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**Market competition, efficiency and
profitability: an empirical study on the
Chinese banking industry 1997-2006**

by

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Abstract

Since the economic reform was initiated in 1978, the Chinese banking sector has undergone significant changes, particularly during the period under our investigation. This is primarily induced by the WTO entry in 2001, which brought in to full openness the financial market in China. The ultimate objective of the recent banking reform is to promote competition and efficiency as a way of improving the overall competitiveness and banking performance, in order to cope with challenges from foreign competitors.

With the purpose of examining whether the recent banking reform is effective in achieving the targets as well as suggesting future policy directions, this study investigates market competition, cost efficiency and profitability in the Chinese banking industry over those critical years (1997-2006) before and after the WTO entry. We first employ both structural (the SCP) and non-structural (the Panzar-Rosse) approach to evaluate market competition. Then we estimate cost efficiency for Chinese banks under the Stochastic Frontier Approach (SFA). Finally, we assess the relationship between profitability and market structure under the structure-performance hypothesis and the efficient-structure hypothesis.

Our findings show that Chinese banking market become less concentrated and more competitive since the WTO entry. Chinese banks improve their cost efficiencies, with state-owned banks are the least efficient while joint equity banks are the most efficient. The explanation for the relationship between profitability and market structure is quite mixed. The acceptance of which hypothesis depends on which dependent variable is used.

Key words: Market structure, Competition, Stochastic Frontier Approach, Cost efficiency, Bank performance, Shadow return on equity, Chinese banking reform

Dedication

To

My parent, Qifen Fan and Wuxiu Yang

Thank you for your unconditional sacrifice and tolerance.
Without your unending support and love from childhood to now, I never
would have achieved this and pass any of the tough times in my life.

I owe you my whole life and love you forever.

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If I have seen further it is only by standing on the shoulders of giants.

Sir Isaac Newton

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Abbreviations

- ABC: Agricultural Bank of China
- AE: Allocative efficiency
- AMC: Asset Management Company
- Basel II: New Basel Capital Accord of 2004
- B&C 92: Battese and Coelli (1992)
- B&C 95: Battese and Coelli (1995)
- BOC: Bank of China
- BOCOM: Bank of Communications
- CAR: Capital adequacy ratio
- CBRC: China Banking Regulatory Commission
- CCBs: City commercial banks
- CCB: China Construction Bank
- CE: Cost efficiency
- CITIC: China International Trust and Investment Corporation
- CMCV: Conditional mean conditional variance
- CR: Concentration ratio
- CRS: Constant return to scale
- DEA: Data Envelopment approach
- ES: Efficient structure
- ESS: Scale efficient structure
- ESX: X-efficient structure
- FE: Fixed effect
- FF: Fourier-flexible
- GDP: Gross domestic product
- FGLS: Feasible generalised least squares
- GMM: Generalised method of moments

HHI: Herfindahl-Hirschman index
ICBC: Industrial and Commercial Bank of China
JSCB: Joint stock commercial bank
LR: Log likelihood
LSDV: Least square dummy variable
MLE: Maximum likelihood estimation
NPL: Non-performing loan
OLS: Ordinary least squares
P-R: Panzar Rosse
PBoC: People's Bank of China
P&L: Pitt and Lee
QL: Quiet life
RCCs: Rural credit cooperatives
RE: Random effect
RMB: Renmingbi (Chinese currency)
RMP: Relative market power
ROA: Return on assets
ROE: Return on equity
SCP: Structure conduct performance
SROE: Shadow return on equity
SE: Scale efficiency
SFA: Stochastic Frontier approach
SME: Small and medium enterprise
SOB: State-owned bank
TE: Technical efficiency
TIC: Trust and Investment Company
UCCs: Urban credit cooperatives
WTO: World Trade Organisation

Chapter 1: Introduction

1.1 The motivation of the research

Banking competition has always been the center of debate in the economic literature. It is controversial because competition in the banking sector can be both beneficial and detrimental (Canoy et al 2001, Berger et al 2009, and Liu et al 2010). On the one hand, banking competition is generally expected to have positive impact on the level of efficiency, price, quality, innovation and international competitiveness (Claessens and Laeven 2004). Specifically, higher competition encourages banks to enhance their efficiencies (reduce costs), lower prices, improve quality of products and services, promote (technological and financial) innovations, and finally result in increase in profitability and competitiveness. On the other hand, competition may hamper financial stability through excessive risk taking by banks. To the extreme case, such risky behaviour will cause financial crisis, such as the financial crisis in 2008. These potential impacts always make regulators face a dilemma in a trade-off between competition and instability. Moreover, the expected gains and losses are also a particularly major issue for countries in which capital markets are underdeveloped and banks represent the main channel for finance, as is the case in China.

China, one of the fast growing economies in the world, sustained the phenomenon of continuous annual GDP growth around 9% for the last three decades since the economic reform has been initiated in 1978 (CBRC report 2008). As part of the economic reform, China's banking sector has undergone gradual but profound reforms before the WTO entry. Since China's accession into the WTO in 2001, the pace and strength of the banking reform

has been accelerated and intensified, in order to cope with challenges from foreign banks under the WTO agreement which required full openness of Chinese financial market. The ultimate objective of the recent banking reform implemented by the Chinese government is to build an efficient, competitive and stable banking system in order to improve its profitability and competitiveness.

The banking sector is the most important player in the Chinese financial system. The total assets of China's banking sector amounted to RMB 43.95 trillion (US\$ 5.81 trillion) in 2006 and accounted for 87% of the total assets in the entire financial sector (CBRC report 2006). Although the capital market in China is also growing fast, it is still underdeveloped and incomplete. Banks continue to dominate China's financial landscape as indirect financing remains the main channel of financing for business enterprises in China. In 2006, approximately 83% of financing was still through banks, while stocks were only 5% and bonds 12% (11% government bonds and 1% corporate bonds) (CBRC report 2006). Moreover, the banking system is the main financier of state-owned enterprises (SOEs) which contributed 43.5% of China's GDP 2006, so that bank reform (1997-2006) will have a direct impact on the Chinese economy through the SOEs. Additionally, the Chinese banking market is so large that the way in which the reform is resolved could have systemic consequences. More details about the Chinese banking sector and recent banking reform (1997-2006) will be discussed in Chapter 2.

1.2 The objective and contribution of the study

Despite a substantial amount of empirical literature exists in the American and European banking systems and the gradually increasing empirical evidence pertaining to developing countries, only a few empirical studies have been undertaken in the Chinese banking sector. It is insufficient to match the importance of China in the world economy today. As the vital

role of banking sector in China and significant changes under the recent banking reform (1997-2006), this thesis describes and assesses China's recent ongoing banking reform to help draw conclusions and recommendations, which may be of interest to policy makers, regulators and economists.

The main objective of this study is to assess and evaluate the market competition, cost efficiency and profitability in the Chinese banking sector during those critical years before and after the WTO entry in 2001, when Chinese banks experienced significant changes under the recent banking reform. In particular, this study attempts to address the following questions:

1. Estimate the level of market competition in the Chinese banking sector by using both the traditional structure conduct performance (SCP) model and the new empirical industrial organization (NEIO) approach: the Panzar-Rosse method
2. Assess the impact of the recent banking reform on the competition in the Chinese banking market
3. Measure the cost efficiency for Chinese banks by employing the stochastic frontier approach (SFA)
4. Examine price elasticity, economies of scale and shadow return on equity
5. Compare and check the consistency of the results under different models
6. Compare the level of cost efficiency based on ownership differences
7. Investigate the impact of the recent banking reform on the cost efficiency in the Chinese banking market
8. Explore the relationship among profitability, market power and efficiency in the Chinese banking industry by following the Berger's (1995) methodology.

The five expected contributions of this research are listed below

1. Provide an excellent and concise introduction to the Chinese banking system as well as the recent banking reform in China
2. Fill the literature gap by measuring and examining competition and efficiency in the Chinese banking market
3. Use a comprehensive and recent dataset to provide updated evidence
4. Define and measure the shadow return on equity, i.e. the shadow price of the capital constraint and utilize it as alternative measure of profitability in the model specification
5. Help draw conclusions about the effectiveness of the Chinese banking reform and provide recommendations on the direction of future policy

1.3 The structure of the thesis

The whole thesis is organized in eight chapters as follows:

Chapter 2: Overview of China's banking system, current reforms and the WTO accession

This chapter provides the background which is necessary and essential for understanding the empirical analysis of the Chinese banking sector presented in subsequent chapters of this thesis. It mainly overviews the structure of Chinese banking system as well as the banking reforms and institutional arrangement for WTO accession in 2001. We first briefly review the current banking reforms which have been motivated by the full openness of Chinese financial market under the WTO requirement. Then we explain the detailed arrangement of China's WTO accession as well as discuss challenges that the Chinese banks have to face after the WTO entry. Finally, we outline the institutional mechanisms and structure of the Chinese banking sector and summarize some important features of the Chinese banking sector.

Chapter 3: Market competition in Chinese banking industry: application of traditional Structure Conduct Performance (SCP)

The competitive environment in which banks operate has long been of interest to researchers and policymakers. Most of the early literature on competition in banking markets was based on the structure-conduct-performance (SCP) paradigm which claims that bank performance is positively related to market concentration. The aim of this chapter is to test the validity of the SCP hypothesis in Chinese banking market. Our empirical results find no support for the traditional SCP hypothesis as explanation for the bank performance in the Chinese banking industry during the period under consideration. This is mainly due to the weakness of the SCP model itself, and motivates us to adopt more advanced approach Panzar-Rosse method and Berger's (1995) method in Chapter 4 and Chapter 6.

Chapter 4: Market competition in the Chinese banking industry: application of new empirical industrial organization (NEIO) Panzar-Rosse approach

In this chapter, we extend the previous market competition literature by employing the new empirical industrial organization (NEIO) Panzar-Rosse model to empirically estimate the competitive bank behaviour in China between 1997 and 2006. Four alternative specifications for dependent variable (bank performance) are employed in the model, we find out that all different specifications report similar values of Panzar-Rosse H statistics, which lead to the same conclusion that Chinese banks operate under condition of monopolistic competition rather than monopoly in such highly concentrated market in China. The results also show that current banking reform is effective in improving market competition.

Chapter 5: Cost efficiency and shadow return on equity in Chinese banking industry

This chapter investigates the efficiency level from cost perspective in the Chinese commercial banking market. In our study, we employ six models under the stochastic frontier approach to ensure the robustness of our results, namely, the fixed effect model, random effect model, Pit and Lee model, Battese and Coelli 1992 model, Battese and Coelli 1995 model, and conditional mean conditional variance model. We first assess the efficiency level and efficiency change for our sample of banks as a whole. Then we carry out a similar analysis for three sub-groups based on ownership differences. In addition, we carry out rank correlation tests to check efficiency consistency and conduct monotonicity and concavity tests to check the properties of the translog cost function.

Our results show clear evidence that the cost efficiency of the Chinese commercial banks is greatly enhanced over our examination period, and the gap among different ownership types of banks has shrunk. The improved cost efficiency enjoyed by Chinese banks shows that they reacted positively to the recent banking reforms which focus on improving their asset quality, capital adequacy, profitability and competitiveness.

In this chapter, we also measure the shadow return on equity which is derived from the cost function. And we find out that the shadow return on equity turns to be negative after recapitalization. This might suggest that efficiency gains may be offset by the recapitalization cost.

Chapter 6: Explaining profitability in the Chinese banking industry: the structure conduct performance hypothesis vs the efficient-structure hypothesis

This chapter analyses what explains the profitability of the Chinese commercial banks for the period 1997-2006 under the debate of the traditional structure-performance hypothesis

and the efficient-structure hypothesis. This study follows the test developed by Berger (1995) which incorporated direct measures of efficiency and integrate four specific hypotheses in the regression, namely the traditional structure-conduct-performance (SCP), relative market power (RMP), X-efficiency (ESX) and scale efficiency (ESS). We innovate Berger's study by incorporating computed shadow return on equity as an alternative measure of profitability. Moreover, we test the 'quiet life' hypothesis in addition to the above four typical hypotheses in Berger's test.

Chapter 7: Conclusion

Finally, Chapter 7 summarises the main findings of our study and discusses policy recommendations based on our evaluation as well as suggestions for future research directions.

Chapter 2: Overview of China's banking system, current reforms and the WTO accession

Since the Chinese economic reform was started in 1978 which aimed to transform China's stagnant, impoverished planned economy into a market economy capable of generating strong economic growth and increasing the well-being of Chinese citizens, China's economy experienced one of the world's biggest booms. China is playing an increasingly important role in the world's economy (world trade in particular) and is widely seen as world factory and an engine of world growth. After three decades of change, the success of China's economic reform has resulted in massive changes in the Chinese economy. The unprecedented economic growth occurred, with the real GDP increasing by 9.5% on average a year (see Table 2.1). China's economy became the second largest after the US, based on the GDP figure, and poverty was reduced, as indicated by the GDP per capita growth (see Figure 2.1).

