of the Basel III Framework, addressing the aspects of quality of total capital, risk sensitivity, and liquidity requirements, can be detailed as follows:

- i) The quality of the regulatory capital

The Basel Committee requires banks to maintain higher quality of capital to absorb the unexpected losses. The Tier 1 Capital (mainly comprised of common equity) requirement has risen from 4% to 6% of Risk-Weighted Assets at the minimum.

In addition to the risen Tier 1 capital requirement, the Basel Committee introduced a Capital Conservation Buffer requirement which comprises 2.5% of common equity to ensure that banks build up capital during normal times and have the capability to absorb losses during the difficult times. As a result of the Capital Conservation Buffer (CCB), the total common equity capital requirement has been brought up to 7%.

A Countercyclical Buffer has also been introduced by the Basel Committee for the similar aim of limiting pro-cyclicality. This buffer can be set to between 0%-2.5% at the discretion of national supervisory authorities in its implementation.

For those internationally 'Too Big to Fail' banks which caused financial market turmoil during the 2007-2009 crisis, the Basel Committee defines them as 'Global Systemically Important

Banks (G-SIBs)' and requires 1%-3.5% extra Tier 1 equity capital charge to reflect the greater risk that those banks pose in the global financial system.

ii) Risk sensitivity

The regulatory capital is the cornerstone of the Basel Framework. As an integrate part of Risk-based regulatory capital ratio, the Risk-Weighted Assets (RWAs) have attracted most attention in Basel III Reforms to reflect greater risk sensitivity and reduce the variability between RWAs calculated by banks.

The Standardized Approaches for calculating the credit risk, market risk and operational risk have been revised. And the internal models used by banks to calculate the RWAs subject to credit risk have been put on strains to eliminate the possibility of regulatory arbitrage; those internal model approaches used to calculate the RWAs of operational risk have been removed from the Basel III Reforms.

The requirement of taking account of the counterparty risk was introduced into the framework in 2010 and was revised in 2017 reforms. The Credit Value Adjustment (CVA), which is the expected loss due to the possibility of default of a counterparty has been required and become more stringent to strengthen the resilience of financial system.

In addition to the Risk-based regulatory capital ratio, a non-risk-based Leverage Ratio has been introduced into the Basel III Reforms to constrain banks' leverage. Global Systemically Important Banks (G-SIBs) are subject to higher Leverage Ratio standards on the ground that they should maintain higher loss absorbing capacity.

iii) Improvement of liquidity

The 2007-2009 financial crisis proved that it is not enough to focus on sufficient capital holding by banks. It turned out that many collapses of big institutions during the crisis were induced by severe liquidity risk. The Basel Committee introduced two Liquidity Ratios into the Basel III Reforms to ensure that banks can survive liquidity pressure. The Liquidity Coverage Ratio (LCR) focuses on banks' ability to withstand a 30-day liquidity stress. The Net Stable Funding Ratio (NSFR) focuses on a longer term (over 1 year) liquidity management and to encourage banks to use a stable source of funding.

2.4.4.3 The evolving framework

Basel Accords are a prudential regulation framework which is closely tied to global economic developments. By going through the brief history of Basel Accords, we can find that almost every aspect in the Basel Framework has been changed and the Framework has evolved into a more advanced place. The Basel Framework is still evolving.

In this section, changes in Basel Accords will be categorized and presented according to their features and aims, in order to reveal the trajectory of the development of the Basel Framework.

i) The regulatory capital requirements

The regulatory capital requirements can be considered as the soul of the Basel Framework. The 1988 Basel Accord set international risk-based standards for capital adequacy for the first time. The capital adequacy was measured by the ratio of the total regulatory capital to the Risk-Weighted Assets (RWAs), which should be at least 8%. This ratio is known as ‘the Cooke Ratio’ which was named after Peter Cooke, the Chairman of the Basel Committee at that time. In the following years, the spirit of supervision of the financial system through risk-based capital requirements has never changed and been defended by constant progress.

In Basel I, the regulatory capital had two constituents: Tier 1 capital and Tier 2 capital. Tier 1 capital is the core capital which is mainly comprised of the common equity of a bank. Tier 2 capital is the supplemental capital, including reserves and hybrid instruments and other elements. Goodwill has been deducted from Tier 1 capital. The Basel Committee also required that Tier 1 capital should be at least 50% of the total capital, which equals to 4% of the RWAs.

In the 1996 Amendment, some short-term subordinated debt was added into the regulatory capital as ‘Tier 3 capital’ to meet part of banks’ market risk mitigation requirements only. Tier 1 and Tier 2 capital remained unchanged.

The Basel II Framework remained the capital framework stated in the 1988 Basel Accord and the 1996 Amendment unchanged.

The Basel III Reforms have not only detailed every constituent included in the regulatory capital, but also changed the capital structure and requirements for specific components. The regulatory capital in the Basel III Reforms consists of two tiers of capital: Tier 1 capital (common equity Tier 1 and additional Tier 1 capital) and Tier 2 capital. Tier 3 capital stipulated in the Basel II Framework has been removed.

The Basel Committee has set three independent minimum capital requirements within the total capital requirements. Common equity Tier 1 capital must be at least 4.5% of the Risk-Weighted Assets (RWAs); total Tier 1 capital must be at least 6% of RWAs; total capital must be at least 8% of RWAs. Through the above setting, the total Tier 1 capital has increased from 4% to 6%. The total regulatory capital requirement remained unchanged.

Capital buffers have been established above the minimum capital requirements to ensure that banks have the capability to survive stressful times. A Capital Conservation Buffer is set as 2.5% which is comprised of Common Equity Tier 1 capital. The Counter-cyclical Buffer varies from 0%-2.5% which is decided at the national authorities’ discretion.

For those Global Systemically Important Banks (G-SIBs), the Basel Committee has set G-SIB Buffer to require G-SIBs to have higher loss absorbency ability. G-SIBs Buffer varies between 1% and 3.5%, which is met with Common Equity Tier 1 Capital only.

ii) The calculation of RWAs

As an integrating part of regulatory capital adequacy requirements, Risk-Weighted Assets have been through great changes in terms of risk profiles, methodologies and categories.

a) The treatment of credit risk

In the 1988 Basel Accord, the capital framework was mainly directed to assess the credit risk banks faced. The credit risk exposures were categorized as: those arising from on-balance-sheet assets, those arising from off-balance-sheet assets and those arising from Over-the Counter (OTC) derivatives. These exposures (loans) were put into different risk-weight bands according to the types of loans such as loans to Organization for Economic Co-operation and Development (OECD) sovereigns, loans to banks, and loans to private sectors, etc. The RWAs of credit risk were the total amount of exposures taking into account of these conditions and prerequisites. This approach is called Standardized Approach in calculation of the RWAs for credit risk in the Basel II Framework. Nonetheless, the methodologies to give the weighting bands had been changed a lot.

In the Basel II Framework, two approaches were provided by the Basel Committee for the treatment of credit risk: The Standardized Approach (SA) and the Internal Ratings Based (IRB) Approach.

Under the Standardized Approach (SA), credit exposures were still slotted into weighting bands. However, the weight bands were given based on ratings by the eligible external rating agencies permitted by national supervisory authorities. The Internal Ratings Based (IRB) Approach allowed banks to categorize credit exposures using their internal risk assessments. The Internal Ratings Based (IRB) framework was further divided into two approaches: The Foundation Internal Ratings Based (F-IRB) Approach which only allowed banks to estimate the Probability of Default (PD), and the Advanced Internal Ratings Based (A-IRB) Approach which allowed banks to provide their own estimates of PD, LGD (Loss Given Default), and EAD (Exposure at Default).

Under the Basel III Reforms, the above two approaches have been greatly changed. Under the Standardized Approach, The Basel Committee has provided an approach to give more detailed weight bands to exposures to increase the risk sensitivity. And the Basel Committee also provided approaches for national authorities in decision making process to reduce the rely on the external rating agencies.

Due to regulatory arbitrage and other issues caused by the Internal Ratings Based (IRB) Approach, the Basel Committee introduced more constraints on the use of the Internal Ratings

Based (IRB) Approach. In some certain exposure classes, such as exposure to banks and other financial institutions, the Advanced Internal Ratings Based (A-IRB) Approach has been removed. In the exposure of class of equity, the two Internal Ratings Based Approaches have both been removed.

Under the Basel III Reforms, the capital requirement for Credit Valuation Adjustment (CVA) risk is required to cover the default risk of counterparties due to the adjustments of derivative valuation.

b) The treatment of market risk

The treatment of market risk was provided in the 1996 Amendment due to the insufficiency that the Basel I was seen when risk was assessed in banks' trading book. Two approaches were provided in the 1996 Amendment: The Standardized Approach (SA) and the Internal Model Approach (IMA). The Standardized Approach (SA) assigned market risk capital charge to each type of instruments such as debt, equity, foreign exchanges, commodities and options, then add those separate capital charges together. The Internal Model Approach (IMA) allowed banks to use their internal Value-at Risk (VaR) models to calculate the market risk capital charge as long as they got permission from the national supervisory authorities. Under these two approaches, a Specific Risk Charge (SCR) was calculated in the total market risk capital charge to avoid what banks used the trading book as a tool for regulatory arbitrage.

The Basel II Framework retained the treatment of market risk presented in the 1996 Amendment. It was until Basel II.5: Revisions to the Basel II Market Risk Framework that the treatment was developed to cope with the stress scenarios. The Basel II.5 Revisions refined and strengthened the capital requirements on Specific Risk Charge (SCR) under both approaches.

Specifically, under the Internal Model Approach (IMA), the Basel Committee required banks to calculate a Stressed Value at Risk (SVaR) to be added in the calculation of total market risk capital charge, which assessed the capital adequacy in a period of stress. The Basel Committee also required banks to calculate Incremental Capital Charge (IRC) to capture default risk and migration risk of certain securitization exposures. The 'Comprehensive Risk Measure (CRM)' was introduced, which was intended to capture all price risks, but was still subject to national supervisory approval.

The Basel III Reforms have phase-in arrangements for treatment of market risk. From January 1, 2022, the current approaches (SA, IMA) will be replaced by the new Standardized Approach and the new Internal Model Approach to assess the market risk under the Basel Framework.

Under the new Standardized Approach (SA), the market risk capital charge is composed of three components: the capital charge calculated by the sensitivity-based method, the Default Risk Capital (DRC) charge, and the Residual Risk Add-On (RRAO). For those banks using the new Internal Model Approach (IMA), the Basel Committee require banks to use Expected

Shortfall (ES) models or Stressed Expected Shortfall (SES) Models to capture all modellable market risk factors. All non-modellable risk factors are required to be captured using a stress scenario.

c) The treatment of operational risk

It is under the Basel II Framework that regulatory capital requirements for operational risk were considered for the first time. The Basel II Framework allowed three methods in calculation of operational risk capital charge: The Basic Indicator Approach (BIA), the Standardized Approach (SA) and the Advanced Measurement Approach (AMA).

Under the Basic Indicator Approach (BIA), a fixed percentage (15%) indicator was given, multiplied by the average over the positive annual gross income over the previous three years in order to meet the operational risk capital charge. In the Standardized Approach (SA), banks' activities were divided into eight business lines, each of lines was given a fixed percentage indicator to calculate the operational risk capital charge.

The Advanced Measurement Approach (AMA) allowed banks to assess the expected losses for operational risk through the frequency and the severity risk factors by using internal and external data.

The Basel III Reforms will replace the current methodologies under the Basel II Framework by a single Standardized Approach (SA) from January 1, 2022. Under this Standardized Approach (SA), the operational risk capital charge is calculated by multiplying the Business Indicator Component (BIC) and the Internal Loss Multiplier (ILM). The Business Indicator Component (BIC) and the Internal Loss Multiplier (ILM) can be calculated through the business indicators in banks' financial statements and internal loss data.

iii) Development of other aspects of the Basel Framework

The center of the Basel Framework – the minimum regulatory capital requirement has experienced great changes in the past decades. In recent years, the Basel Framework also has developed and reformed other aspects in the framework.

Liquidity standards - The Liquidity Coverage Ratio (LCR) focuses on banks' ability to withstand a 30-day liquidity stress. The Net Stable Funding Ratio (NSFR) focuses on a longer term (over 1 year) liquidity management.

Leverage management – Leverage Ratio (3%) has been placed restraints on banks' on-and-off balance-sheet exposures and acts as supplementary measure to the regulatory capital requirements. A Leverage Ratio Buffer has been introduced for the Global Systemically Important Banks (G-SIBs) to ensure that those banks maintain higher absorbency capability.

2.4.4.4 How do the Basel Accords work?

The Basel Accords are a financial supervisory framework built up by the Basel Committee which, as stated in its charter, has no formal supranational authority on the implementation of, or the compliance with, the standards under the Basel Framework. The functions of the Basel Framework rely on communication and cooperation between national supervisory authorities which are the members of the BCBS. The national supervisory authorities have the discretion to go beyond the minimum requirements stipulated under the Basel Framework.

The Basel Committee monitors the adoption of regulations and standards under the Basel Framework by banks in its member countries through the Regulatory Consistency Assessment Programme (RCAP).

2.4.4.5 What is next?

The Basel III Reforms are responses to the global financial crises and the rebuilding of the post-crisis global financial system. Besides the imperative Pillar one – the minimum capital requirements, Pillar two – Supervisory Review and Pillar three – Market Discipline also are indispensable parts of the Basel Framework. Especially, Pillar two and Pillar three can be testaments of communication and cooperation between related stakeholders to the Basel Framework.

The Basel Committee has already started to conduct work programs on evaluation of the impact and effectiveness of its post-crisis reform framework. Financial innovation and the changes in the structure of the financial system will never stop. There will be another financial crisis and there will be a ‘Basel IV’ or whatever it is called in the future.

3 Ownership dynamics, risk and regulation in Chinese banking: New evidence

3.1 Introduction

The relationship between capital buffers and bank risk-taking has long attracted academic attention (See Cooper and Ross, 2002; Demirguc-Kunt and Kane, 2002; and Keeley, 1990). The implementation of the Basel Accords also led to work focusing on the effects of capital regulation on bank behavior; in particular regarding the impact of capital adequacy requirements on bank risk-taking behavior. The 2007-2009 global financial crisis (GFC) uncovered structural weaknesses in pre-crisis capital regulations. After the crisis, the Basel Committee on Banking Regulation and Supervision (BCBS) developed a consolidated framework (Basel III) for more stringent capital adequacy regulations and liquidity assessment, in recognition of the need for banks to be subject to more stringent capital regulations. Following the goals set by the BCBS, member countries, including China, have established legislation and regulatory frameworks. While regulatory consensus has been reached focusing on capital buffers, there is continued academic debate about the potential effects of capital requirements on bank risk-taking (Chiaramonte and Casu, 2017; Demirguc-Kunt et al., 2013; and Roulet, 2018).

China's banking sector plays an essential role in the country's economic development. It underwent fundamental changes in 1978, as an integrate part of China's overall economic reform. Since 2001, when China got accession to the World Trade Organization (WTO), the reform of China's banking industry has stepped up its pace and the entire banking sector has been dramatically reshaped. The reform has transformed Chinese banks into market-oriented enterprises, changed their ownership structure, established modern corporate governance mechanisms, and introduced legislation and regulatory framework. Since 2010, improvements and refinements have continued in China's banking sector as part of the advanced stage of the reform. China's financial authority fully accepted the Basel III framework and began its implementation in 2013. A rich body of literature focusing on the previous stages of the reform assesses the relationship between capital requirements and Chinese banks' performance and risk-taking (Lee and Chih, 2013; Pessarossi and Weill, 2015; Tan and Floros, 2013). The objective of this paper is to analyze the impact of capital requirements on Chinese bank risk-taking following the 2007-2009 GFC using the risk-based capital definition of the Basel III framework.

In this paper, we extend existing empirical research studying the impact of capital requirements on bank credit risk-taking by incorporating the interaction between capital regulation and ownership structure. Financial theories suggest that capital regulations impact banks' risk-taking due to the effect of the regulation on shareholders' incentives (Allen et al., 2011; Demirguc-Kunt and Kane, 2002) and are supported by empirical studies. Nevertheless, empirical research finds mixed results including negative association (see Berger and Bouwman, 2013; Tan and Floros, 2013), positive association (see Calem and Rob, 1999) and nonlinear relationships (see Calem and Rob, 1999) between capital regulation and bank risk-taking. Agency theory suggests that corporate risk-taking is influenced by ownership structure depending on the power of shareholder control (see Shleifer and Vishny, 1997). These theoretical keystones provide the foundation for us to examine the effect of capital regulation on bank risk-taking and how this interacts with ownership structure in determining risk-taking.

This paper provides empirical evidence using forensically analysed data on 231 Chinese commercial banks over the period 2010-2019. To perform our analysis, we hand collect the ownership structure information of these 231 Chinese commercial banks and classify them into five categories of ownership identities: State-owned (Big Six and other than Big Six), Local government-holding, Joint-stock, Foreign joint-stock, and Foreign-owned banks (Table 1). In the next step, our empirical model, we investigate the causal relationship between both regulatory capital requirements from the Basel III framework and ownership identities on bank credit risk-taking proxies, respectively. We calculate and analyse banks' Non-performing Loans (NPL) ratios and Loan Loss Reserves (LLR) ratios to reflect the level of banks' credit risk-taking. We also examine the actual impact of Basel III capital regulation on credit risk-taking incorporating the interaction between capital regulation and ownership structure.

Our key findings are as follows. First, credit risk is generally lower in banks that have higher regulatory capital. This finding is consistent with theory suggesting that regulatory capital acts as a buffer to resist economic shocks and lower banks' risk-taking incentives (see Mehran et al., 2011). This finding also supports the empirical studies of Chinese banks conducted by Tan and Floros (2013) and Lee and Chih (2013).

Second, state-owned banks in general have higher credit risk compared to foreign-owned banks and other ownership identities. This finding is consistent with the results of Zhu and Yang (2016) which examines risk-taking of state-owned banks and foreign banks. This finding also, to some extent, reiterates the empirical results of Laeven and Levine (2009) which finds banks with large owners who have significant cash flow rights take higher credit risk. During the financial reform, the state-shareholder in Chinese banks has transformed from a state-bureau (e.g., the Finance Ministry) to a state-corporation (e.g., Central Huijin Investment Co.) with modern corporate governance mechanisms. The state-shareholder has become a shareholder *with highly concentrated control rights and significant cash flow rights*. Due to this fact, our findings can be considered consistent with the agency theory that concentrated ownership and powerful shareholders suggest higher corporate risk-taking (Saunders et al., 1990; Stulz, 2005). This finding also supports the social view of the theory of state ownership of banks that state-owned banks are willing to undertake credit projects which might not be financially profitable

(Stiglitz, 1993).

Third, the actual impact of Basel III capital regulation on credit risk-taking can be influenced, to some extent, by ownership structure. For example, the results suggest that in government-holding banks, the negative effect of capital regulation on credit risk-taking can be enhanced by its ownership identity when there is no shareholder with significant power to increase risk-taking incentives.

This paper contributes to the literature in several ways. First, this study assesses the impact of risk-based capital regulation on Chinese bank credit risk-taking following the GFC, using the definition of capital from Basel III framework. The BCBS first released Basel III framework in 2010. The Chair of the BCBS stated that evaluating the regulation effects is part of the BCBS post-crisis reform in the current macroeconomic environment. In addition, China's banking industry achieved extensive transformation before 2010 and the Chinese case provides uniqueness in terms of ownership structure.

Second, our study bridges the research gap by incorporating the interaction between ownership structure and capital regulation while examining the impact of Basel III capital requirements on bank credit risk-taking. Only a small number of existing studies evaluate the joint effects of ownership structure and bank regulations on bank risk-taking, such as Laeven and Levine (2009). Pessarossi and Weill (2015) test the impact of the interaction between capital regulation and ownership structure on cost efficiency of Chinese banks. To the best of our knowledge, this is the first study to assess how Basel III regulation and ownership structure jointly shape Chinese bank credit risk-taking following the global financial crisis.

Third, we compile and analyse a bespoke data-set of 231 Chinese commercial banks over a period (2010-2019) of the advanced reform stage to study China's banking sector. Previous studies focus on the period before 2010. These 231 banks account for over 80% of China's banking sector in terms of total assets. Apart from employing the data provided by the SNL database, we hand collected any missing values from the original annual reports of individual banks, which makes our data set extremely comprehensive and novel.

The remainder of this paper is organised as follows. Section II reviews related literature, develops the testable predictions, as well as a brief introduction of the evolution of ownership structure of commercial banks in China. Section III presents the data set and the empirical model including the variables considered in our analysis. The empirical results are presented in section IV. And section V concludes.

3.2 Literature

As a member of the G20 and the Basel Committee on Banking Supervision, China has been fully supporting and participating in the global regulatory reform following the GFC of 2007-

2009. In June 2012, The China Banking Regulatory Commission (CBRC)¹ issued the regulation *Commercial Bank Capital Management Measure (Trial)*, essentially adopting and incorporating the Basel III framework into the banking regulatory framework in China.² The relationship between macro and micro prudential regulations has a hierarchical structure. Borio (2003) argues that the objectives of macro-prudential regulation subsume the rationales of the micro-prudential approach. The Basel III Framework is a macro-prudential framework based on Basel II framework (a micro-prudential framework). Through examining the relation between credit risk/solvency risk and Basel III, the impact of this macro-prudential oriented framework can be assessed from the institutional angle.

3.2.1 Bank capital and risk

Empirical literature and financial theories provide mixed views regarding the impact of bank capital on risk-taking and bank stability. The Basel framework, centered with capital regulation, is designed to reduce bank risk and enhance bank resilience. Anginer and Demirguc-Kunt (2014) support this view that bank capital acts as a buffer in absorbing economic shocks and strengthens systemic stability. Demirguc-Kunt et al. (2013) find that a strong capital position helps banks resist earning shocks and have higher probability to survive the crisis. They also find evidence to advocate higher quality capital, i.e., Tier 1 capital, in the regulatory capital requirements. A number of theories highlight that risk-based capital, more effective than interest rate ceilings, boosts banks' "franchise value," improves borrowers screening, and lowers banks' excessive risk-taking incentives (Allen et al., 2011; Mehran et al., 2011; Repullo, 2004). Other theories emphasize a moral hazard perspective, arguing that effective regulatory capitalization may offset the excessive risk-taking incentives created by deposit insurance (Demirguc-Kunt and Kane, 2002; Keeley, 1990). In terms of Chinese commercial banks, Tan and Floros (2013) find a significant negative relationship between bank capital and risk. Lee et al. (2015) report that bank capital is negatively related to NPL and support theories with the moral hazard view.

On the other hand, some research posits that greater capital regulations may induce higher bank risk. Cooper and Ross (2002) extend the research of Diamond and Dybvig (1983), stating that the existence of deposit insurance weakens depositors' incentive to monitor banks and causes them to engage in excessive risk-taking activities. Blum (1999) suggests that banks may have higher incentives to raise risk due to the binding capital adequacy requirements. Calem and Rob (1999) find a U-shaped relationship between bank capital position and risk. The risk-taking first decreases with the increase of bank capital; then it increases as bank capital increases on its high level. They also argue that the increase in capital adequacy requirements induces banks to take additional portfolio risk even if they are well-capitalized. For Chinese banking data, Lee and Chih (2013) find that the negative relationship between

¹The CBRC and the China Insurance Regulatory Commission (CIRC) was combined into the China Banking and Insurance Regulatory Commission (CBIRC) in 2018.

²China also adopted and implemented Basel II and Basel II.5 in previous years.

capital and risk only exists in the sub-sample of small banks and is not found in the sub-sample of large banks.

The first research question: *is there a negative/positive relationship between regulatory capital and credit risk?*

3.2.2 Owership structure and risk

Agency theory posits that corporate governance affects corporate risk-taking in sourcing outside financing and in the choice of value-enhancing projects because the private benefit of corporate control comes at the expense of the firm's outside investors (Jensen and Meckling, 1976). As one of the most important approaches to corporate governance, the legal investor protection (shareholder rights) approach suggests that corporate risk-taking is influenced by shareholder rights. Agency theory literature provides the results of both positive and negative links between shareholder rights and firms' risk-taking. Amihud and Lev (1981) and Hirshleifer and Thakor (1992) argue that in firms where managers have high levels of discretion, managers have the motive to engage their firms in conservative investment projects such as conglomerate mergers and low net present value (NPV) projects, in order to protect their careers or build their professional reputation. Based on this view, better investor protection may constrain the managers' excessive control rights in firms, and may result in higher corporate risk-taking behavior. John et al. (2008) conduct a cross-country study and support this view. They find a positive relationship between investor protection and corporate risk-taking.

This school of thought suggests that investor protection is negatively related to corporate risk-taking. Burkart et al. (2003) argue that strong investor protection gives managers the freedom to divert company resources within their compensation packages. Therefore, it would be optimal for the firm founders to sell the equity and hire professionals to manage the company. According to this view, strong legal protection, in fact, leads to a scenario of no controlling shareholding in firms; and induces managers to take more conservative actions in choosing investment in order to protect their private benefit. The model provided by Burkart et al. (2003) predicts that there is a negative relationship between legal investor protection and ownership concentration which is another popular approach to corporate governance.

Ownership concentrated in large investors with significant control rights and significant cash flow rights is another common approach to corporate governance (Laeven and Levine, 2009). La Porta et al. (1999) suggest that corporations with dominant owners are more common globally, compared to widely held firms. Controlling shareholders with strong incentives of monitoring inside managers and maximizing firms' expected profits, execute their control rights and cash flow rights mainly through the pyramid³ corporate setting (La Porta et al., 1999; Shleifer and Vishny, 1986). Agency models of large investors suggest a positive relationship between ownership concentration and corporate risk-taking. Saunders et al. (1990) argue that

³The pyramid structure is defined as if: the firm has a large ultimate owner; and there is a listed company between the firm and the ultimate owner acting as a proxy of voting (La Porta et al., 1999).

stockholder controlled banks have more intention to take higher risks than banks controlled by managers. Stulz (2005) suggests that highly concentrated ownership decreases risk aversion of managers inside the firms. Laeven and Levine (2009) provide empirical evidence supporting banks with concentrated shareholding generally have higher risk.

3.2.3 State ownership

State ownership is regarded as one of the special corporate arrangements. From a corporate governance perspective, state firms are defined as being “*controlled by the public; and the de facto control rights usually belong to bureaucrat shareholders with highly concentrated control rights and no significant cash flow rights*” (Shleifer and Vishny, 1997). According to this view, state shareholders can be considered as a special form of large investors with highly concentrated control rights and lack of cash flow rights.

There are two alternative theories in the literature regarding state ownership in banks: the social view and the political view. The social view, based on the economic theory of institutions, suggests that state ownership is a form of government intervention which addresses market failures and improves market functions and economic performance (Stiglitz, 1993). According to this view, state-owned banks may finance those projects which might not be profitable but might have a high value of social welfare. Therefore, state-owned banks may have poorer performance in terms of profitability along with higher default risk compared to their counterparts in the private sector. In contrast, the political view claims that state ownership creates sources of political benefits for politicians rather than social welfare. For example, excessive employment of state firms only benefits those who support government politically (Shleifer and Vishny, 1994). Shleifer and Vishny (1997) suggests that state-owned firms are inefficient because the state shareholders, with highly concentrated control rights and no cash flow rights, only maximize their political goals which may jeopardize social welfare.

There exists a large body of literature examining the impact of state ownership of banks, from both the macroeconomic angle and the perspective of individual banks, mostly on economic growth and bank performance. Andrianova et al. (2012) find that state ownership of banks improves countries’ long-run economic growth. However, La Porta et al. (2002) find that higher government ownership is related to lower economic growth. Beck and Levine (2002) find no supporting evidence for either the social view or the political view. At the individual bank level, studies tend to focus on bank performance under different ownership structures. Many studies report that state-owned banks are less efficient than private-owned banks. For example, Beck et al. (2004) argue that state ownership intensifies bank concentration and restrains market competition. Berger et al. (2005) and Iannotta et al. (2007) find that state-owned banks have lower profitability and poor long-term performance.

Ownership structure of banks in China’s financial markets has attracted academic attention following China’s accession to the WTO in 2001. Many studies focusing on bank efficiency report that state-owned banks exhibit lower efficiency compared to joint-stock banks and

foreign banks (Berger et al., 2009; Fungáčová et al., 2013). Several papers focus on ownership structure and bank risk. Tan and Floros (2013) argue that state-owned banks have higher volume of non-performing loans and lower profitability. Zhu and Yang (2016) report that state-owned banks take higher risk than foreign banks in China.

The second research question: *Do state-owned banks have higher credit risk compared to other type of banks?*

3.2.4 The evolution of ownership structure of commercial banks in China

The dramatic changes regarding the ownership structure of commercial banks in China are an essential part of every stage of China's financial reform. The four largest state-owned banks⁴ were founded during the first stage of the financial reform (1978-early 1990s), along with other national banks⁵. These large banks were owned by the Finance Ministry and state-owned enterprises. The lower level of financial institutions, known as city credit cooperatives (later evolved to city banks), were controlled by the local Bureau of Finance; and foreign banks were operating in Special Economic Zones (Berger et al., 2009).⁶

During the second stage (early 1990s-2001), most of the policy-lending business of the four largest state-owned banks was released to three policy banks founded during this period. Private enterprises and individuals began entering different levels of financial institutions as shareholders. Local Bureaus of Finance began to exit city banks by transferring their shareholding to local business enterprises. The biggest change to the ownership structure happened at the third stage of the financial reform (2001-2010). An investment enterprise, Central Huijin Investment Ltd. (hereafter CH), was established by the state government acting as a designated shareholder of those state-owned banks, in order to fulfill the corporate governance requirements set by laws and regulations. Direct government shareholding has sharply decreased. Foreign financial institutions such as RBS Group and Bank of America invested in all levels of Chinese banks including state-owned banks, national banks and city banks, as strategic investors. The majority of state-owned banks and several city banks went public at this stage, introducing more diversified shareholders. After 2010, more detailed improvements occurred regarding ownership structure; and private-owned banks were established. Local government shareholders become minority shareholders in city banks. Over 50% of shareholding in city banks and over 87% of shareholding in rural commercial banks had become private enterprises by 2017. In total 61 commercial banks were listed by the end of 2022.