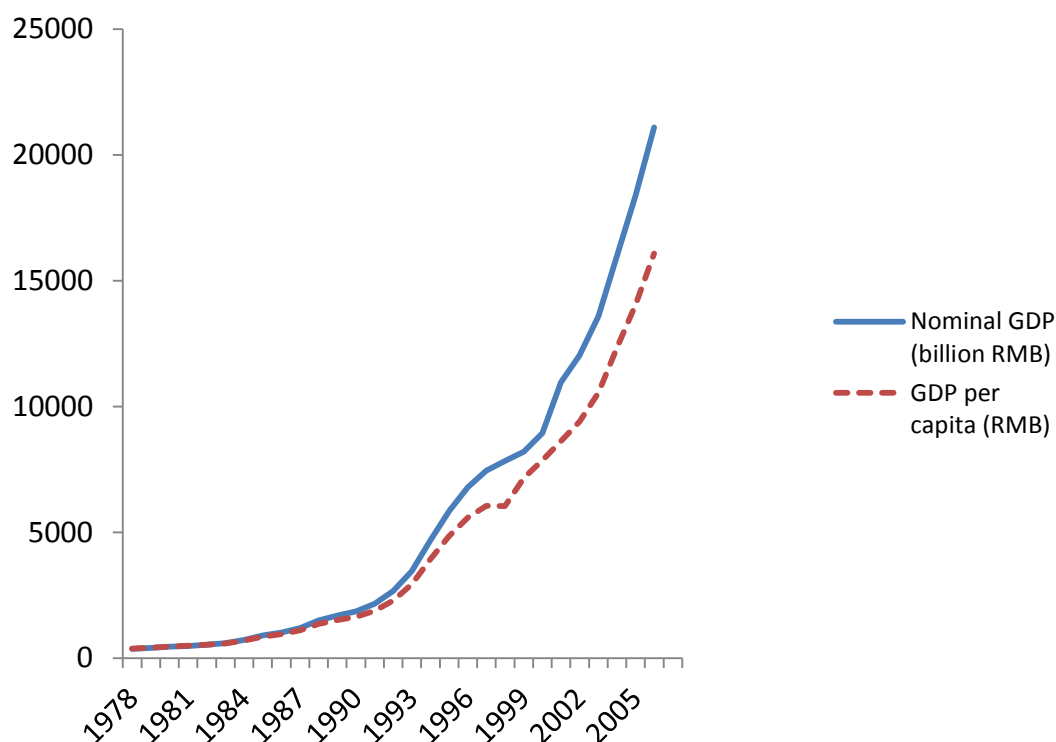
As part of the economic reform¹, the Chinese financial sector has experienced significant institutional and structural changes over the last thirty years. Because of the incomplete development of capital market in China, the Chinese financial system is heavily dominated by banks. The main objective of this chapter is to give a introduction about the banking system in China as well as summarize several main features characterizing the Chinese banking system. Moreover, we review recent banking reforms and the detailed arrangement of the WTO accession. In particular, this chapter provides the background which is essential

¹ Economic reforms occurred in two stages. The first stage, in the late 1970s and 1980s, involved the decollectivization of agriculture, the opening up of the country to foreign investment, and permission for entrepreneurs to start up businesses. The second stage of reform, in the 1990s, involved the privatization and contracting out of state-owned enterprises and reforming the financial sector.

Table 2.1: China's nominal GDP, nominal GDP per capita and GDP growth rate at constant prices from 1978-2006

Year	Nominal GDP (Billion RMB)	Nominal GDP per capita (RMB)	Real growth rate %
1978	362.4	379	11.7
1979	403.8	417	7.6
1980	451.8	460	7.8
1981	486.2	489	5.2
1982	529.5	525	9.1
1983	593.5	580	10.9
1984	717.1	692	15.2
1985	896.4	853	13.5
1986	1,020.2	956	8.8
1987	1,196.3	1,104	11.6
1988	1,492.8	1,355	11.3
1989	1,690.9	1,512	4.1
1990	1,854.8	1,634	3.8
1991	2,161.8	1,879	9.2
1992	2663.8	2,287	14.2
1993	3,463.4	2,939	13.5
1994	4,675.9	3,923	12.6
1995	5,847.8	4,854	10.5
1996	6,788.5	5,576	9.6
1997	7,446.3	6,054	8.8
1998	7,834.5	6,038	7.8
1999	8,206.8	7,159	7.1
2000	8,946.8	7,858	8
2001	10,965.5	8,622	8.3
2002	12,033.3	9,398	9.1
2003	13,582.3	10,542	10
2004	15,987.8	12,336	10.1
2005	18,386.8	14,040	9.9
2006	21,087.1	16,084	11.1

Source: Financial yearbook published by the China National Bureau of Statistics

Figure 2.1: China's nominal GDP and nominal GDP per capita from 1978-2006

for understanding the empirical analysis of the Chinese banking sector presented in subsequent chapters of this thesis.

The rest of this chapter is organized as follows. Section 2.1 will briefly review the banking reforms which have taken place over the last decade. Section 2.2 outlines the institutional mechanisms and structure of the Chinese banking sector. Section 2.3 summarizes some important attributes of the Chinese banking sector. Finally, Section 2.4 will explain the arrangement of China's WTO accession as well as discuss challenges that the Chinese banks have to face after the WTO entry.

2.1 Current reforms in the Chinese banking industry

In spite of rapid economic growth in China and fast expansion in banking sector, the whole banking system is highly inefficient and wasteful. In order to ensure that the banking sector will be able to support continued rapid economic growth, substantial effort has been made to reform China's banking system over the last three decades since the economic reform proposed in 1978, including regulatory reforms in the 1980s and 1990s, introduction of competition from foreign banks entry in the 1990s, and substantial reforms following China's World Trade Organization (WTO) entry in 2001. In the following, we provide some background information on the reforms in the Chinese banking industry.

The banking reform in China can be classified into three distinct periods. The first period is known as dated from 1979 to 1989. The second period is recognized as started from 1990 until 1996. And the third period is identified from 1997 to 2006. We will briefly explain the first two periods, and concentrate more on the third period which is more recent and has much more influences.

2.1.1 First period 1979-1989 (institutional change from mono-bank system to multi layered system)

The reform of the Chinese banking system started with an institutional shake-up. Prior to 1979, the Chinese banking system followed a mono-bank model, where the People's Bank of China (PBOC) combined the roles of central and commercial banking. The first and the foremost important step was replacing the mono-bank system with a multi layered system that separates commercial activities from central banking functions. In September 1983, a true central bank was created: the People's Bank of China. By establishing four state-owned

specialised banks – Bank of China (BOC), Agricultural Bank of China (ABC), Industrial and Commercial Bank of China (ICBC) and China Construction Bank (CCB), with each having its own specific business focus, the PBOC was left to focus on its central banking responsibilities alone. Furthermore, a number of new medium and small-sized commercial banks were established with the objective of providing competition for the Big Four banks, such as the joint stock commercial banks and city commercial banks. In addition, non-banking financial institutions, such as investment and trust corporations and insurance companies, also emerged and multiplied during this period.

2.1.2 Second period 1990-1996 (separation of commercial banking activities from policy lending activities and legislative reform)

Since the quality of SOCBs assets deteriorated significantly², the government started to reconsider their political interventions on bank lending decisions. The second period was characterized by the separation of commercial banking activities from those policy lending activities which were designed for economic development. To fulfil this objective, three policy lending banks were established in 1994, namely China Development Bank (CDB), China Export-Import Bank (EXIM) and China Agricultural Development Bank (CADB), in order to take over all policy lending from SOCBs for development purposes and transform the Big Four into true commercial banks. Moreover, two major legislative reforms occurred in 1995. One is the Central Bank Law which was enacted in March, 1995. The Central Bank

² Stated-owned commercial banks served as policy-lending institutions for the government, and provided loans to state-owned enterprises (SOEs). Policy loans have accounted for more than one third of total loans for SOCBs. The industrial reforms which began in 1984 made the number of loss-making SOEs dramatically increased. As a result, the state-owned banks accumulated an enormous volume of non-performing loans.

Law further enhanced the legal status of the Peoples' Bank of China and reduced government intervention. According to this law, three main responsibilities of the PBOC were specified: monetary stability, banking supervision and oversight of the payments system. Another is the Commercial Banking Law which was also approved in 1995. It aims to establish a diversified market-oriented and independent modern banking system. Also it defines a series of requirements for commercial banks to encourage market-based management and pricing principles.

2.1.3 Third period 1997-2006 (market-oriented reform)

The third period from 1997 to 2006 was highlighted by marketization, as the reform in this period aimed to transform the Chinese banking industry into a modern, more flexible and market-oriented banking system. This effort has been largely motivated by the prospects of facing increased foreign competition in the banking market under the World Trade Organization's (WTO) requirements since China's entry in 2001. The latest reforms signal to the rest of the world that China is truly going to modernize its banking system, however this take place gradually through last ten years.

China successfully joining in the WTO in 2001 set the background for this phase of reform. Once the transition period (2002-2006) ended in 2006, for the first time the Chinese banking industry would be fully exposed to international competition. However, according to current performance, the Chinese banks are far less able to compete with those foreign rivals. Chinese banks exhibit weaknesses in many aspects, such as the efficiency, profitability, assets quality, international network, variety of products, technologies, financial innovations, staff quality and corporate governance etc. Therefore, in order to cope with the pressure and challenge from the entry of foreign banks, it is quite urgent to accelerate and intensify the reform progress for domestic banks. As the state-owned commercial banks (SOCBs) play a

vital role in China's economic and social developments as well as they take a leading role in the country's banking system, unquestionably, the reform of the state-owned banks should be given high priority in restructuring the banking industry and set them as the primary targets for the reform. In the following, we will discuss recent reform process based on three main pillars, namely restructure of the state-owned banks, reduced government intervention and strengthened regulation and supervision.

2.1.3.1 Restructure of the state-owned banks

The first pillar is bank restructuring, also known as bank recapitalization. Bank restructuring has probably been the most important pillar of current phase bank reform since poor asset quality, coupled with very low capitalization was a very serious problem. Bank restructuring has mainly focused on the SOCBs because of their formidable sizes and systemic natures.

As we have mentioned above, in previous decades, many years of government-directed lending has presented the Chinese state-owned banks with a large accumulated amount of NPLs which has become unmanageable by banks themselves. Without the government's financial support, it would take much longer for the state-owned banks to clean up their balance sheet. Hence, the government plays an indispensable role in providing invaluable assistance to the Big Four to effectively reduce their NPLs. As a result, a series of strategic reforms were deployed as well as sequential steps were arranged for the state-owned banks. Three steps can be clearly identified for the restructure process of the SOCBs. The first step is government capital injections for dealing with NPLs. The second step is diversifying the ownership structure by introducing foreign strategic investors to become joint-shareholding companies. The last step is seeking opportunities for stock market listing. Each step will be explained in turn below.

In order to accomplish the first step that reduces the NPLs and rehabilitate the balance sheets of the four largest state-owned banks, government established four asset management companies (AMCs) to take over and deal with ‘bad loans’ (approximately over US\$ 1600 billion in total) from the Big Four state-owned banks by using foreign exchange reserves from the central bank³. China has used part of its international trade surplus to recapitalize its underperforming banking system, a form of indirect foreign investment. Before the WTO accession, the government has injected more than US\$ 160 billion to recapitalize the four largest banks and has transferred US\$ 200 billion worth of NPLs out of these banks in 2001 alone. At the end of 2006, the total value of such transfers was about US\$ 432 billion, about 18% of China’s 2006 GDP.

The government capital injection enabled the Big Four to reduce both the absolute amount of NPLs and the NPLs ratio. With the combination of rapid credit expansion, implementation of conservative lending policies and tough over-sight by the regulator, the Chinese banking sector has clearly made enormous progress in dealing with the NPLs problem. The central bank figures showed the total outstanding amount of NPLs for SOCBs at the end of 2006 had fallen by half of the original amount in 2002, but still totalled RMB 1170 billion. The NPLs ratio fell from 19.8 % at the end of 2003 to 8.7% in 2006.

After dealing with the NPLs problem, the ‘Big Four’ started to seek for foreign strategic investors. As joint stock banks and some of city commercial banks have healthier balance sheet and better asset quality, they also follow the footsteps of the SOCBs by hunting for foreign strategic investors. By the end of 2006, a total of 20 overseas strategic investors have

³ The four AMCs were established in 1999, namely Orient AMC, Great Wall AMC, Cinda AMC and Huarong AMC. They are legally independent agencies and originally designed to assign one AMC to each state-owned bank. Cinda AMC was assigned to CCB, Oriental AMC was assigned to BOC, Great Wall AMC was assigned to ABC, and Huarong AMC was assigned to ICBC. These AMCs were under the supervision of the PBOC. They are responsible for collecting NPLs, repacking them through restructuring or converting into viable assets, and sell them off to investors. They are also responsible for issuing bonds and borrowing from financial institutions to pay for the NPLs they receive. Finally, they are also in charge of restructuring SOEs and recommending companies for listing.

been introduced by 25 Chinese commercial banks, providing equity worth US\$ 18.1 billion.

The four state-owned banks are playing an important role in the banking market as they account for about 75 percent of the country's banking business volume, so keeping a controlling share in the state's hands is crucial for the big four banks to operate in a sound way, which will enable them to have a relatively stable shareholding structure. Current regulation regarding foreign equity investment in the Chinese financial institutions is that a single foreign investor can hold up to a 20% ownership stake in a domestic bank, and total foreign investments in one domestic bank are not permitted to exceed 25 % of total equity. Therefore, foreign strategic investors have only been permitted to take a minority stake in the Chinese banks. This may be because the ultimate purpose of the introduction of foreign investors is not for their capital, but for introducing advanced foreign management practices, expertise, and standardized corporate governance to improve internal control and management, and promote financial innovations. In addition to bring in foreign strategic investors, some private entrepreneurs also are invited to buy a minority stake.