⁴They are the "Big Four": Bank of China, China Construction Bank, Agricultural Bank of China, and Industrial and Commercial Bank of China.

⁵National banks: commercial banks which operate nationwide.

⁶Special Economic Zones: a form of Free Ports in China where companies may benefit from tariff allowances and exemption. Chinese government designated the first four Special Economic Zones – Shenzhen, Xiamen, Shantou, and Hainan Province – in order to encourage foreign investments and improve economy and technology by the end of 1980's. More details may be found in <http://www.npc.gov.cn/npc/c9757/200904/8e461e2ba405480697185186122812d4.shtml>.

3.2.5 The evolution of the regulation framework in China's financial sector

Until 1978, Chinese banking system followed the mono-bank model. The People's Bank of China (PBOC), which acted as a unit of the State Council and was appointed as 'a National Bank', undertook functions including 'issuing national currency, managing national treasury, managing national finance, stabilizing financial markets and supporting economic recovery'⁷ when it was initially established. After the incorporation of private financial institutions into the financial system in the following years, the PBOC played the dual role in the financial system: a central bank simultaneously acting as a commercial bank. The PBOC performed its supervisory function through directly controlling permission on establishments of financial institutions, approval of their key operational decisions, and senior management appointments in financial institutions, etc.

Five years after the national economic reform started, in 1984, the PBOC began to perform the sole function as a central bank, which was decided by the State Council in the year before. In 1995 that 'the People's Bank of China Law of the People's Republic of China' reinforced the PBOC's status as a central bank in the form of legislation.

In 2003, most of the regulatory duties performed by the People's Bank of China (PBOC) during the initial stages of the economic recovery and reform was officially separated from the PBOC and transferred to the new founded supervisory body - the China Banking Regulatory Commission (CBRC)⁸.

Since then, the CBRC has been regulating banks and financial institutions other than insurance companies and securities firms. In 2018, the CBRC was merged with the China Insurance Regulatory Commission into a new regulatory body - the China Banking and Insurance Regulatory Commission (CBIRC) which is responsible for regulating banking and insurance sectors⁹.

The regulatory functions of the PBOC focus on regulating bank behavior in interbank markets involving repurchase agreements (Repo), interbank foreign exchanges, and interbank bonds. The PBOC also issues regulatory rules on the payment system cooperating with the CBIRC.

3.2.6 Ownership structure and regulation

Financial theories suggest that banking regulations impact banks' risk-taking by influencing shareholders' incentives (Allen et al., 2011; Demirguc-Kunt and Kane, 2002). Corporate governance theories suggest that ownership structure affects corporate risk-taking through

⁷See the website of the People's Bank of China <http://www.pbc.gov.cn/rmyh/105226/105433/index.html>

⁸See the official document of the National People's Congress 'About China Banking Regulatory Commission Decision of supervision and management duties originally performed by the People's Bank of China' http://www.gov.cn/gongbao/content/2003/content_62100.htm.

⁹See the official document of the Chinese Government "The Central Committee of the Communist Party of China issued the 'Deepening Party and State Institution Reform Plan'" http://www.gov.cn/zhengce/2018-03/21/content_5276191.htm#2

Table 3.1: Cross tabulation of Ownership and Type

shareholder control rights on corporate decision-making (Jensen and Meckling, 1976; Shleifer and Vishny, 1997). Few studies on bank risk and regulation take account of the interaction between regulation and ownership structure. However, Koehn and Santomero (1980) argue that bank owners would compensate their potential expected utility loss by allocating assets to riskier portfolios when facing more stringent capital regulation. This means that the effects of bank regulation on credit risk are manifested through bank owners' incentives and power. Boyd and Hakenes (2008) build models examining the relation between bank risk-taking and bank regulations under the circumstances of different ownership structure. They claim that banks' incentives for taking excessive risk (risk-shifting) and bank managers' looting,¹⁰ in response to bank regulations, are affected by ownership structure. Laeven and Levine (2009) further the empirical research of bank risk, regulation, and ownership structure by examining cross-country data. They find that the stringency of regulatory oversight can be dampened by ownership with large control rights and cash flow rights. Concerning empirical studies of commercial banks in China, Pessarossi and Weill (2015) suggest that the effects of capital requirements on commercial banks may vary depending on the individual banks' ownership structure. Thus, based on financial theories and corporate governance theories, we examine whether or not bank regulation and ownership structure jointly impact on bank credit risk:

The third research question: *Is the impact of bank regulation on credit risk dependent on ownership structure?*

3.3 Data and forensic accounting analysis

This study analyses annual data for 231 commercial banks in China, for the period 2010-2019, providing a total of 2,310 observations. The categories of sample financial institutions of the banking sector and their ownership structure are listed in Table 3.2.

The main data source used is SNL Financial (a service provided by S&P Global Inc.). However, this source provides only incomplete data. Therefore, in cases where the SNL database does not provide enough information or has doubtful values, we double-check and hand collect data from other official sources including the annual issues of China's Statistical Yearbook, the press release and the annual reports of the China Banking and Insurance Regulatory Commission (CBIRC), and the annual reports of individual banks. Macroeconomic data is collected from the official channels of the World Bank, IMF, FSB, BCBS, the national regulatory authorities such as CBIRC, and China's Statistical Yearbook.

¹⁰In Boyd and Hakenes (2008), "risk-shifting": banks take excessive risks during the crisis to gamble that they would be bailed by government. "looting": bank managers expropriate banks' resources for their personal benefits.

Table 3.2: Cross tabulation of Ownership and Type

Ownership/Type	Big Six	City bank	Foreign bank subsidiary	National bank	Rural commercial	Total
Foreign-owned	0 (0.0%)	0 (0.0%)	33 (100.0%)	0 (0.0%)	0 (0.0%)	33 (14.3%)
Foreign Joint-stock	0 (0.0%)	12 (11.0%)	0 (0.0%)	1 (8.3%)	0 (0.0%)	13 (5.6%)
Joint-stock	0 (0.0%)	48 (44.0%)	0 (0.0%)	5 (41.7%)	66 (93.0%)	119 (51.5%)
Local government-holding	0 (0.0%)	45 (41.3%)	0 (0.0%)	2 (16.7%)	5 (7.0%)	52 (22.5%)
State-owned	6 (100.0%)	4 (3.7%)	0 (0.0%)	4 (33.3%)	0 (0.0%)	14 (6.1%)
Total	6 (100.0%)	109 (100.0%)	33 (100.0%)	12 (100.0%)	71 (100.0%)	231 (100.0%)

*Ownership Structure:*¹ Foreign-owned: Foreign bank operating in China;² Foreign Joint-stock: Joint-stock Banks having foreign strategic investors (usually shareholding over 15%);³ Joint-stock: Banks' share held by mixed-ownership institutions and individuals; if shareholding involves indirect local government holding, the stake is less than 10%;⁴ Local government-holding: Banks' share either held by local Treasury Bureau (no matter how much of the stake), or indirectly held by local government over 10%;⁵ State-owned: Bank directly controlled by Central Huijin, Finance Ministry or state-owned enterprises.*Bank Types:*^a Big Six: The biggest six banks, all state-owned;^b City bank: Branches usually cover a city and the near cities within the province where the bank headquarter is located;^c Foreign bank subsidiary: Foreign bank branches and subsidiaries;^d National bank: Branches cover the whole country and based on the CBIRC's categorization;^e Rural commercial: Branches usually cover local communities and rural area within a province where the bank headquarter is located.

3.4 Methodology

Our empirical design follows Tan and Floros (2013) and Bitar et al. (2018). Bitar et al. (2018) examine the impact of risk-based and non-risk-based capital ratios on bank risk, performance and profitability, using a sample of banks from OECD countries. Tan and Floros (2013) analyse data on Chinese banks from 2003 to 2009 to examine the relationship between bank capital, risk and efficiency. Both studies use OLS regression models and provide enlightening results regarding the relationship between capital and risk. Bitar et al. (2018) focus on the impact of different measures of capital ratios on bank risk. Tan and Floros (2013) attempt to disentangle the inter relationship between capital, efficiency and risk. The banking data they employ covers the third stage of China's financial reforms. Both studies provide plausible benchmarks for our research. This paper tests the impact of regulatory capital requirements of CBIRC (based on the Basel III framework) on bank credit risk, incorporating the interaction between bank regulation and ownership structure of Chinese banks. This study employs the annual panel data of 231 commercial banks over the period 2010-2019 (the fourth stage of the financial reform). We begin by examining the impact of regulatory capital on credit risk. Then, we explore the relationship between ownership structure and bank credit risk. Finally, we extend the analysis by testing whether the relation between regulatory capital and credit risk varies with different ownership structure. The baseline OLS regression model specification is outlined as follows:

$$Risk_{i,t} = \beta_0 + \beta_1 * Capital_{i,t} + \beta_2 * BankControl_{i,t} + \beta_3 * Ownership_i + \beta_4 * Capital_i * Ownership_i + \beta_5 * IndustrySepcific_{i,t} + \beta_6 * Macro_{i,t} + \epsilon_{i,t} \quad (3.1)$$

In Equation (1), the subscripts i and t denote the individual bank and year respectively. The

Table 3.3: Variable Definitions

variable $Risk_{i,t}$ refers to bank i 's credit risk indicators which are represented by financial ratios of asset quality in the CAMEL rating system. The variables $Capital_{i,t}$ and $BankControl_{i,t}$ are different dimensions of capital adequacy requirements and control variables. The variable $Ownership_i$ is a firm specific dummy variable. The variables are defined in Table 3.4.

3.4.1 Bank Credit Risk

We use the non-performing loan (NPL) ratio (i.e., Non-Performing Loans/Total Gross Loans) to represent banks' credit risk, with higher values indicative of increased credit risk (Bitar et al., 2018). However, NPL ratios only reflect the size of the problem not the quality of the loan book, which reflects the future expectation of loans write-offs. In order to ensure the robustness of our results, Loan Loss Reserve/Gross Loans (LLR) ratio is also employed, representing the proportion of the loan book a bank expects to be written-off. Taken together, these ratios capture banks' potential credit default risk (NPL) and loan book quality (LLR).¹¹

3.4.2 Capital Adequacy Requirements

The impact of capital adequacy regulation on credit risk has been widely debated yet remains an empirical challenge (Allen et al., 2011; Anginer and Demircuc-Kunt, 2014; Blum, 1999; Cooper and Ross, 2002; Demircuc-Kunt et al., 2013; Demircuc-Kunt and Kane, 2002; Keeley, 1990; Lee et al., 2015; Lee and Chih, 2013; Repullo, 2004). Hogan (2015) suggests that capital requirements are negatively related to bank risk-taking. Hellmann et al. (2000) argue that capital regulation induces banks to take excessive risk. Calem and Rob (1999) find a U-shaped association between capital buffer and bank risk-taking which is also found in the Chinese banks by Jiang et al. (2020). In terms of the measurement of bank capital, studies such as Tan and Floros (2013) and Lee and Hsieh (2013) both use Equity/Total Assets to measure individual banks' capital adequacy. Demircuc-Kunt et al. (2013) find stronger association between bank capital and stock return when the leverage ratio is used to measure bank capital instead of risk-based capital ratios. Berger and Bouwman (2013) find broadly similar empirical results using risk-based and non-risk-based capital ratios. The Basel III framework, as the core of the Basel Committee's post-crisis reforms, aims at strengthening banks' risk capture and the resilience of the whole banking system. Risk-based capital ratios are commonly employed to examine the relationship between regulation and bank risk-taking (Bitar et al., 2018; Laeven and Levine, 2009; Roulet, 2018).¹²

¹¹Similar to Bitar et al. (2018), we focus on bank credit default which is one of the components of Pillar I of Basel III. Because our sample banks include listed and un-listed banks in China, we will not consider market risk and operational risk.

¹²Laeven and Levine (2009) use the regulatory capital ratio (TC/RWA) as the variable of capital requirements

Table 3.4: Variable Definitions

[!h]

Variable	Definition	Source
NPL	Non- Performing Loans/Gross Loans; Non- Performing Loans as a percentage of loans before reserves	SNL Database and bank annual reports
LLR	Loan Loss Reserves/Gross Loans; Reserves for loan losses as a percent of loans before reserves	SNL Database and bank annual reports
Tier1_Ratio	Tier 1 capital ratio as defined by the latest regulatory and supervisory guidelines	SNL Database and bank annual reports
TC_to_RWA	Total Regulatory Capital/Risk Weighted Assets; Total capital ratio as defined by the latest regulatory and supervisory guidelines.	SNL Database and bank annual reports
NL_to_TA	Total Net Loans/Total Assets; loans and finance leases, net of loan-loss reserves, as a percent of total assets	SNL Database and bank annual reports
ROE	Return on average equity; net income as a percent of average equity	SNL Database and bank annual reports
Total_Assets	Total Assets; all assets owned by the company as of the date indicated, as carried on the balance sheet and defined under the indicated accounting principles	SNL Database and bank annual reports
LnAssets	Natural Logarithm of Total_Assets; as an indicator of the size of a bank	Manually computation based on the data of Total_Assets
Income_Div	Income diversity; $1 - (\text{Net Interest Income} - \text{Other Operating Income}) / \text{Total Operating Income}$	Manually computation based on SNL Database and bank annual reports
Concentration	The total assets of the largest five (the largest six in 2019) commercial banks (in terms of assets), as percentage of the total assets of the whole banking sector	CBIRC statistics release
GDP	GDP Growth rate (%); annual percentage growth rate of GDP at market prices based on constant local currency.	World Bank Database
Inflation_CPI	Inflation as measured by the consumer price index (CPI) reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly.	World Bank Database

Risk-based capital adequacy requirements are deemed as the core of the Basel III framework and CBIRC capital management regulation. The Tier 1 capital ratio, is defined as the ratio of Tier 1 capital to the total risk-weighted assets (RWA). The total regulatory capital ratio is measured as Tier 1 and Tier 2 capital to RWA. These two ratios have the same numerator, focusing on different aspects of the bank capital buffer. To examine the impact of Basel III on the individual banks' credit risk, we choose the total regulatory capital ratio as our variable of interest (*TC_to_RWA*), taking into account of the higher accessibility of the data.

3.4.3 Bank-level Predictors

The vector $BankControl_{i,t}$ includes a set of variables which account for banks' particular characteristics. The following bank-level control variables are employed:

NL_to_GL: we use the ratio of the Total Net Loans/Total Assets as a proxy for asset quality. The existing literature shows that banks with traditional loan portfolios may be exposed to lower risk than those investing in derivatives (Bitar et al., 2018). Tan and Floros (2013) use the loan to total assets ratio as an indicator of liquidity.

ROE: we employ the ratio of return on equity to measure profitability of banks. This predictor exhibits the ability of a bank to employ its own resource, i.e., equity, to generate profits.

Income_Div: a measure of banks' income diversity. The ratio is calculated as $1 - ((NetInterestIncome - OtherOperatingIncome) / TotalOperatingIncome)$ (Laeven and Levine, 2007). Literature has a mix of views on banks' risk and return. For example, Diamond (1984) states that diversification of financial intermediaries may improve market valuation under delegated monitoring. Laeven and Levine (2007) argue that diversified financial conglomerates may have a lower market value compare to those who concentrate on lending activities. Demirgüç-Kunt and Huizinga (2010) report that both bank risk and return increase with the increase of non-interest income share in the total operation income.

LnAssets: we employ the natural logarithm of total assets to control for bank size. Bank size is considered as one of the important influences of risk given a bank's scale economies of scale. A higher value of total assets may decrease individual banks' risk (Pasiouras, 2008; Tan and Floros, 2013); and a larger bank may have higher probability to survive during the financial crisis (Berger and Bouwman, 2013). Thus, a negative relationship would be expected between bank size and credit risk.

3.4.4 Industry and Macroeconomic variables

In addition to bank-specific variables, industry and macroeconomic conditions are taken into account when assessing the relationship between bank credit risk and regulation.

Concentration: we use the ratio of total assets of the largest six banks (Big Six) to the total assets of all Chinese commercial banks to measure the level of industry competition. We employ

this ratio by following Tan and Floros (2013) as a measure of competition in China’s banking sector. Tan and Floros (2013) take the total assets of the largest three banks, matching their data period 2003-2009. We take four systemic important banks plus Bank of Communications and the Postal Savings Bank. These six banks individually are considered as much larger than the rest of commercial banks in terms of total assets. A high concentration ratio may reflect low competition. Boyd and De Nicoló (2005) argue that more concentrated financial markets may lead to more bank risks.

Macroeconomic conditions may influence bank activities. Dagher et al. (2016) argue that there may be a procyclical relationship between economic development and bank lending. Demircuc-Kunt and Detragiache (1997) find that countries are more prone to financial crisis when economic growth is low and inflation is high. We take the annual GDP growth rate (*GDP_Growth*) and the consumer price index (*Inflation_CPI*) as measures of macroeconomic conditions. Both variable definitions are presented in Table2.

3.4.5 Ownership Structure

A key focus of our analysis is the influence of ownership structure on the responsiveness of Chinese banks to capital regulation changes. Institutional structure is an essential part of corporate governance, attracting much academic attention. Ownership structure and business model dynamics are a distinct characteristic of risk and profitability profiles in European banking (Ayadi et al., 2020). Laeven and Levine (2009) argue that ownership structure should be taken into account when assessing individual banks’ risk-taking behaviour. Existing literature tests bank risk-taking, regulation and ownership structure and finds the risk preference of managers depends on the importance of private benefit and the level of shareholder rights (John et al., 2008), yet typically does not integrate the ownership structure into the risk-regulation studies (Laeven and Levine, 2009). Banking theory suggests that bank regulation influences the incentives of bank risk-taking (Allen et al., 2011; Blum, 1999; Cooper and Ross, 2002; Demircuc-Kunt et al., 2013; Demircuc-Kunt and Kane, 2002; Lee et al., 2015; Tan and Floros, 2013). Agency theory suggests that ownership structure determines shareholder power and affects corporate risk-taking (Jensen and Meckling, 1976; John et al., 2008; La Porta et al., 1999; Shleifer and Vishny, 1997; Stulz, 2005). Based on the above discussion, ownership structure should be incorporated into the analysis of the risk-regulation relationship, because ownership structure influences the incentive of bank risk-taking in response to bank regulation (Boyd and Hakenes, 2008). Thus, we examine the impact of Basel III regulation on banks’ credit risk, taking into account the interaction between ownership structure and regulation requirements.

Using a forensically hand-crafted data-set, gathered by hand from translations of annual reports, we employ ownership structure as a categorical variable, and classify commercial banks in China into five categories: state-owned, local government-holding, joint-stock, foreign-joint stock, and foreign-owned. We learn from the above classification that two kinds of banks involved with government shareholding: state-owned banks and local government-holding banks.

The state-owned banks and local government-holding banks both have state or local government as their direct or indirect shareholders. We differentiate these two types of banks on the grounds that:

1. concerning the government involved, the state-owned banks only have the state government as their direct or ultimate shareholder, for example, Finance Ministry and Central Huijin Investment Ltd.; while the local government-holding banks only have local Bureau of Finance as their government shareholder.
2. In terms of power of government shareholders, the state-ownership has much greater control rights in the state-owned banks, compared to local Bureau of Finance in local government-holding banks where the local government has less than 20% shareholding.
3. With regard to size, the state-owned banks are the largest ones in terms of total assets, and most of them are national banks¹³; while local government-holding banks usually are medium sized banks and provide financial services in cities and nearby areas¹⁴.

From these perspectives, these two categories of banks may have distinctive reactions to risk-taking and bank regulation. Therefore, we separate these two types of government-ownership.

From the perspective of corporate governance, state firms are defined as being “controlled by the public; and the de facto control rights usually belong to bureaucrat shareholders with highly concentrated control rights and no significant cash flow rights” (Shleifer and Vishny, 1997). Based on this definition, state shareholders can be considered as a special form of the large shareholders with highly concentrated control rights and lack of cash flow rights.

Associated with the theorem of welfare economics and the property rights theory, there are two alternative views of government participation in financial markets: the social view and the political view. The social view suggests that state ownership is a form of government intervention which addresses to market failures and improves market functions and economic performance (Atkinson and Stiglitz, 1980; Stiglitz, 1993). According to this view, state-owned banks may finance those projects which might not be profitable but might have high value of social welfare. Therefore, state-owned banks may have poorer performance in profitability along with higher default risk compared to their counterparties in the private sector. In contrast, the political view claims that state ownership acts as a conduit for politicians to fulfill the political benefits rather than improve social welfare. For example, excessive employment of state firms only benefits those who support government politically (Shleifer and Vishny, 1994). According to the political view, state-owned firms are inefficient because the state shareholders, with highly concentrated control rights and no cash flow rights, only maximize their political goals which may jeopardize social welfare (Shleifer and Vishny, 1997).

¹³commercial banks that have branches operating nationwide. See Table 3.2

¹⁴Most local government-holding banks are city banks, see Table 3.2

Empirical literature reports mixed results regarding the impact of state ownership on macroeconomic development (Andrianova et al., 2012; La Porta et al., 2002). At the individual bank level, most studies report that state-owned banks have poorer performance and higher risk-taking, compared to other types of ownership. For example, Sapienza (2004) finds state-owned banks favor large firms and charge them lower interest rates than private-owned banks in Italy. Berger et al. (2005) report that state-owned banks in Argentina have poor long-term performance. Iannotta et al. (2007) argue that government owned banks have lower loan quality and higher insolvency risk than other bank types in Europe. As part of the results of the financial reform in China, the evolved ownership structure of banks in China has attracted academic attention after China’s accession to the WTO in 2001. Studies focusing on the third stage of China’s financial reform (2001-2010) report that state-owned banks do not perform as well as their peers regarding bank risk and performance (Berger et al., 2009; Pessarossi and Weill, 2015).

3.5 Main Results

Table 3.5: Descriptive Statistics

	N	Mean	Median	SD	Min	Max
NPL	1818	1.503	1.353	1.387	0.000	27.515
LLR	2073	3.226	3.009	1.363	0.000	15.883
TC_to_RWA	1989	18.429	13.345	35.733	-11.043	676.753
LnAssets	2128	16.585	16.448	1.646	12.065	22.188
NL_to_TA	2118	43.929	45.126	10.860	0.000	74.219
ROE	1973	12.862	12.756	6.708	-11.947	46.606
Income_Div	2091	0.447	0.346	0.400	-3.566	2.976
Concentration	2310	41.569	40.740	4.134	36.670	48.700
GDP_Growth	2310	7.678	7.234	1.336	5.950	10.636
Inflation_CPI	2310	2.590	2.347	1.123	1.437	5.554

Table 5.2 presents the descriptive statistics for the sample. The mean of NPL to Gross Loans is 1.503%, slightly lower than the figure of 1.8% in Jiang et al. (2020) which analyse a sample of banks in China over the period 2004-2017, and higher than the figure of 0.92% in Tan and Floros (2013) which analyse a sample sample over the period 2003-2009. The relatively low NPL ratio of Chinese banks can be regarded as one of the results of the financial industry reform in China. During the reform, the four Asset Management Companies (AMCs) purchased a large amount of NPLs from the state-owned banks (Tan and Floros, 2013). Apart from the increase of the numbers of Chinese commercial banks, the NPL figure suggests an average increase in the NPL to Gross Loan ratio of Chinese commercial banks in recent years.

Tier1_Ratio (Tier 1 Ratio) and *TC_to_RWA* (total capital ratio) have a similar number of observations, both of which are over 1900. The disclosure of regulatory capital information is mandatory for commercial banks in China as Commercial Bank Capital Management Measures – the China version of Basel III has become effective since 2013. *Tier1_Ratio* has a mean of 16.290% which is higher than the minimum 6% requirement proposed by the Basel III Framework. This result is higher than the results of Bitar et al. (2018). The mean of *TC_to_RWA* is close to the results of European banks in Bitar et al. (2018) (18.18%).

The mean of *ROE* is 12.86 which is slightly lower than what is reported in Lee et al. (2015) (13.86). They examine the relationship between bank capital and profitability and risk, using the data of Chinese commercial banks from 1997-2011. This period is a transitional time for China’s banking industry since it witnessed the three main stages of the financial reform in China’s banking industry. By 2011, key regimes of the financial reform had finished and essential mechanisms regarding corporate governance, legislation, among others had been established. Therefore, banks’ profitability may be lower than the era of high-speed development due to constraints in markets, supervision and corporate governance.

Figure 3.1 reports the Pearson correlation matrix between the predictor variables. All correlation coefficients of the variables are lower than 0.6, except for the correlation between Tier 1 capital ratio and the total capital ratio due to the different definition of capital ratios. Therefore, the regression models will be run only using *TC_to_RWA* as the variable of interest, in order to avoid high collinearity and duplication.

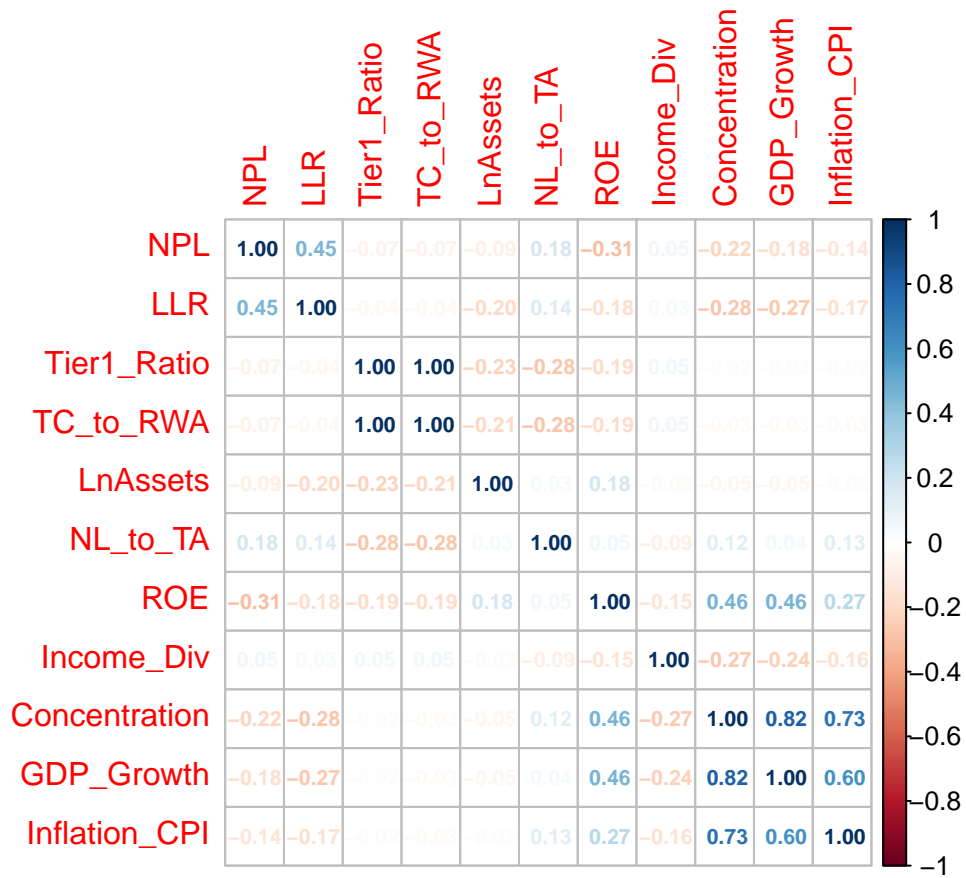


Figure 3.1: Linear Correlation Matrix

3.5.1 Impact on bank credit risk – Risk-based total capital ratio

Table 3.6: OLS Baseline Regression

	NPL			LLR		
Predictors	Estimates	CI		Estimates	CI	
(Intercept)	3.845 ***	2.727	– 4.962	10.797 ***	9.726	– 11.868
TC_to_RWA	-0.005 ***	-0.007	– -0.002	-0.003 *	-0.005	– -0.000
LnAssets	-0.050 **	-0.086	– -0.014	-0.179 ***	-0.214	– -0.144
NL_to_TA	0.023 ***	0.017	– 0.029	0.019 ***	0.013	– 0.024
ROE	-0.054 ***	-0.065	– -0.044	0.023 ***	0.014	– 0.032
Income_Div	0.001	-0.145	– 0.146	-0.224 **	-0.363	– -0.084

Table 3.6: OLS Baseline Regression

Concentration	-0.056 ***	-0.087 – -0.025	-0.112 ***	-0.142 – -0.083
GDP_Growth	0.082	-0.005 – 0.169	-0.161 ***	-0.245 – -0.077
Inflation_CPI	-0.022	-0.102 – 0.057	0.082 *	0.006 – 0.157
Observations	1649		1847	
R ² / R ² adjusted	0.160 / 0.156		0.177 / 0.174	
			* p<0.05	** p<0.01 *** p<0.001

Table 3.6 reports fixed effect baseline regression results for the full sample of banks. The columns show the results for Equation (1). The first two columns use NPL, and columns (3) and (4) use LLR as the dependent variable. The regressions report negative and statistically significant relationships between bank credit risk variables and the risk-based the total capital ratio (TC_to_RWA). The results support the hypothesis: higher regulatory capital requirements are related to lower bank credit risk.

The finding can be explained by the fact that those Chinese banks with higher level of regulatory capital have higher capability to reduce the impact of Non-Performing Loans, and thus lower Loan Loss Reserve. Tan and Floros (2013) find a negative but insignificant relationship between bank risk and capitalization when Loan Loss Reserve to Gross Loans is employed as the proxy of risk. Lee et al. (2015) report a significant negative relationship between bank capital and credit risk (proxied by NPL ratio). This finding may reveal that the capital adequacy requirements of Basel III equip commercial banks in China with proper capital buffers in terms of mitigating credit risk.

Among bank-specific and macroeconomic control variables, we find that bank size, asset quality, and profitability are the most significant variables. Bank size has a significant and negative impact on Chinese banks' credit risk. This result is consistent with findings from some studies regarding the impact of capital ratios on bank credit risk Bitar et al. (2018). This finding suggests that large banks are more competent in dealing with risky loans and or they can spread the risk across a larger more diverse loan risk profile. Because large banks may benefit from firm reputation, compared to small banks, and have wide-ranging access to fixed-income and equity markets to diversify and hedge their credit risk. There is a significant and negative relationship between banking industry concentration and individual banks' credit risk. The total assets of the largest six commercial banks¹⁵ account for 41.87% averagely during 2010-2019, although the industry concentration shows roughly a year-by-year decrease in the past decade. The first four out of these six banks are listed as global systemically important banks (G-SIBs) by Financial Stability Board (FSB) in 2020. In the context of China's banking industry, these six banks have a better ability to reduce the pressure in their credit activities, compared with other medium and smaller-sized banks.

¹⁵The largest six commercial banks: Industrial and Commercial Bank of China, Agricultural Bank of China, Bank of China, China Construction Bank, Bank of Communications, and Postal Savings Bank of China. The first four banks are listed as global systemically important banks (G-SIBs) in the FSB 2020 G-SIBs list.

3.5.2 Impact on bank credit risk – Ownership structure

Table 3.7: OLS Regression-Ownership Structure

Predictors	NPL		LLR	
	Estimates	CI	Estimates	CI
(Intercept)	3.271 ***	2.027 – 4.516	9.705 ***	8.584 – 10.826
TC to RWA	-0.003 *	-0.005 – -0.000	-0.000	-0.003 – 0.002
LnAssets	-0.075 **	-0.120 – -0.030	-0.224 ***	-0.265 – -0.183
NL to TA	0.019 ***	0.013 – 0.025	0.011 ***	0.005 – 0.016
ROE	-0.070 ***	-0.081 – -0.059	-0.017 ***	-0.027 – -0.007
Income Div	0.056	-0.089 – 0.201	-0.104	-0.236 – 0.027
Concentration	-0.043 **	-0.074 – -0.012	-0.083 ***	-0.111 – -0.055
GDP Growth	0.079	-0.007 – 0.165	-0.139 ***	-0.218 – -0.060
Inflation CPI	-0.020	-0.098 – 0.058	0.068	-0.003 – 0.138
Ownership	0.877 ***	0.552 – 1.203	1.523 ***	1.260 – 1.787
[Foreign				
Joint-stock]				
Ownership	0.913 ***	0.656 – 1.170	1.521 ***	1.333 – 1.708
[Joint-stock]				
Ownership	0.938 ***	0.671 – 1.205	1.452 ***	1.252 – 1.653
[Local				
government-				
holding]				
Ownership	1.002 ***	0.639 – 1.364	1.603 ***	1.303 – 1.903
[State-owned]				
Observations	1649		1847	
R ² / R ²	0.186 / 0.180		0.281 / 0.276	
adjusted				
* p<0.05 ** p<0.01 *** p<0.001				

Table 4.1 reports the results of the impact on bank credit risk by adding banks' ownership structure as a specific control variable. We find that adding ownership structure does not change the significant and negative impact of bank size, equity return and industry concentration on bank credit risk, respectively. However, the relationship between the capital requirement and Loan Loss Reserve becomes insignificant, although it remains negative. The relationship between total regulatory capital and Loan Loss Reserve also remains negative. The results presented in Table 4.1 demonstrate that ownership structure is positively associated with bank credit risk. This finding is consistent with the view that shareholders have greater incentives for risky projects than managers (see John et al., 2008). This finding also supports the empirical results of Laeven and Levine (2009) that find a positive association between risk and ownership of a large owner (10% or more voting rights).

As discussed in the previous sections, ownership structure is always a focus of research in terms of China's banking industry. Berger et al. (2009) study efficiency of Chinese banks from the perspective of ownership structure and suggest that a minority of foreign ownership help improve bank efficiency. Pessarossi and Weill (2015) investigate the effect of capital ratio on Chinese banks' cost efficiency adjusting for ownership structure. Zhang et al. (2016) compare bank risks between different ownership structures of Chinese banks. The reason that the ownership structure becomes one of the main interest factors in Chinese banking research could stem from the unique growth path of China's banking industry and suspicion in Western democracies of latent state manipulation. The past four decades witnessed dramatic changes and development in China's banking sector. The three stages of the reform in China's banking industry achieved the advancement of the legal and financial infrastructure, as well as the more diversified ownership structure. By 2010 the four G-SIBs and other 12 commercial banks all completed IPOs. Private shareholding accounted for 77.7% in rural commercial banks. The period after 2010 could be considered not only as a stage of the financial reform for further progressing and improving, but also a time to evaluate the effectiveness of the substantial bank ownership changes. In recent times, as China seeks to decouple its reserve banking system from the US, there may be important implications for continued regulatory cooperation in international banking¹⁶.

The results reveal that state-owned banks have higher credit risk compared to those foreign-owned banks in China's banking industry. This finding, to some extent, supports the viewpoint that state-owned banks would be involved in policy-guided credit activities instead of profit-centered ones (see Pessarossi and Weill, 2015). The social lending theory of state ownership (see Atkinson and Stiglitz, 1980) suggests that state-owned enterprises contribute to "correcting the 'failure' of market economy" due to imperfect competition, inefficiency and public good. According to this view, government-owned enterprises may help improve overall performance of economy (see Stiglitz, 1993). In China's banking context, the biggest four commercial banks were founded and conducted a large amount of government lending in the early 1990's, before national banks and city banks were established. Within a relatively long period, the state-owned banks (including local government-holding banks founded later in the end of 1990's) played a role of 'government agencies' to pursue the broader social welfare objectives rather than profit maximizing; for example, the projects of the nationwide High-speed Rail network. Since the state-owned banks target multiple welfare objectives which might not be measurable, the managers in the state-owned banks have low powered incentives (see Tirole, 1994). However, this resulted in the significant non-performing loan levels of 'Big Four' banks before China's WTO accession in 2001.

Since 2001, the ownership structure has been dramatically transformed, due to China's overall industrial reforms and the commitments to the WTO agreement. The large part of shares directly held by local government were gradually replaced by mixed ownership enterprises, foreign investments, and private investors. In terms of the state-owned banks, direct state intervention was replaced by Central Huijin (a company representing the state government)

¹⁶<https://rhg.com/research/us-china-decoupling>

along with the establishment of modern corporate governance system. Why does state ownership still have relatively higher credit risk? This can be explained by two reasons: (1) although the direct government shareholding structure changed, business connection with state-owned enterprises remains due to the long-lasting business relationship and contracts such as those nationwide infrastructure projects lasting for decades; (2) the development of modern corporate governance mechanisms in China's banking industry could transform government ownership into concentrated ownership, the ownership similar to the one of large investors with significant control rights and cash flow rights (see Shleifer and Vishny, 1997). From this perspective, concentrated ownership puts pressure on management decision (Shleifer and Vishny, 1997) and bank risk taking incentives (Boyd and Hakenes, 2008). Almost all state-owned banks are listed banks. With their significant control rights and cash flow rights, the state (large) shareholder in these state-owned, listed banks may take excessive risk by favouring particular clientele such as large conglomerates in projects with potential of social-benefits rather than those with target of profit-maximizing. Sapienza (2004) finds that state-owned banks favour large firms and charge lower interest rates than other types of banks in Italy. This finding is also consistent with Laeven and Levine (2009) that report banks with large investors have higher risk.

3.5.3 Impact on bank credit risk – Interaction between regulation and ownership structure

Table 3.8: Regression with Interaction between Ownership and Capital Regulation

Predictors	NPL		LLR	
	Estimates	CI	Estimates	CI
(Intercept)	3.636 ***	2.404 – 4.867	9.766 ***	8.643 – 10.888
TC to RWA	-0.002	-0.005 – 0.000	-0.000	-0.002 – 0.002
LnAssets	-0.100 ***	-0.145 – -0.055	-0.229 ***	-0.271 – -0.187
NL to TA	0.019 ***	0.014 – 0.025	0.010 ***	0.005 – 0.015
ROE	-0.071 ***	-0.082 – -0.060	-0.019 ***	-0.029 – -0.009
Income Div	0.024	-0.120 – 0.168	-0.091	-0.222 – 0.041
Concentration	-0.042 **	-0.073 – -0.012	-0.082 ***	-0.110 – -0.054
GDP Growth	0.063	-0.023 – 0.148	-0.137 ***	-0.215 – -0.058
Inflation CPI	0.001	-0.076 – 0.078	0.059	-0.011 – 0.130
Ownership	1.245	-0.428 – 2.918	2.125 ***	1.738 – 2.512
[Foreign				
Joint-stock]				
Ownership	2.269 ***	1.787 – 2.752	1.312 ***	0.882 – 1.743
[Joint-stock]				
Ownership	1.988 ***	1.266 – 2.709	0.908 **	0.242 – 1.573
[Local				
government-				
holding]				

Table 3.8: Regression with Interaction between Ownership and Capital Regulation

Ownership [State-owned]	2.314 ***	0.984 – 3.644	1.743 **	0.456 – 3.029
TC to RWA × Ownership [Foreign Joint-stock]	-0.022	-0.150 – 0.105	-0.039 ***	-0.057 – -0.021
TC to RWA × Ownership [Joint-stock]	-0.097 ***	-0.126 – -0.067	0.018	-0.010 – 0.046
TC to RWA × Ownership [Local government- holding]	-0.076 **	-0.126 – -0.025	0.044	-0.004 – 0.092
TC to RWA × Ownership [State-owned]	-0.091	-0.192 – 0.009	-0.007	-0.104 – 0.091
Observations	1649		1847	
R ² / R ² adjusted	0.211 / 0.204		0.290 / 0.284	
* p<0.05 ** p<0.01 *** p<0.001				

Table 3.8 presents results pertaining to the interactive associations among ownership structure, the regulatory capital, and bank credit risk. Some studies suggest that the relationship between risk and ownership structure is closely associated with national regulation because regulation influences both bank owners' and bank managers' incentives of risk-taking and risk-shifting (John et al., 2008, 2000). Laeven and Levine (2009) examine the interactions between ownership structure and national regulatory requirements and stringency, and find the relationship between risk and regulation stringency depends on ownership structure. Berger and Bouwman (2013) state that capital requirements have different impact on bank performance based on different bank size. Here we include the interaction term of the capital adequacy variable with different ownership structure variables. The capital adequacy variable becomes statistically insignificant under the circumstance of the interactive association between the capital ratio and ownership structure, although is still negatively related to bank credit risk.

After adding the interactive term, the coefficients of the ownership structure variables are positive and significant in Table 3.8. This finding may partially support the theories arguing that bank owners may choose to increase portfolio risk when facing more stringent capital requirements, in order to compensate their potential loss of expected utility (Buser et al., 1981; Koehn and Santomero, 1980). Table 3.8 shows that local government-holding banks have a

relatively lower positive coefficient than other types of banks, indicating that local government-holding banks may have lower incentives to reshuffle risk when facing higher capital adequacy regulation.

Most of the interactive coefficient estimates in the NPL regression show negative relation to bank credit risk-taking. By including the interaction term between capital and ownership structure, the results reveal that the effect of capital regulation of mitigating bank credit risk and enhance bank stability, to some extent, depends on ownership structure. Among these terms, the joint-stock and local government-holding terms enter the most significantly. This shows that the impact on bank credit risk of the total regulatory capital ratio can be magnified when banks are not dominated by a single large owner¹⁷.

The interaction between regulatory capital and the state ownership also acts effectively in reducing bank risk-taking. Laeven and Levine (2009) argue that regulations affecting risk-taking incentives of banks with powerful owners and the ones widely held may be in different ways. The finding may be interpreted in that the interaction between capital regulations and the incentives of joint-stock shareholders is more significant than powerful shareholders, because shareholders of joint-stock banks may have different risk-taking incentives from the influential state-shareholders. The joint-stock banks and those local government-holding banks may be more sensitive to capital regulation. This result, to some extent, collaborates with the estimates of the coefficients of ownership structure.

3.6 Conclusion

This paper aims to analyze the impact of capital regulation on Chinese banks' credit risk-taking following the 2007-2009 GFC and to assess the impact of capital regulation on credit risk-taking by incorporating the interaction between capital regulation and ownership structure. We focus on risk-based capital regulation from the Basel III framework that affects Chinese commercial banks over the period 2010-2019. This period coincides with the fourth stage of China's financial reform and the implementation of Basel III framework in China. Financial theories, supported by empirical studies, suggest that the impact of bank regulation on bank risk-taking varies due to different ownership structure (Laeven and Levine, 2009). Therefore, this study provides implications for regulatory strategies and the stability of China's banking system.

We find that Basel III risk-based capital regulation has a negative impact on bank credit risk-taking. This finding implies that implementation of Basel III capital regulation has strengthened financial stability. We compare the credit risk-taking level of different ownership structure in China's commercial banks and find that state-owned banks have higher credit risk-taking

¹⁷In our sample, the direct(indirect) shares of local government-holding banks held by government or its agencies are over 10%. However, the local government-holding banks don't have dominant direct(indirect) government shareholders (50% more voting rights). In fact, most of these banks are widely held and have mixed-ownership shareholders.

than any other ownership structure in China's banking industry. This finding is consistent with the social view of the state ownership theory, as well as the theory predicting that powerful shareholders have stronger incentives to take risks due to the transformation of ownership structure during China's financial reform.

Furthermore, we find that the impact of capital regulation on credit risk-taking is influenced by ownership structure. The same bank regulations have different effects on credit risk-taking because of the interaction between bank regulation and ownership structure. Thus, this paper provides strategic implication for regulatory authorities making regulatory decisions to take into account bank ownership structure.

4 Does stringent capital regulation affect persistent or transient Chinese bank efficiency-A four-component model analysis

4.1 Introduction

Since the first Basel Accord (Basel I) in 1988, followed by Basel II in 2004 and Basel III in 2010, capital regulation has been put at the front and center to regulate banks' behavior and maintain well-functioning banking systems. Over the last few decades, regulatory capital requirements have been refined and broadened to cover increasing types of risk and keep up with the growing complexity of banking. The 2007-2009 global financial crisis uncovers that capital regulations which were implemented before the crisis were inadequate to prevent a financial panic and cover unexpected losses. After the crisis, the Basel Committee on Banking Regulation and Supervision (BCBS) developed a consolidated framework (Basel III) for more stringent capital adequacy regulations and liquidity assessment, in recognition of the need for banks to be subject to more stringent capital regulations. Following the goals set by the BCBS, member countries including China have established legislation and regulatory frameworks.

China's banking sector plays an essential role in the country's economic development. China's banking sector has started a fundamental reform since 1978, as an integrate part of China's overall economic reform. Since 2001 when China got accession to the World Trade Organization (WTO), the reform of China's banking system has stepped up its pace and the whole banking sector has been dramatically reshaped. The reform has transformed Chinese banks into market-oriented enterprises, changed ownership structure of Chinese banks, established modern corporate governance mechanisms, and introduced legislation and regulatory framework. Since 2010, improvements and refinements have happened in China's banking sector as an advanced stage of the reform. China's financial authority fully accepted the Basel III framework and started the implementation in 2013.

While regulatory consensus has been reached that more stringent capital requirements maintain an essential role in the Basel III framework, there has been less agreement among academics on debates regarding whether capital regulation influences financial stability through the impact it has on bank efficiency. From the perspective of the role of government, "the public interest" approach holds that bank regulation enhances social welfare therefore improve efficiency (see Barth et al., 2005). The conflicting approach "the private interest" view argues that regulation

only benefits political patronage (see Stigler, 1971) and impedes bank efficiency. From the perspective of corporate governance, literature provides two main hypotheses to explain the relationship between capital and efficiency. The conflict between shareholders and creditors (“asset substitution” hypothesis, see Smith and Warner, 1979) favors that high capital reserve leads to better bank performance. In contrast, the conflict between shareholders and managers (“control” hypothesis, see Jensen, 1986) asserts that high regulatory capital holding harms bank efficiency.

In this paper, we evaluate the impact of the capital regulation on bank’s cost efficiency in China’s banking industry. Given these opposing views and previous empirical studies with conflicting results based on various theoretical models, we believe that our empirical research could be important for policy decision making.

A second question that we address in this paper is relationship between ownership and bank efficiency. China’s financial reform has dramatically transformed bank ownership which could be important implication for bank efficiency (Berger et al., 2009). Along with embracing privatization and establishment modern corporate governance, China’s financial reform has evolved state ownership into a large-investor shareholding type with significant cash flow rights. Theory offers two opposing views on the nexus between state ownership and bank efficiency: the public view holds that state ownership improves bank efficiency (see Atkinson and Stiglitz, 1980; Stiglitz, 1993); while the political view claims that state ownership jeopardizes bank performance (see Shleifer and Vishny, 1997, 1994). Therefore, these theoretical keystones provide the foundation for us to examine bank efficiency associated with ownership structure of Chinese banks.

Our empirical research provides evidence using a four-component panel stochastic frontier cost model on an unbalanced panel of 233 China’s commercial banks over the period 2010-2020. To perform our analysis, we hand collect the ownership structure information of these 233 China’s commercial banks and categorize them into 5 ownership identities: State-owned (Big Six and other than Big Six), Local government-holding, Joint-stock, foreign joint-stock, and Foreign-owned banks, referencing the definitions by China Banking and Insurance Regulatory Commission(CBIRC) (see Table 4.1). We employ the total regulatory capital ratio (TC/RWA) defined by the Basel III to investigate impact of capital regulation on bank cost efficiency and the relationship between ownership and bank cost efficiency.

The key findings are as follows: first, we do not find statistically significant relation between the regulatory capital requirements and bank persistent(time-invariant) cost efficiency, but a negative association between Basel III regulatory capital and transient(time-varying) efficiency. This result supports the results by Barth et al. (2004), Lee and Chih (2013), Djalilov and Piesse (2019) and Lešanovská and Weill (2016), but differ from other previous studies.

Second, the estimate of state ownership shows statistically significant relation with bank cost efficiency. The results provide that state-owned banks have higher transient efficiency and much lower persistent efficiency compared with other ownership types. This finding collaborate the findings by Fungáčová et al. (2020). By decomposing the overall efficiency into transient

and persistent efficiency, we also provide explanations for different ownership types with similar efficiency patterns.

This paper contributes to the literature in several ways. First, this study assesses the impact of risk-based capital regulation on Chinese banks' cost efficiency following the global financial crisis, using the definition of capital from Basel III framework. The BCBS first released Basel III framework in 2010. The Chair of the BCBS addressed that evaluating the regulation effects is part of the BCBS post-crisis reform in the current macroeconomic environment. In addition, China's banking industry achieved extensive transformation before 2010 and the Chinese case provides uniqueness in terms of ownership structure.

Second, despite the extensive literature on bank efficiency, the literature falls short of explaining low efficiency. This gap may be due to limitation on methodologies. In this paper, we apply the most recent four-component SFA cost model developed by Colombi et al. (2011), Colombi et al. (2014), Filippini and Greene (2016), and Kumbhakar et al. (2015). It enables us to decompose the overall efficiency into transient and persistent components. The transient inefficiency is time-varying and may stem from short-run moral hazard such as non-optimal resource allocation and changes to adapt new economic environment. The persistent inefficiency may be due to regulations, infrastructure, investments or lasting management habits (of wasting inputs) such as poor organization or private incentives of preventing cost minimization. By using the new model we disentangle transient and persistent (in)efficiencies and provide important empirical evidence for efficiency literature.

Third, we use a bespoke dataset of 233 Chinese commercial banks over a relatively long period (2010-2020) to study China's banking sector. These 233 banks account for over 91% of China's banking sector in terms of total assets. Apart from employing the data provided by the SNL database, we hand collected the missing values of the data set from the original annual reports of individual bank, which makes our data set extremely comprehensive.

The remainders of this paper proceeds as follows. Section II reviews the related literature, as well as information of China's financial reform and the evolution of ownership structure of commercial banks in China. Section III presents the data set and the empirical model specification. The empirical results are presented in section IV. And section V concludes.

4.2 Literature review

In this section, we review the theoretical and empirical literature pertaining to the effect of capital regulation on bank efficiency, and provide information of China's financial reform as well as the evolution of ownership structure in China's banking industry.

4.2.1 Two approaches to bank regulation

Regarding the role of government in regulating economic activities, there are two main approaches to bank regulation and supervision: the public interest view and the private interest view. The public interest approach to bank regulation and supervision emphasizes that governments regulate banks thereby safeguarding the interest of the public and enhancing social welfare (Barth et al., 2005). Cannan and Pigou (1921) and Atkinson and Stiglitz (1980) are in favor of government intervention in bank regulating and supervising which can be traced back to welfare economics. They argue that there are important reasons for government intervention including failure of perfect competition, external shocks, public goods, among others. According to the public interest view, bank regulation may reduce unnecessary risk in lending and boost competition, leading to great bank efficiency (Barth et al., 2005).

ON the other hand, the private interest view (the “capture” theory, see Jensen (1986)) argues that regulation only benefits specific groups because it is sabotaged by the political process. Applied to banking industry, bank regulations are captured to enhance the well-being of bankers and closely connected to the political parties. The private interest view can be considered to share the similar viewpoint with the political view regarding state ownership in the economy. Governments have agendas which are other than social welfare and dominated by their own political interests. Governments use their control only to transfer wealth to their supporters, leading low efficiency of state firms (Shleifer, 1998; Shleifer and Vishny, 1997). Accordingly, the private view criticizes that stringent bank regulations may reduce bank efficiency and exacerbate corruption in lending. The private interest view also advocates extensive reliance on market discipline, voluntary disclosure and private sector initiatives (Shleifer, 2005).

Given that the theories provide conflicting prediction about the impact of bank regulation policies on efficiency, the empirical literature gives mixed findings related to the above theoretical models. Barth et al. (2004) investigate the relationship between regulatory and supervisory practices and bank performance and stability of banking sector using the World Bank survey data for a sample of 107 countries. The empirical results suggest that there is no statistically significant relation between official supervisory power and bank performance. However, they find private monitoring is positively related to bank development and negatively associated with overhead costs. They also report that countries facilitating strong market discipline system have better preformed banks. Beck et al. (2006) examine the impact of bank supervision on lending across 37 countries employing firm data of the World Business Environment Survey (WBES) and the bank supervisory data of Barth et al. (2004). The results suggest that strengthening official supervisory power increases the corruption in lending which may result in lower efficient credit allocation. The results also advocate that supervisory policies enforcing accurate information disclosure facilitate integrity in lending with implication of higher efficient credit allocation. Being consistent with the public interest view, Pasiouras (2008) finds powerful supervisory agencies have positive impact on banks’ technical efficiency in several cases of Tobit regression. Pasiouras et al. (2009) also report that banks’ cost and profit efficiency are influenced positively by strong official supervisory power. Nevertheless, Pasiouras

(2008) and Pasiouras et al. (2009) also find empirical evidence supporting the view that creating and strengthening market discipline mechanism are associated with higher bank efficiency. Barth et al. (2013) study the impact of bank regulation and supervision on bank efficiency using the previous bank supervisory database (Barth et al., 2008, 2005, 2004) and firm-level data for a sample of 72 countries over the period 1999-2007. They find that enhancing official supervisory power has positive impact on bank efficiency in those countries where supervisory authorities are more independent. The results also suggest that market-based monitoring with more financial transparency is positively related to bank efficiency.

Regionally, Chortareas et al. (2012) examine the relationship between the supervisory policies and bank efficiency employing a sample of banks in 22 European Union countries. They find that both strengthening official supervisory powers and private sector monitoring can improve bank efficiency levels. Lee and Chih (2013) study how bank regulation affect banks' cost efficiency and risk in China. They report empirical results that different regulatory ratios have different impact on efficiency of big banks and small banks. They also suggest that policymakers in China face a trade-off between risk and efficiency. Haque and Brown (2017) examine the effects of bank regulation and ownership on bank efficiency in Middle East and North Africa (MENA) region and find evidence supporting the public view that official power has positive impact on cost efficiency. Djalilov and Piesse (2019) investigate the relationship between bank regulation and bank efficiency in 21 transition countries for the period 2002-2014 and find that neither official supervisory power nor market discipline have statistically significant effects on bank efficiency.

4.2.2 Bank Capital and Efficiency

Capital adequacy requirements, as one of the main regulatory tools, are of the essence of the Basel III framework. Regulatory capital provides a potential buffer in absorbing liquidity and economic shocks during the time of stress and thereby improve stability of the financial system (Anginer et al., 2021; Repullo, 2004). Based on the public interest view, a powerful regulatory agency can improve bank operations by requiring higher regulatory capital which aligns the incentives of bank owners and creditors (Barth et al., 2013, 2005). In contrast, the private interest approach holds that strong official regulatory agencies cannot rectify market failures. Rather, the potential benefit from higher capital adequacy requirements might be offset by increased regulatory costs including a higher entry barrier and a greater government rent (Barth et al., 2013, 2005).

Besides the above two approaches to bank regulation and supervision, the theory literature provides the theories of agency, information asymmetry, and capital structure to explain the relationship between bank capital and efficiency. Based on agency theory and information asymmetry, Jensen and Meckling (1976) argue that asymmetric information problems may create the conflict between shareholders and creditors. This may lead to a moral hazard opportunity for shareholders to shift wealth from creditors to themselves. For example, shareholders may invest in high-risk assets to substitute lower/safer ones ("asset substitution," see

Smith and Warner, 1979), which increases the risks faced by creditors whereas shareholders are protected by the limited liability condition. Shareholders may also have the incentives to reject a project or lack motivation to fund investments which have positive net present values if the benefits would accrue to creditors (Myers, 1977). This may cause creditors to suffer opportunity loss. According to these arguments, higher regulatory capital holding can curtail the shareholders incentives in risk-taking and risk-shifting, which may result in more prudent lending and better bank performance (Berger et al., 1995; Keeley and Furlong, 1990). These arguments show that incentive effects are consistent with the theoretical grounds of the public interest view mentioned in Barth et al. (2005). In fact, the risk-shifting incentive and potential external shocks have been strongly justified bank capital regulation (Santos, 2001).

However, agency theory also analyzes the conflict between shareholders and managers arising from managers' control over free cash flows ("control hypothesis," see Jensen, 1986). Managers, with divergent interest from shareholders, have discretion over how to use the future cash flows. Managers may lower their effort or waste resources rather than maximize the firm value. By issuing debt, managers are bonding themselves to act in the interest of shareholders (Grossman and Hart, 1982). Because managers are held to promise to repay the interests, which reduces the free cash flow available to management's control (Jensen, 1986); and the potential threat from bankruptcy may effectively motivate management to improve the firm's efficiency to avoid personal costs due to bankruptcy (Grossman and Hart, 1982; Jensen, 1986). Based on these arguments, higher regulatory capital holding can impede bank efficiency, as it may exacerbate the conflict between shareholders and management.

Most of the aforementioned empirical research regarding the impact of bank regulation and supervision on bank performance report that stringent capital regulation improve bank performance. Barth et al. (2004) state that capital stringency may prevent non-performing loans. Barth et al. (2013) find more stringent capital regulation is positively associated with bank efficiency. Empirical results provide evidence that the adoption of stringent capital adequacy standards has a positive impact on technical efficiency (Pasiouras, 2008) and cost efficiency (Pasiouras et al., 2009), but a negative impact on profit efficiency (Pasiouras et al., 2009). Similarly, Chortareas et al. (2012) and Haque and Brown (2017) also report that strict capital requirements increase bank efficiency in EU and MENA countries, respectively. However, capital regulation (regulatory ratio and stringency) does not appear to have a significant effect on bank efficiency in China (Lee and Chih, 2013) and transition countries (Djalilov and Piesse, 2019), respectively. In addition to the above research, Lešánovská and Weill (2016) analyze the relation between regulatory capital and bank efficiency in Czech's banking industry and find no relation. Bitar et al. (2018) investigate the effect of capital ratios on bank risk, efficiency and profitability in 39 OECD countries and they state that risk-based capital ratio improve banks' efficiency and profitability.

Although there is a growing empirical literature concerning bank efficiency in China's banking industry, the research focusing on the impact of regulatory capital and bank efficiency is still sparse. Most research papers concentrate on investigating Chinese banks' efficiency of different ownership types and sizes (Berger et al., 2009; for example, Fu and Heffernan, 2007;

Huang et al., 2017). Tan and Floros (2013) assess the relationship between bank capital, risk and efficiency in China's banking industry using non-risk based capital (equity to total assets ratio) and the empirical results show that bank capital enters with a positive but not statistically significant coefficient. Pessarossi and Weill (2015) study the effect of capital requirements on cost efficiency of Chinese banks over 2004-2009 and they find that capital adequacy requirements have a positive effect on cost efficiency.

4.2.3 Ownership Structure and bank efficiency

The theory of ownership stems from the pioneering work of the property rights theory by Coase (1937), Alchian (1965), Demsetz (1966), and Alchian and Demsetz (1972); has been extended by Grossman and Hart (1986) and Hart and Moore (1990), and integrated with the agency theory by Jensen and Meckling (1976), Fama (1980), and Fama and Jensen (1983). The property rights theory defines ownership as residual right to income (Alchian and Demsetz, 1972) and residual right to control (Hart and Moore, 1990); and states that the owners' property rights have been attenuated by managers' diverting the firm's resources to their own ends (Furubotn and Pejovich, 1972). The property rights theory allows the prediction of behavioral consequences of individuals in the contractual relations (De Alessi, 1980). Therefore, according to the theory literature, the issue of ownership and efficiency should be considered in the context of principal-agent framework and public choice theory (Altunbas et al., 2001). In the following subsections, we review the theoretical and empirical literature of ownership from two dimensions: the degree of ownership concentration (shareholder rights) and the nature of the shareholders (see Shleifer and Vishny, 1997).

4.2.3.1 The degree of ownership concentration

The separation of ownership and control in modern corporations, emphasized by Berle and Means (1932), retains a central position in the literature of the theory of the firm. From the agency perspective, shareholder rights and ownership concentration are two common approaches to influence managerial behavior and thereby impact corporate performance. It is often believed that the diffused ownership would increase the power of managers and reduce their dependence on the owners (Berle and Means, 1932). Alchian and Demsetz (1972) argue that, in a corporation with dispersion of shareholding, control may be facilitated by turning shareholders' votes into voting blocs, which strengthens shareholders' power. Amihud and Lev (1981) and Hirshleifer and Thakor (1992) argue that better investor protection (shareholder rights) constrain managers' conservative (sub-optimal) risk-taking choices and may lead to the enhanced firm value. John et al. (2008) conduct a cross-country study and support this view. They find the positive relationship between investor protection and firm growth rates. However, Burkart et al. (2003) present a model arguing that great protection of shareholder rights reduces the need for dominant shareholders which may prevent managers' shirking behavior (Shleifer and Vishny, 1986). Therefore, dispersed shareholding with unrestricted salability

may keep a long-lived management team (Alchian and Demsetz, 1972), and may result in greater managerial discretion in forgoing value-enhancing investment projects (Bebchuk, 1999; Burkart et al., 2003).