Following the introduction of strategic investors, the state-owned banks prepared to go public. This step is viewed as the most important part of the financial reforms in China. The previous two steps: NPLs write off and the introduction of foreign strategic investors actually serve as preparation to achieve the goal of listing finally. The government officials believe going public will prompt the banks to speed up their reforms. The aim of the state-owned banks' going public is not just to broaden fund procurement channels for them, but also for transparency in operation, establishing corporate governance, and enhancing competition capability with overseas rivals.

The China Construction Bank (CCB) was selected as pilot, the first among the big four state-owned banks to seek stock market listing. It went public in Hong Kong in 2005. Its IPO raised US\$ 9 billion funds. A foreign strategic investor, Bank of America acquired a 9

percent stake for US\$ 3 billion. Temasek Holdings bought US\$ 2.47 billion for a 5.88 percent stake. After the success of the CCB's IPO, two other state-owned banking giants, the Bank of China (BOC) and the Industrial and Commercial Bank of China (ICBC) went public one year later in June and October 2006 respectively.

The BOC raised US\$9.7 billion from its IPO on Hong Kong stock exchange. The bank held another IPO on the Shanghai Stock Exchange in the same year, raising around RMB 20 billion (US\$2.5 billion). The Royal Bank of Scotland Group purchased a US\$3.1 billion investment which would give the British bank control of 10 percent stake in the Bank of China. Further investments were made by Swiss bank UBS AG who acquired 1.6%, and Temasek Holdings gained 5.0%.

China's largest commercial bank by total assets, the ICBC was simultaneously listed on both the Hong Kong Stock Exchange and Shanghai Stock Exchange in October 2006. It created the world's largest IPO to date, surpassing the previous record US\$18.4 billion IPO created by Japan's NTT in 1998. It is also the first Chinese company to debut simultaneously on both the Hong Kong and Shanghai stock exchanges. The ICBC raised US\$19.1 billion in total, with US\$14 billion in Hong Kong and another US\$5.1 billion in Shanghai. A group of foreign strategic investors invested \$3.78 billion in total for a 10% stake in the ICBC. Goldman Sachs invested US\$2.6 billion for a 7% stake. Allianz Group paid US\$1 billion for 2.5% of the ICBC, while American Express invested an additional US\$216 million. Goldman Sachs agreed to offer support in related business areas such as asset management, investment banking, disposing of non-performing assets, risk management and internal control systems. Allianz Group pledged to sell insurance and asset-management services to the ICBC's clients. American Express had an agreement to issue American Express branded credit cards through the ICBC.

By the end of 2006, the Agricultural Bank of China (ABC) is the only state-owned bank

among the Big Four remained unlisted due to the bank's unusually large amount of non-performing loans. For preparing the ABC listing, the government made a bigger investment in the ABC than in the other three banks to further write off non-performing loans and improve the capital-adequacy ratio and the balance sheet. It has required capital injection of about RMB 900 billion (US\$115 billion) in total. The ABC was the last among the Big Four in China to go public in 2010. It was listed on both the Shanghai Stock Exchange and the Hong Kong Stock Exchange. It created the world's biggest IPO (US\$22.1 billion) surpassing the one set by the ICBC (US\$21.9 billion) in 2006.

The successful reform of China's state-owned commercial banks has substantially improved the asset quality and enhanced the international image of the Chinese banks. Becoming public firms help banks improve their performances, as listed firms are subject to greater transparency, tighter supervision and close scrutiny by regulators and shareholders. Now almost all major Chinese commercial banks follow the roadmap of the state-owned banks reform and have formulated plans to seek market listing with the aim of improving their structure, operations and corporate governance. It is a tough task for Chinese banks to shift to “commercial banks” in real sense, and there is still a long way to go after public listing. However, the massive injections of additional equity capital by the state will/may have implications for the shadow of return on equity and this is an issue that will be tested in Chapter 5 later in the thesis.

2.1.3.2 Financial liberalization and government intervention reduction

Financial liberalization and reduction of government intervention in the banking market is another important pillar of the recent banking reform in China. For quite a long time, government intervention in the Chinese banking system was massive and still is, in certain aspects. Liberalization efforts aim to eliminate several major obstacles hindering the

formation of a competitive environment for the banking industry in China. Financial liberalization has been undertaken from several aspects, such as freeing interest rates by introducing market mechanism on pricing, opening up to foreign competition and liberalizing exchange rate controls.

Reducing the government intervention in the banking system started in the 1990s with a number of different actions. An important one was the reduction of reserve requirements from 20 to 8 percent in 1998 and again to 6 percent in 1999⁴. Moreover, the remuneration of excess reserves was lowered to discourage banks from hoarding liquid assets and encourage them to manage their assets. Furthermore, the SOCBs were given more responsibility for their lending decisions and some of their credit quotas were removed. Another important step was taken in 1999, when government interference in commercial lending was restricted, and private capital was allowed to enter JSCBs and CCBs.

Moreover, domestic banks are encouraged for financial innovation to increase their competitiveness. Banks should develop and innovate new products and services in addition to their core business, such as mortgage, credit card, online banking service and portfolio investment. In addition, the PBOC encouraged banks to diversify their portfolios by increasing their services to the private sector and consumers. In July 2000, a personal credit rating system was launched and used to assess consumer credit risk and set rating standards. This was seen as an important move in developing China's consumer credit industry and increase bank's evaluation and supervision ability over loans to individuals.

Furthermore, interest rate liberalization (i.e. moving from a position where the central bank

⁴ Western central banks rarely alter the reserve requirements these days, although it was a relatively common way in 1970s and 1980s, because it would cause immediate liquidity problems for banks with low excess reserves. They prefer to use open market operations (OMO) to implement their monetary policy. However, in recent years the PBOC uses changes in reserve requirements frequently, especially as an inflation-fighting tool. The reason of not using OMOs is that capital market in China is relatively uncompetitive and underdeveloped.

imposes an interest rate structure to one where interest rates are market determined) is another important element of China's efforts to enhance the role of market forces in resource allocation. It is also a prerequisite for increasing the competitiveness of financial institutions. The central bank is poised to accelerate its pace of freeing up interest rates. This market-based interest rate reform is intended to establish the pricing mechanism of the deposit and lending rates based on market supply and demand which allows the market mechanism to play a dominant role in financial resource allocation. This could help China establish modern banking system like in the UK and the US.

The approach towards interest rate liberalization has been gradual and is not yet completed. The sequence of the reform is to liberalize interest rates in money markets and bond markets first, followed by the gradual liberalization of the interest rates of loans and later deposits. In addition, the interest rate of foreign currency was liberalized before that of domestic currency, and large amount and long term before small amount and short term.

Here we briefly list some major events concerning the interest rate liberalization which took place under the current phase of reform. The interest rates in the interbank market were firstly liberalized in 1996. The interest rate in the bond repo market was also freed from controls in 1997 and the issuing rate of government bonds started to be determined by market forces in 1998. In 2000, the central bank liberalized the interest rates for foreign currency loans and large deposits (US\$3 million and over), while rate for deposits below US\$3 million remain subject to the PBOC control. In March 2002, the PBOC unified foreign currency interest rate policies for both Chinese and foreign financial institutions in China, so that domestic and foreign financial institutions are treated fairly with regard to the interest rate policy of foreign exchange.

For domestic currency, as interest rate liberalization progressed, the PBOC simplified and abandoned 114 categories of interest rates initially under control since 1997. At present, 34

categories of interest rates remain subject to the PBOC control. Both lending and deposit benchmark rates are set by the central bank, but individual banks are allowed to adjust the discrepancy within the boundary set by the PBOC. For domestic currency loans, a band was established in 1996, which was gradually widened until the upper limit was lifted in October 2004 and lower limit on lending rates was abolished for all institutions. Interest rates on long-term large-value RMB deposits started to be liberalized in 1999, but on a gradual basis. In October 2004, the lower limit on the interest rate of all RMB deposits was lifted but not the upper limit. The PBOC intends to eliminate the upper limit for all RMB deposits in the near future. At present, lending rate has no upper limit and the lower bound is 90% of the benchmark rate. The rates for mortgage loan can be 85%. Deposit rate has the benchmark rate as the upper limit and is allowed to float downward⁵.

The full liberalization of interest rates on other deposit accounts, including checking and saving accounts, is expected to take much longer. On the lending side, market-determined interest rates on loans will first be introduced in rural areas and then followed by rate liberalization in cities. Interbank rate SHIBOR was introduced in 2006 and determined by market forces⁶. Despite interest rate liberalization process has not yet been completed, it raise the curtain of competition over interest rate among the banks in China, which helps improve the competitiveness of financial institutions and enhance the role of market forces in resource allocation.

⁵ The PBOC surprised financial markets by floating up interest rates on Oct 2004 for the first time in more than nine years. The benchmark rate for one-year RMB loans was increased by 0.27% from 5.31% to 5.58%, the first increase since July 1995. One-year RMB deposit rate was raised by the same magnitude from 1.98% to 2.25%, the first increase since July 1993. This was an important step, as it signalled the authority started to move toward more market-oriented.

⁶ SHIBOR is Shanghai Interbank Offered Rate, which is like LIBOR in the UK.

2.1.3.3 Strengthened financial regulation and supervision

The third pillar is strengthened financial regulation and supervision, coupled with efforts to improve corporate governance and transparency in China's banks. The China Banking Regulatory Commission (CBRC) was established in 2003 to supervise the entire banking system. The supervision role was previously carried out by the central bank PBOC⁷. The newly created banking supervisor is well positioned to take the challenges in a long march toward building a strong banking sector and an effective banking supervisory system in China. Basically, the PBOC cannot always strictly and prudentially monitor banks since they have multiple objectives such as economic growth, low inflation and financial stability. They usually willingly sacrifice prudent lending practices if it would serve another goal, such as financing state-owned enterprise which is in danger of financial difficulty or bankruptcy, and lending money to local government for priority projects especially infrastructure. In hindsight, the creation of the single accountable bureaucracy with the sole mission turned out to be a right decision based on the fact that the central bank cannot take care of everything.

The newly established CBRC is not a mere split from the central bank but the CBRC is determined to develop the right mission, and introduce new supervisory concepts and methodologies in building a strong banking sector and supervisory system. It also encourages Chinese banks to adopt best international banking practices which involve resolving issues related to capital adequacy, non-performing loans and corporate governance. In an effort to accomplish this, a set of principles is formulated to assess the result of supervisory activities such as maintaining systemic stability, enhancing banks

⁷ The central bank had a broad mandate to regulate and supervise the entire financial sector, since its creation in 1984. Now each segment of the financial sector, namely, banking, securities and insurance, is regulated and supervised by three separate and independent government agencies. Securities regulator and insurance regulator were set up in 1992 and 1998 respectively (see Figure 2.3).

competitiveness and encouraging competition.

There are several improvements made by the CBRC's effort. First, the five-tier loan classification system was enhanced and made fully compulsory for all banks⁸. It helps the Chinese banks to build a real credit culture in which lending decisions are made on the basis of the credit worthiness of the borrower and risk analysis, regardless of government policies. Second, the capital adequacy ratio is given much emphasis by the CBRC. The compulsory requirement of 8% minimum capital adequacy ratio was introduced which was based on both Basel I and Basel II. The capital adequacy ratios of over 100 commercial banks now exceed 8%. Third, risk-based supervision started to be implemented through the new type Risk Assessment System, which not only uses quantitative criteria but also qualitative ones for capital, asset quality, management competence, liquidity and profitability. Moreover, the CBRC enhance the transparency through the publication of individual bank data, including the NPLs. The regulators also make much effort to push banks to adopt good corporate governance, through the creation of shareholder boards with outside directors, especially for listed banks, which must go through an auditing process as well as the publication of more transparent balance sheets and income statements. They also believe that it is necessary and essential to introduce comprehensive and well defined accounting rules in line with international standards, as well as bankruptcy laws, efficient resolution procedures for problem banks, and preferably a deposit insurance system.

2.1.3.4 Summary of recent banking reforms

Following the restructuring, deregulation and liberalization, such as listing of the state-owned banks, relaxing restrictions on interest rate and establishing new regulatory

⁸ Under the new classification, bank loans are classified as performing (normal and special-mention) and non-performing (sub-standard, doubtful and loss) based on their inherent risks.

authority, significant changes have taken place in China's domestic commercial banking industry over last ten years. The increase in the number of banks (most of them are city commercial banks) result in a decrease in market concentration. The total assets, total deposits and total loans of the overall banking sector increased significantly from 2003 to 2006. The both absolute amount of NPLs and NPLs ratio fell considerably. The profitability of the Chinese banking industry also improved substantially. The return on asset (ROA) and return on equity (ROE) rose from 0.4% to 0.71% and 9.36% to 11.23% respectively. Although the reform is still ongoing, our preliminary assessment indicates great improvement in the Chinese banking market.

A healthy banking system is necessary for China not only for competition with foreign rivals but also vital to sustain its economic growth. What China has accomplished so far in its banking reform is impressive. China has witnessed a remarkable achievement in reforming its banking industry. The banking reforms have spurred Chinese banks to improve their asset quality, corporate governance and risk management. However, Chinese banks still have a long way to go to meet international best practices, with many challenges ahead, for example, how to eliminate interest rate regulation and introduce real competition, how to compensate government-appointed bank officials, and how to establish deposit insurance system. The rest of the journey could be very tough and more challenging than expected. Still, there is good reason to believe that China will get there eventually, given the fruitful progress has shown in the banking reform so far.

2.2 Overall banking system in China

Until 1978, China had a mono-bank financial system. The central bank, People's Bank of China (PBOC) was the only bank, and therefore, in charge of a large number of issues. It not only performed functions of a central bank such as the conduct of monetary policy, exchange

rate policy and foreign reserve management. Simultaneously, it also engaged in many commercial banking operations, like deposit-taking, commercial lending activities and the financing of development projects. The introduction of a two-tier banking system in 1979 which aimed to separate the central bank function from commercial banking business and improve resource allocation in domestic economy, was the first milestone in the modernization of the Chinese banking system. Since then, a number of significant reforms were implemented to redesign and reshape the banking sector in China.

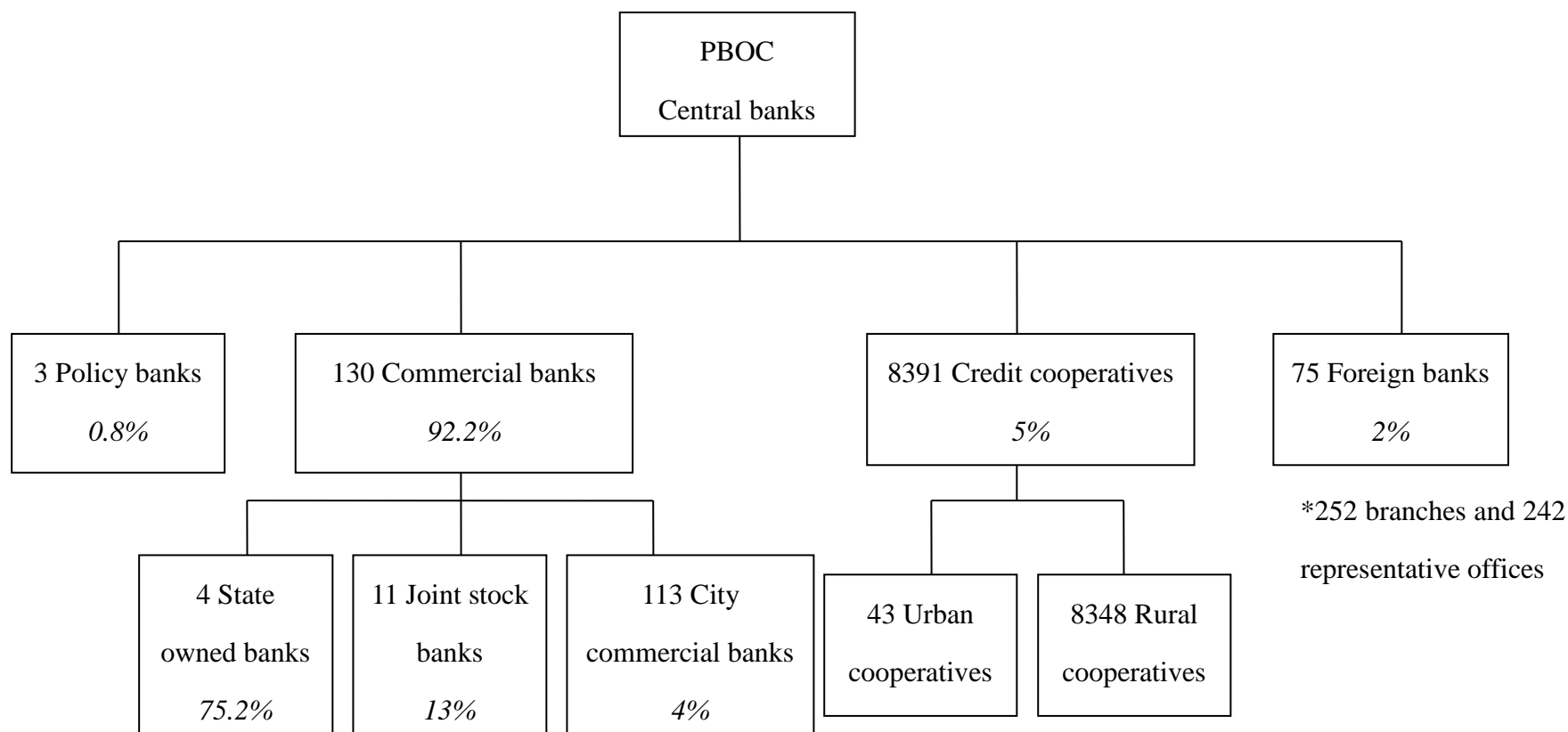
Today, China's banking sector has become very diverse; it comprises many kinds of deposit taking institutions⁹. According to the China Banking Regulatory Commission's (CBRC) record, at the end of 2006, China's banking sector comprised a total of 8553 banking institutions, made up of total assets RMB 43.95 Trillion (US\$ 5.81 Trillion) and total employees 2,696,760¹⁰. These institutions mainly include four state-owned commercial banks (SOCB) (known as the 'Big Four'), three policy banks, eleven joint stock commercial banks (JSCB), 113 city commercial banks (CCB), 8348 rural credit cooperatives (RCC), 43 urban credit cooperatives (UCC), 1 postal savings bank and 75 foreign banks (see Figure 2.2).

All the banking institutions are supervised by two regulatory institutions, namely the central bank (PBOC) and the China Banking Regulatory Commission (CBRC), both as well as the rest of the financial system are ultimately overseen by the State Council (the cabinet) (see Figure 2.3). In the following, we will briefly discuss two regulatory bodies which govern the banking sector as well as each type of banks in turn.

⁹ Non-deposit taking financial institutions in China include: 4 asset management companies, 54 trust companies, 73 finance companies, 10 financial leasing companies, 2 money brokerage firms and 9 auto financing companies (source: CBRC annual report 2006).

¹⁰ Renminbi (RMB) is the official currency of People's Republic of China, Chinese Yuan (CNY) is primary unit of measurement for RMB.

Figure 2.2: The overall structure of Chinese banking system



Four state-owned banks: Bank of China (BOC), China Construction Bank (CCB), Agricultural Bank of China (ABC), and Industrial and Commercial Bank of China (ICBC)

The italic figures represent the percentage of assets each group in the total banking sector assets.

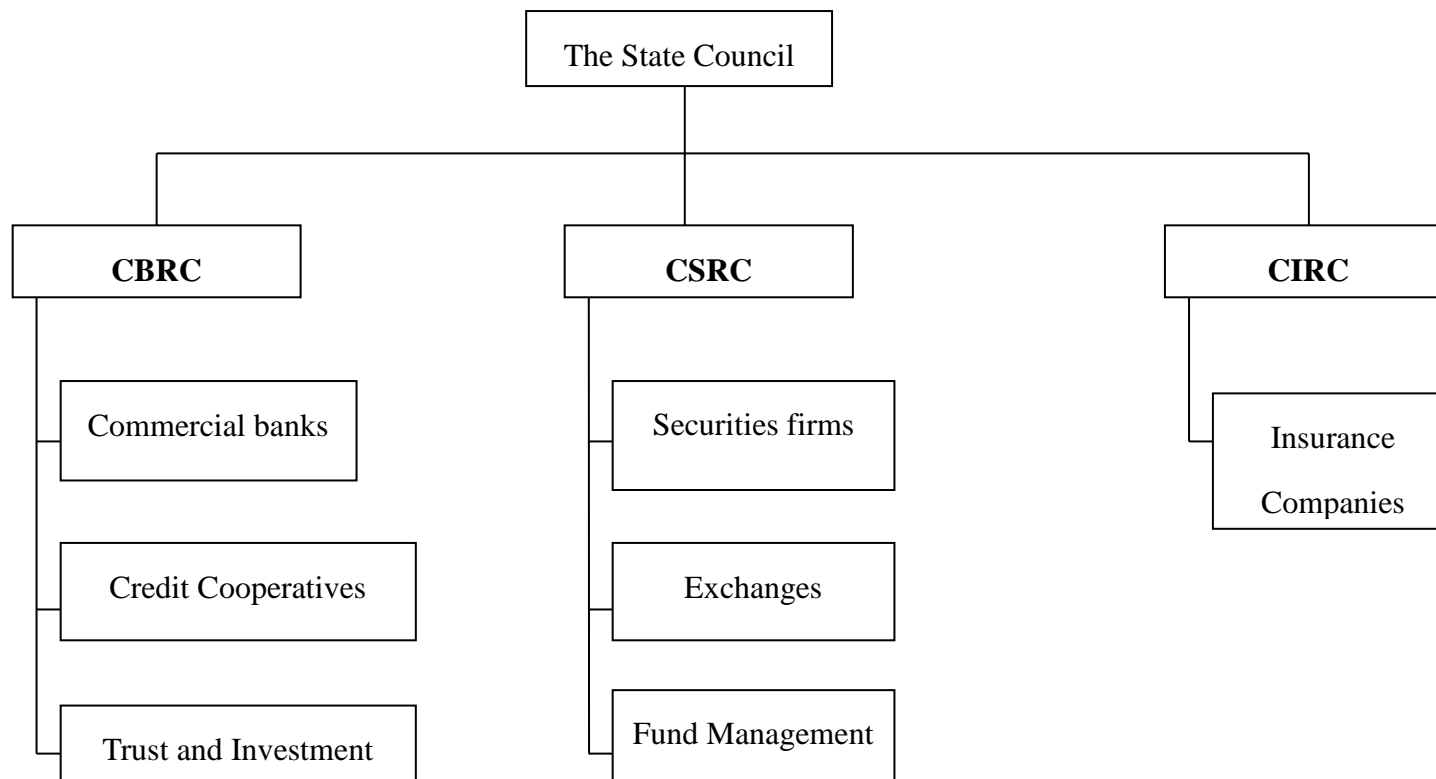
Source: CBRC 2006 year book

2.2.1 Banking Regulatory authority in China

The central bank People's Bank of China (PBOC) is currently in charge of the monetary policy and the liquidity of the financial system. It aims at promoting economic growth and price stability. The PBOC manages the interest rate bands for loans and deposits, since the interest rates are not fully liberalized yet, the reserve requirements and other instruments affecting banks' liquidity. The PBOC also monitors and regulates the credit expansion of the banking system. In addition, the central bank acts as lender of last resort which provides lending facilities for domestic banks.

The China Banking Regulatory Commission (CBRC) was established in April 2003 to take over the regulatory and supervisory functions of the banking sector from the PBOC. It aims to separate policy making and implementation from supervision, so that the PBOC could concentrate on monetary policy and other central bank responsibilities. The objectives of this newly created supervision body include protecting consumers and depositors, maintaining the stability in the banking system, enhancing banks' competitiveness, encouraging competition, educating the public on the role of finance and eradicating financial crime. To this end, it focuses on the strength and soundness of financial institutions, capital adequacy issues, and the restructuring of the banking sector. More details about the CBRC will be discussed in Section 2.3.3.3.

Figure 2.3: Financial regulatory structure in China



*CBRC: China Banking Regulatory Commission

*CSRC: China Security Regulatory Commission

*CIRC: China Insurance Regulatory Commission

Source: CBRC report 2008

2.2.2 Non-bank financial institutions

Before considering each type of banking institutions in China, we take a quick look at non-bank financial institutions. There is a number of non-bank financial institutions in the Chinese financial system. According to the CBRC, there are five major types of non-banking financial institutions; namely, trust companies, finance companies, financial leasing companies, auto financing companies and money brokerage firms. The main ones are the Trust and Investment Companies (TICs), created in the 1980s to support the development of the private sector and to provide financing outside the credit quotas imposed to commercial banks. Some TICs act as the investment tool of local or provincial governments. Some others are intermediaries of international funds (through bond issues or syndicated medium and long-term loans) to finance local companies and infrastructure and construction projects. Other important non-bank financial institutions are Asset Management Companies (AMCs), established in 1999 to receive the non-performing loans (NPLs) from the state owned commercial banks (SOCBs) and recover them through different asset resolution techniques. Moreover, securities companies have played an important role in the development of the stock exchanges since the 1990s. Their ownership has become more diversified with an increasing participation of the private sector. Insurance companies, in turn, are basically in state hands although most of the newly created companies are joint-stock ones and have shifted their focus from market share to economic return. Since China's WTO entry, foreign companies have expressed great interest in the Chinese insurance sector.

Despite increasingly diversified as well as fast increase and expansion of non-bank financial institutions, the financial system in China is still bank dominated like Japan and Germany, rather than market-orientated financial system in the UK and the US. In the following, each type of banks will be discussed in turn.

2.2.3 State-owned commercial banks (SOCBs)

The banking market in China is dominated by the four state-owned commercial banks often known as 'Big Four', which were created in the 1980s. They are originally established as specialized banks to take over the banking business from the PBOC, allowing the PBOC to focus on regulation and monetary policy. These four specialized state-owned banks are the Industrial and Commercial Bank of China (ICBC), China Construction Bank (CCB), Bank of China (BOC) and Agricultural Bank of China (ABC). They were initially established to grant credit to several key sectors as their names suggest namely industry, business, construction and agriculture. The 'Big Four' remained as specialized banks until 1994 when three policy banks were established to take over the policy-directed lending responsibilities.