Voting blocs are a transient reformation of the ownership structure, converting the diffused ownership into decisive power (Alchian and Demsetz, 1972) which is one of the characteristics of large shareholders. Ownership concentration, or large shareholders, is defined as shareholders having concentrated control rights with significant cash flow rights (Shleifer and Vishny, 1997). The model presented by Shleifer and Vishny (1986) to estimate the value of ownership concentration. They propose that a presence of a large shareholder may lead to value-increasing takeovers. However, Grossman and Hart (1988) argue that large shareholders might try to maximize their private benefit at the expense of other small shareholders if their high control rights are not associated with high cash flow rights. The model employed by Grossman and Hart (1988) shows that this happens if there is a substantial departure from one share-one vote structure. Demsetz and Lehn (1985) find no linear relationship between ownership concentration and firm profit rate. Morck et al. (1988) only get significant statistical result of profit rates rising in the range of ownership between 0 to 5%. Based on their finding, as ownership concentration increases beyond a certain point, large shareholders expropriate the firm resource to generate private benefits of control and dampen the interests of other investors and the firm.

4.2.3.2 State ownership

From the perspective of corporate governance, state firms are defined as being “controlled by the public; and the de facto control rights usually belong to bureaucrat shareholders with highly concentrated control rights and no significant cash flow rights” (Shleifer and Vishny, 1997). Based on this definition, state shareholders can be considered as a special form of the large shareholders with highly concentrated control rights and lack of cash flow rights.

The property rights theory suggests that the difference between public ownership and private ownership is that public ownership can not be transferred; and public ownership arrangements have higher costs (lower efficiency) compared to private property agencies (Alchian, 1965). De Alessi (1974) states that due to the inability of transferring his share, the owners of government firms have lower incentives to monitor managerial behavior. This may imply that a greater attenuation in owners’ rights in government (political) firms, which may lead to less efficient operations, compared to private firms (De Alessi, 1974).

Associated with the theorem of welfare economics and the property rights theory, there are two alternative views of government participation in financial markets: the social view and the political view. The social view suggests that state ownership is a form of government intervention which addresses to market failures and improves market functions and economic performance (Atkinson and Stiglitz, 1980; Stiglitz, 1993). According to this view, state-owned banks may finance those projects which might not be profitable but might have high value

of social welfare. Therefore, state-owned banks may have poorer performance in profitability along with higher default risk compared to their counterparties in the private sector. In contrast, the political view claims that state ownership creates sources of political benefits for politicians rather than social welfare. For example, excessive employment of state firms only benefits those who support government politically (Shleifer and Vishny, 1994). According to the political view, state-owned firms are inefficient because the state shareholders, with highly concentrated control rights and no cash flow rights, only maximize their political goals which may jeopardize social welfare (Shleifer and Vishny, 1997).

A growing literature has examined the impact of state ownership of banks, from both the macroeconomic angle and the perspective of individual banks, on economic growth and bank performance. Andrianova et al. (2012) find that government-owned banks have higher growth rates and contribute to countries' long-run economic growth. However, La Porta et al. (2002) find that higher government ownership is related to lower economic growth. Beck and Levine (2002) find no supporting evidence for either the social view or the political view. Employing a data set of banks in 74 countries, Iannotta et al. (2007) argue that state ownership intensifies bank concentration and exacerbate financing obstacles. Berger et al. (2005) and Iannotta et al. (2007) find that state-owned banks have lower profitability and poor long-term performance, compared to private-owned banks.

As part of the results of the financial reform in China, the evolved ownership structure of banks in China has attracted academic attention after China's accession to the WTO in 2001. Studies focusing on bank efficiency report that state-owned banks exhibit lower efficiency compare to joint-stock banks and foreign banks (Berger et al., 2009; Shleifer, 2005). Tan and Floros (2013) argue that state-owned banks have higher volume of non-performing loans and lower profitability. Zhu and Yang (2016) report that state-owned banks take higher risk than foreign banks in China. Using the four-component efficiency model (see Tsionas and Kumbhakar, 2014), Fungáčová et al. (2020) analyze the overall efficiency of Chinese banks and find state-owned banks (the Big Five) suffer low efficiency because of the low persistent efficiency.

4.2.3.3 The evolution of ownership structure of commercial banks in China

The dramatic changes regarding the ownership structure of commercial banks in China are the essential part of every stage in China's financial reform. The four largest state-owned banks ¹ were founded during the first stage of the financial reform (1978-early 1990s), alongside with other national banks ². These large banks, at this stage, were owned by Finance Ministry and state-owned enterprises. The lower level of financial institutions, known as city credit cooperatives, were controlled by local Bureau of Finance when established. Foreign banks were

¹They are the "Big Four": Bank of China, China Construction Bank, Agricultural Bank of China, and Industrial and Commercial Bank of China.

²National banks: commercial banks which operate nationwide

operating in Special Economic Zones ³ (Berger et al., 2009).

During the second stage (early 1990s-2001), most ‘policy-lending’ business of the four largest state-owned banks was released to three policy banks founded during this period. Private enterprises and individuals began entering different levels of financial institutions as shareholders. Local Bureau of Finance began to exit city banks by transferring their shareholding to local business enterprises.

The biggest change to the ownership structure happened at the third stage of the financial reform (2001-2010). An investment enterprise, Central Huijin Investment Ltd. (hereafter CH), was established by the state government acting as a designated shareholder of those state-owned banks, in order to fulfill the corporate governance requirements set by laws and regulations. Direct government shareholding has sharply decreased due to the share transfer to CH and state-owned banks going public. Foreign financial institutions such as RBS Group and Bank of America invested in all levels of Chinese banks including state-owned banks, national banks and city banks, as strategic investors. The majority of state-owned banks and several city banks went public at this stage, introducing more diversified shareholders. After 2010, more detailed improvements happened regarding ownership structure. Private-owned banks were established. Local government shareholders become minority shareholders in city banks. Over 50% of shareholding in city banks and over 87% of shareholding in rural commercial banks are private enterprises by 2017. In total 57 commercial banks are listed by 2020.

After the financial reform, both of shareholding by the state government and local governments in commercial banks have decreased. Different from that state-owned banks have Finance Ministry or CH as their controlling shareholder; ownership structure of local government-holding banks evolved to government-private “Mixed” ownership. In these banks, local Bureau of Finance is not the controlling shareholder. Local government-holding banks usually are medium sized banks and provide financial services in cities and nearby areas.

4.3 Data and methodology

4.3.1 Data

Our sample is an unbalanced panel composed of financial and ownership data of 233 Chinese banks during the period of 2010-2020, giving in total 2574 observations. Our data includes all major commercial banks and covers over 91% of the Chinese commercial banks in terms of the total assets. The composition of the sample banks and the information of their ownership structure are listed in Table 4.1.

³Special Economic Zones: a form of Free Ports in China where companies may benefit from tariff allowances and exemption. Chinese government designated the first four Special Economic Zones – Shenzhen, Xiamen, Shantou, and Hainan Province – in order to encourage foreign investments and improve economy and technology by the end of 1980’s. More details may be found [here](#)

Table 4.1: Ownership structure in Chinese banking industry

Ownership/Type	Big Six	City bank	Foreign bank subsidiary	National bank	Rural commercial	Total
Foreign-owned	0 (0.0%)	0 (0.0%)	34 (100.0%)	0 (0.0%)	0 (0.0%)	34 (14.6%)
Foreign Joint-stock	0 (0.0%)	12 (10.8%)	0 (0.0%)	1 (8.3%)	0 (0.0%)	13 (5.6%)
Joint-stock	0 (0.0%)	49 (44.1%)	0 (0.0%)	5 (41.7%)	65 (92.9%)	119 (51.1%)
Local government-holding	0 (0.0%)	46 (41.4%)	0 (0.0%)	2 (16.7%)	5 (7.1%)	53 (22.7%)
State-owned	6 (100.0%)	4 (3.6%)	0 (0.0%)	4 (33.3%)	0 (0.0%)	14 (6.0%)
Total	6 (100.0%)	111 (100.0%)	34 (100.0%)	12 (100.0%)	70 (100.0%)	233 (100.0%)

Ownership Structure:

¹ Foreign-owned: Foreign bank operating in China;

² Foreign Joint-stock: Joint-stock Banks having foreign strategic investors (usually shareholding over 15%);

³ Joint-stock: Banks' share held by mixed-ownership institutions and individuals; if shareholding involves indirect local government holding, the stake is less than 10%;

⁴ Local government-holding: Banks' share either held by local Treasury Bureau (no matter how much of the stake), or indirectly held by local government over 10%;

⁵ State-owned: Bank directly controlled by Central Huijin, Finance Ministry or state-owned enterprises.

Bank Types:

^a Big Six: The biggest six banks, all state-owned;

^b City bank: Branches usually cover a city and the near cities within the province where the bank headquarter is located;

^c Foreign bank subsidiary: Foreign bank branches and subsidiaries;

^d National bank: Branches cover the whole country and based on the CBIRC's categorization;

^e Rural commercial: Branches usually cover local communities and rural area within a province where the bank headquarter is located.

We use the SNL database (provided by S&P Global Market Intelligence) as our main data source. The data is expressed in real (2010) term using China GDP deflator. Whenever the SNL does not provide enough information or has doubtful values, we manually collect or correct the data from the annual reports released by the individual banks on their official websites or mandatory disclosure on the website of [China Central Depository & Clearing Co., Ltd.](#) We also obtain regulatory and macroeconomic data and information from the following official sources including China Banking and Insurance Regulatory Commission (CBIRC), the World Bank, the Basel Committee (BCBS), the National Bureau of Statistics of China, and the International Monetary Fund (IMF).

4.3.2 Methodology

4.3.2.1 Efficiency estimation

In this paper, we focus on Chinese banks' cost efficiency. Cost frontier efficiency, or how close a bank (firm) is to a "best practice" cost frontier, can be measured using nonparametric approaches such as Data Envelopment Analysis (DEA) or parametric approaches such as Stochastic Frontier Approach (SFA).

The stochastic frontier (SF) model, originally proposed by Aigner et al. (1977) and Meeusen and Den Broeck (1977), has considerably been researched, extended and applied. A typical SF model splits the error term into two random components: a normally distributed noise term (for exogenous random shocks and measurement errors) and a non-negative inefficiency term. In 1990s, the inefficiency term is decomposed into two components: persistent and time-varying components in several papers by Kumbhakar and co-authors (Kumbhakar, 1991;

Kumbhakar and Heshmati, 1995; and Heshmati and Kumbhakar, 1994). The persistent inefficiency term is consistent with the models developed by Battese and Coelli (1988) and Schmidt and Sickles (1984); and the time-varying component is consistent with the model developed by Cornwell et al. (1990) and Battese and Coelli (1992). In the recent advances in the SF model, researchers pay special attention to separation of firm heterogeneity, persistent and time-varying inefficiency terms. Early literature such as Mundlak (1961) states that empirical production function should include management variables which do not change greatly over time. Mester (1997) finds that estimates of cost efficiency can be biased without accounting for bank heterogeneity in the U.S. bank data. To address this issue, a four-component SF model has been introduced and developed by Colombi et al. (2011), Colombi et al. (2014), Filippini and Greene (2016), and Kumbhakar et al. (2015). The four-component model splits the error term into four components. The first component captures firms' latent heterogeneity (see Greene, 2005); the second component captures random shocks and measurement errors. The third component captures the persistent (long-run) inefficiency (see Kumbhakar and Heshmati, 1995); and the fourth component captures time-varying (transient/short-run) inefficiency. The model disentangles the firms' unobserved heterogeneity which may represent different types of firms, from inefficiency. The persistent inefficiency may be due to regulations, infrastructure, investments or lasting management habits (of wasting inputs). Both of the first two components are time-invariant. The transient (time-varying) part of inefficiency may stem from short-run moral hazard such as non-optimal resource allocation. The time-varying component and the noise component are both vary across firms and over time. Following Kumbhakar et al. (2015), the model is specified as:

$$y_{it} = \alpha_0 + f(x_{it}; \beta) + \mu_i + v_{it} - \eta_i - u_{it} \quad (4.1)$$

where η_i is random firm effects that capture unobserved inputs (time-invariant). The two of the components ($\eta_i > 0$ and $u_{it} > 0$) are inefficiency terms and the other two components (μ_i and v_{it}) are firm effects and random noise.

The above model can be called as the homoscedastic four-component model [see @BADUNENKO2017]. All the four-components are in the assumption of independently and identically distributed (i.i.d) random variables. We choose to follow this model because this relative new SF model fills the gaps in the current SF literature. First, the current literature (such as @GREENE2005) allows time-invariant firm effects but does not allow them as inefficiency. The above four-component model takes into account the possible presence of some inputs that might have time-invariant effects on firms' inefficiency. Second, the current SF models have the assumption that inefficiency as a product of a deterministic function of time (such as @KUMBHAKAR1991 and @BATTESE1992); or assume that a firm's inefficiency at time t is independent of previous level inefficiency [see @KUMBHAKAR2015]. The above four-component model splits persistent and time-varying inefficiency effects, by assuming that some sources of inefficiency can be removed by the short-run adjustments, while

others may stay over time. Finally, current SF models proposed by @GREENE2005 and @WANG2010, for example, do not take into account the effect of unobserved firm effects, although these models include permanent inefficiency effects. The time-invariant inefficiency is conflated with firms' latent heterogeneity. The above four-component model makes an argument that there are unobserved firms' time-invariant effects that are not efficiency by disentangling firm heterogeneity from inefficiency.

To examine Chinese banks' cost efficiency, we follow Kumbhakar et al. (2015) and Badunenko and Kumbhakar (2017) and specify the four-component cost function as follows:

$$\log C_{it} = h(y_{it}, w_{it}; \beta) + \mu_i + v_{it} + \eta_i + u_{it} \quad (4.2)$$

where $\eta_i > 0$ represents persistent inefficiency and $u_{it} > 0$ represents time-varying (transient) inefficiency. μ_i represents unobserved firm heterogeneity; and v_{it} captures random noise.

Model(4.1) can be estimated employing a single-stage Maximum Likelihood estimation method based on the assumptions of the distributions regarding the four components [see @COLOMBI2014]. However, as one of the features of banking datasets, the large outliers in our data sample may disproportionately influence the estimation process, leading to non-existence of the Likelihood Function. Therefore, here we follow @KUMBHAKAR2015 and employ a multi-step procedure to estimate model(4.1). For this, we rewrite model(4.1) as:

$$\log C_{it} = h(y_{it}; w_{it}; \beta) + \alpha_i + \epsilon_{it} \quad (4.3)$$

Where $\alpha_i = \mu_i + \eta_i - E(\eta_i)$ is the time-invariant part of the error term; $\epsilon_{it} = v_{it} + u_{it} - E(u_{it})$ is the random component of the error term. With this specification, α_i and ϵ_{it} have zero mean and constant variance (Kumbhakar et al., 2015).

Following the three-step approach developed by Kumbhakar et al. (2015), in step 1 the random-effect panel data regression model is used to estimate $\hat{\beta}$. This procedure also gives the predicted values of α_i (by employing the best linear unbiased prediction(BLUP) method) and ϵ_{it} , respectively.

In step 2 we use the predicted values of ϵ_{it} obtained from step 1 to estimate the time-varying inefficiency u_{it} , since

$$\epsilon_{it} = v_{it} + u_{it} - E(u_{it}) \quad (4.4)$$

We assume that v_{it} , a random noise, is i.i.d. $\mathcal{N}(0, \sigma_v^2)$; and u_{it} follows a half_normal distribution $\mathcal{N}^+(0, \sigma_u^2)$. Using a standard stochastic-frontier technique, we estimate u_{it} by following Battese and Coelli (1992) and calculate $\hat{u}_{it} = \exp(u_{it}|\epsilon_{it})$.

In step 3 we estimate persistent inefficiency η_i following a similar procedure as in step 2. We use the predictor of α_i from step 1, since

$$\alpha_i = \mu_i + \eta_i - E(\eta_i) \quad (4.5)$$

Again, we assume that μ_i is i.i.d. with a distribution $\mathcal{N}(0, \sigma_\mu^2)$; and η_i follows a half-normal distribution $\mathcal{N}^+(0, \sigma_\eta^2)$. We employ the method in Battese and Coelli (1992) and estimate $\hat{\eta}_i = \exp(\eta_i)$.

Finally, following Kumbhakar et al. (2015), the overall cost (in)efficiency (OCE) is obtained as $OCE = \hat{u}_{it} * \hat{\eta}_i$.

Following Fungáčová et al. (2020), Berger et al. (2009), Pasiouras et al. (2009), Fungáčová et al. (2013), and others, we employ a translog model to picture the cost efficiency of Chinese banks. The price homogeneity restriction has been built into the model by normalizing the total costs and all the input prices by the price of funds. We include year dummies in the cost function to account for technology changes over time.

In terms of specification of inputs and outputs, we follow the intermediation approach which defines banks as the primary intermediary of funds between depositors and debtors. We also use a dual approach employed by Berger and Humphrey (1991) and Bauer et al. (1993) which takes the amount of deposits as an output and the interest paid as part of the costs (the rate paid as an input price). This empirical approach takes into consideration both input and output characteristics of deposits (Berger and Humphrey, 1997). We choose two outputs to be included in the cost function, total loans and total deposits. Three input prices are employed: price of funds (interest expense/total deposits), price of labor (personnel expense/total assets), and price of physical capital (other operating expense/fixed assets). The dependent variable - total costs is calculated as the sum of the interest expense and non-interest expense. The cost function is given by:

$$\begin{aligned} \ln(TC/w_1) = & \beta_0 + \beta_1 \ln y_1 + \beta_2 \ln y_2 + \beta_3 \ln(w_2/w_1) + \beta_4 \ln(w_3/w_1) \\ & + \beta_5 \frac{1}{2} (\ln y_1)^2 + \beta_6 \ln y_1 \ln y_2 + \beta_7 \frac{1}{2} (\ln y_2)^2 \\ & + \beta_8 \frac{1}{2} (\ln(w_2/w_1))^2 + \beta_9 \ln(w_2/w_1) \ln(w_3/w_1) \\ & + \beta_{10} \frac{1}{2} (\ln(w_3/w_1))^2 + \beta_{11} \ln y_1 \ln(w_2/w_1) \\ & + \beta_{12} \ln y_1 \ln(w_3/w_1) + \beta_{13} \ln y_2 \ln(w_2/w_1) \\ & + \beta_{14} \ln y_2 \ln(w_3/w_1) + \sum_t \theta_t Year_t + \alpha_i + \epsilon_{it} \end{aligned} \quad (4.6)$$

Where TC is total costs (the sum of interest expense, personnel expense and other operating expenses); y_m is the m th output ($m=1,2$): total loans (y_1) and total deposits (y_2); w_n is the

Table 4.2: Descriptive Statistics

	N	Mean	SD	Median	Min	Max
Total_Loans	2,313	50,183,163.969	201,005,967.554	5,792,402.708	621.546	2,246,556,572.560
Total_Deposits	2,356	68,103,754.046	273,579,578.093	8,763,366.180	46.413	3,024,862,309.805
w_Fund	2,313	0.027	0.020	0.025	0.002	0.709
w_Personnel	2,140	0.005	0.003	0.005	0.000	0.038
w_Fixed	2,137	1.680	3.508	0.707	0.061	59.464
TC_RWA	2,206	13.646	9.755	11.470	1.034	141.304
BCapital	2,356	7.830	6.583	6.364	1.650	82.665
Total_Costs	2,315	2,764,723.128	9,332,599.078	411,126.070	4,428.648	81,757,198.544

n th input prices ($n=2,3$): price of funds (w_1), price of labor (w_2), and price of physical capital (w_3). $Year_t$ is the year dummies.

To examine the impact of the Basel III regulation and ownership structure on (in)efficiency, the Basel III total regulatory capital ratio calculated as the total regulatory capital divided by risk weighted assets (TC/RWA). Ownership is a categorical variable indicating the ownership structure of individual banks. The ownership categories and definitions are listed in tbl-ownership. The main variables used in the analysis are provided in Table 4.6 in Appendix.

4.4 Results

4.4.1 Descriptive statistics and variable correlations

Table 4.2 provides the descriptive statistics for our sample data. We compare the statistics to Berger et al. (2009), since Pessarossi and Weill (2015) only provides value in RMB and Fungáčová et al. (2020) presents statistics by ownership categories. The mean of total costs of Chinese banks is 2.765 billion US dollars and the standard deviation is 9.332 billion US dollars, both are slightly higher than the value reported by Berger et al. (2009) where they take the sample over 1994-2003. This might mean that the total costs have been increasing steadily over the last two decades. The means of the two outputs - total loans and total deposits - are reported as 68.104 billion US dollars and 50.183 billion US dollars, which indicates that Chinese banks have expanded dramatically in size by around two times as the figures presented in Berger et al. (2009).

The mean of total regulatory capital ratio (TC_RWA) reports the mean of 13.646% with a sample of 2206 observations. The disclosure of regulatory capital information is mandatory for commercial banks in China as ‘Commercial Bank Capital Management Measures’ – the China version of Basel III has become effective since 2013. The mean value is a little lower than the results of European banks reported by Bitar et al. (2018) (18.18%).

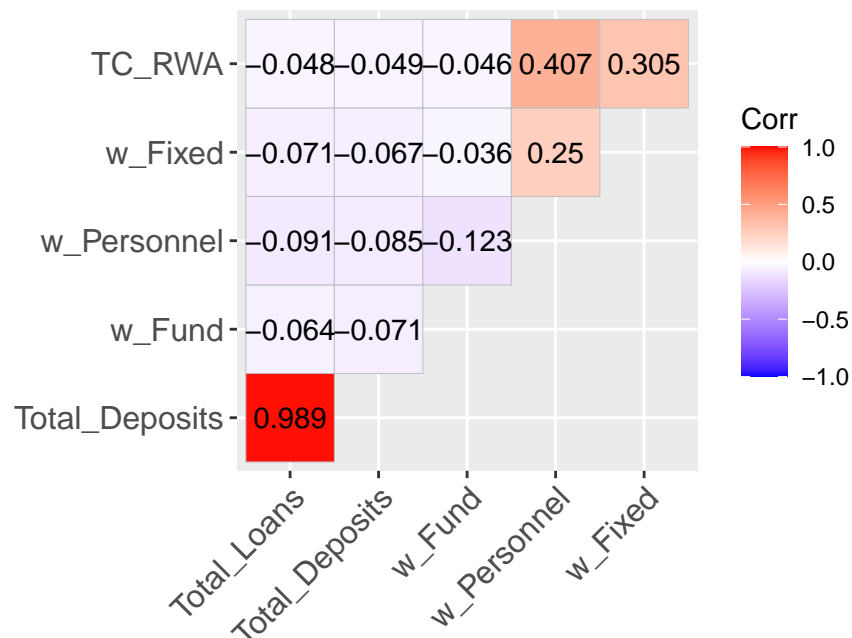


Figure 4.1: Correlation Matrix

Figure 4.1 reports the Pearson correlation matrix between the predictor variables. All correlation coefficients of the variables are lower than 0.6, except for the correlation between total deposits and total loans due to the fact that we choose to follow the intermediation approach and a dual approach employed by Berger and Humphrey (1991) and Bauer et al. (1993) in our analysis.

4.4.2 Main results

Table 4.3: Translog cost frontier

Variable	Estimates	std. Error
(Intercept)	-0.379 ***	0.066
ly1	-0.639 **	0.244
ly2	1.892 ***	0.324
lx2	0.027	0.107
lx3	-0.454 ***	0.081
I(0.5 * ly1^2)	2.821 ***	0.614
I(ly1 * ly2)	-1.885 *	0.799
I(0.5 * ly2^2)	1.747	1.085

Table 4.3: Translog cost frontier

I(0.5 * lx2^2)	-0.175	0.090
I(lx2 * lx3)	0.288 ***	0.067
I(0.5 * lx3^2)	0.558 ***	0.069
I(ly1 * lx2)	0.240	0.351
I(ly1 * lx3)	1.065 ***	0.255
I(ly2 * lx2)	-0.646	0.435
I(ly2 * lx3)	-0.904 **	0.320
Year2011	0.024 ***	0.002
Year2012	0.035 ***	0.002
Year2013	0.036 ***	0.002
Year2014	0.045 ***	0.002
Year2015	0.045 ***	0.002
Year2016	0.031 ***	0.002
Year2017	0.023 ***	0.002
Year2018	0.030 ***	0.002
Year2019	0.026 ***	0.002
Year2020	0.012 ***	0.002
Observations	2121	
R ² / R ² adjusted	0.933 / 0.932	
* p<0.05 ** p<0.01 *** p<0.001		

Table 4.4: Efficiency Measures by Ownership Structure

Ownership	Year	Transient	Persistent	Overall
Foreign-owned				
Foreign-owned	2010	97.776%	95.807%	93.577%
Foreign-owned	2011	97.686%	95.807%	93.679%
Foreign-owned	2012	97.790%	95.807%	93.697%
Foreign-owned	2013	97.748%	95.807%	93.807%
Foreign-owned	2014	97.818%	95.807%	93.799%
Foreign-owned	2015	97.833%	95.807%	93.813%
Foreign-owned	2016	97.848%	95.807%	93.828%
Foreign-owned	2017	98.024%	95.807%	93.767%
Foreign-owned	2018	98.088%	95.807%	93.812%
Foreign-owned	2019	98.101%	95.807%	93.825%
Foreign-owned	2020	98.114%	95.807%	93.837%
Foreign Joint-stock				
Foreign Joint-stock	2010	97.992%	95.515%	93.957%

(continued)

Ownership	Year	Transient	Persistent	Overall
Foreign Joint-stock	2011	98.005%	95.515%	93.970%
Foreign Joint-stock	2012	98.110%	95.515%	93.941%
Foreign Joint-stock	2013	98.163%	95.515%	93.938%
Foreign Joint-stock	2014	98.278%	95.515%	93.859%
Foreign Joint-stock	2015	98.290%	95.515%	93.870%
Foreign Joint-stock	2016	98.301%	95.515%	93.882%
Foreign Joint-stock	2017	98.313%	95.515%	93.893%
Foreign Joint-stock	2018	98.325%	95.515%	93.904%
Foreign Joint-stock	2019	98.336%	95.515%	93.915%
Foreign Joint-stock	2020	98.348%	95.515%	93.926%
Joint-stock				
Joint-stock	2010	98.368%	94.799%	93.733%
Joint-stock	2011	98.436%	94.799%	93.678%
Joint-stock	2012	98.493%	94.799%	93.660%
Joint-stock	2013	98.644%	94.799%	93.551%
Joint-stock	2014	98.630%	94.799%	93.599%
Joint-stock	2015	98.674%	94.799%	93.568%
Joint-stock	2016	98.676%	94.799%	93.593%
Joint-stock	2017	98.707%	94.799%	93.566%
Joint-stock	2018	98.713%	94.799%	93.560%
Joint-stock	2019	98.712%	94.799%	93.570%
Joint-stock	2020	98.719%	94.799%	93.569%
Local government-holding				
Local government-holding	2010	98.487%	95.097%	93.730%
Local government-holding	2011	98.506%	95.097%	93.717%
Local government-holding	2012	98.518%	95.097%	93.728%
Local government-holding	2013	98.549%	95.097%	93.729%
Local government-holding	2014	98.548%	95.097%	93.752%
Local government-holding	2015	98.555%	95.097%	93.752%
Local government-holding	2016	98.580%	95.097%	93.750%
Local government-holding	2017	98.590%	95.097%	93.759%
Local government-holding	2018	98.603%	95.097%	93.762%
Local government-holding	2019	98.605%	95.097%	93.783%
Local government-holding	2020	98.578%	95.097%	93.829%
State-owned				
State-owned	2010	98.692%	94.841%	93.557%
State-owned	2011	98.701%	94.841%	93.566%
State-owned	2012	98.710%	94.841%	93.574%
State-owned	2013	98.718%	94.841%	93.583%

(continued)

Ownership	Year	Transient	Persistent	Overall
State-owned	2014	98.712%	94.841%	93.610%
State-owned	2015	98.721%	94.841%	93.618%
State-owned	2016	98.730%	94.841%	93.627%
State-owned	2017	98.738%	94.841%	93.635%
State-owned	2018	98.747%	94.841%	93.643%
State-owned	2019	98.756%	94.841%	93.652%
State-owned	2020	98.764%	94.841%	93.660%

The means of efficiency scores by year and by ownership structure are presented in Table 4.4. In almost all earlier banking efficiency studies, time-varying (transient) (in)efficiency is the only source of inefficiency. Using the above 3-step method, we report higher average scores than what has been found in the previous studies such as Fungáčová et al. (2013), Pessarossi and Weill (2015) and Dong et al. (2016).

The decomposition of the overall efficiency has been presented in Table 4.4. We observe that transient efficiency and persistent efficiency show every similar values and overall efficiency ranging between 95%-97% across all ownership types. This result collaborate what has been reported in Fungáčová et al. (2020).

```
TableGrob (3 x 1) "arrange": 3 grobs
  z      cells      name      grob
1 1 (1-1,1-1) arrange gtable[layout]
2 2 (2-2,1-1) arrange gtable[layout]
3 3 (3-3,1-1) arrange gtable[layout]
```

Figure 4.2 are the visualization of Table 4.4, from which we may draw some conclusions about efficiency of Chinese banks. We notice that the evolution of both overall efficiency and transient efficiency do not show high volatility over time. This result is also in line with Fungáčová et al. (2020).