After the creation of the policy-lending banks in 1994, the 'Big Four' responsibilities shift to commercial purposes. Now they function more like market orientated commercial banks. The Big Four's total assets reached RMB 28 trillion in 2006, which account for 70.7% of the total banking assets. They dominate the banking activities, by accounting for 67.4% of the total deposits and 67.4% of the total loans in the whole market. The remaining banks are relatively small, which explains why the degree of concentration is relatively high no matter we measured in terms of the share of assets, deposits or loans, although the market share of the Big Four has fallen over the last decade from 70.7% of total assets in the banking system to 63.3% at the end of 2006 (see Table 2.2). More details about concentration in Chinese banking market will be discussed in Chapter 3.

In spite of the shrinking market share, the presence and influence of the Big Four will continue to dominate China's banking system. However, the dominant leadership may tend to lower the efficiency for allocating financial resources and result in distortions in the system. Furthermore, the dominant ownership in the banking sector has been considered as

Table 2.2: Concentration index in Chinese banking sector during 2001-2006

	2001	2002	2003	2004	2005	2006
<i>Total assets</i>						
CR4	0.707	0.669	0.641	0.626	0.636	0.633
CR10	0.925	0.904	0.889	0.880	0.869	0.868
HHI	0.146	0.135	0.127	0.121	0.120	0.118
<i>Total deposits</i>						
CR4	0.674	0.656	0.642	0.649	0.647	0.633
CR10	0.929	0.913	0.901	0.893	0.881	0.881
HHI	0.152	0.142	0.137	0.128	0.125	0.121
<i>Total loans</i>						
CR4	0.674	0.652	0.636	0.618	0.610	0.592
CR10	0.932	0.903	0.914	0.891	0.886	0.867
HHI	0.154	0.141	0.135	0.121	0.115	0.113

Source: Bankscope and author's calculation

threat of market failure and tends to erode the credibility of the banking market and the effectiveness of the banking supervisory authorities which enforce prudential rules and requirements. Until now, the four state-owned commercial banks are still the biggest players though their dominance is in gradual decline. Below, each of the four SOCBs will be briefly considered.

- The Industrial and Commercial Bank of China (ICBC) is the youngest of the “Big Four” banks, and was founded in 1984. The ICBC primarily engages in corporate and retail banking throughout China, and has strong profitability. It is the largest bank in China based on both tier 1 capital and total assets (see Table 2.3). It is also the biggest lender in the banking market. In 2006, the ICBC was simultaneously listed on the Hong Kong Stock

Table 2.3: Top 30 Chinese banks by tier 1 capital and assets (US\$ million) 2009

Rank	Bank	Ownership	Tier 1 Capital	Assets	Rank
1	ICBC	SOCB	74701	1427685	1
2	Bank of China	SOCB	64961	1017718	4
3	China Construction Bank	SOCB	63113	1105471	2
4	Agricultural Bank of China	SOCB	39998	1026300	3
5	Bank of Communications	JCB	19336	391867	5
6	China CITIC Bank	JCB	13467	173798	8
7	China Merchants Bank	JCB	10457	229976	6
8	China Minsheng Bank	JCB	7507	154267	9
9	Industrial Bank	JCB	6777	149372	10
10	Shanghai Pudong Bank	JCB	5537	191588	7
11	Bank of Beijing	CCB	4641	68917	15
12	China Everbright Bank	JCB	4200	124638	11
13	Bank China Huaxia Bank	JCB	3865	107049	12
14	Guangdong Development	JCB	2691	79890	13
15	Bank of Shanghai	CCB	2516	53805	16
16	Shenzhen Development Bank	JCB	2152	69417	14
17	Shanghai Rural Commercial	CCB	1674	25360	19
18	Huishang Bank	CCB	1574	19212	22
19	Bank of Jiangsu	CCB	1529	33701	17
20	Nanjing City Commercial	CCB	1513	13711	26
21	Shenzhen Ping An Bank	CCB	1230	21351	21
22	Bank of Ningbo	CCB	1229	15109	24
23	Beijing Rural Commercial	CCB	1088	33303	18
24	Tianjin City Commercial	CCB	950	17970	23
25	Bohai Bank	CCB	726	9106	33
26	Hangzhou City Commercial	CCB	655	14575	25
27	Dalian City Commercial Bank	CCB	632	10473	30
28	China Zheshang Bank	CCB	602	12262	27
29	Evergrowing bank	JCB	600	22093	20
30	Shengzhen Rural Commercial	CCB	595	9593	31

Source: The Banker, 2009

Table 2.4: Top 10 world bank by market capitalization (US\$ billion) 2008

Rank	Bank	Mkt Cap US\$bl
1	ICBC	277.514
2	Bank of America	195.933
3	HSBC Holdings	176.788
4	China Construction Bank	165.234
5	Bank of China	165.087
6	JPMorgan Chase	159.615
7	Citigroup	140.698
8	Wells Fargo	112.365
9	Banco Santander	109.862
10	Mitsubishi UFJ Financial	105.412

Source: www.bloomberg.com

Exchange and the Shanghai Stock Exchange, raised US\$ 21.9 billion, making it the largest bank in the world in terms of market capitalization (see Table 2.4). Until 2009, it had assets of RMB 11 trillion (US\$ 1.6 trillion), with over 18,000 outlets including 106 overseas branches and agents globally.

- The China Construction Bank (CCB) was originally created in 1954 to administer and disburse government funds for construction and infrastructure related projects. Until 1994, the CCB had gradually become a full service commercial bank. Its business now consists of corporate banking, personal banking, and treasury operations. It maintains a leading position in infrastructure loans and residential mortgages. In 2008, it holds about two-thirds of residential mortgages in China. The bank has approximately 13,629 domestic branches. In addition, it maintains overseas branches in Frankfurt, Hong Kong, Johannesburg, New York, Seoul, Singapore, Tokyo, Sydney, and London. The CCB is the first SOCB went to public. In October 2005, the CCB was publicly listed on the Hong Kong Stock Exchange. Since then, the CCB start their international expansion journey. It

acquired Bank of America (Asia) in 2006, opened branches in New York and London in 2008, and become a member of Global ATM Alliance.

- The Bank of China (BOC), founded in 1912, is the country's oldest bank. It originally specialized in international financial transactions such as foreign exchange services and extending trade credit, but now the BOC is mainly engaged in commercial banking, including corporate and retail banking, treasury business and financial institution banking. It is the number one foreign exchange lender. It also conducts investment banking and insurance activities through its subsidiaries. The BOC is the most international bank of all the commercial banks in China. At present, it has in excess of 11,000 domestic branches and over 600 overseas branches, and representative offices covering 27 countries and regions. In 2006, the BOC held an initial public offering (IPO), both on the Hong Kong Stock Exchange and the Shanghai Stock Exchange, in which it raised around US\$ 22.5 billion of new equity capital. Recently, the BOC has also made further efforts to attract strategic investors from overseas. Foreign shareholders now hold a 20% stake in the BOC.

-The Agricultural Bank of China (ABC) was founded in 1951 to facilitate financial operations in the agricultural sector and rural areas. Today, the ABC's business has developed from its original rural credit and settlement to a wide range of financial business transactions. The ABC has extensive outlets covering both urban and rural areas of China. It has 447,519 employees across 24,452 branches in mainland China, two overseas branches in Singapore and Hong Kong, and three representative offices in London, Tokyo, and New York. According to information recently released by the ABC, it has become the third largest bank in China in terms of total assets, which had reached RMB 6.05 trillion at the end of 2007. As the ABC has substantially more NPLs, it is the last SOCB went public with a US\$ 22.1 billion IPO in 2010 on both the Shanghai Stock Exchange and the Hong Kong Stock Exchange¹¹.

¹¹ As Agricultural Bank of China used to be a specialised bank which focused on deposit and lending activities in rural

2.2.4 Policy lending banks

Three policy-lending banks were created in 1994 to carry out the development policy lending previously assigned to the SOCBs and hold about 0.8 percent of the total bank assets. These are the Agricultural Development Bank, the China Development Bank and the Export-Import Bank of China. Each of these policy banks provides financial services especially policy-directed lending for specialised sections. The Agricultural Development Bank of China is mainly engaged in the state policy oriented agricultural finance business and extends credit for agriculture and agricultural economic development. The China Development Bank is primarily responsible for providing loans for capital investment projects and large infrastructure projects, with special attention to the poorer, western and central regions. The Export-Import Bank grants trade credit, export insurance, and working capital loans for firms involved in international trade and investment. Policy-lending banks fund themselves primarily through the issuance of bonds, central bank loans, and government deposits. They hardly accept retail deposits. Moreover, the policy banks are deliberately exempted from many of the prudential controls imposed on Chinese commercial banks, and profitability is not ultimate objective for their managers. Therefore, policy banks are not commercial banks in real sense.

2.2.5 Joint stock commercial banks (JSCB)

As discussed above, beside the four state-owned commercial banks, there is a number of other types of commercial banks in the Chinese banking system with a diverse ownership structure and geographical scope, namely joint stock commercial banks (JSCBs), city

area, it accumulated a substantial amount of NPLs due to heavy subsidy directed by the government to agriculture related industries and large but poor population.

commercial banks (CCBs), urban credit cooperatives (UCCs) and rural credit cooperatives (RCCs). Part of them has been used as an experiment for the liberalization process of the financial system and others are specialized in some market niches.

The joint-stock commercial banks (JSCBs) were created in late 1980s and initially designed to provide specialized product niches, but now offer a full range of financial services and operate at the national level. The most distinguishing difference between the JSCBs and SOCBs is that JSCBs have a diversified ownership structure (see Table 2.5). They are partially owned by local governments, state-owned enterprises, private enterprises or foreign companies. Among them, local governments and the state-owned enterprises are the key shareholders of these banks.

There are currently 11 banks in this category and they account for 13 percent of the total banking assets (see Figure 2.2). All of them are in the top 30 Chinese banks by total assets and equity (see Table 2.3). Since Shenzhen Development Bank firstly went public in 1991, other six joint stock banks are already listed on stock market, namely Bank of Communications, China Minsheng Bank, China CITIC bank, China Everbright Bank, China Merchants Bank, and Shanghai Pudong Development Bank.

The JSCBs are allowed to engage in a wide variety of banking services including accepting deposits, extending loans, as well as providing foreign exchange and international transaction services. The comparative advantages of those joint stock banks are that they are more market-oriented, with better governance and management and less government intervention. Moreover, joint stock banks provide finance to small state-owned enterprises (SOEs) and private small medium enterprises (SMEs), since the access of fund from large state-owned banks is restricted to small firms. Furthermore, JSCBs are specialized in particular business area where the state-owned banks have traditionally been weak. For example, Minsheng Bank is strong in trade financing; China Merchants Bank

Table 2.5: Ownership Structure of the JSCBs (2008)

Bank	Largest shareholder	Government ownership	Private ownership	Foreign ownership
Bank of Communications	Ministry of Finance (21.6%)	45%	35%	20%
China Merchants Bank	HKSCC (17.88%)	46.53%	53.47%	0%
China CITIC Bank	CITIC Group (62%)	64.18%	15.82%	20%
China Mingsheng Bank	New Hope Investment Co., Ltd. (5.9%)	5.1%	94.9%	0%
China Everbright Bank	China SAFF Investment Ltd. (70.88%)	84.7%	15.3%	0%
Shanghai Pudong Development Bank	Shanghai International Group (23.57%)	46.88%	49.34%	3.78%
Shenzhen Development Bank	New bridge Capital (16.7%)	0.2%	83.1%	16.7%
Guangdong Development Bank	Citigroup (20%)	75.26%	0%	24.74%
Industrial Bank	China Grid Corp (20%) The Finance Bureau of Fujian Province (20.4%)	46.35%	33.67%	19.98%
HuaXia Bank	Shougang Corporation (10.19%)	38.87%	47.15%	13.98%
Evergrowing Bank	Yantai Blue Sky Investment	46.19%	36.43%	17.38%

Source: author's own calculation based on banks' annual reports

*Government ownership includes central government, local governments, and state-owned enterprises

*Private ownership includes institutional investors and individual investors

performs well in credit card business; whilst the Industrial Bank has made great advances in institutional banking services. Those joint stock banks usually maintain much smaller branch networks than state-owned banks, typically confined to the region of origin or to the fast-growing coastal area and urban area, although they are generally allowed to operate at the national level.

The JSCBs have experienced the fastest expansion compared to other groups in the last few years. For example, in 2002 alone, their assets increased by 24%. And until 2006, their assets represent 13% of the total banking sector assets. As they were established more recently and subject to less central government inference, they generally have less non performing loans, better asset quality, greater profitability and higher efficiency than the state-owned banks. As the joint-stock commercial banks expanded rapidly, they constitute an important part of China's banking system.

2.2.6 City commercial banks (CCBs)

Another important type of banking institution is the city commercial banks (CCBs). Most of the city commercial banks are newly created since the mid-1990s by way of restructuring and consolidating urban cooperatives. They were mainly designed to support local development, typically lend to local authorities for infrastructure, schools, local SMEs and local residents in their municipalities. Hence local governments and local enterprises are the main shareholders. There are currently 113 city commercial banks and these banks represent 4% of the total banking assets. Initially, they were not allowed to operate at the national level unlike the JSCBs, which was their major competitive disadvantage. But since 2006, the CBRC started to eliminate this geographical restriction in order to promote further competition.

2.2.7 Urban and rural credit cooperatives (UCCs or RCCs)

In addition, there are 8391 urban and rural cooperatives in total. They were established in the 1980s as a mechanism to diversify the financial system and to finance projects in areas where resources were scarce. They typically attract deposits from small towns or rural areas and provide credit to SMEs or farmers. As a compensation for them to operate in poor area, they are subsidized from the central bank. Although the number of these institutions is quite substantial, their relative size is very small, accounting in total for 5% of the total banking assets in 2006.

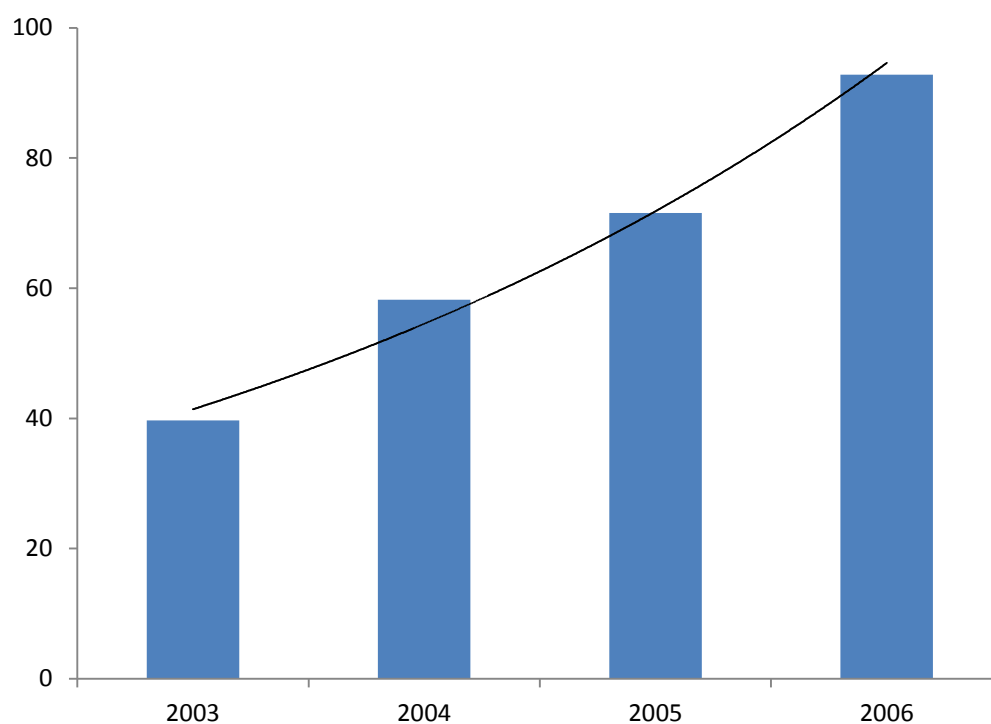
The number of UCC and RCC collectively has experienced a steady reduction since 1997. This is mainly due to their inability to attract deposits and expand lending. Also some UCCs were restructured to the city commercial banks. Nowadays, the RCCs are more important and numerous than urban ones, after the consolidation of the latter into the CCBs. Today the RCCs provide financial services for agricultural production, farmers and village enterprises in rural areas, where almost two-thirds of the total Chinese population living there. However, the RCCs are the worst performing financial institutions in China, with very poor governance and the highest NPL ratios.

2.2.8 Foreign banks

Foreign banks play a positive but at least for now a limited role in the Chinese banking system. In 2006, there are 75 licensed foreign banking institutions in China, with 252 branches and 242 representative offices (see Table 2.6 for lists of major foreign banks in China). Foreign banks represent 0.5% in the local currency lending market but take around 13% in the foreign currency lending business. Their total assets increased from RMB 39.69

billion to RMB 92.79 billion at the end of 2006 (see Figure 2.4), and about 2% of the total banking assets. If compared to Figure 2.7 later, the growth rate of foreign bank assets is faster than that of total banking assets. The foreign bank assets to total assets grow from 1.24% to 2.06%.

Figure 2.4: Total assets of foreign banks (RMB billion) (2003-2006)



Source: CBRC report 2006

Table 2.6: Major foreign banks in China

Asian	Europe	North America
ANZ (Australia)	Banco Santander (Spain)	Bank of America
Bank of East Asia (HK)	BNP Paribas S.A. (France)	Bank of Montreal
Commonwealth Bank of Australia	Crédit Agricole (France)	Bank of Nova Scotia
Dah Sing Bank (HK)	Commerzbank (Germany)	Bank of New York(US)
DBS (Singapore)	Credit Suisse (Swiss)	Citibank
First Sino Bank (Taiwan)	Deutsche Bank (Germany)	JPMorgan Chase Bank
Hang Seng Bank (HK)	Fortis Bank (Belgium)	Royal Bank of Canada
Mizuho Corporate Bank (Japan)	HSBC (UK)	Wachovia Bank (US)
OCBC (Singapore)	ING Bank (Netherlands)	
SMBC (Japan)	Intesa Sanpaolo Bank (Italy)	
Westpac (Australia)	KBC Bank (Belgium)	
Wing Hang Bank (HK)	Natixis (France)	
Wing Lung Bank (HK)	Norddeutsche Landesbank	
	Rabobank (Netherlands)	
	Raiffeisen Zentralbank	
	RBS (UK)	
	Société Générale (France)	
	Standard Chartered Bank	
	UBS (Swiss)	
	VTB (Russia)	
	WestLB (Germany)	

*ANZ, Commonwealth Bank of Australia and Westpac are Australian banks and for convenience have been grouped for Asian banks.

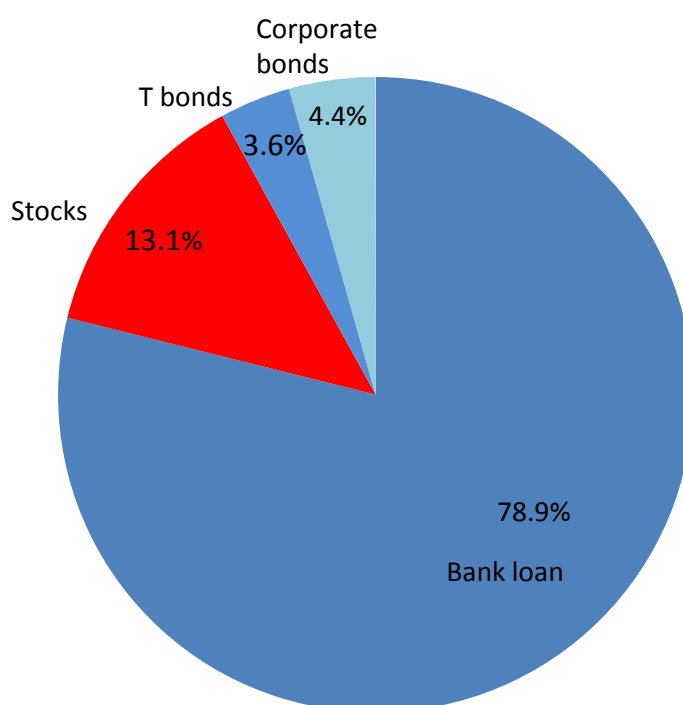
Source: CBRC report 2008

2.3 Main features characterizing the Chinese banking sector

In order to better understand the Chinese banking system, in this section, we intend to discuss several important features characterizing the banking industry in China.

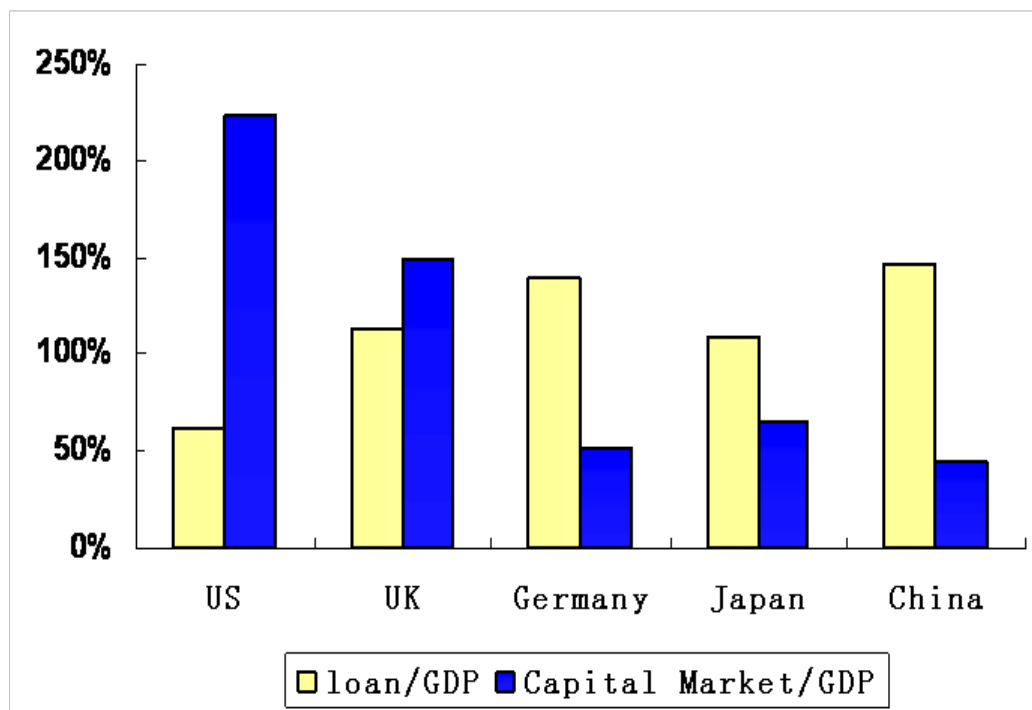
The first striking feature is the large size of the Chinese banking system not only in relative terms but also in absolute ones. At present, banks continue to dominate China's financial landscape as indirect financing remains the main channel of financing for business enterprises in China (see Figure 2.5 and Figure 2.6).

Figure 2.5: Share of financing channels in China (2008)



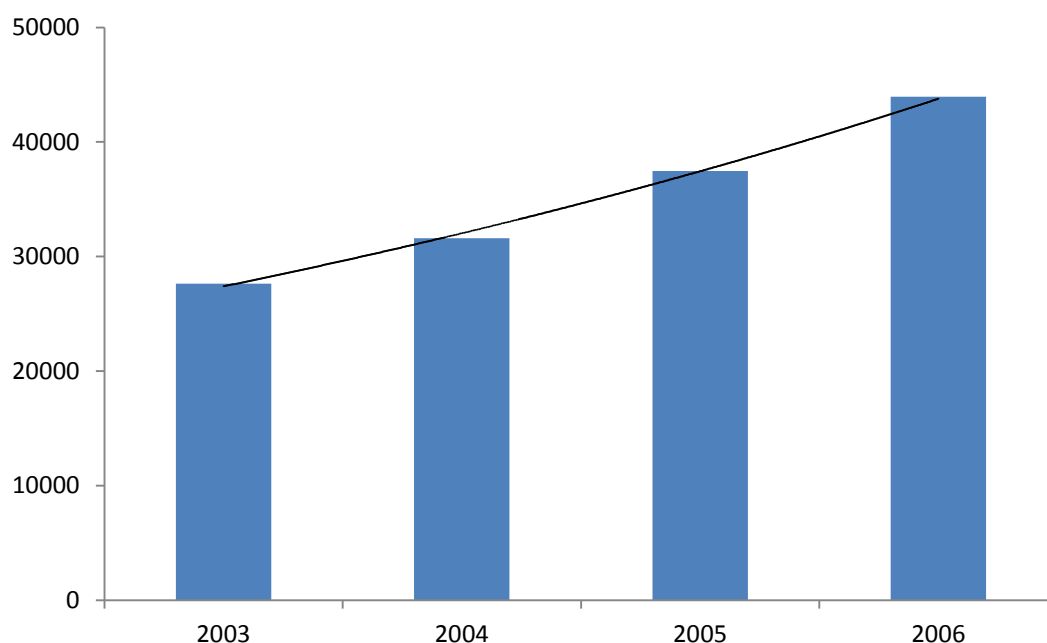
Source: CBRC report 2008

Figure 2.6: Heavy reliance on bank financing in China compare to other big economies (2006)