In terms of overall efficiency depending on ownership structure, we report that state-owned banks have relatively low level of efficiency. The trends show that the state-owned banks' overall efficiency level is lower than foreign joint-stock banks, foreign-owned banks, and local government-holding banks; it is also lower than (domestic) joint-stock banks before the mid-2012. This result partially collaborates the trends presented in the previous studies including Fungáčová et al. (2013), Dong et al. (2016), Fungáčová et al. (2020) and Berger et al. (2009), where they find the state-owned banks are less efficient than joint-stock banks and foreign banks. In the above figures, the foreign-owned banks have lower efficiency than other joint-stock types before 2011 (except for the state-owned banks). However, the increasing trends in overall and transient efficiency of foreign-owned banks are clearly shown. The reasons that our

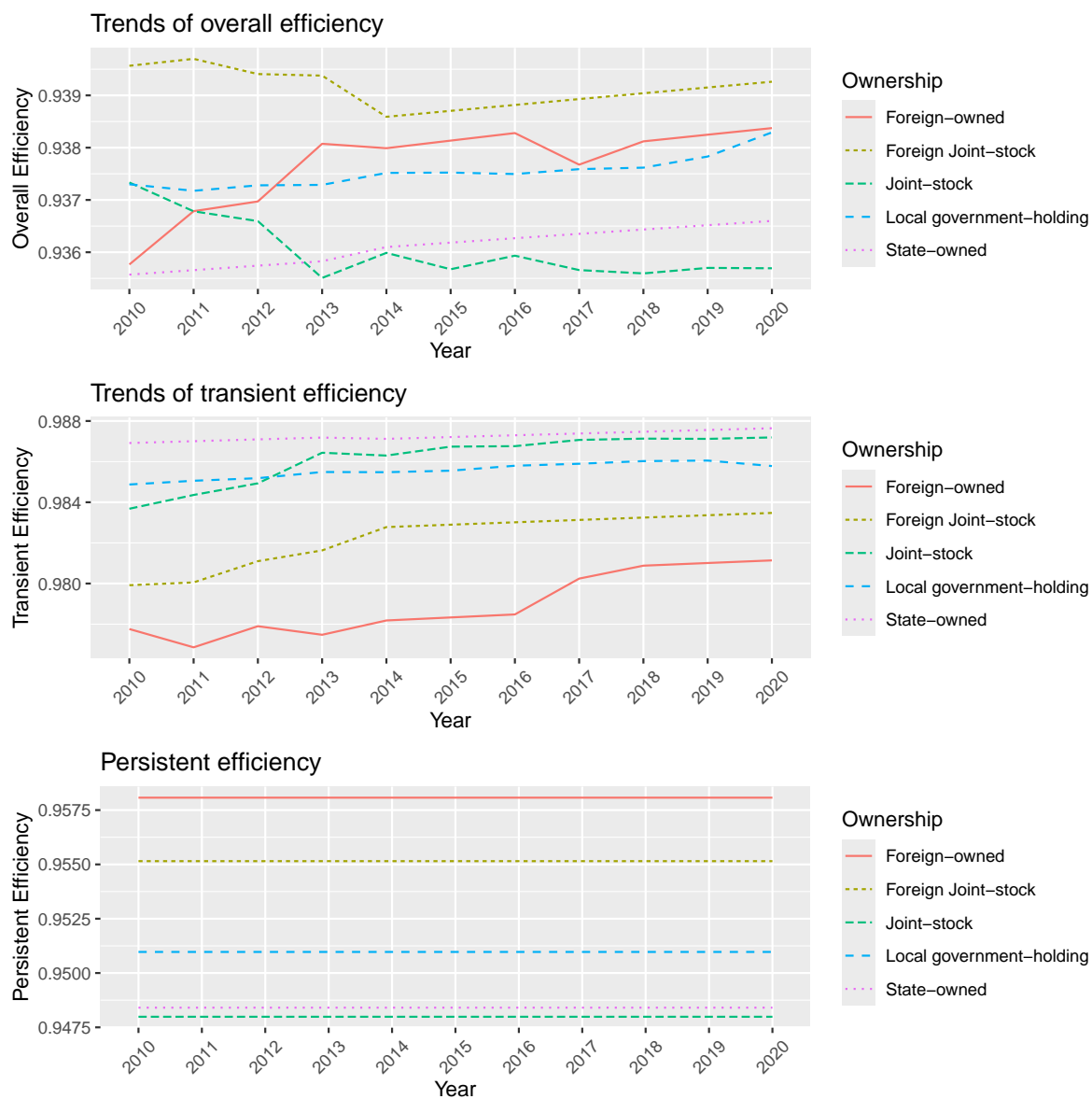


Figure 4.2: Changes of efficiencies by ownership

results differ from the previous study might due to the different sample periods and sample banks. Furthermore, our study also select 12 state-owned banks based on CBIRC definition instead of the Big five (the biggest 5 state-owned banks in size).

By decomposing overall efficiency to transient and persistent parts, Figure 4.2 reveals the sources which may result in the efficiency pattern shown in fig-trends. The state-owned banks have higher transient efficiency than other ownership types. However, the state-owned banks have lower time-invariant efficiency than most of other ownership banks, which can be considered as the main cause of the medium level of overall efficiency. This finding support the results reported by Iannotta et al. (2007) and Berger et al. (2005). The joint-stock banks show similar pattern of relatively high transient efficiency and the lowest persistent efficiency compared to other ownership types.

According to Colombi et al. (2011), Filippini and Greene (2016), Kumbhakar et al. (2015), transient (in)efficiency component has the feature of time-varying which captures the short-term pattern of (in)efficiency. Transient inefficiencies might be attributed to short-term management moral hazard and/or adverse selecting problem. Firms can take some time to solve short-term deviation from expected operating behavior. Time-invariant inefficiency, on the other hand, captures persistent inefficiency which stems from structural rigidities of the organization and the production process, as well as regulatory constrains on the firm. It is reasonable to assume that these sources of inefficiency remain constant and stay with the firm over time. The joint-stock banks have relatively high transient efficiency level which may reveal those banks are more flexible and efficient in dealing with short-term sub-optimal resource allocation and adjusting costs. However, the low persistent efficiency could indicate these banks may have long-run moral hazard problems and/or respond negative to regulatory constrains.

The similar pattern has been revealed in the state-owned banks. However, due to the sizes and ownership structure of the state-owned banks are quite different from the joint-stock banks, the interpretation could be different. Over 50% of shareholding in city banks and over 87% of shareholding in rural commercial banks (most of these banks have the join-stock ownership structure) are private enterprises which can be considered as small and medium businesses (SMEs) by 2017. The state-owned banks are much larger than the joint-stock banks in assets. The high transient efficiency may demonstrate that the state-owned banks have benefit of economies of scale. Badunenko and Kumbhakar (2017) state that the state-owned banks have a larger portion operating under scale economies than other ownership types in the post re-regulation period, using the empirical data in Indian banking. The results reveal that the state-owned banks have lower persistent efficiency than almost all other ownership types. Instead of structural problems, we suggest that the low persistent efficiency might be attributed to the characteristics of business of the state-owned banks in China's banking industry. This finding, to some extent, supports the viewpoint that state-owned banks would be involved in policy-guided credit activities instead of profit-centered ones (Pessarossi and Weill, 2015). The social lending theory of state ownership (see Atkinson and Stiglitz, 1980) suggests that state-owned enterprises contribute to "correcting the 'failure' of market economy"

due to imperfect competition, inefficiency and public good. According to this view, government-owned enterprises may help improve the overall economy performance (Stiglitz, 1993). In China's banking context, the biggest four commercial banks were founded and conducted a large amount of government lending in the early 1990's, before national banks and city banks were established. Within a relatively long period, the state-owned banks (including local government-holding banks founded later in the end of 1990's) played a role of 'government agencies' to pursue the broader social welfare objectives rather than profit maximizing, for example, the projects of the nationwide High-speed Rail network. Since 2001, the ownership structure has been dramatically transformed, due to China's overall industrial reforms and the commitments to the WTO agreement. The state shareholder was replaced by Central Huijin Investment Ltd. The state-owned banks are still the main funding providers for nationwide infrastructure projects focusing on social welfare due to the huge amount of financing required and the complexity of structure of financing. Since the state-owned banks target multiple welfare objectives which might not be measurable, it is reasonable to draw a conclusion that the state-owned banks suffer low persistent efficiency over time.

4.4.3 Inefficiency effects

Call:

```
lm(formula = u_it ~ Ownership + TC_RWA, data = effects)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.059567	-0.005571	0.001279	0.007156	0.029113

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	0.9834274	0.0009076	1083.553	< 2e-16 ***
OwnershipForeign Joint-stock	0.0004729	0.0011138	0.425	0.671
OwnershipJoint-stock	0.0044529	0.0007755	5.742	1.08e-08 ***
OwnershipLocal government-holding	0.0036484	0.0008447	4.319	1.64e-05 ***
OwnershipState-owned	0.0053735	0.0010818	4.967	7.38e-07 ***
TC_RWA	-0.0210296	0.0041762	-5.036	5.20e-07 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.009991 on 1987 degrees of freedom

(570 observations deleted due to missingness)

Multiple R-squared: 0.06052, Adjusted R-squared: 0.05815

F-statistic: 25.6 on 5 and 1987 DF, p-value: < 2.2e-16

Call:

```
lm(formula = eta_i ~ Ownership + TC_RWA, data = effects)
```

Residuals:

	Min	1Q	Median	3Q	Max
	-0.036203	-0.010844	-0.000651	0.008893	0.051362

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	0.9560082	0.0013065	731.746	< 2e-16 ***
OwnershipForeign Joint-stock	-0.0003766	0.0016622	-0.227	0.821
OwnershipJoint-stock	-0.0078977	0.0011403	-6.926	5.67e-12 ***
OwnershipLocal government-holding	-0.0054579	0.0012353	-4.418	1.04e-05 ***
OwnershipState-owned	-0.0079552	0.0016201	-4.910	9.77e-07 ***
TC_RWA	0.0044248	0.0054469	0.812	0.417

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.0153 on 2180 degrees of freedom

(377 observations deleted due to missingness)

Multiple R-squared: 0.04017, Adjusted R-squared: 0.03797

F-statistic: 18.25 on 5 and 2180 DF, p-value: < 2.2e-16

Call:

```
lm(formula = u_it ~ Ownership + BCapital, data = effects)
```

Residuals:

	Min	1Q	Median	3Q	Max
	-0.062852	-0.005729	0.001431	0.007436	0.025167

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	9.833e-01	9.153e-04	1074.323	< 2e-16 ***
OwnershipForeign Joint-stock	8.339e-04	1.137e-03	0.733	0.463
OwnershipJoint-stock	4.981e-03	7.799e-04	6.386	2.09e-10 ***
OwnershipLocal government-holding	4.027e-03	8.599e-04	4.683	3.00e-06 ***
OwnershipState-owned	5.625e-03	1.107e-03	5.080	4.11e-07 ***
BCapital	-2.797e-04	4.656e-05	-6.006	2.23e-09 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.01018 on 2112 degrees of freedom
 (445 observations deleted due to missingness)
 Multiple R-squared: 0.07444, Adjusted R-squared: 0.07225
 F-statistic: 33.97 on 5 and 2112 DF, p-value: < 2.2e-16

Call:
 lm(formula = eta_i ~ Ownership + BCapital, data = effects)

Residuals:

Min	1Q	Median	3Q	Max
-0.041872	-0.010567	-0.000523	0.009292	0.051894

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	9.541e-01	1.261e-03	756.477	< 2e-16 ***
OwnershipForeign Joint-stock	-4.371e-04	1.646e-03	-0.266	0.791
OwnershipJoint-stock	-7.519e-03	1.120e-03	-6.716	2.35e-11 ***
OwnershipLocal government-holding	-4.802e-03	1.226e-03	-3.917	9.21e-05 ***
OwnershipState-owned	-7.171e-03	1.628e-03	-4.406	1.10e-05 ***
BCapital	2.481e-04	5.635e-05	4.404	1.11e-05 ***

 Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.01549 on 2328 degrees of freedom
 (229 observations deleted due to missingness)
 Multiple R-squared: 0.05625, Adjusted R-squared: 0.05422
 F-statistic: 27.75 on 5 and 2328 DF, p-value: < 2.2e-16

Table 4.5: Inefficiency effects

Table 4.5: Inefficiency Effects

Variable	Transient Efficiency	Persistent Efficiency
	Estimates	Estimates
(Intercept)	0.983 ***	0.956 ***
OwnershipForeign Joint-stock	0.000	-0.000
OwnershipJoint-stock	0.004 ***	-0.008 ***
OwnershipLocal government-holding	0.004 ***	-0.005 ***
OwnershipState-owned	0.005 ***	-0.008 ***
TC_RWA	-0.021 ***	0.004

Observations	1993	2186
R^2 / R^2 adjusted	0.061 / 0.058	0.040 / 0.038
	* $p < 0.05$	** $p < 0.01$ *** $p < 0.001$

Following Colombi et al. (2017) and Fungáčová et al. (2020), we parametrize the inefficiency terms through linear models in “Methodology” section. The estimates are presented in Table 4.5. The estimates suggest a statistically significant negative relationship between regulatory capital requirements and transient (time-varying) efficiency, but no significant relationship between capital adequacy and persistent (time-invariant) efficiency. This finding partially supports the results in Barth et al. (2004) where they find capital stringency is not strongly linked with bank efficiency where they use different measure of bank efficiency. Similarly, Lee and Chih (2013), Djalilov and Piesse (2019), and Lešanovská and Weill (2016) also do not find sufficient evidence to support a statistically significant relationship between capital regulation and bank efficiency. However, Barth et al. (2013) find that greater capital regulation stringency is negatively associated with bank efficiency. Our finding shows that that Basel III capital regulation can influence commercial banks’ decisions and perspectives on cost containment strategies which are closely associated time. This can be provided as part of research evidence of the development of the Basel framework.

From the agency theory perspective, this finding may support the viewpoint provided in Lešanovská and Weill (2016): the two agency costs caused by “asset substitution” (see Smith and Warner, 1979) and “control hypothesis” (see Jensen, 1986), respectively, may have the effect of offsetting each other. The reforms in China’s banking industry took further steps following the WTO agreement in 2001. The joint-stock banks (including local government-holding banks, city banks, and rural commercial banks) have become the mainstream of Chinese banks. The modern corporate governance framework has been established in banks. Transformation in ownership structure has accelerated development of banks regarding assets growing and branch expansion; and has also raised the conflict between shareholders and managers over the free cash flow (“control hypothesis”). On the other hand, the rapid development of capital markets provides more funding channels for banks such as public offering and inter-bank funding. The changes make banks less dependent on debt financing, which may lessen the conflict between shareholders and creditors. Therefore, the impact of capital reserve on efficiency could reflect the result of the offset of these two agency costs.

In terms of the impact of ownership structure on bank cost efficiency, the state-owned ownership type shows a statistically significant result, however, inconclusive. Combining with the results presented in tbl-scores, we believe that it could be reasonable to assume lower cost efficiency of state-owned banks. Since 2001, direct state-stakes in state-owned banks has been replaced by a Central Huijin shareholder-stake, along with the establishment of modern corporate governance system. We argue that the direct state intervention has transformed, instead of state ownership, but into state concentrated ownership which is an ownership type similar to the one of large investors with significant control rights and cash flow rights (“large investors,”

see Shleifer and Vishny, 1997). From this perspective, concentrated ownership puts pressure on management decision making (Shleifer and Vishny, 1997) and therefore bank performance. Justified by the theory of property rights (see Berle and Means, 1932) and the theory of agency (see Jensen and Meckling, 1976), state concentrated ownership could create decisive power and may favor particular projects. Sapienza (2004) finds that state-owned banks favor large firms and charge lower interest rates than other types of banks in Italy. Rather than political patronage (see Sapienza, 2004), China's state-owned banks support projects with potential of social-benefits rather than those with target of profit-maximizing. Therefore, state-owned banks suffer lower cost efficiency than other ownership types.

4.5 Conclusion

This study aims to analyze cost efficiency of commercial banks in China's banking industry and explore the impact of regulatory capital and ownership structure on banks' cost efficiency in Basel III era following 2007-2009 global financial crisis. This period we choose (2010-2020) coincides with the fourth stage of China's financial reform and the implementation of Basel III framework in China. We analyze cost efficiency using in total 2574 annual observations over the period 2010-2020 on 233 commercial banks in China with 5 types of ownership structure - state-owned, local government holding, joint-stock, foreign joint-stock, and foreign owned. Our data covers over 91% of total assets in China's banking industry. We employ a four-component panel stochastic cost frontier model developed by Colombi et al. (2011), Colombi et al. (2014), Filippini and Greene (2016) and Kumbhakar et al. (2015) in the most recent years, decomposing the cost inefficiency into transient and persistent components, to investigate bank cost efficiency and inefficiency effects. In addition, we provide background information on China's financial reform regarding evolution of ownership structure.

Our empirical results show that transient efficiency and persistent efficiency have very similar values which suggest that overall inefficiency decomposes almost equally between these two components. The state-owned banks have the overall efficiency ranking in the middle across the ownership types, with higher transient efficiency and much lower persistent efficiency. This finding collaborates the findings by Fungáčová et al. (2020).

Our investigation to the impact of regulatory capital requirements on bank cost efficiency reveals that Basel III capital regulation is negatively associated with transient(time-varying) (in)efficiency but shows no statistically relation to persistent(time-invariant) (in)efficiency. Our findings partially support the results by @BARTH2004, @LEE2013, @DJALILOV2019 and @LESANOVSKA2016, but differ from other previous studies. We provide the explanation for the different efficiency level between different ownership structure and the reason why the state-owned banks suffers low efficiency over time based on historical and theory perspectives. Based on the findings outlined above, the study proposes several policy recommendations. Firstly, because Basel

III capital adequacy requirements have a negative impact on banks' transient (in)efficiency, China's regulatory authorities may set up a well-established, dynamic framework to address banks' cost containment strategies as well as control the risk-taking behaviors. Secondly, Chinese regulators may leverage the insights and methodology of this study. With more complete data sets, regulators can establish further detailed analysis on the determinants of banks' (in)efficiency. Internationally, regulators may also conduct similar analyses using local bank-level data to ascertain the Basel III framework's appropriateness within their respective jurisdictions. Lastly, the study reinforces the necessity of consolidation of the Basel III regulatory framework by revealing the diversified relation between capital regulation and bank transient /persistent efficiency. Regulators may contemplate employing the mix of Basel III variables not only to shield banks from potential economic and financial turbulence but also uphold banks' efficiency.

4.5.1 Bias and Further Directions

This study employs a four-component SF model that has been introduced and developed by @COLOMBI2011, @COLOMBI2014, @FILIPPINI2016, and @KUMBHAKAR2015, and separates the random firm effects from banks' persistent(time-invariant) inefficiency and transient(time-varying) inefficiency. The model has the assumption that all the error components are independently and identically distributed (i.i.d.) random variables. Estimation of the model can be conducted in a single stage Maximum Likelihood method based on distributional assumptions on the four components [COLOMBI2011]. In consideration of our data availability, we conduct a three-step method to estimate the model. According to @BATTESE1995, a multi-step method where the final stage involves the specification of a regression model for the predicted inefficiency effects may contradict the distributional assumption of i.i.d., thereby causing the biased estimation.

Regarding further direction of our research, we intend to explore the heteroskedastic four-component model [see @BADUNENKO2017] in which error component variances are functions of covariates that are determinants of inefficiency and try the single step Maximum Likelihood method in estimation. We will also consider conducting comparative analyses with banking sectors in other emerging markets undergoing similar regulatory changes, such as Brazil. The comparative analyses can offer valuable insights. Countries experiencing analogous shifts in regulatory frameworks may provide useful comparative data to assess the generalizability and robustness of our findings. Exploring how different regulatory environments impact banking practices and performance metrics across diverse emerging economies could enrich our understanding of the broader implications of regulatory reforms.

4.6 Appendix

4.6.1 The Variable Definition Table for Efficiency Analysis

Table 4.6: Variable Definition

Variable	Acronym	Definition	Data Source
Cost Frontier Variables_Output			
Cost Frontier Variables_Output	Total Gross Loans	Loans and finance leases held for investment or held for sale, net of unearned discount and gross of loss reserves. Does not include accrued interest on loans.	SNL Database and bank annual reports
	Total Deposits	Total deposits from customers. For US banks, this is the total deposits from customers and banks.	SNL Database and bank annual reports
Cost Frontier Variables_Input Price			
Cost Frontier Variables_Input Price	Price of funds	Interest Expense/Total Deposits	Manually computation based on SNL Database and bank annual reports
		Interest Expense: Interest on debt and other borrowings, on an incurred basis. Includes the amortization of discount or premiums and interest on capital leases.	SNL Database and bank annual reports
	Price of labor	Personnel Expense/Total Assets	Manually computation based on SNL Database and bank annual reports
		Total Assets: All assets owned by the bank as of the date indicated, as carried on the balance sheet and defined under the indicated accounting principles	SNL Database and bank annual reports
		Personnel Expense: Salaries, wages, bonuses, commissions, changes in reserve for future stock option expense, and other employee benefit costs. Includes any expenses related to employment or retirement benefits, whether paid or deferred, recognized during the period.	SNL Database and bank annual reports
	Price of fixed assets	Other Operating Expense/Fixed Assets	Manually computation based on SNL Database and bank annual reports
		Other Operating Expense: Operating Expense excludes Personnel Expense	Manually computation based on SNL Database and bank annual reports
		Fixed Assets: Property, plant and equipment acquired for long-term use in normal operations. Fixed assets are carried at cost, net of accumulated depreciation.	SNL Database and bank annual reports
Total Costs			
Total Costs	TC	The sum of interest expense, personnel expense and othe operating expenses	Manually computation based on SNL Database and bank annual reports
Determinants of Inefficiency			
Determinants of Inefficiency			
Regulation	TC_RWA	Total Regulatory Capital/Risk Weighted Assets, Total capital ratio as defined by the latest regulatory and supervisory guidelines.	SNL Database and bank annual reports
Ownership		Ownership categories and definitions listed in Table 1	
Bank Size	LnAssets	Natrual Logarithm of Total Assets, as an indicator of the size of a bank	Manually computation based on data of Total Assets

5 Assessing Systemic Risk Dynamics in Chinese Banking: The Impact of Basel III and Ownership Structures

5.1 Introduction

The 2007-2009 Global Financial Crisis (GFC) triggered an overhaul of financial regulation system. Seeking to address structural weaknesses of pre-crisis banking regulation, the Basel III framework (Basel III), based on the regulatory reform agenda endorsed by Group of Twenty (G20) leaders in 2009, was finalized in 2017. Regulatory consensus has focused on increasing capital adequacy requirements and liquidity assessment, in recognition of that banks should be subject to more stringent capital regulation (Demirgüç-Kunt et al., 2018). The updated Basel regulatory framework (Basel III) focuses on systemic risk and macro-prudential regulation designed to enhance the banking sector's resilience and strengthen risk management practices, and mitigate the potential for systemic risk. As one of the member countries of Basel Committee on Banking Regulation and Supervision (BCBS), China has been at the forefront of implementing Basel III framework.

China's banking sector, marked by its rapid growth and increasing integration into the global financial system, plays a crucial role in sustaining the country's economic development. China's banking sector underwent fundamental changes in 1978, as part of China's overall economic reform. Since 2001, when China got accession to the World Trade Organization (WTO), the reform of China's banking industry has stepped up its pace and the entire banking sector has been dramatically reshaped. The reform has transformed Chinese banks into market-oriented enterprises, changed their ownership structure, established modern corporate governance mechanisms, and introduced legislation and regulatory framework. Since 2010, improvements and refinements have continued in China's banking sector and entered the advanced stage of the reform. In the wake of the GFC, Chinese regulatory authorities have proactively embraced the Basel III framework, aiming to fortify the national financial system against potential shocks. The evolution of China's banking landscape presents a unique context for investigating the implementation of Basel III regulation. A rich body of literature focusing on the previous stages of the reform assesses the relationship between capital requirements and Chinese banks' performance and standalone risk including Pessarossi and Weill (2015), Tan and Floros (2013), and Lee and Chih (2013). By exploring the relationship between risk-based regulatory capital requirements and systemic risk in China's banking sector, this study aims to provide insights

for regulators, policymakers and market participants in the context of China’s financial environment.

Building upon our previous investigations in Chapter 3, which focused on the influence of Basel III on banks’ credit risk-taking, and Chapter 4, which dissected efficiency dynamics within China’s banking sector, this chapter further enriches our understanding of financial stability. In this paper, we extend existing empirical research studying the dynamic between Basel III capital adequacy requirements, systemic risk and ownership structure in China’s banking sector. Notwithstanding the policy consensus, economic theories are split on the impact of capital on standalone risk. Some theories emphasize that bank capital acts as a buffer to absorb shocks (e.g. Repullo, 2004) and higher capitalization optimize the borrower screening (e.g. Allen et al., 2011). Other theoretical literature claims that capital regulation may exacerbate banks’ portfolio risk and reduce bank stability (see Koehn and Santomero, 1980). Since the early 2000s, academic literature started to direct its focus towards systemic risk. Systemic risk is defined by De Bandt and Hartmann (2019) as “the risk of experiencing systemic events in the strong sense”. Pioneering works by Allen and Gale (2000) study the diffusion of financial contagion via multiple channels in reaction to an initial small chock. After the GFC, the approach to identify the mechanisms of driving systemic risk has been directed to tail interdependences between market indices (Acharya et al., 2017; see Adrian and Brunnermeier, 2016). Laeven et al. (2016) and Demirgüç-Kunt et al. (2018) examine the relation between Basel III capital regulation and systemic risk using cross-country data employing the approaches proposed by these two studies. Both of the studies find that there is a negative relationship between capital regulation and systemic risk. The investigation of the relationship between capital and systemic risk in Chinese banking sector is relatively scarce in the current body of research. Recent studies have focused on systemic risk in Chinese financial system. Wang et al. (2018) investigate the systemic risk of China’s financial institutions employing tail-event networks. Huang et al. (2019) examine systemic risk in Chinese banking system by employing multiple measures to capture different aspects of systemic risk of Chinese banks.

This paper provides empirical evidence using forensically analysed data on 376 Chinese financial institutions over the period 2010-2022. Because our focus is on the dynamics of systemic risk and Chinese banks, we hand collect the ownership structure information of these 236 Chinese commercial banks and classify them into five categories of ownership identities: State-owned (Big Six and other than Big Six), Local government-holding, Joint-stock, Foreign joint-stock, and Foreign-owned banks (Table 5.1). We compute conditional value at risk (CoVaR) proposed by Adrian and Brunnermeier (2016). We expect risk-based capital regulation to have a negative impact on the individual banks’ contribution to systemic risk.

Consistent with the theoretical literature that emphasizes bank capital as a buffer in absorbing economic shocks, we find that higher regulatory capital reduces individual banks’ contribution to systemic risk. Our results show that systemic risk increased with bank size. We also find evidence that state-ownership make higher contribution to systemic risk compared to joint-stock and local government-holding structure.

This paper contributes to the literature in several ways. First, our research bridges the global regulatory framework and the localized implementation in the Chinese context. This study provides insights into how global financial regulatory standards interact with the specificity of Chinese national banking system. China has become a major player in the global financial system by internationally integrated and closely interconnected with financial institutions. China fully adopted Basel III framework as part of its “open-door” economic reform. Understanding how Basel III framework interact with the idiosyncrasies of China’s banking industry contributes not only to academic research, but also informs policymakers and stakeholders about potential areas of concern or improvement, regarding the challenges of fostering global financial stability.

Second, our study contributes to the extant literature on systemic risk by analyzing the effect of ownership structure on systemic risk. The study examines the influence of different ownership structures on systemic risk in the Chinese banking sector. Our findings that state ownership influences systemic risk through factors including shareholding concentration, significant cash flow rights, and asset size provide new insights into the determinants of systemic risk; and facilitate the ongoing efforts to design effective and targeted regulatory measures that improve overall financial stability.

Third, this study fills a gap in the existing literature by focusing on the Chinese banking sector’s systemic risk in relation to capital regulation. Most existing literature focus on European and the US banks. Research focusing on the Chinese banks’ contribution to systemic risk is still scarce. This is a relatively under-explored area in current research, especially post-implementation of the Basel III framework in China.

Finally, The paper provides empirical evidence using data on 376 Chinese financial institutions over the period 2010-2022. This extensive data allows for a comprehensive analysis of the dynamics between systemic risk and regulatory capital in a unique national implementation context.

The remainder of this paper is organised as follows. Section II reviews related literature, as well as a brief introduction of the evolution of ownership structure of commercial banks in China. Section III presents the data set and the empirical model including the variables considered in our analysis. The empirical results are presented in section IV. And section V concludes.

5.2 Literature Review

5.2.1 Capital Regulation and Bank Risk

Bank capital affects individual banks’ risk as well as a bank’s contribution to systemic stability (Demirgüç-Kunt et al., 2018). Policy makers have consensus on increasing the stringency of capital adequacy requirements. However, economic theories offer split views on the impact of capital on bank risk; and empirical studies provides mixed findings.

The Basel framework, centered with the strict capital regulation, is designed to reduce bank risk and enhance bank resilience. Theoretical papers such as Repullo (2004) and Von Thadden (2004) support this view that risk-based bank capital is a more efficient regulatory tool and acts as a buffer in absorbing economic shocks and strengthens systemic stability. Demircug-Kunt et al. (2013) find that a strong capital position helps banks resist earning shocks and have higher probability to survive the crisis. They also find evidence to advocate higher quality capital, i.e., Tier 1 capital, in the regulatory capital requirements. These views are consistent with one of the most important purpose of the strict capital regulation: improving banks' survival probability. Another reason why stringent capital requirements are considered to be effective is that they refine banks' risk management and curb excessive risk-taking incentives. A number of theories highlight that risk-based capital, more effective than interest rate ceilings, boosts banks' "franchise value," improves borrowers screening, and lowers banks' excessive risk-taking incentives (Allen et al., 2011; Mehran et al., 2011; Repullo, 2004). Other theories emphasize a moral hazard perspective, arguing that effective regulatory capitalization may offset the excessive risk-taking incentives created by deposit insurance (Demircug-Kunt and Kane, 2002; Keeley, 1990). In terms of Chinese commercial banks, Tan and Floros (2013) find a significant negative relationship between bank capital and risk. Lee et al. (2015) report that bank capital is negatively related to NPL and support theories with the moral hazard view.

On the other hand, some research posit that greater capital regulations may induce higher bank risk. Cooper and Ross (2002) extend the research of Diamond and Dybvig (1983), stating that the existence of deposit insurance weakens the depositors' incentive to monitor banks and causes them to engage in excessive risk-taking activities. Blum (1999) suggests that banks may have higher incentives to raise risk due to the binding capital adequacy requirements. Callem and Rob (1999) find a U-shaped relationship between bank capital position and risk. The risk-taking first decreases with the increase of bank capital; then it increases as bank capital increases on its high level. They also argue that the increase in capital adequacy requirements induces banks to take additional portfolio risk even if they are well-capitalized. Using Chinese banking data, Lee and Chih (2013) find that the negative relationship between capital and risk only exists in the sub-sample of small banks and is not found in the sub-sample of large banks.

With regards to systemic risk, individual-bank models are only part of the story. The banking literature has developed theoretical models to explain systemic risk in recent years. Systemic risk may be associated with models of contagion and macroeconomic shocks and endogenous procyclicality (Acharya et al., 2017; Adrian and Brunnermeier, 2016; De Bandt and Hartmann, 2019). Chen (1999) extends Diamond and Dybvig (1983) bank run model with the rational herding approach and claims that failures of few banks can trigger runs on other banks, caused by the first-come, first-serve rule and information externalities. Rochet and Tirole (1996) present a model of the interbank market and argue that failures of large insolvent bank could induce contagion risk and propagate through the whole financial system. Kaufman and Scott (2003) provide one of the definitions of systemic risk focusing on spillovers of an initial external shock which causes fire-sale driven changes both in liquidity and interest rates. Allen and

Gale (2000) set up a model and explain financial contagion by the structure of the banking network.

Higher capital may absorb unexpected losses from macro-shocks (Kaufman and Scott, 2003). Capital requirements imposed on the interbank lending may reduce contagious defaults (Demirgüç-Kunt et al., 2018; Rochet and Tirole, 1996). The joint failure risk of individual banks, arising from the highly correlated asset returns, could cause systemic or aggregate risk (Acharya, 2009). Correlated bank failures also produce prohibitive social costs and capital regulation has different effect on bank risk when multiple Nash equilibria are created by the presence of the bail-out or central bank as lender of last resort (LOLR) (Acharya et al., 2016). On one hand, high leverage can reduce the moral hazard caused by managers seeking rent and providing inadequate loan monitoring (Calomiris and Kahn, 1991). On the other hand, sufficient bank capital ameliorates the asset-substitution moral hazard created by banks taking excessively risk (Bhattacharya et al., 1998); hence decreases systemic risk arising from high correlation of asset returns (Acharya, 2009).

The evidence on the linkage between capital regulation and systemic risk in Chinese banking industry is limited in literature. Not until recent years (after Chinese banking regulatory authority fully adopted the Basel III framework in 2013) that researches of systemic risk in Chinese banking sector emerged. Gang and Qian (2015) study the effect of China's monetary policies on systemic risk and find the systemic risk has been increased by monetary policy shocks. Huang et al. (2019) examine systemic risk in Chinese banking system by employing multiple measures to capture different aspects of systemic risk of Chinese banks. Zhang et al. (2021) focus on the impact of liquidity creation on systemic risk in Chinese banking industry and report a "U shape" relationship between liquidity creation and systemic risk. They report that systemic risk is positively related to bank liquidity creation when a bank is broadly connected with the entire financial system. Bellavite Pellegrini et al. (2022) evaluate the contribution of different financial sectors to systemic risk including traditional banks, shadow banks and real estate financial services. Liu et al. (2021) employ the MIXed DATA Sampling(MIDAS)-Quantile Regression(QR)-CoVaR approach to measure Chinese banks' systemic risk during the financial turmoils in 2010-2020. They find that bank leverage and market risk coefficient(β) are positively related to the systemic risk.

Building on the existing theoretical framework, our paper is related to a number of empirical studies focusing on identifying the drivers of systemic risk after the GFC. Anginer and Demirguc-Kunt (2014) investigate the impact of bank capital on systemic risk by employing various definitions of capital. They find that greater capital reduces fragility of financial system as a whole. Laeven et al. (2016) study the individual bank factors that determine systemic risk. They find that systemic risk is positively related to bank size and inversely related to bank capital.

5.2.2 Ownership Structure and Bank Risk

The theory of ownership stems from the pioneering work of the property rights theory by Coase (1937), Alchian (1965), Demsetz (1966), and Alchian and Demsetz (1972); was extended by Grossman and Hart (1986) and Hart and Moore (1990), and integrated with the agency theory by Jensen and Meckling (1976), Fama (1980), and Fama and Jensen (1983). The property rights theory defines ownership as residual right to income (Alchian and Demsetz, 1972) and residual right to control (Burkart et al., 2003); and states that the owners' property rights have been attenuated by managers' diverting the firm's resources to their own ends (Furubotn and Pejovich, 1972). The property rights theory allows the prediction of behavioral consequences of individuals in the contractual relations (De Alessi, 1980). According to the theory literature, the impact of bank ownership structure should be considered in the context of principal-agent framework and public choice theory (Altunbas et al., 2001; Sapienza, 2004), focusing on shareholder rights (the degree of ownership concentration) and the nature of the shareholders (see Shleifer and Vishny, 1997).

The separation of ownership and control in modern corporations is an essential part of the theory of the firm (see Berle and Means, 1932). From the perspective of agency theory, shareholder rights and ownership concentration are two common approaches to influence managerial behavior and thereby impact corporate performance. It is often believed that the diffused ownership would increase the power of managers and reduce their dependence on the owners (Berle and Means, 1932). Alchian and Demsetz (1972) argue that, in a corporation with dispersion of shareholding, control may be facilitated by turning shareholders' votes into voting blocs, which strengthens shareholders' power. Amihud and Lev (1981) and Hirshleifer and Thakor (1992) argue that strong shareholder rights (better investor protection) constrain managers' conservative (sub-optimal) risk-taking choices. John et al. (2008) conduct a cross-country study and support this view. They find the positive relationship between investor protection and corporate risk-taking. However, Burkart et al. (2003) present a model arguing that great protection of shareholder rights constrains managerial discretion, which reduces the need for dominant shareholders in order to prevent managers' shirking behavior (Shleifer and Vishny, 1986).

Alchian and Demsetz (1972) state that firm control can be facilitated by unrestricted salability of stock. Share trading may temporarily reform the ownership structure, converting the diffused ownership into decisive power blocs. Decisive power is one of the characteristics of large shareholders. Ownership concentration, or large shareholders, is defined as shareholders having concentrated control rights with significant cash flow rights (Shleifer and Vishny, 1997). The model presented by Shleifer and Vishny (1986) to estimate the value of ownership concentration. They propose that a presence of a large shareholder may lead to value-increasing takeovers. However, Grossman and Hart (1988) argue that large shareholders might try to maximize their private benefit at the expense of other small shareholders if their high control rights are not associated with high cash flow rights. The model employed by Grossman and Hart (1988) shows that this happens if there is a substantial departure from one share-one

vote structure. Saunders et al. (1990) argue that stockholder controlled banks have stronger motivation to take higher risks than banks controlled by managers/insiders. Smith and Warner (1979) and Laeven and Levine (2009) provide empirical evidence supporting banks with concentrated shareholding generally have higher risk.

5.2.3 State Ownership

State ownership is regarded as one of the special corporate arrangements. In agency theory, state firms are defined as being “*controlled by the public; and the de facto control rights usually belong to bureaucrat shareholders with highly concentrated control rights and no significant cash flow rights*” (Shleifer and Vishny, 1997). According to this view, state shareholders (directly-holding shares) can be considered as a special form of large investors with highly concentrated control rights and lack of cash flow rights.

There are two alternative theories in the literature regarding state ownership in banks: the social view and the political view. The social view, based on the economic theory of institutions, suggests that state ownership is a form of government intervention which addresses market failures and improves market functions and economic performance (Stiglitz, 1993). According to this view, state-owned banks may finance those projects which might not be profitable but might have a high value of social welfare. Therefore, state-owned banks may have poorer performance in terms of profitability along with higher default risk compared to their counterparts in the private sector. In contrast, the political view claims that state ownership creates sources of political benefits for politicians rather than social welfare. For example, excessive employment of state firms only benefits those who support government politically (Shleifer and Vishny, 1994). Shleifer and Vishny (1997) suggest that state-owned firms are inefficient because the state shareholders, with highly concentrated control rights and no cash flow rights, only maximize their political goals which may jeopardize social welfare.

A body of literature investigate the impact of state ownership of banks, from both the macroeconomic angle and the perspective of individual banks, mostly on economic growth and bank performance. Andrianova et al. (2012) find that state ownership of banks improves countries’ long-run economic growth and make positive contributions to economic growth. On the contrary, La Porta et al. (2002) find that higher government ownership is related to lower economic growth. Beck and Levine (2002) find no supporting evidence for either the social view or the political view, regarding the role that state-owned banks played in the economy. Beck et al. (2004) argue that state ownership intensifies bank concentration and exacerbates financing obstacles. Sapienza (2004) claims that state-owned banks favor large firms in banking lending, which can be explained by political view. Berger et al. (2005) and Berger et al. (2009) find that state-owned banks have lower profitability and poor long-term performance.

Ownership structure of banks in China’s financial markets has attracted academic attention since China obtained accession to the WTO in 2001. Many studies focusing on bank efficiency report that state-owned banks exhibit lower efficiency compared to joint-stock banks and

foreign banks (Berger et al., 2009; Fungáčová et al., 2013). Several research papers focus on ownership structure and standalone bank risk. Tan and Floros (2013) argue that state-owned banks have higher volume of non-performing loans and lower profitability. Zhu and Yang (2016) report that state-owned banks take higher risk than foreign banks in China. Bai et al. (2020) state that the issues of non-performing loans and moral hazard are increased in state-owned banks due to the implicit government support. However, the evidence on the linkage between ownership structure and systemic risk is still scarce. Morelli and Viotto (2020) report that the Chinese banking sector contributes the most to systemic risk among the sectors of insurance, brokerage, and real estate. They also suggest that the reduced level of bank competition due to a strong government role in the banking sector (Jiang et al., 2019) leads to the increase of systemic risk. Bellavite Pellegrini et al. (2022) find that systemic risk is positively associated with the size of financial institutions, which supports the empirical results of Laeven et al. (2016).

Our paper extends the empirical literature studying the determinants of systemic risk. Apart from systemic risk is influenced by bank capital, existing literature has found that systemic risk is associated with bank size (Laeven et al., 2016), institutional environment (Demirgüç-Kunt et al., 2018), bank liquidity creation (Zhang et al., 2021), and the volatility of market return (Tzouvanas, 2024). The existing literature highlights the importance of well-designed regulatory context. State-ownership is one of the distinct features of corporate governance in China's banking sector since the assets of the Big Six account for 40.27% of the total assets of the banking sector. Four of the Big Six are defined as Global Systemically Important Banks (G-SIBs) by Financial Stability Board (FSB). Corporate governance in the banking sector, as stated by Mehran et al. (2011), diverge from that in non-financial sectors, particularly concerning transparency, business complexity, and regulatory oversight. Our research addresses this issue and extends the empirical literature studying the determinants of systemic risk by exploring the relation between ownership structure and banks' contribution to systemic risk.

5.2.4 The evolution of ownership structure of commercial banks in China

The dramatic changes regarding the ownership structure happened in Chinese commercial banks at each stage of China's financial reform. The four largest state-owned banks¹ were founded during the first stage of the financial reform (1978-early 1990s), along with other national banks². These large banks were owned by the Finance Ministry and state-owned enterprises. The lower level of financial institutions, known as city credit cooperatives (later evolved to city banks), were controlled by the local Bureau of Finance; and foreign banks were operating in Special Economic Zones (Berger et al., 2009).³

¹They are the "Big Four": Bank of China, China Construction Bank, Agricultural Bank of China, and Industrial and Commercial Bank of China.

²National banks: commercial banks which operate nationwide.

³Special Economic Zones: a form of Free Ports in China where companies may benefit from tariff allowances and exemption. Chinese government designated the first four Special Economic Zones – Shenzhen, Xiamen, Shantou, and Hainan Province – in order to encourage foreign investments and improve economy and

During the second stage (early 1990s-2001), most of the policy-lending business of the four largest state-owned banks was released to three policy banks founded during this period. Private enterprises and individuals began entering different levels of financial institutions as shareholders. Government shareholders, such as local Bureaus of Finance began to exit city banks by transferring their shareholding to local business enterprises. The biggest change to the ownership structure happened at the third stage of the financial reform (2001-2010). An investment enterprise, Central Huijin Investment Ltd. (hereafter CH), was established by the state government acting as a designated shareholder of those state-owned banks, in order to fulfill the corporate governance requirements set by laws and regulations. Direct government shareholding has sharply decreased. Foreign financial institutions such as RBS Group and Bank of America invested in all levels of Chinese banks including state-owned banks, national banks and city banks, as strategic investors. The majority of state-owned banks and several city banks went public at this stage, introducing more diversified shareholders. After 2010, more detailed improvements occurred regarding ownership structure; and private-owned banks were established. Local government shareholders become minority shareholders in city banks. Over 50% of shareholding in city banks and over 87% of shareholding in rural commercial banks had become private enterprises by 2017. In total 61 commercial banks were listed by the end of 2022.

5.3 Data and Empirical Methodology

5.3.1 Data Sample

We obtain financial information at institution level from S&P Capital IQ Pro database (a service provided by S&P Global Inc.) over the period 2010:Q1-2022:Q4. Our sample contains 236 banks, 32 insurance companies, 23 securities, 22 trusts, 40 real estate companies, 4 financial-leasing companies, 15 other-financial companies and 4 policy-finance companies. We use stock market information from Compustats Global for total 133 publicly traded financial institutions in our sample. The Compustats Global provides daily stock price information for all listed financial institutions and the S&P Capital IQ Pro is the main data source of financial indicators. In cases where the S&P Capital IQ Pro does not provide enough information or has doubtful values, we double-check and hand collect data from other official sources including the annual issues of China's Statistical Yearbook, the press release and the annual reports of the China Banking and Insurance Regulatory Commission (CBIRC), and the annual reports of individual financial institutions.

Our empirical analysis focuses on the dynamics between capital adequacy regulation and systemic risk of a panel of 236 Chinese banks. Table 5.1 presents the information of the ownership structure and the types of the commercial banks in China's banking industry.

technology by the end of 1980's. More details may be found in <http://www.npc.gov.cn/npc/c9757/200904/8e461e2ba405480697185186122812d4.shtml>.

Table 5.1: Cross Tabulation of Ownership and Type

Ownership/Type	Big Six	City bank	Foreign bank subsidiary	National bank	Rural commercial	Total
Foreign-owned	0 (0.0%)	0 (0.0%)	35 (100.0%)	0 (0.0%)	0 (0.0%)	35 (14.8%)
Foreign Joint-stock	0 (0.0%)	12 (11.0%)	0 (0.0%)	1 (8.3%)	0 (0.0%)	13 (5.5%)
Joint-stock	0 (0.0%)	51 (46.8%)	0 (0.0%)	4 (33.3%)	69 (93.2%)	124 (52.5%)
Local government-holding	0 (0.0%)	43 (39.4%)	0 (0.0%)	2 (16.7%)	5 (6.8%)	50 (21.2%)
State-owned	6 (100.0%)	3 (2.8%)	0 (0.0%)	5 (41.7%)	0 (0.0%)	14 (5.9%)
Total	6 (100.0%)	109 (100.0%)	35 (100.0%)	12 (100.0%)	74 (100.0%)	236 (100.0%)

Ownership Structure:

¹ Foreign-owned: Foreign bank operating in China;

² Foreign Joint-stock: Joint-stock Banks having foreign strategic investors (usually shareholding over 15%);

³ Joint-stock: Banks' share held by mixed-ownership institutions and individuals; if shareholding involves indirect local government holding, the stake is less than 10%;

⁴ Local government-holding: Banks' share either held by local Treasury Bureau (no matter how much of the stake), or indirectly held by local government over 10%;

⁵ State-owned: Bank directly controlled by Central Huijin, Finance Ministry or state-owned enterprises.

Bank Types:

^a Big Six: The biggest six banks, all state-owned;

^b City bank: Branches usually cover a city and the near cities within the province where the bank headquarter is located;

^c Foreign bank subsidiary: Foreign bank branches and subsidiaries;

^d National bank: Branches cover the whole country and based on the CBIRC's categorization;

^e Rural commercial: Branches usually cover local communities and rural area within a province where the bank headquarter is located.

5.3.2 The Empirical Model

We run the following baseline regression to investigate the relationship between regulatory capital and systemic risk:

$$systemicrisk_{it} = \beta_0 + \beta_1 * capital_{it-1} + \beta_2 * bankcontrols_{it-1} + \epsilon_{it} \quad (1)$$

In Equation (1), the subscripts i and t denote the individual bank and year respectively. The dependent variable is bank i 's systemic risk in year t ($systemicrisk_{it}$), quantified using CoVaR following Adrian and Brunnermeier (2016) described in the following section. The main explanatory variable is the risk-based capital ratio in the Basel III framework and CBIRC capital management regulation. In our model, we use the total regulatory capital ratio TC_to_RWA .

As for bank-level control variables, we employ bank size, bank liquidity ratio, reliance on deposit funding, loan loss reserve (indicator of asset quality), and the ratio of net loans to total assets (indicator of business model). All explanatory variables are lagged by one year. In our regression, we employ institution-year fixed model in order to reduce concerns about possible omitted variables, based on the results of Hausman Test.

5.3.3 The Measure of Systemic Stability

We measure systemic risk as an individual bank's contribution to the overall financial system when financial distress is spreading across financial institutions.

Following Adrian and Brunnermeier (2016), we employ the conditional value-at-risk which is one of the most commonly used measures in the literature (Bierth et al., 2015). It is the value-at-risk (VaR) of the overall financial system conditional on an individual institution being under financial distress. It captures both spillover effects and an individual institution's contribution to the overall risk of the system as a whole (Adrian and Brunnermeier (2016), Demirgüç-Kunt et al. (2018)). We use $\Delta CoVaR$ as our main systemic risk measure, which is “the difference between the CoVaR conditional on the distress of an institution and the CoVaR conditional on the median state of that institution” (Adrian and Brunnermeier, 2016). Following Adrian and Brunnermeier (2016), we compute the forward- $\Delta CoVaR$ using quantile regressions and a set of macro state variables. This method estimates $\Delta CoVaRs$ (and $VaRs$) as a function of a set of state variables, allowing us to capture time-variation in the joint distribution of systemic return and individual institutions' return. The quantile regressions are as follows:

$$R_t^i = \alpha_q^i + \gamma_q^i M_{t-1} + \epsilon_t^i \quad (2)$$

$$R_{m,t} = \alpha_q^{system|i} + \gamma_q^{system|i} M_{t-1} + \beta_q^{system|i} R_t^i + \epsilon_{qt}^{system|i} \quad (3)$$

Where, R_{it} is the daily equity return for an individual bank i . M_{t-1} are a vector of lagged state variables that are employed to capture time variation in the conditional moments of asset returns. The state variables include the change in the Chinese Renminbi 3-month SHIBOR rate, the change in the term spread, daily stock index return⁴, and the volatility of the daily stock index return over previous month (22 trading days). $R_{m,t}$ is the daily return of all financial institutions. We employ daily stock returns from Compustats Global and other state variable information from Bloomberg.

Nest step, we use the predicted values from the above regression models in the quantile regression models to obtain:

$$VaR_{qt}^i = \hat{\alpha}_q^i + \hat{\gamma}_q^i M_{t-1} \quad (4a)$$

$$CoVaR_{qt}^i = \hat{\alpha}_q^{system|i} + \hat{\gamma}_q^{system|i} M_{t-1} + \hat{\beta}_q^{system|i} VaR_{qt}^i \quad (4b)$$

Finally, we compute $\Delta CoVaR_{qt}^i$ for individual banks using the values from the above regressions which has captured time-variation in the joint distribution of R^{system} and R^i .

⁴We collect daily stock index return from Shanghai Index, HangSeng Volatility Index, SSE180 Volatility Weighted Index, CSI Real Estate Index, and Shanghai Shenzhen CSI300 Index based on the exchange where the financial institutions are listed. The mean of the returns is collected if a financial institution is listed on multiple stock exchanges.

$$\Delta CoVaR_{qt}^i = CoVaR_{qt}^i - CoVaR_{50t}^i = \hat{\beta}_q^{system|i} (VaR_{qt}^i - VaR_{50t}^i) \quad (5)$$

Here we condition the VaR of the whole financial system on the event that an individual bank's loss changed from its median level (50%) to the $VaR_{q\%}^i$. We compute the $CoVaR$ measure when $q=5\%$ and $q=1\%$ for banks in our sample from 2010-2022.

5.3.4 Capital Adequacy Requirement

Regulatory consensus has viewed capital regulation helps curbing bank risk-taking and absorbing losses. However, economic theorists rarely agree on the role of capital. Hogan (2015) suggests that capital requirements are negatively related to bank risk-taking. Hellmann et al. (2000) argue that capital regulation induces banks to take excessive risk. After the GFC, there is growing consensus to adjust the capital adequacy requirements to better reflect individual banks' risk contribution to the system-wide fragility (Brunnermeier et al., 2009). Anginer and Demirgüç-Kunt (2014), Demirgüç-Kunt et al. (2018) and Laeven et al. (2016) all find that great capital position improves systemic stability.

Risk-based capital adequacy requirements are deemed as the core of the Basel III framework and CBIRC capital management regulation. Taking into account of the higher accessibility of the data, we use total regulatory capital ratio as the variable of interest in our analysis. The total regulatory capital ratio TC_to_RWA is computed as the sum of Tier 1 and Tier 2 capital divided by risk-adjusted assets and off-balance sheet exposures (total regulatory capital/RWA).

5.3.5 Bank-Level Control Variables

In investigating the relationship between regulatory capital and systemic risk, we follow Demirgüç-Kunt et al. (2018) and choose a set of bank-level control variables ($BankControl_{i,t}$):

Size: we employ the natural logarithm of total assets as the measurement of bank size. Bank size has been considered as one of the determinants of systemic risk due to the GFC (Laeven et al., 2016). Large banks, funded by unstable funding, tend to take excessive risks which might cause liquidity shocks and market failures, and generate systemic risk (Gennaioli et al., 2013; Shleifer and Vishny, 2010). Laeven and Levine (2007) argue that large banks engage in multiple (and risky) activities which induce high agency costs and corporate governance problems, and generate systemic risk.

Liquidity: we compute liquidity assets divided by total assets (liquidity assets/total assets) to measure bank liquidity. Bank liquidity is closely related to system-wide fragility. Liquidity crunches can quickly propagate within the whole financial system and induce systemic instability (Davydov et al., 2021). However, there is no consensus on the relationship between

Table 5.2: Descriptive Statistics

[!h]	N	Mean	Median	Sd	Min	Max
TC_RWA	5030	14.947	13.396	7.099	1.168	111.153
LnAssets	7440	16.939	16.801	1.980	6.897	22.495
NL_to_TA	6988	44.134	47.144	14.969	0.000	98.029
Liquidity_Ratio	6603	34.370	29.585	17.205	0.009	98.904
Funding_Ratio	7118	66.090	69.432	19.391	0.000	97.011
LLR	6623	3.499	3.045	4.089	0.000	79.960

bank liquidity creation⁵ and systemic risk. Davydov et al. (2021) find that liquidity creation decrease systemic risk. Zhang et al. (2021) find liquidity creation increases systemic risk with a “U” shape relationship.

Funding: reliance on deposit funding is measured by deposits divided by total assets (total deposits/total assets).

LLR: for asset quality, loan loss provision divided by total assets (loan loss provision/gross loan) is employed as the proxy, representing the proportion of the loan book a bank expects to be written-off.

NL_to_TA: we use the ratio of the total net loan divided by total assets (total net loan/total assets) as a proxy for an individual banks’ business model. The existing literature shows that banks with traditional loan portfolios may be exposed to lower risk than those investing in derivatives (Bitar et al., 2018).

5.4 Empirical Results

5.4.1 Descriptive Statistics and Correlation Matrix

Table 5.2 reports descriptive statistics of bank-level variables. The values of the mean and the median of total regulatory capital ratio (TC_RWA) are 14.947% and 13.396%, respectively. The above two values both are about 1% higher than the values of the global banks reported by Demirgüç-Kunt et al. (2018) (13.8% and 12.5%), which may indicate that a majority of jurisdictions⁶ have accepted and been implementing the Basel III capital adequacy regulation. Bank size is represented by the variable *LnAssets* and measured as the natural logarithm of the value of total assets. The mean of *LnAssets* is 16.939 which is much higher than the

⁵banks create liquidity by transforming liquid/short-term liabilities (e.g. deposits) into illiquid assets/investments (Berger et al., 2009; see Bhattacharya and Thakor, 1993).

⁶Demirgüç-Kunt et al. (2018) use the sample of 1735 banks in 61 countries.

Table 5.3: Summary Statistics of CoVaR

	N	Mean	Median	Sd	Min	Max
95%CoVaR	139807	0.010	0.010	0.005	-0.008	0.045
99%CoVaR	139807	0.019	0.020	0.009	-0.009	0.111
95%VaR	139807	0.030	0.029	0.009	-0.014	0.111
99%VaR	139807	0.058	0.054	0.020	-0.010	0.288

cross-sectional data of the global bank sample at the end of 2006 reported by Laeven et al. (2016) (3.83). However, the mean value of our sample is lower than the value reported by Zhang et al. (2021) (28.8799). The reason should be due to Zhang et al. (2021) use 16 listed Chinese banks accounting for 70% of total banking assets in 2010. The ratio of net loans to total assets (*NL_to_TA*) measures how much the individual banks rely on loans as one of the income sources. The mean value is 44.134% which is lower than the Demirgüç-Kunt et al. (2018) sample (63.4%); relatively, the mean of *Liquidity_Ratio* is 34.37% which is higher than the Demirgüç-Kunt et al. (2018) sample (10.7%). The values of the above pair of variables may show that financial assets for trading (e.g. bonds, inter-bank repurchase) serve as one of vital sources of income for banks over the period 2010-2022, since trading assets make up the principle component of liquidity assets. The statistics of *Funding_ratio* backs up the above statement. The ratio of deposits to total assets (*Funding_ratio*) has the mean value as 66.09% which is lower than the Demirgüç-Kunt et al. (2018) sample (78.6%). However, the value of loan loss reserves (*LLR*) has the mean value as 3.499% which is much higher than the Demirgüç-Kunt et al. (2018) sample (0.6%), and higher than what reported by Tan and Floros (2013) where they use a sample of 101 Chinese banks over the period 2003-2009. The higher mean of LLR might imply that the overall asset quality of Chinese banks has coincided with the expanding number of banks after the GFC.

Appendix Figure 5.2 reports the Pearson correlation matrix for the bank-level variables employed in our analysis. The strength of the associations between the bank-level variables are weak to moderate, which may indicate that the risk of multicollinearity is probably low.

5.4.2 Relationship between Capital and Systemic Risk

Table 5.3 reports the descriptive statistics of CoVaR at 95% and 99% confidence levels (the 95th and 99th percentiles of the loss distributions of an individual bank), respectively. The higher values indicate greater systemic risk. The 95%CoVaR has the mean value as 0.01 which is lower than the mean value reported by Zhang et al. (2021). The reason might be due to that they use 16 large listed banks over the period 2011-2016. According to the empirical analysis by Laeven et al. (2016), bank size is positively related to systemic risk.

Figure 5.1 presents the individual financial institutions' contribution to systemic risk based on industry. Based on the visualization, CoVaR of financial institutions in the industries of

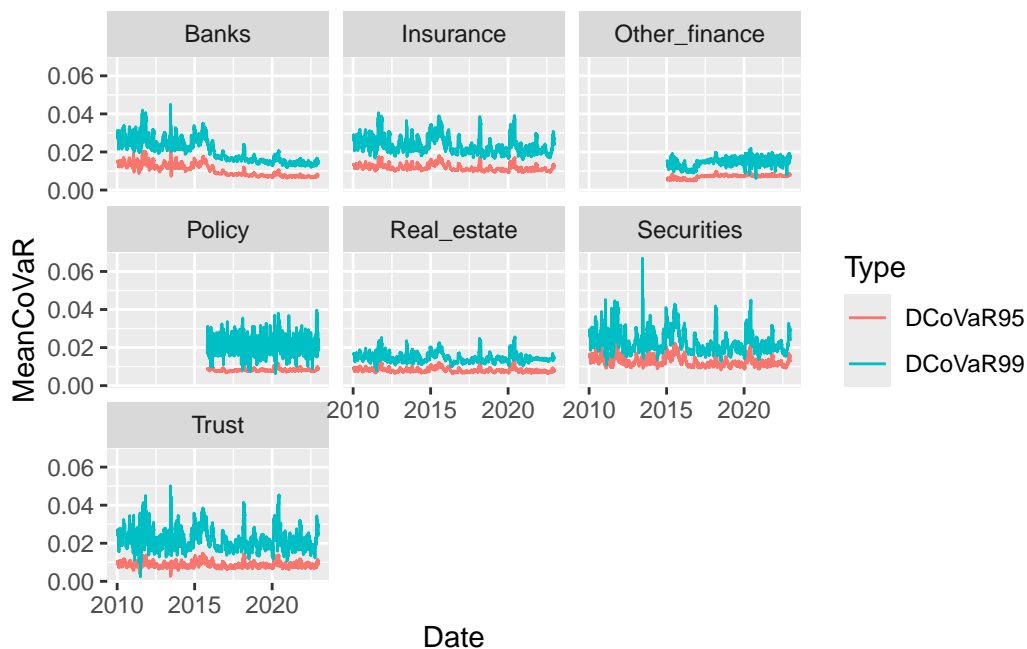


Figure 5.1: DCoVaR Visualization by Industry

securities and trust have higher volatility than banks, especially over the period 2015-2022.

Pooling Model

Call:

```
plm(formula = CoVaR95 ~ TC_RWA + LnAssets + NL_to_TA - LLR +
      Liquidity_Ratio + Funding_Ratio + Ownership, data = panel,
      effect = "twoways", model = "pooling")
```

Unbalanced Panel: n = 56, T = 2-49, N = 960

Residuals:

Min.	1st Qu.	Median	3rd Qu.	Max.
-1.093470	-0.193100	0.063343	0.215215	1.006844

Coefficients:

	Estimate	Std. Error	t-value	Pr(> t)	
(Intercept)	-2.4657637	0.3000293	-8.2184	6.707e-16	***
TC_RWA	-0.0229822	0.0072285	-3.1794	0.0015236	**
LnAssets	0.1722945	0.0112422	15.3257	< 2.2e-16	***
NL_to_TA	0.0036256	0.0018123	2.0005	0.0457304	*

Liquidity_Ratio	0.0113665	0.0021201	5.3614	1.037e-07	***
Funding_Ratio	-0.0024321	0.0015114	-1.6092	0.1078994	
OwnershipState-owned	0.1254448	0.0450398	2.7852	0.0054557	**
OwnershipLocal government-holding	0.1032956	0.0305601	3.3801	0.0007541	***
OwnershipForeign Joint-stock	0.1771555	0.0363904	4.8682	1.318e-06	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares: 189.54

Residual Sum of Squares: 103.66

R-Squared: 0.45309

Adj. R-Squared: 0.44849

F-statistic: 98.4819 on 8 and 951 DF, p-value: < 2.22e-16

Table 5.4: Regulatory Capital and Systemic Risk Estimated

Predictors (Intercept)	CoVaR_95%CI	CoVaR_99%CI
	Estimates	Estimates
	-2.466 *** (-3.055 – -1.877)	-4.389 *** (-5.549 – -3.229)
TC RWA	-0.023 ** (-0.037 – -0.009)	-0.054 *** (-0.082 – -0.027)
LnAssets	0.172 *** (0.150 – 0.194)	0.283 *** (0.240 – 0.327)
NL to TA	0.004 * (0.000 – 0.007)	0.013 *** (0.006 – 0.020)
Liquidity Ratio	0.011 *** (0.007 – 0.016)	0.031 *** (0.023 – 0.039)
Funding Ratio	-0.002 (-0.005 – 0.001)	-0.001 (-0.007 – 0.004)
Ownership [State-owned]	0.125 ** (0.037 – 0.214)	0.305 *** (0.131 – 0.479)
Ownership [Local government-holding]	0.103 *** (0.043 – 0.163)	-0.005 (-0.123 – 0.113)
Ownership [Foreign Joint-stock]	0.177 *** (0.106 – 0.249)	0.194 ** (0.053 – 0.335)
Observations	960	960
R ² / R ² adjusted	0.453 / 0.448	0.412 / 0.407

* p<0.05 ** p<0.01 *** p<0.001

Table 5.4 presents the results from the regression Equation(1) where we examine the baseline relationship between Basel III capital adequacy regulation and systemic risk measured using

CoVaR. Based on the results of Hausman test, we employ the fixed-effect OLS regression model to examine the relation between total regulatory capital ratio and CoVaR95 (CoVaR at 95% confidence level) and CoVaR99 (CoVaR at 99% confidence level), respectively. We find a significant (at 90% confidence level) negative relationship between total regulatory capital ratio and CoVaR. Our results are consistent with the findings of Laeven et al. (2016) and Demirgüç-Kunt et al. (2018) that regulatory capital is inversely related to systemic risk, and higher levels of the regulatory capital ratio may contribute to decreasing systemic risk.

5.4.3 Bank Characteristics and Systemic Risk

The bank-level variables perform as expected and show consistent results with the ones in Adrian and Brunnermeier (2016), Demirgüç-Kunt et al. (2018) and Laeven et al. (2016). Bank size (variable *LnAssets*) is positively associated with systemic risk. Large banks usually have broad connectedness to the entire financial system and have inclines to engage more in risky investments such as trading. Therefore, the high maturity mis-match ratio makes those large banks more vulnerable and generate externalities of liquidity shocks and market failures such as fire sale (Boot and Ratnovski, 2012; see Shleifer and Vishny, 2010). Our results also support the view of agency cost that large banks, because of their engagement with complex trading, may suffer from increased agency problems leading to build-up and generation of higher systemic risk (Laeven and Levine, 2007). *Liquidity Ratio* shows positive relation with systemic risk. When banks have higher liquidity ratio (i.e. more short-term trading assets), they may be exposed to higher illiquid risk. In financial distress, an individual bank's liquidity shortage can be transmitted to the entire financial system through fire sales. The positive relation holds between bank loans (variable *NL_to_TA*) and systemic risk. The ratio of total net loans to total assets (*NL_to_TA*) can be used as the proxy of an individual bank's involvement in market-based activities (Laeven et al., 2016). An individual bank with a lower net loan ratio may be considered that it may be engaged with more frequent market-based activities. Intuitively, the individual bank may be exposed to higher risk of negative externalities that affect the whole financial system. However, our result shows that high market-based exposures may not increase the individual bank's contribution to systemic risk (increasing the risk of contagion) when the bank is in financial distress.

Ownership structure of Chinese banks is always a research area that attracts academic interests. We find that adding ownership structure does not change the significant and negative association between the total regulatory capital ratio and systemic risk. Berger et al. (2009) study efficiency of Chinese banks from the perspective of ownership structure and report that a minority of foreign ownership help improve bank efficiency. Tan and Floros (2013) investigate the effect of capital ratio on Chinese banks' cost efficiency adjusting for ownership structure. The thirty years of the reform in China's banking industry (1978-2010) achieved the advancement of the legal and financial infrastructure, as well as the more diversified ownership structure. By 2010 the four G-SIBs and other 12 commercial banks all completed IPOs. Private shareholding accounted for 77.7% in rural commercial banks. The period after 2010

could be considered as a stage of the financial reform for further progressing and improving on both infrastructure and ownership changes. In recent times, as China seeks to decouple its reserve banking system from the US, there may be important implications for continued regulatory cooperation in international banking⁷.

The results reveal that compared to joint-stock banks which is the base category, state-owned banks, local government-holding banks and foreign joint-stock banks (foreign ownership as the minority shareholder) have higher contribution to systemic risk when individual banks are in distress. From the perspective of standalone bank risk, our findings support the viewpoint that state-owned banks are engaged with a number of policy-guided credit activities which might not be profit-centered (see Pessarossi and Weill, 2015). The social lending theory of state ownership proposed by Atkinson and Stiglitz (1980) suggests that state-owned enterprises contribute to “correcting the ‘failure’ of market economy” due to imperfect competition, inefficiency and public good. Therefore, government-owned enterprises may help improve overall performance of economy (see Stiglitz, 1993). Nevertheless, state-owned banks may be exposed to high credit risk brought by those social welfare projects. In China’s banking context, the four of the “Big Six” were founded and conducted a large amount of government lending in the early 1990’s, before national banks and city banks were established. Within a relatively long period, the state-owned banks (including local government-holding banks founded later in the end of 1990’s) played a role of ‘government agencies’ to pursue the broader social welfare objectives rather than profit maximizing; for example, the projects of the nationwide High-speed Rail network. These projects are long-term focus, requiring patient capital and borne with high opportunity costs and probably low profitability. According to Tirole (1994), the managers in the state-owned banks have low powered incentives, since the state-owned banks target multiple welfare objectives which might not be measurable. The engagement with social welfare projects resulted in the significant non-performing loan levels of ‘Big Four’ banks before China’s WTO accession in 2001.

Since 2001, the ownership structure has been dramatically transformed due to China’s overall industrial reforms and the commitments to the WTO agreement. The large part of shares directly held by local government were gradually replaced by mixed ownership enterprises, foreign investments, and private investors. In terms of the state-owned banks, direct state intervention was replaced by Central Huijin (a corporate shareholder representing the state government) along with the establishment of modern corporate governance system. Those infrastructure projects that purely focus on social welfare would be taken over by the policy banks⁸ or would be financed by syndicated loans, in order to mitigate potential downsides and remain resilient to adverse market conditions. The state-shareholding in state-owned banks have been transformed into concentrated ownership (see Shleifer and Vishny, 1997) but with powerful cash flow rights. Therefore, concentrated ownership puts pressure on management decision (Shleifer and Vishny, 1997) and bank risk taking incentives (Boyd and Hakenes, 2008).

⁷<https://rhg.com/research/us-china-decoupling>

⁸The three policy banks, China Development Bank, The Export-Import Bank of China, and The Agricultural Development Bank of China, were founded in 1994.

Most of state-owned Chinese banks are those largest banks in China’s market in terms of branches/subsidiaries and total assets. According to “Too-big-to-fail” view, large and complex banks tend to take excessive risk depending on anticipated regulatory policy reaction (Farhi and Tirole, 2012). These large and complex state-owned banks are the essential part of the whole financial system through their diversified activities and connected the whole financial network. Therefore, large size and the network connectedness increase the systemic risk contribution of state-owned banks, escalating the externalities created when they are in distress.

5.5 Conclusion

The global financial crisis (GFC) in 2007-2009 has demonstrated that the capital regulations in place were not adequate to protect financial institutions from systematic distress. Therefore, there has been academic interest in assessing the key reforms in Basel regulation and supervision framework. In this paper, we examine the relation between Basel III regulatory capital ratio and systemic risk in China’s banking industry over the period 2010-2022. We find that there is negative relation between total regulatory capital ratio and systemic risk, which means systemic risk is lower in more-capitalized banks in China.

We also analyze the impact of bank-level variables on systemic risk. Bank size makes positive contribution to the increase of systemic risk. Our findings also show that high liquidity ratio imposes excessive systemic risk, which can be considered as evidence in support of more stringent regulations on inter-bank trading and maturity mismatch. However, calls to regulate trading business should come with prudence because our empirical research does not provide more detailed evidence on optimal size of trading relative to liquid assets or total assets.

Moreover, we investigate the impact of different ownership structure on systemic risk. Our results show that state-owned banks have higher contribution to systemic risk than joint-stock banks. We argue that systemic risk is influenced by the interplay of ownership structure, bank size and diversification. The concentration of state-owned shareholding with significant cash flow rights, coupled with the sheer size, may amplify the systemic repercussion in times of economic stress. Furthermore, the high level of diversification across state-owned banks’ portfolio can exacerbate systemic risk by the broad interconnectedness of the bank in the financial system. Four of twelve state-owned banks are G-SIBs. From this perspective, our findings underpin the importance of regulating “Too-big-to-fail” financial institutions. However, more detailed research is needed to facilitate regulations and supervision framework.

5.6 Appendix

5.6.1 Correlation Matrix

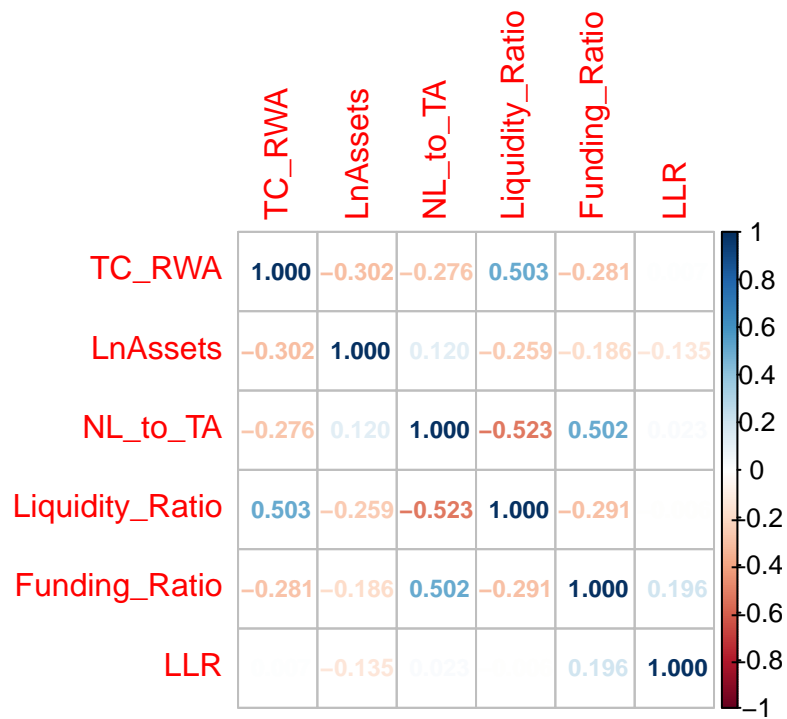


Figure 5.2: Linear Correlation Matrix

6 Conclusion

6.1 Research Summary

My thesis explores the interplay between Basel III capital adequacy regulation and risk-taking, efficiency, and systemic stability within the Chinese banking industry, with a specific focus on the influence of ownership structure. The objectives were to analyze the impact of Basel III capital regulation on bank credit risk, cost efficiency and stability of the whole financial system, and to assess the influence of different ownership structure in the Chinese context. The 2007-2009 Global Financial Crisis (GFC) uncovered that the pre-crisis capital regulations have structural weaknesses and were not adequate to protect financial institutions from systemic distress. The Basel Committee on Banking Regulation and Supervision (BCBS) developed a consolidated framework (Basel III) for more stringent capital adequacy regulations. There is continued academic interest on the effect of implementation of Basel III capital requirements (see Demirguc-Kunt et al., 2013), despite the regulatory consensus. This thesis reveals nuanced insights that contribute significantly to our understanding of the interplay between regulatory framework, ownership structures, and the broader financial stability landscape.

Since 1978, the Chinese banking sector has been reformed as part of the country's overall economic reform. After forty years, Chinese banks actively participate in global financial markets as influential players and contribute to the interconnectedness of the international financial system. Chapter 2 provides a review of China's banking landscape including the evolution of the financial reforms, the regulatory framework and the essential financial indicators. The objectives of Chapter 2 were to understand the unique context of China's banking industry, the adherence to the Basel III framework, and the Chinese banks' presence in and interconnectedness to global financial system, thereby offering research background for the following chapters of empirical analyses. The review shows that the reform and legislative advancements in China's banking sector, coupled with transformation initiatives, have resulted in diversified ownership structure, contemporary corporate governance frameworks, and heightened market competition. The active intervention of the government appears to be progressively receding with each phase of reform. The Basel III framework has been fully adopted and incorporated into the banking regulatory framework in China ¹. Employing the CAMELS rating system, Chapter 2 assesses the safety and soundness of Chinese banks. In summary, China's commercial banks exhibit robust capital adequacy, surpassing the Basel III standard with a ratio

¹China fully adopted Basel III in 2012, after adopted and implemented Basel II and Basel II.5 in previous years.

exceeding 10%, and maintain a lower average NPL ratio compared to G20 peers. However, our analysis highlights potential vulnerabilities for small and medium banks facing elevated credit risks, suggesting a need for enhanced safeguards. Notably, Chinese commercial banks demonstrate a competitive edge with lower cost-to-income ratios and an average return on equity exceeding 14%. While liquidity risk is generally well-managed in the biggest and those small-sized banks, medium-sized banks, particularly those historically linked to local government shareholders, may face higher liquidity risks due to increased reliance on wholesale funding channels.

Chapter 3, our initial investigation builds upon previous empirical studies that examine how Basel III risk-based capital requirements influence banks' credit risk-taking. We enhance our research by considering the interplay between capital regulation and ownership structure. This study employs forensically analyzed data on 231 Chinese banks over the period 2010-2019. The negative impact on bank credit risk-taking suggests that the implementation of Basel III has indeed fortified financial stability. Notably, state-owned banks emerge as key players in this dynamic, exhibiting higher credit risk-taking compared to other ownership structures. This finding is consistent with the results of Zhu and Yang (2016) and to some extent, echo the empirical results of Laeven and Levine (2009), indicating that banks with large shareholders holding substantial cash flow rights tend to assume greater credit risk. Our findings also align with the social perspective of the theory of state ownership of banks (see Stiglitz, 1993), indicating that state-owned banks are inclined to undertake credit projects even if they may not be financially profitable. Moreover, this study provides new evidence that the influence of Basel III capital regulation on credit risk-taking is, to some extent, contingent on ownership structure. This result reinforces the empirical conclusion drawn by Laeven and Levine (2009).

Efficiency analysis forms the core of Chapter 4, unraveling the nuanced components of transient and persistent efficiency, which contributes granularity to our comprehension of the efficiency dynamics with China's banking sector. Our empirical research provides evidence using a four-component panel stochastic frontier cost model on an unbalanced panel of 233 China's commercial banks over the period 2010-2020. A key finding of this chapter is the distinctive profile exhibited by state-owned banks in terms of efficiency. The results provide that state-owned banks have higher transient efficiency and much lower persistent efficiency compared with other ownership types, which corroborate the findings by Fungáčová et al. (2020). We do not find statistically significant relation between the regulatory capital requirements and persistent cost efficiency but a negative relation between regulatory capital and transient efficiency. This result supports the findings of some empirical literature (see Barth et al., 2004; Djalilov and Piesse, 2019; Lee and Chih, 2013; Lešánovská and Weill, 2016), however differs from other previous studies. The intricate relationship between ownership structure and bank cost efficiency is statistically significant. We provide the explanation for state-owned banks' relatively low persistent efficiency and high transient efficiency, compared with other ownership.

Efficiency analysis in Chapter 4 sheds light on broader banking dynamics by adding a layer of complexity to the understanding of the regulatory impact of Basel III framework. In particular,

the findings refines our understanding of state-owned banks by introducing the distinctive efficiency profile of state-owned banks.

Chapter 5 delves into the complex realm of Basel III regulatory capital ratios and systemic risk. We collect data of 376 Chinese financial institutions including 236 banks over the period of 2010-2022, and compute the conditional value at risk (CoVaR) proposed by Adrian and Brunnermeier (2016) as the measure of systemic risk. This study establishes a negative relation between total regulatory capital ratio and systemic risk, signaling a pivotal role of Basel III risk-based capital adequacy requirements in enhancing financial stability. Our finding aligns and corroborate the previous empirical results (see Demirgüç-Kunt et al., 2018; Laeven et al., 2016). Bank size is identified as a positive contributor to systemic risk, while a high liquidity ratio emerges as a potential source of excessive systemic risk, emphasizing the necessity for more stringent regulations. Importantly, the examination of ownership structures highlights state-owned banks as significant contributors to systemic risk, reinforcing the importance of regulating “Too-big-to-fail” financial institutions. The intricate interplay of ownership structure, bank size, and diversification is unveiled as a crucial determinant of systemic risk in times of economic stress.

Chapter 5, our final empirical chapter serves as a crucial piece of the overall narrative, relating and expanding the insights gleaned from the first two studies. This chapter further solidifies that Basel III capital regulation enhance overall financial stability by establishing a negative relation between total regulatory capital ratio and systemic risk. The bank efficiency considerations are incorporated into the broader context of systemic stability, demonstrating that efficiency dynamics are integral to understanding the potential systemic repercussion of different ownership structure. The empirical results from the three chapters contribute to a holistic understanding of the determinants of systemic risk. The interplay of Basel III capital regulations, ownership structure, efficiency dynamics, and risk dimensions provides a comprehensive view of the factors influencing financial stability under the context of China’s banking sector.

6.1.1 Contribution

Based on the research that was investigated, this thesis contributes to the understanding of China’s banking industry by exploring dimensions related to Basel III capital regulations, efficiency components and systemic stability. The study holds importance to policy-making as it aligns with the Basel Committee on Banking Supervision’s (BCBS) post-crisis reform initiative, as well as addresses fostering global financial stability, by evaluating the influence of Basel III risk-based capital regulations on individual bank risk-taking and overall systemic risk in China’s banking system given China’s significant role in the global financial system. The research bridges a gap by examining the joint effects of ownership structure and Basel III capital requirements on bank credit risk-taking. Existing studies rarely explore this interaction, making this research valuable in understanding how ownership structure and regulatory measures collectively shape risk-taking behavior in Chinese banks. The study also contributes

to literature by analyzing how ownership structure influences efficiency and financial stability, offering insights into moral hazard factors and designing targeted regulatory measures. The study addresses a gap in literature by focusing on the systemic risk within China's banking sector which is a relatively under-explored area, particularly post the implementation of Basel III in China.

6.1.2 Limitations

This thesis has limitations that should be addressed:

6.1.2.1 Data Quality and Availability

The accuracy and comprehensiveness of the findings depend on the quality and availability of the data used. The data provided by our main data source - the SNL Capital Pro database have been supplemented by manually collected data from other official data sources such as the China Banking and Insurance Regulatory Commission (CBIRC), and the annual reports of individual banks. Incomplete data could be a limitation that affects the study's robustness.

6.1.2.2 Model Limitation

The efficiency study employs a three-step, four component stochastic frontier model may introduce complexity and high demands on data and computation, which could affect the accuracy of empirical results.

CoVaR is employed in Chapter 5 as a measure of systemic risk. However, this measure has been criticized not fully capturing externalities such as contagion, fire sales or spillover effects (see Demirgüç-Kunt et al., 2018), and might need to be complemented by other metrics such as Marginal Expected Shortfall (MES) to obtain a comprehensive view of systemic risk.

6.1.2.3 External Factors

The study may not account for all external factors that could influence the observed relationships. Economic, geopolitical, or regulatory changes not considered in the research could impact the results, for example, the input and output variables for measuring the level of bank efficiency might not be exhaustive.

Bibliography

- A decade after the global financial crisis: Are we safer?, 2019.
- About the BCBS, 2018. www.bis.org.
- Acharya, V.V., 2009. A theory of systemic risk and design of prudential bank regulation. *Journal of Financial Stability* 5, 224–255. <https://doi.org/https://doi.org/10.1016/j.jfs.2009.02.001>
- Acharya, V.V., Mehran, H., Thakor, A.V., 2016. Caught between scylla and charybdis? Regulating bank leverage when there is rent seeking and risk shifting. *The Review of Corporate Finance Studies* 5, 36–75. <https://doi.org/10.1093/rcfs/cfv006>
- Acharya, V.V., Pedersen, L.H., Philippon, T., Richardson, M., 2017. Measuring systemic risk. *The Review of Financial Studies* 30, 2–47. <https://doi.org/10.1093/rfs/hhw088>
- Admati, A.R., DeMarzo, P.M., Hellwig, M.F., Pfleiderer, P., 2014. **FALLACIES AND IRRELEVANT FACTS IN THE DISCUSSION ON CAPITAL REGULATION**, in: Goodhart, C., Gabor, D., Vestergaard, J., Ertürk, I. (Eds.), *Central Banking at a Crossroads, Europe and Beyond*. Anthem Press, pp. 33–50.
- Adrian, T., Brunnermeier, M.K., 2016. **CoVaR**. *The American Economic Review* 106, 1705–1741.
- Aigner, D., Lovell, C.A.K., Schmidt, P., 1977. Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics* 6, 21–37. [https://doi.org/https://doi.org/10.1016/0304-4076\(77\)90052-5](https://doi.org/https://doi.org/10.1016/0304-4076(77)90052-5)
- Alchian, A.A., 1965. **SOME ECONOMICS OF PROPERTY RIGHTS**. *Il Politico* 30, 816–829.
- Alchian, A.A., Demsetz, H., 1972. **Production, information costs, and economic organization**. *The American Economic Review* 62, 777–795.
- Allen, F., Carletti, E., Marquez, R., 2011. **Credit market competition and capital regulation**. *The Review of Financial Studies* 24, 983–1018.
- Allen, F., Gale, D., 2000. Financial contagion. *Journal of Political Economy* 108, 1–33. <https://doi.org/10.1086/262109>
- Altunbas, Y., Carbo, S., Gardener, E.P.M., Molyneux, P., 2007. Examining the relationships between capital, risk and efficiency in european banking. *European Financial Management* 13, 49–70. <https://doi.org/https://doi.org/10.1111/j.1468-036X.2006.00285.x>
- Altunbas, Y., Evans, L., Molyneux, P., 2001. Bank ownership and efficiency. *Journal of Money, Credit and Banking* 33, 926–954. <https://doi.org/10.2307/2673929>
- Amihud, Y., Lev, B., 1981. Risk reduction as a managerial motive for conglomerate mergers. *The Bell Journal of Economics* 12, 605–617. <https://doi.org/10.2307/3003575>
- Andrianova, S., Demetriades, P., Shortland, A., 2012. **Government ownership of banks, institutions and economic growth**. *Economica* 79, 449–469.

- Anginer, D., Bertay, A.C., Cull, R., Demirgüç-Kunt, A., Mare, D.S., 2021. Bank capital regulation and risk after the global financial crisis. *Journal of Financial Stability*. <https://doi.org/10.1016/j.jfs.2021.100891>
- Anginer, D., Demirguc-Kunt, A., 2014. Bank capital and systemic stability. *Policy Research Working Papers* 6948, 42. <https://doi.org/doi:10.1596/1813-9450-6948>
- Arena, M., 2008. Bank failures and bank fundamentals: A comparative analysis of latin america and east asia during the nineties using bank-level data. *Journal of Banking & Finance* 32, 299–310. <https://doi.org/https://doi.org/10.1016/j.jbankfin.2007.03.011>
- Atherton, A., Newman, A., 2016. The emergence of the private entrepreneur in reform era china: Re-birth of an earlier tradition, or a more recent product of development and change? *Business History* 58, 319–344. <https://doi.org/10.1080/00076791.2015.1122702>
- Atkinson, Anthony.B., Stiglitz, Joseph.E., 1980. *Lectures on public economics*. McGraw-Hill Book Co, London ; New York.
- Ayadi, R., Bongini, P., Casu, B., Cucinelli, D., 2020. Bank business model migrations in europe: Determinants and effects. *British Journal of Management* n/a. <https://doi.org/https://doi.org/10.1111/1467-8551.12437>
- Badunenko, O., Kumbhakar, S.C., 2017. Economies of scale, technical change and persistent and time-varying cost efficiency in indian banking: Do ownership, regulation and heterogeneity matter? *European Journal of Operational Research* 260, 789–803. <https://doi.org/https://doi.org/10.1016/j.ejor.2017.01.025>
- Bai, H., Ba, S., Huang, W., Hu, W., 2020. Expected government support and bank risk-taking: Evidence from china. *Finance Research Letters* 36, 101328. <https://doi.org/https://doi.org/10.1016/j.frl.2019.101328>
- Barth, J.R., Caprio, G., Levine, R., 2008. Bank regulations are changing: For better or worse? *Comparative Economic Studies* 50, 537–563. <https://doi.org/http://dx.doi.org/10.1057/ces.2008.33>
- Barth, J.R., Caprio, G., Levine, R., 2005. *Rethinking bank regulation: Till angels govern*. Cambridge University Press, Cambridge. <https://doi.org/DOI:10.1017/CBO9780511753817>
- Barth, J.R., Caprio, G., Levine, R., 2004. Bank regulation and supervision: What works best? *Journal of Financial Intermediation* 13, 205–248. <https://doi.org/https://doi.org/10.1016/j.jfi.2003.06.002>
- Barth, J.R., Lin, C., Ma, Y., Seade, J., Song, F.M., 2013. Do bank regulation, supervision and monitoring enhance or impede bank efficiency? *Journal of Banking & Finance* 37, 2879–2892. <https://doi.org/https://doi.org/10.1016/j.jbankfin.2013.04.030>
- Battese, G.E., Coelli, T.J., 1992. *Frontier production functions, technical efficiency and panel data: With application to paddy farmers in india*. *Journal of Productivity Analysis* 3, 153–169.
- Battese, G.E., Coelli, T.J., 1988. Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data. *Journal of Econometrics* 38, 387–399. [https://doi.org/https://doi.org/10.1016/0304-4076\(88\)90053-X](https://doi.org/https://doi.org/10.1016/0304-4076(88)90053-X)
- Bauer, P.W., Berger, A.N., Humphrey, D.B., 1993. Efficiency and productivity growth in US banking, in: *The Measurement of Productive Efficiency: Techniques and Applications*. pp. 386–413.

- BCBS, 2013. Regulatory consistency assessment programme (RCAP) assessment of basel III regulations - china (Report). Basel Committee on Banking Supervision.
- Bebchuk, L.A., 1999. A rent-protection theory of corporate ownership and control. *Law & Economics eJournal*.
- Beck, T., Demirgüç-Kunt, A., Levine, R., 2006. Bank supervision and corruption in lending. *Journal of Monetary Economics* 53, 2131–2163. <https://doi.org/https://doi.org/10.1016/j.jmoneco.2005.10.014>
- Beck, T., Demirgüç-Kunt, A., Maksimovic, V., 2004. [Bank competition and access to finance: International evidence](#). *Journal of Money, Credit and Banking* 36, 627–648.
- Beck, T., Levine, R., 2002. Industry growth and capital allocation:: Does having a market- or bank-based system matter? *Journal of Financial Economics* 64, 147–180. [https://doi.org/https://doi.org/10.1016/S0304-405X\(02\)00074-0](https://doi.org/https://doi.org/10.1016/S0304-405X(02)00074-0)
- Bellavite Pellegrini, C., Cincinelli, P., Meoli, M., Urga, G., 2022. The contribution of (shadow) banks and real estate to systemic risk in china. *Journal of Financial Stability* 60, 101018. <https://doi.org/https://doi.org/10.1016/j.jfs.2022.101018>
- Berger, A.N., Bouwman, C.H.S., 2013. How does capital affect bank performance during financial crises? *Journal of Financial Economics* 109, 146–176. <https://doi.org/https://doi.org/10.1016/j.jfineco.2013.02.008>
- Berger, A.N., Clarke, G.R.G., Cull, R., Klapper, L., Udell, G.F., 2005. Corporate governance and bank performance: A joint analysis of the static, selection, and dynamic effects of domestic, foreign, and state ownership. *Journal of Banking & Finance* 29, 2179–2221. <https://doi.org/https://doi.org/10.1016/j.jbankfin.2005.03.013>
- Berger, A.N., Hasan, I., Zhou, M., 2010. The effects of focus versus diversification on bank performance: Evidence from chinese banks. *Journal of Banking & Finance* 34, 1417–1435. <https://doi.org/https://doi.org/10.1016/j.jbankfin.2010.01.010>
- Berger, A.N., Hasan, I., Zhou, M., 2009. Bank ownership and efficiency in china: What will happen in the world's largest nation? *Journal of Banking & Finance* 33, 113–130. <https://doi.org/https://doi.org/10.1016/j.jbankfin.2007.05.016>
- Berger, A.N., Herring, R.J., Szegö, G.P., 1995. The role of capital in financial institutions. *Journal of Banking & Finance* 19, 393–430. [https://doi.org/https://doi.org/10.1016/0378-4266\(95\)00002-X](https://doi.org/https://doi.org/10.1016/0378-4266(95)00002-X)
- Berger, A.N., Humphrey, D.B., 1997. Efficiency of financial institutions: International survey and directions for future research. *European Journal of Operational Research* 98, 175–212. [https://doi.org/https://doi.org/10.1016/S0377-2217\(96\)00342-6](https://doi.org/https://doi.org/10.1016/S0377-2217(96)00342-6)
- Berger, A.N., Humphrey, D.B., 1991. The dominance of inefficiencies over scale and product mix economies in banking. *Journal of Monetary Economics* 28, 117–148. [https://doi.org/https://doi.org/10.1016/0304-3932\(91\)90027-L](https://doi.org/https://doi.org/10.1016/0304-3932(91)90027-L)
- Berger, A.N., Molyneux, P., S., W.J.O., 2019. *The oxford handbook of banking*. Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780198824633.001.0001>
- Berle, A.A., Means, G.C.(Gardiner.C., 1932. *The modern corporation and private property*. Macmillan, New York.
- Bhattacharya, S., Arnoud, W.A.B., Thakor, A.V., 1998. The economics of bank regulation. *Journal of Money, Credit and Banking* 30, 745–770. <https://doi.org/10.2307/2601127>

- Bhattacharya, S., Thakor, A.V., 1993. Contemporary banking theory. *Journal of Financial Intermediation* 3, 2–50. <https://doi.org/https://doi.org/10.1006/jfin.1993.1001>
- Bierth, C., Irresberger, F., Weiß, G.N.F., 2015. Systemic risk of insurers around the globe. *Journal of Banking & Finance* 55, 232–245. <https://doi.org/https://doi.org/10.1016/j.jbankfin.2015.02.014>
- Bitar, M., Pukthuanthong, K., Walker, T., 2018. The effect of capital ratios on the risk, efficiency and profitability of banks: Evidence from OECD countries. *Journal of International Financial Markets, Institutions and Money* 53, 227–262. <https://doi.org/https://doi.org/10.1016/j.intfin.2017.12.002>
- Blum, J., 1999. Do capital adequacy requirements reduce risks in banking? *Journal of Banking & Finance* 23, 755–771. [https://doi.org/https://doi.org/10.1016/S0378-4266\(98\)00113-7](https://doi.org/https://doi.org/10.1016/S0378-4266(98)00113-7)
- Boot, A.W.A., Ratnovski, L., 2012. Banking and trading. *IMF Working Papers* 2012, 48. <https://doi.org/https://doi.org/10.5089/9781475511215.001>
- Borio, C.E.V., 2003. Towards a macroprudential framework for financial supervision and regulation? / by claudio borio, BIS working papers, 1020-0959 ; no. 128. Bank for International Settlements, Monetary; Economic Dept, Basle.
- Boyd, J., Hakenes, H., 2008. Looting and gambling in banking crises. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.1099566>
- Boyd, J.H., De Nicoló, G., 2005. *The theory of bank risk taking and competition revisited*. *The Journal of Finance* 60, 1329–1343.
- Brunnermeier, M., Crockett, A., Goodhart, C.A., Persaud, A., Shin, H.S., 2009. The fundamental principles of financial regulation. ICMB, Internat. Center for Monetary; Banking Studies Geneva.
- Burkart, M., Panunzi, F., Shleifer, A., 2003. *Family firms*. *The Journal of Finance* 58, 2167–2201.
- Buser, S.A., Chen, A.H., Kane, E.J., 1981. Federal deposit insurance, regulatory policy, and optimal bank capital. *The Journal of Finance* 36, 51–60. <https://doi.org/10.2307/2327463>
- Calem, P., Rob, R., 1999. The impact of capital-based regulation on bank risk-taking. *Journal of Financial Intermediation* 8, 317–352. <https://doi.org/https://doi.org/10.1006/jfin.1999.0276>
- Calomiris, C.W., Kahn, C.M., 1991. *The role of demandable debt in structuring optimal banking arrangements*. *The American Economic Review* 81, 497–513.
- Cannan, E., Pigou, A.C., 1921. The economics of welfare. *The Economic Journal* 31, 206–213. <https://doi.org/10.2307/2222816>
- Chen, Y., 1999. Banking panics: The role of the first-come, first-served rule and information externalities. *Journal of Political Economy* 107, 946–968. <https://doi.org/10.1086/250086>
- Chiamonte, L., Casu, B., 2017. Capital and liquidity ratios and financial distress. Evidence from the european banking industry. *The British Accounting Review* 49, 138–161. <https://doi.org/https://doi.org/10.1016/j.bar.2016.04.001>
- Chortareas, G.E., Girardone, C., Ventouri, A., 2012. Bank supervision, regulation, and efficiency: Evidence from the european union. *Journal of Financial Stability* 8, 292–302. <https://doi.org/https://doi.org/10.1016/j.jfs.2011.12.001>
- Coase, R.H., 1937. The nature of the firm. *Economica* 4, 386–405. <https://doi.org/https://doi.org/10.1017/S001305160000737>

- [//doi.org/10.1111/j.1468-0335.1937.tb00002.x](https://doi.org/10.1111/j.1468-0335.1937.tb00002.x)
- Colombi, R., Kumbhakar, S.C., Martini, G., Vittadini, G., 2014. Closed-skew normality in stochastic frontiers with individual effects and long/short-run efficiency. *Journal of Productivity Analysis* 42, 123–136. <https://doi.org/10.1007/s11123-014-0386-y>
- Colombi, R., Martini, G., Vittadini, G., 2017. Determinants of transient and persistent hospital efficiency: The case of Italy. *Health Economics* 26, 5–22. <https://doi.org/https://doi.org/10.1002/hec.3557>
- Colombi, R., Martini, G., Vittadini, G., 2011. *A stochastic frontier model with short-run and long-run inefficiency random effects* (Report). Department of Economics; Technology Management, University of Bergamo.
- Cooper, R., Ross, T.W., 2002. *Bank runs: Deposit insurance and capital requirements*. *International Economic Review* 43, 55–72.
- Cornwell, C., Schmidt, P., Sickles, R.C., 1990. Production frontiers with cross-sectional and time-series variation in efficiency levels. *Journal of Econometrics* 46, 185–200. [https://doi.org/https://doi.org/10.1016/0304-4076\(90\)90054-W](https://doi.org/https://doi.org/10.1016/0304-4076(90)90054-W)
- Dagher, J., Dell’Ariccia, G., Laeven, L., Ratnovski, L., Tong, H., 2016. Benefits and costs of bank capital. *Staff Discussion Notes* 2016, A001. <https://doi.org/10.5089/9781498387712.006.A001>
- Davydov, D., Vähämaa, S., Yasar, S., 2021. Bank liquidity creation and systemic risk. *Journal of Banking & Finance* 123, 106031. <https://doi.org/https://doi.org/10.1016/j.jbankfin.2020.106031>
- De Alessi, L., 1980. The economics of property rights: A review of the evidence. *Rsch. in L. & Econ.* 2, 1.
- De Alessi, L., 1974. *AN ECONOMIC ANALYSIS OF GOVERNMENT OWNERSHIP AND REGULATION: THEORY AND THE EVIDENCE FROM THE ELECTRIC POWER INDUSTRY*. *Public Choice* (pre-1986) 19, 1.
- De Angelo, H., Stulz, R.M., 2013. Why high leverage is optimal for banks (Working Paper No. 19139), Working paper series. National Bureau of Economic Research. <https://doi.org/10.3386/w19139>
- De Bandt, O., Hartmann, P., 2019. Systemic risk in banking after the great financial crisis. <https://doi.org/10.1093/oxfordhb/9780198824633.013.27>
- Demirguc-Kunt, A., Detragiache, E., 1997. The determinants of banking crises : Evidence from industrial and developing countries. *Policy research working papers*.
- Demirguc-Kunt, A., Detragiache, E., Merrouche, O., 2013. *Bank capital: Lessons from the financial crisis*. *Journal of Money, Credit and Banking* 45, 1147–1164.
- Demirguc-Kunt, A., Kane, E., 2002. Deposit insurance around the globe: Where does it work? *Journal of Economic Perspectives* 16, 175–195. <https://doi.org/10.1257/0895330027319>
- Demirgüç-Kunt, A., Anginer, D., Mare, D.S., 2018. Bank capital, institutional environment and systemic stability. *Journal of Financial Stability* 37, 97–106. <https://doi.org/https://doi.org/10.1016/j.jfs.2018.06.001>
- Demirgüç-Kunt, A., Huizinga, H., 2010. Bank activity and funding strategies: The impact on risk and returns. *Journal of Financial Economics* 98, 626–650. <https://doi.org/https://doi.org/10.1016/j.jfineco.2010.06.004>

- Demsetz, H., 1966. [Some aspects of property rights](#). *The Journal of Law & Economics* 9, 61–70.
- Demsetz, H., Lehn, K., 1985. [The structure of corporate ownership: Causes and consequences](#). *Journal of Political Economy* 93, 1155–1177.
- Diamond, D.W., 1984. Financial intermediation and delegated monitoring. *Review of Economic Studies* 51, 393. <https://doi.org/10.2307/2297430>
- Diamond, D.W., Dybvig, P.H., 1983. [Bank runs, deposit insurance, and liquidity](#). *Journal of Political Economy* 91, 401–419.
- Djalilov, K., Piesse, J., 2019. Bank regulation and efficiency: Evidence from transition countries. *International Review of Economics & Finance* 64, 308–322. <https://doi.org/https://doi.org/10.1016/j.iref.2019.07.003>
- Dong, Y., Firth, M., Hou, W., Yang, W., 2016. Evaluating the performance of chinese commercial banks: A comparative analysis of different types of banks. *European Journal of Operational Research* 252, 280–295. <https://doi.org/https://doi.org/10.1016/j.ejor.2015.12.038>
- Dong, Y., Girardone, C., Kuo, J.-M., 2017. Governance, efficiency and risk taking in chinese banking. *The British Accounting Review* 49, 211–229. <https://doi.org/https://doi.org/10.1016/j.bar.2016.08.001>
- Doumpos, M., Gaganis, C., Pasiouras, F., 2015. Central bank independence, financial supervision structure and bank soundness: An empirical analysis around the crisis. *Journal of Banking & Finance* 61, S69–S83. <https://doi.org/https://doi.org/10.1016/j.jbankfin.2015.04.017>
- Fama, E.F., 1980. [Agency problems and the theory of the firm](#). *Journal of Political Economy* 88, 288–307.
- Fama, E.F., Jensen, M.C., 1983. [Separation of ownership and control](#). *The Journal of Law & Economics* 26, 301–325.
- Farhi, E., Tirole, J., 2012. Collective moral hazard, maturity mismatch, and systemic bailouts. *American Economic Review* 102, 60–93. <https://doi.org/10.1257/aer.102.1.60>
- Filippini, M., Greene, W., 2016. Persistent and transient productive inefficiency: A maximum simulated likelihood approach. *Journal of Productivity Analysis* 45, 187–196. <https://doi.org/10.1007/s11123-015-0446-y>
- FSB, 2020. [Global monitoring report on non-banking financial intermediation](#) (Report). Financial Stability Board.
- Fu, X., Heffernan, S., 2007. Cost x-efficiency in china’s banking sector. *China Economic Review* 18, 35–53. <https://doi.org/https://doi.org/10.1016/j.chieco.2006.10.002>
- Fungáčová, Z., Klein, P.-O., Weill, L., 2020. Persistent and transient inefficiency: Explaining the low efficiency of chinese big banks. *China Economic Review* 59, 101368. <https://doi.org/https://doi.org/10.1016/j.chieco.2019.101368>
- Fungáčová, Z., Pessarossi, P., Weill, L., 2013. Is bank competition detrimental to efficiency? Evidence from china. *China Economic Review* 27, 121–134. <https://doi.org/https://doi.org/10.1016/j.chieco.2013.09.004>
- Furubotn, E.G., Pejovich, S., 1972. [Property rights and economic theory: A survey of recent literature](#). *Journal of Economic Literature* 10, 1137–1162.
- Gang, J., Qian, Z., 2015. China’s monetary policy and systemic risk. *Emerging Markets*

- Finance and Trade 51, 701–713. <https://doi.org/10.1080/1540496X.2015.1039895>
- Gennaioli, N., Shleifer, A., Vishny, R.W., 2013. A model of shadow banking. *The Journal of Finance* 68, 1331–1363. <https://doi.org/https://doi.org/10.1111/jofi.12031>
- Greene, W., 2005. Reconsidering heterogeneity in panel data estimators of the stochastic frontier model. *Journal of Econometrics* 126, 269–303. <https://doi.org/https://doi.org/10.1016/j.jeconom.2004.05.003>
- Grossman, S.J., Hart, O.D., 1988. One share-one vote and the market for corporate control. *Journal of Financial Economics* 20, 175–202. [https://doi.org/https://doi.org/10.1016/0304-405X\(88\)90044-X](https://doi.org/https://doi.org/10.1016/0304-405X(88)90044-X)
- Grossman, S.J., Hart, O.D., 1986. [The costs and benefits of ownership: A theory of vertical and lateral integration](#). *Journal of Political Economy* 94, 691–719.
- Grossman, S.J., Hart, O.D., 1982. Corporate financial structure and managerial incentives, in: *The Economics of Information and Uncertainty*. University of Chicago Press, pp. 107–140.
- Gunther, J.W., Moore, R.R., 2003. Early warning models in real time. *Journal of Banking & Finance* 27, 1979–2001. [https://doi.org/https://doi.org/10.1016/S0378-4266\(02\)00314-X](https://doi.org/https://doi.org/10.1016/S0378-4266(02)00314-X)
- Haque, F., Brown, K., 2017. Bank ownership, regulation and efficiency: Perspectives from the middle east and north africa (MENA) region. *International Review of Economics & Finance* 47, 273–293. <https://doi.org/https://doi.org/10.1016/j.iref.2016.10.015>
- Hart, O., Moore, J., 1990. [Property rights and the nature of the firm](#). *Journal of Political Economy* 98, 1119–1158.
- Hellmann, T.F., Murdock, K.C., Stiglitz, J.E., 2000. [Liberalization, moral hazard in banking, and prudential regulation: Are capital requirements enough?](#) *The American Economic Review* 90, 147–165.
- Herring, RichardJ., Carmassi, J., 2008. The structure of cross-sector financial supervision. *Financial Markets, Institutions & Instruments* 17, 51–76. <https://doi.org/https://doi.org/10.1111/j.1468-0416.2007.00132.x>
- Heshmati, A., Kumbhakar, S.C., 1994. [Farm heterogeneity and technical efficiency: Some results from swedish dairy farms](#). *Journal of Productivity Analysis* 5, 45–61.
- Hirshleifer, D., Thakor, A.V., 1992. [Managerial conservatism, project choice, and debt](#). *The Review of Financial Studies* 5, 437–470.
- Hirtle, B.J., Stiroh, K.J., 2007. The return to retail and the performance of US banks. *Journal of Banking & Finance* 31, 1101–1133. <https://doi.org/https://doi.org/10.1016/j.jbankfin.2006.10.004>
- Hogan, T.L., 2015. Capital and risk in commercial banking: A comparison of capital and risk-based capital ratios. *The Quarterly Review of Economics and Finance* 57, 32–45. <https://doi.org/https://doi.org/10.1016/j.qref.2014.11.003>
- Hsiao, C., Shen, Y., Bian, W., 2015. Evaluating the effectiveness of china’s financial reform—the efficiency of china’s domestic banks. *China Economic Review* 35, 70–82. <https://doi.org/https://doi.org/10.1016/j.chieco.2015.05.006>
- Huang, Q., De Haan, J., Scholtens, B., 2019. Analysing systemic risk in the chinese banking system. *Pacific Economic Review* 24, 348–372. <https://doi.org/https://doi.org/10.1111/1468-0106.12212>
- Huang, T.-H., Lin, C.-I., Chen, K.-C., 2017. Evaluating efficiencies of chinese commercial

- banks in the context of stochastic multistage technologies. *Pacific-Basin Finance Journal* 41, 93–110. <https://doi.org/https://doi.org/10.1016/j.pacfin.2016.12.008>
- Iannotta, G., Nocera, G., Sironi, A., 2007. Ownership structure, risk and performance in the european banking industry. *Journal of Banking & Finance* 31, 2127–2149. <https://doi.org/https://doi.org/10.1016/j.jbankfin.2006.07.013>
- Jackson, P., 2001. [Bank capital standards: The new basel accord](#).
- Jensen, M.C., 1986. [Agency costs of free cash flow, corporate finance, and takeovers](#). *The American Economic Review* 76, 323–329.
- Jensen, M.C., Meckling, W.H., 1976. Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics* 3, 305–360. [https://doi.org/https://doi.org/10.1016/0304-405X\(76\)90026-X](https://doi.org/https://doi.org/10.1016/0304-405X(76)90026-X)
- Jiang, C., Liu, H., Molyneux, P., 2019. Do different forms of government ownership matter for bank capital behavior? Evidence from china. *Journal of Financial Stability* 40, 38–49. <https://doi.org/https://doi.org/10.1016/j.jfs.2018.11.005>
- Jiang, C., Yao, S., Zhang, Z., 2009. The effects of governance changes on bank efficiency in china: A stochastic distance function approach. *China Economic Review* 20, 717–731. <https://doi.org/https://doi.org/10.1016/j.chieco.2009.05.005>
- Jiang, H., Zhang, J., Sun, C., 2020. How does capital buffer affect bank risk-taking? New evidence from china using quantile regression. *China Economic Review* 60, 101300. <https://doi.org/https://doi.org/10.1016/j.chieco.2019.04.008>
- John, K., Litov, L., Yeung, B., 2008. [Corporate governance and risk-taking](#). *The Journal of Finance* 63, 1679–1728.
- John, K., Saunders, A., Senbet, L.W., 2000. [A theory of bank regulation and management compensation](#). *The Review of Financial Studies* 13, 95–125.
- Kaufman, G.G., Scott, K.E., 2003. [What is systemic risk, and do bank regulators retard or contribute to it?](#) *The Independent Review* 7, 371–391.
- Keeley, M.C., 1990. [Deposit insurance, risk, and market power in banking](#). *The American Economic Review* 80, 1183–1200.
- Keeley, M.C., Furlong, F.T., 1990. A reexamination of mean-variance analysis of bank capital regulation. *Journal of Banking & Finance* 14, 69–84. [https://doi.org/https://doi.org/10.1016/0378-4266\(90\)90036-2](https://doi.org/https://doi.org/10.1016/0378-4266(90)90036-2)
- Koehn, M., Santomero, A.M., 1980. Regulation of bank capital and portfolio risk. *The Journal of Finance* 35, 1235–1244. <https://doi.org/10.2307/2327096>
- Kumbhakar, S.C., 1991. [The measurement and decomposition of cost-inefficiency: The translog cost system](#). *Oxford Economic Papers* 43, 667–683.
- Kumbhakar, S.C., Heshmati, A., 1995. Efficiency measurement in swedish dairy farms: An application of rotating panel data, 1976–88. *American Journal of Agricultural Economics* 77, 660–674. <https://doi.org/10.2307/1243233>
- Kumbhakar, S.C., Wang, H.-J., Horncastle, A.P., 2015. A practitioner’s guide to stochastic frontier analysis using stata. Cambridge University Press, Cambridge. <https://doi.org/DOI: 10.1017/CBO9781139342070>
- La Porta, R., Florencio, L.-S., Shleifer, A., 2002. [Government ownership of banks](#). *The Journal of Finance* 57, 265–301.

- La Porta, R., Florencio, L.-S., Shleifer, A., 1999. *Corporate ownership around the world*. The Journal of Finance 54, 471–517.
- Laeven, L., Levine, R., 2009. Bank governance, regulation and risk taking. Journal of Financial Economics 93, 259–275. <https://doi.org/https://doi.org/10.1016/j.jfineco.2008.09.003>
- Laeven, L., Levine, R., 2007. Is there a diversification discount in financial conglomerates? Journal of Financial Economics 85, 331–367. <https://doi.org/https://doi.org/10.1016/j.jfineco.2005.06.001>
- Laeven, L., Ratnovski, L., Tong, H., 2016. Bank size, capital, and systemic risk: Some international evidence. Journal of Banking & Finance 69, S25–S34.
- Lee, C.-C., Hsieh, M.-F., 2013. The impact of bank capital on profitability and risk in asian banking. Journal of International Money and Finance 32, 251–281. <https://doi.org/https://doi.org/10.1016/j.jimonfin.2012.04.013>
- Lee, C.C., Ning, S.L., Lee, C.C., 2015. How does bank capital affect bank profitability and risk? Evidence from china’s WTO accession. China & World Economy 23, 19–39. <https://doi.org/https://doi.org/10.1111/cwe.12119>
- Lee, T.H., Chih, S.H., 2013. Does financial regulation affect the profit efficiency and risk of banks? Evidence from china’s commercial banks. The North American Journal of Economics and Finance 26, 705–724. <https://doi.org/https://doi.org/10.1016/j.najef.2013.05.005>
- Lešánovská, J., Weill, L., 2016. Does greater capital hamper the cost efficiency of banks? A bi-causal analysis. Comparative Economic Studies 58, 409–429. <https://doi.org/http://dx.doi.org/10.1057/s41294-016-0002-4>
- Lin, K.J., Lu, X., Zhang, J., Zheng, Y., 2020. State-owned enterprises in china: A review of 40 years of research and practice. China Journal of Accounting Research 13, 31–55. <https://doi.org/https://doi.org/10.1016/j.cjar.2019.12.001>
- Liu, S., Xu, Q., Jiang, C., 2021. Systemic risk of china’s commercial banks during financial turmoils in 2010–2020: A MIDAS-QR based CoVaR approach. Applied Economics Letters 28, 1600–1609. <https://doi.org/10.1080/13504851.2020.1839629>
- Meeusen, W., Den Broeck, J. van, 1977. Efficiency estimation from cobb-douglas production functions with composed error. International Economic Review 18, 435–444. <https://doi.org/10.2307/2525757>
- Mehran, H., Morrison, A.D., Shapiro, J.D., 2011. Corporate governance and banks: What have we learned from the financial crisis? FRB of New York Staff Report.
- Mester, L.J., 1997. Measuring efficiency at u.s. Banks: Accounting for heterogeneity is important. European Journal of Operational Research 98, 230–242. [https://doi.org/https://doi.org/10.1016/S0377-2217\(96\)00344-X](https://doi.org/https://doi.org/10.1016/S0377-2217(96)00344-X)
- Morck, R., Shleifer, A., Vishny, R.W., 1988. Management ownership and market valuation: An empirical analysis. Journal of Financial Economics 20, 293–315. [https://doi.org/https://doi.org/10.1016/0304-405X\(88\)90048-7](https://doi.org/https://doi.org/10.1016/0304-405X(88)90048-7)
- Morelli, D., Vioto, D., 2020. Assessing the contribution of china’s financial sectors to systemic risk. Journal of Financial Stability 50, 100777. <https://doi.org/https://doi.org/10.1016/j.jfs.2020.100777>
- Mundlak, Y., 1961. Empirical production function free of management bias. Journal of Farm

- Economics 43, 44–56. <https://doi.org/10.2307/1235460>
- Myers, S.C., 1977. Determinants of corporate borrowing. *Journal of Financial Economics* 5, 147–175. [https://doi.org/https://doi.org/10.1016/0304-405X\(77\)90015-0](https://doi.org/https://doi.org/10.1016/0304-405X(77)90015-0)
- Pasiouras, F., 2008. International evidence on the impact of regulations and supervision on banks' technical efficiency: An application of two-stage data envelopment analysis. *Review of Quantitative Finance and Accounting* 30, 187–223. <https://doi.org/10.1007/s11156-007-0046-7>
- Pasiouras, F., Tanna, S., Zopounidis, C., 2009. The impact of banking regulations on banks' cost and profit efficiency: Cross-country evidence. *International Review of Financial Analysis* 18, 294–302. <https://doi.org/https://doi.org/10.1016/j.irfa.2009.07.003>
- Pessarossi, P., Weill, L., 2015. Do capital requirements affect cost efficiency? Evidence from china. *Journal of Financial Stability* 19, 119–127. <https://doi.org/https://doi.org/10.1016/j.jfs.2014.11.002>
- Repullo, R., 2004. Capital requirements, market power, and risk-taking in banking. *Journal of Financial Intermediation* 13, 156–182. <https://doi.org/https://doi.org/10.1016/j.jfi.2003.08.005>
- Rochet, J.-C., Tirole, J., 1996. Interbank lending and systemic risk. *Journal of Money, Credit and Banking* 28, 733–762. <https://doi.org/10.2307/2077918>
- Roulet, C., 2018. Basel III: Effects of capital and liquidity regulations on european bank lending. *Journal of Economics and Business* 95, 26–46. <https://doi.org/https://doi.org/10.1016/j.jeconbus.2017.10.001>
- Santos, J.A.C., 2001. Bank capital regulation in contemporary banking theory: A review of the literature. *Financial Markets, Institutions & Instruments* 10, 41–84. <https://doi.org/https://doi.org/10.1111/1468-0416.00042>
- Sapienza, P., 2004. The effects of government ownership on bank lending. *Journal of Financial Economics* 72, 357–384. <https://doi.org/https://doi.org/10.1016/j.jfineco.2002.10.002>
- Saunders, A., Strock, E., Travlos, N.G., 1990. Ownership structure, deregulation, and bank risk taking. *The Journal of Finance* 45, 643–654. <https://doi.org/10.2307/2328676>
- Schmidt, P., Sickles, R.C., 1984. Production frontiers and panel data. *Journal of Business & Economic Statistics* 2, 367–374. <https://doi.org/10.2307/1391278>
- Shleifer, A., 2005. Understanding regulation. *European Financial Management* 11, 439–451. <https://doi.org/https://doi.org/10.1111/j.1354-7798.2005.00291.x>
- Shleifer, A., 1998. [State versus private ownership](#). *The Journal of Economic Perspectives* 12, 133–150.
- Shleifer, A., Vishny, R.W., 2010. Unstable banking. *Journal of Financial Economics* 97, 306–318. <https://doi.org/https://doi.org/10.1016/j.jfineco.2009.10.007>
- Shleifer, A., Vishny, R.W., 1997. A survey of corporate governance. *The Journal of Finance* 52, 737–783. <https://doi.org/10.2307/2329497>
- Shleifer, A., Vishny, R.W., 1994. Politicians and firms. *The Quarterly Journal of Economics* 109, 995–1025. <https://doi.org/10.2307/2118354>
- Shleifer, A., Vishny, R.W., 1986. [Large shareholders and corporate control](#). *Journal of Political Economy* 94, 461–488.
- Smith, C.W., Warner, J.B., 1979. On financial contracting: An analysis of bond covenants.

- Journal of Financial Economics 7, 117–161. [https://doi.org/https://doi.org/10.1016/0304-405X\(79\)90011-4](https://doi.org/https://doi.org/10.1016/0304-405X(79)90011-4)
- Stigler, G.J., 1971. The theory of economic regulation. The Bell Journal of Economics and Management Science 2, 3–21. <https://doi.org/10.2307/3003160>
- Stiglitz, J., 1993. The role of the state in financial markets. The World Bank Economic Review 7, 1.
- Stulz, R.M., 2005. [The limits of financial globalization](#). The Journal of Finance 60, 1595–1638.
- Tan, Y., Floros, C., 2013. Risk, capital and efficiency in chinese banking. Journal of International Financial Markets, Institutions and Money 26, 378–393. <https://doi.org/https://doi.org/10.1016/j.intfin.2013.07.009>
- Tirole, J., 1994. [The internal organization of government](#). Oxford Economic Papers 46, 1–29.
- Tsionas, E.G., Kumbhakar, S.C., 2014. FIRM HETEROGENEITY, PERSISTENT AND TRANSIENT TECHNICAL INEFFICIENCY: A GENERALIZED TRUE RANDOM-EFFECTS model. Journal of Applied Econometrics 29, 110–132. <https://doi.org/https://doi.org/10.1002/jae.2300>
- Tzouvanas, P., 2024. Can market risk explain the systemic risk? Evidence from the US banking industry. Journal of Economic Studies 51, 165–184. <https://doi.org/10.1108/JES-12-2022-0664>
- Von Thadden, E.-L., 2004. Bank capital adequacy regulation under the new basel accord. Journal of Financial Intermediation 13, 90–95. <https://doi.org/https://doi.org/10.1016/j.jfi.2003.04.002>
- Wang, G.-J., Jiang, Z.-Q., Lin, M., Xie, C., Stanley, H.E., 2018. Interconnectedness and systemic risk of china’s financial institutions. Emerging Markets Review 35, 1–18. <https://doi.org/https://doi.org/10.1016/j.ememar.2017.12.001>
- Wang, K., Huang, W., Wu, J., Liu, Y.N., 2014. Efficiency measures of the chinese commercial banking system using an additive two-stage DEA. Omega 44, 5–20. <https://doi.org/https://doi.org/10.1016/j.omega.2013.09.005>
- Yuan, W., 2006. [Corporate banking in china: History, opportunities, and challenges | celent](#).
- Zhang, D., Cai, J., Dickinson, D.G., Kutan, A.M., 2016. Non-performing loans, moral hazard and regulation of the chinese commercial banking system. Journal of Banking & Finance 63, 48–60. <https://doi.org/https://doi.org/10.1016/j.jbankfin.2015.11.010>
- Zhang, X., Fu, Q., Lu, L., Wang, Q., Zhang, S., 2021. Bank liquidity creation, network contagion and systemic risk: Evidence from chinese listed banks. Journal of Financial Stability 53, 100844. <https://doi.org/https://doi.org/10.1016/j.jfs.2021.100844>
- Zhu, W., Yang, J., 2016. State ownership, cross-border acquisition, and risk-taking: Evidence from china’s banking industry. Journal of Banking & Finance 71, 133–153. <https://doi.org/https://doi.org/10.1016/j.jbankfin.2016.05.004>