Source: CBRC report 2006

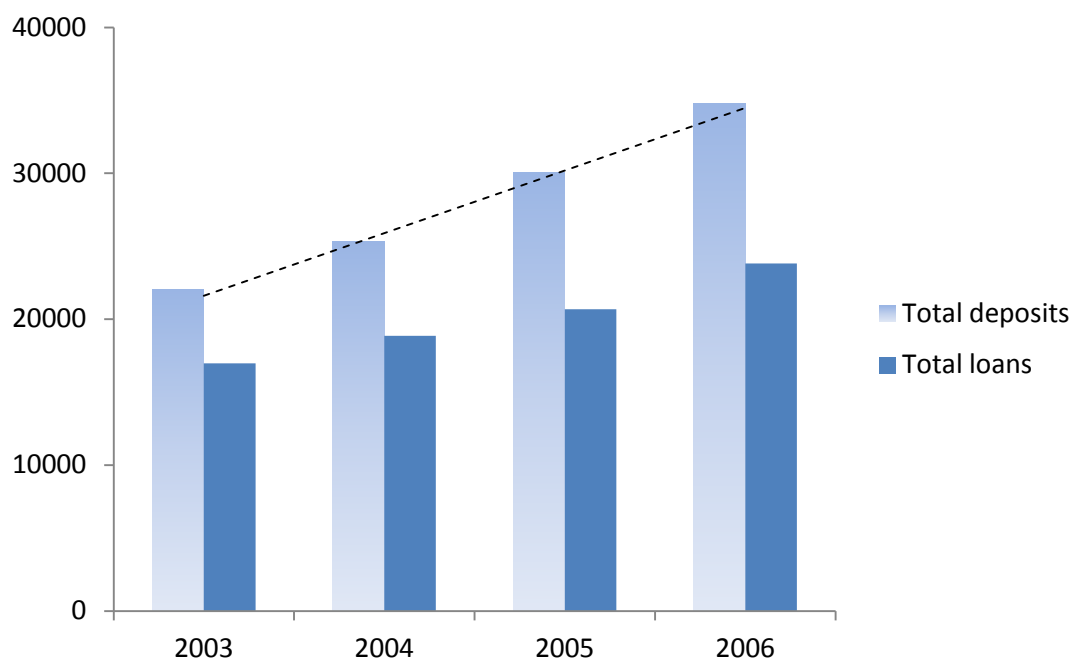
By the end of 2006, the total assets of China's banking sector amounted to RMB 43.95 trillion (US\$ 6.28 trillion) (see Figure 2.7) and accounted for 87% of the total assets in the entire financial sector. The establishment of the stock market in China was very late in 1991, and although the role of capital markets has become more significant nowadays, the size remains quite small, with a capitalization of US\$ 780 billion for stock market, government bond market cap US\$ 364 billion and corporate bond market cap US\$35 billion by end of 2006. It is worth noting that derivatives markets have not been established in China yet. Because of the incomplete development of capital markets in China, enterprises still heavily rely on bank loan as the main source of financing. In 2006, approximately 80% of financing is still through banks. Moreover, a legal framework for private equity financing is just starting. Therefore, banks play a very special and vital role in the Chinese economy.

Figure 2.7: Total assets (RMB billion) of banking system in China (2003-2006)

Source: CBRC report 2006

The second feature of the Chinese banking system is that the whole industry is dominated by a few very large state-owned commercial banks. The concentration measures such as CR4, CR10 and Hirschman Herfindhal index (HHI) based on total assets, deposits, and loans show that the Chinese banking market is still highly concentrated, although there was a slight decrease in the overall market concentration during the period of 2001-2006 (see Table 2.2).

In particular, the four largest banks have taken up the majority of total assets, deposits, and loans, with the four-firm concentration ratios (CR4) amounting to 84.2%, 84.6% and 87.2% respectively before the WTO entry in 2001. However, things seem to be starting to change after the WTO entry, the state-owned banks have seen their monopoly position weakening with a rapid expansion of the joint stock and city commercial banks. The CR4 decreased correspondingly to 75.2%, 74.5% and 74.4% for total assets, deposits and loans by the end of 2006, in spite of the total assets, deposits and loans of the whole banking sector increase (see Figure 2.8).

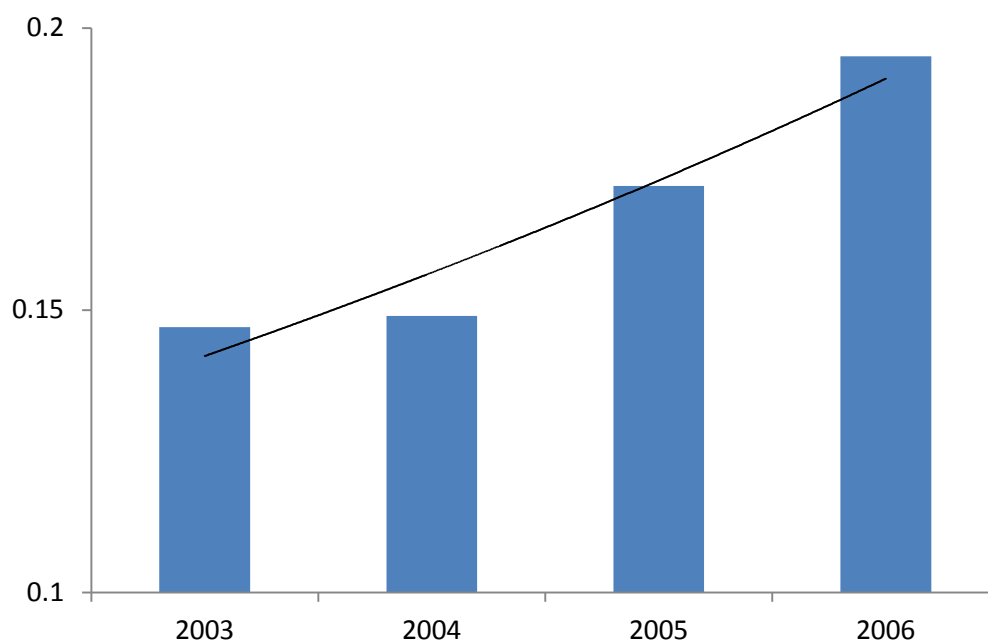
Figure 2.8: Loans and deposits of Chinese banking market (RMB billion) (2003-2006)

Source: CBRC report 2006

The market concentration ratios for the top ten banks (CR10) show a similar trend of decrease. Drops in the HHI also indicate less market concentration, a loss of pricing power and an increase in market competition among banks. For example, the HHI based on total loans decreased the most from 0.19 to 0.13. The HHI also reveals that the Chinese banking market was highly concentrated before joining in the WTO, but five years after entry in 2006, the market could be classified as moderately concentrated¹². In addition, although competition increased in the banking market, the traditional intermediation business still dominated, on average 80% of revenue remains to rely on interest income, and the contribution from fee-based income being around 10%, despite the rate of growth rise substantially in recent years (see Figure 2.9).

¹²

The United States Department of Justice (DOJ) separates values of the HHI index into three categories. For HHI values below 0.1 (or 1000) the market is considered to be unconcentrated. Values between 0.1 and 0.18 (1000 to 1800) indicate that a market is moderately concentrated. Finally, values of the HHI index above 0.18 (1800) indicate high concentration.

Figure 2.9: Ratio of fee-based income to net income (2003-2006)

Source: CBRC report 2006

The third feature is the very traditional structure of the balance sheet, compared with Western banks. First, loans form a large part of the assets and account for 60.8 percent in 2006, the majority of which is granted to the corporate sector. The recent boom in the housing sector has not changed this picture yet; mortgage lending is still less than 15 percent of the total loans. Second, almost all liabilities are deposits, with an average share of 80 percent in 2006. This is even higher in the state-owned commercial banks but much less for the joint stock commercial banks, which have used non-interest bearing funding. Retail depositors are the main financiers of the banking system since corporate deposits only represented one-third of the total deposits. However, large differences exist among different types of banks since retail depositors represent 60 percent of the total deposits for state-owned commercial banks whereas corporate deposits contribute 65 percent for joint stock commercial banks.

The restrictive and biased competition environment in the Chinese banking industry is the

fourth feature. Like many transition economies, Chinese banks are characterized by lacking independence and having poor corporate governance, which results in very poor asset quality, low profitability and inefficiency. The root of these problems is government intervention.

Due to massive government involvement in the banking business, the Chinese banks have piled up a mountain of bad debts through government-ordered lending to the state-owned enterprises and local governments. Despite the improvement of the asset quality in recent years, the size of non-performing loans (NPLs) is generally considered the major threat for the banking system in China. At the end of 2002, the NPLs of the banking sector, including state owned banks, policy banks, joint stock banks and credit cooperatives, amounted to RMB 2,532 billion (US\$ 373 billion) and the ratio of NPLs to total loans was 19%. The NPLs of state-owned commercial banks reached RMB 1,999 billion (US\$ 232 billion) and the NPL ratio was 20%, an equivalent of 17% of GDP in 2002 (see Table 2.7).

Table 2.7: Reported NPLs in the Chinese banking industry (2002)

	NPLs in USD billion	NPLs ratio	% of GDP
State-owned banks	232	20	17
Joint-stock banks	23	7	2
Policy banks	19	18	1
Credit cooperatives	60	30	4
Banking system total	373	19	28

Source: Chinese Financial Yearbook 2002 published by National Bureau of Statistics

The NPL ratio was even larger before the Chinese authorities started the bank restructuring

program (above 30% in 1997). The asset quality of the joint-stock banks varies. They generally have healthier balance sheets than the state owned banks due to different ownership structure and less government intervention. The NPLs for joint-stock commercial banks was 7% on average in 2002. The underlying reasons for such poor asset quality are not only the soft-budget constraints for lending to SOEs, but also a weak credit culture. Therefore, proper management and speedy disposition of NPLs is one of the most critical tasks of the recent banking reform.

Moreover, the capital adequacy ratio (CAR) for most Chinese banks was below regulatory requirements (Basel II) before the WTO accession. At the end of 2001, the total capital adequacy ratio of the state-owned commercial banks was merely 4.61%, significantly below the minimum regulatory requirement level 8%. The same ratio for joint-stock commercial banks and city commercial banks were 6.83 % and 6.01% respectively. However, at present, most domestic commercial banks meet the CAR requirement, although there is still one fifth of banks still cannot meet the standard.

Besides low capital base and poor asset quality, domestic commercial banks in China also suffer from poor corporate governance, weak internal controls and a lack of adequate risk management skills. Particularly, the SOCBs suffer from all corporate governance weakness. As senior management of the state-owned banks are traditionally appointed by government, their decisions are heavily influenced by officials. As a result, their ultimate objectives aim to serve the government's decision rather than pursuing economic profit or maximize shareholder's wealth. Fortunately, the JCSBs do not have the same legacy as SOCBs, so that their management has a higher commitment to shareholder's value although they are possibly influenced by local governments and state-owned enterprises given their large participation in the capital of most of these institutions.

Furthermore, since most domestic banks are not listed and are accountable only to the

government (usually the Ministry of Finance), the disclosure requirements are minimal, no transparency for depositors, investors and regulators. Thus the present structure of state ownership accounts for at least some of their less satisfactory performance. No wonder that in the on-going banking reform program for state-owned banks, the government is so determined to press ahead with the corporatization and ownership diversification of these banks. Although state ownership will continue to dominate (it may take a variety of forms in practice), the proportion will be reduced considerably.

As a consequence of government intervention, the substantial amount of NPLs and poor capital adequacy ratio actually made most Chinese banks unprofitable. The profitability of the banking sector is negligible¹³. In 2002, the return on average equity (ROAE) and the return on average assets (ROAA) for the banking system was 3.05%, and 0.14% respectively, which were well below western standards. Low profitability can be mainly explained by the low operating income and substantial amounts of provisions and write-offs, stemming from the very low asset quality. Later in the thesis, those rates of return are compared to the shadow rate of return on equity based on econometric evidence.

The last feature is the poor institutional framework of the banking system in China. This is featured by a rather loose regulation and supervision, and the lack of bankruptcy law particularly as regards enforcement. The regulatory bodies, as well as the central bank, are dependent on the government's decisions. The lack of enforcement power from the supervisory part helps explain very limited improvement in corporate governance. However, the newly created CBRC try to change the situation.

13

High level of tax levied on commercial banks is another factor contributes to low profitability of the Chinese banking industry. At present, commercial banks are subject to two main forms of taxation. One is Business tax, based on revenue, is currently 5% (lowered from 8% since 2002). Another is Income tax, based on profit, and is set at 33% for domestic commercial banks. Such heavy tax burden makes it difficult for banks to generate and retain earnings and thus to strengthen their capital bases.

2.4 Detailed arrangements for opening-up after the WTO entry

A crucial milestone in the financial liberalization process was China's accession to the World Trade Organization (WTO) in 2001. China's entry into the WTO has attracted worldwide attention. China promised to work hard to strictly fulfil the commitments it made for accession into the WTO. The commitments generally state that China will eliminate all kinds of restrictions on foreign banks, which will be allowed to conduct all the banking businesses in China, for both domestic currency (RMB) and foreign currencies, with customers for both corporate and residents, and in any place of the country.

However, the approach for openness has been very gradual and cautious. The WTO agreed China could take a gradual pace of openness and allowed a five-year transition period (2002-2006) for preparation of full openness after the entry. The transition period is the major benefit given to developing country. Once the transition period ends, for the first time China has to fully open its financial market to foreign competitors after 2006. According to the negotiation with the WTO, China set five-year time schedule for gradual opening-up. The Table 2.8 lists the banking market opening-up schedule after China's accession to the WTO.

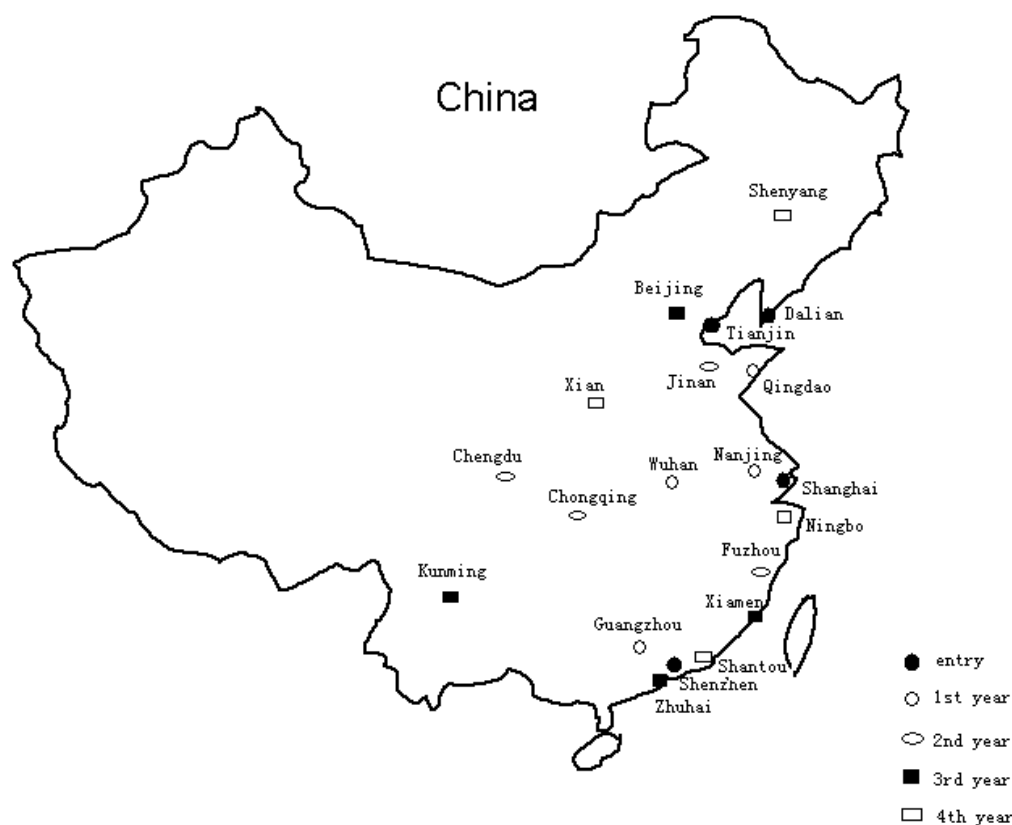
2.4.1 Time schedule for opening-up after WTO entry

Before the WTO entry, foreign banks in China were only allowed to carry out foreign-currency transactions and with several restrictions. Following the formal entry into the WTO, China immediately cancelled all restrictions on regions and clients for foreign banks in handling foreign currency business in China. As a consequence, foreign banks can

open foreign exchanges business to both Chinese enterprises and citizens. However, for domestic currency business, foreign banks were authorized to offer local currency services with geographical restrictions. China gradually abolished regional restrictions on foreign banks within the five-year transition period. In particular, China opened domestic currency banking business in Shenzhen, Shanghai, Dalian and Tianjin at the time of its entry into the WTO. One year following the entry, banking business in Guangzhou, Qingdao, Nanjing and Wuhan were opened. Within two years after the accession, it opened Jinan, Fuzhou, Chengdu and Chongqing. In three years, the market opening-up were expanded to another four cities, namely Kunming, Zhuhai, Beijing and Xiamen. In four years, banking markets in Shantou, Ningbo, Shenyang and Xi'an were further opened. Five years after the accession, all geographical restrictions imposed on domestic currency business for foreign banks were fully eliminated (see Figure 2.10).

Table 2.8: Time schedule for opening-up after the WTO entry

Time	Regions	Clients
<i>Foreign currency business</i>		
Entry (2001)	All the regions	Both enterprise and residents
<i>Domestic currency business</i>		
Entry (2001)	Shenzhen, Shanghai, Dalian, Tianjin	
In one year (2002)	Guangzhou, Qingdao, Nanjing, Wuhan	
In two years (2003)	Jinan, Fuzhou, Chengdu, Chongqing	Enterprise only
In three years(2004)	Kunming, Zhuhai, Beijing, Xiamen	Enterprise only
In four years (2005)	Shantou, Ningbo, Shenyang, Xian	Enterprise only
In five years (2006)	All the regions	Both enterprise and residents

Figure 2.10: Map of areas opened up for domestic currency business

Source: drawn by author based on Table 2.8

Moreover, China called off restrictions on target clients for domestic currency business step by step. In two years after it joined the WTO, China permitted foreign banks to handle RMB business for Chinese enterprises and after five years of entry permitted foreign banks to provide such services to all Chinese clients, namely both enterprise and residents.

The entry of foreign banks into the long protected Chinese local market has been a gradual process, but accelerated by the commitment of China's entry into the WTO in 2001. This is an important milestone in the opening of China's financial markets.

2.4.2 Challenges faced by Chinese banks after the opening-up

After China's entry into the WTO, the competition as well as cooperation between domestic banks and foreign banks has been intensified in the Chinese banking market. As a consequence, both opportunities and challenges exist for the Chinese banks after the entry into the WTO. The opening of banking market is favourable to improve the structure of banking capital, enhance the inflow of international funds and absorb advanced management and operation skills from modern and large banks, which will improve the overall banking services and eliminate the disparity between China and the international standards. Unfavourable factors such as strong competition may cause financial crisis which endanger the stability of the financial system and economic security. Particularly, hot money must be carefully monitored to prevent it rushing in to threaten the national economy. Therefore, the government must bear a sense of urgency, crisis and responsibility to examine the actual situation and weaknesses in current banking system so that they can set a goal and explore new approaches to ensure a steady healthy development of banking market under the process of reform and opening up.

We can foresee that competition in the future will be very intense, foreign banks will participate in various services such as foreign and local currency retail business, mortgage, corporate lending and credit cards. However, in short run, foreign banks do not serve as a big threat to the Chinese domestic banks. Although foreign banks grow very fast, the market share they have captured is still very tiny. This is possibly because domestic banks have some dominated advantages. Firstly, to some extent, there is implicit hidden protection from the Chinese government, especially for big commercial banks. Secondly, domestic banks have well-built reputation and brand image. Thirdly, domestic banks have long business relationship with domestic enterprises. Last but not least, they have already established large number of networking branches spread all over the country. However, foreign banks can

compete with domestic banks for the creative service, middle business, expertise and management team. In short, the Chinese domestic banks have comparative advantage over traditional deposit and loan business, but foreign banks have advantages over the off-balance sheet business which is more likely to improve their profitability in the future.

2.5 Summary and Conclusion

This chapter firstly reviews the banking reform process implemented by the Chinese government since 1979. In general, the Chinese banking reform process can be subdivided into three phases. The first period dated from 1979 to 1989, characterized by institutional change from mono-bank system to multi layered system. The second period started from 1990 until 1996, featured by separation of commercial banking activities from policy lending activities and two legislative reforms. And the third period is identified from 1997 to 2006. China successfully joining the WTO in 2001 set the background for the latest phase of reform. We focus on the third period which is the most recent and has the most important influences. Three important aspects of the market-oriented reform are discussed, namely, restructure of the state-owned banks, reduced government intervention and strengthened regulation and supervision.

This chapter then outlines the structure of the Chinese banking system. Currently, the Chinese banking sector is comprised of two regulatory institutions (the Peoples' Bank of China and China Banking Regulatory Commission), and three major categories of domestic banks, namely: commercial banks (state-owned commercial banks, joint-stock commercial banks, and city commercial banks), policy banks, and (urban and rural) credit cooperatives. The most notable characteristic of the Chinese banking system is that it is dominated by the big four state-owned commercial banks (ICBC, BOC, CCB and ABC) which have formidable sizes. But those giants are burdened with a considerable amount of

non-performing loans which lead to poor asset quality, low profitability and inefficiency.

Finally, this chapter reveals the detailed arrangement during the five-year transition period for financial market opening-up after China's WTO entry in 2001, and consider both opportunities and challenges faced by the domestic commercial banks.

Chapter 3: Market competition in the Chinese banking industry: an application of the traditional Structure-Conduct-Performance (SCP) paradigm

3.1 Introduction

The relationship between performance (price or profitability) and market structure (market share and concentration) has been intensively investigated in various industries in numerous studies, especially in relation to the banking industry. This popularity may be due to the speciality of the banking market which plays a crucial role in the economy and is subject to intense regulations.

Most empirical studies in the bank performance literature find that banks' profitability is positively related to market power (measured by either concentration or market share). However, there are two explanations for this universally agreed positive relationship between the market structure and performance. The two explanations have resulted in two testable hypotheses; one is the traditional structure-conduct-performance (SCP) hypothesis, and another is the efficiency hypothesis. These two competing hypotheses have been subject to controversy for many years and the irresolvable debate will continue.

The structure–conduct–performance (SCP) paradigm states that the structure of an industry (the degree of concentration) determines firm conduct (collusion and monopolistic pricing) which in turn determines firm performance (profitability or rate of return).

Early studies advocated the traditional SCP hypothesis which states that banks in a more concentrated market can obtain higher profit as collusion is easier and less costly in that market. The ability to collude is assumed to be inversely related to the number of firms and their market shares in an industry, and thus is positively correlated with concentration. Therefore, the bank is able to set prices more favourably (i.e. higher loan rates and lower deposit rates) and gain more profit. Successful collusion leads to abnormal profits and a loss of social welfare and potential economic growth.

Later, the hypothesis that concentration leads to higher profitability has been challenged by an alternative hypothesis, known as the efficiency hypothesis. Studies (Demsetz (1973), Peltzamn (1977) and Brozen (1983)) that defend the efficiency hypothesis argued that profit differentials are the result of differences in efficiencies among banks. That is, efficiency is the underlying driving force for market share and profitability rather than market concentration. Banks with superior management or advanced production technologies have lower costs and therefore generate higher profits. In other words, greater efficiency of a bank allows it to gain a greater market share through price competition or acquisition of less efficient banks, and becoming more profitable. Thus, the increase of profits and market share is the result of efficiency, not of a higher level of concentration (collusion). The efficiency hypothesis however appears to be closely related to an alternative version of the SCP. This alternative version, known as the relative market power hypothesis (RMP) will be considered in Chapter 6, it treats individual firm market share (instead of whole market collusion) as the cause of inefficiency. Therefore the difference between the efficiency hypothesis and the RMP hypothesis is whether efficient performance determines high market share or vice versa.

In summarizing the basic points of the proponents of the efficiency hypothesis, Smirlock (1985) wrote: “concentration is not a random event but rather the result of superior efficiency of leading firms”. Firms possessing a comparative advantage in production

become large and obtain a high market share, and as a consequence, the market becomes more concentrated. Therefore, the basic message of efficiency hypothesis is that leading firms' efficiency leads to increased market share thus higher concentration and is positively correlated with higher performance.

Although those two competing hypotheses disagree with each other for the reason behind the positive relationship between profitability and market structure, they actually do not contradict. Indeed, both of them reflect the same relationship between market power and profitability. However they differ in the aspect of how market power can be obtained in the first place. That is, the traditional SCP hypothesis takes market power as exogenous, which is derived from market concentration, whereas, the efficient hypothesis take firm-specific efficiency as given, the market power is acquired through enlarged market share by means of maintaining or improving such efficiency.

Despite the logic and theory behind the two hypotheses are the same, the empirical application is divergent. The two hypotheses suggest different implications for merger and antitrust policy as well as regulatory work. If the SCP hypothesis is correct, the increased market concentration will enable banks to set prices less favourable to consumer. So antitrust policy and regulatory action for preventing accumulation of market power would be necessary. However, if the evidence supports the efficiency hypothesis, mergers and acquisitions that are motivated by greater efficiency should be encouraged. Thus, advocates of the traditional SCP hypothesis believe antitrust and regulatory policy is socially beneficial while the efficient structure hypothesis supporters consider it is socially costly.

In this chapter we will test the validity of the SCP hypothesis in Chinese banking market during 1997-2006. There are three factors motivate this study. First, as the controversy between the two competing hypotheses has not been resolved yet, it is important to find out which one is the best explanation for bank performance in Chinese banking industry. Once

identifying the driving force behind relationship between the bank performance and market structure, it can provide useful policy implications for decision makers. Second, although there have been numerous studies relating to both the SCP hypothesis and efficiency hypothesis, these studies, however, have been restricted to developed countries, mostly the US banking markets and, to a lesser extent, UK and other European banking markets. There are only a few papers carried out examination on the structure performance for Asian countries. Studies that solely focus on Chinese banking industry are hardly present. Before the initiatives of banking reform, the Chinese banking industry was highly concentrated and restrictively regulated and protected from foreign competition. So the Chinese banking market provides excellent example to investigate the relationship between bank performance and market structure. Third, as the debate on the two hypotheses will continue, this study can contribute some new evidences in the banking performance literature.

The rest of the chapter is structured as follow; Section 3.2 briefly explains the SCP framework. Section 3.3 analyzes the market structure in Chinese banking industry. Section 3.4 reviews empirical findings in the SCP literature. Section 3.5 describes the methodology. Section 3.6 provides data collection. Section 3.7 presents and discusses the empirical results. Finally, we summarize our study and conclude in Section 3.8.

3.2 The Structure-Conduct-Performance (SCP) framework

The Structure-Conduct-Performance (SCP) is a well-known paradigm in industrial economics since the 1960s. The SCP model was originally used by the US government in formulating antitrust policy. The model quickly gained popularity and it enjoys widespread application in different industries, especially in the banking sector, Please see Figure 3.1 which provides visual explanation for the general SCP framework.

Figure 3.1: The general SCP framework



The theoretical basis for using the structure-conduct-performance framework is to analyse competition among firms. However it is impossible to observe or measure competition directly, so proxies have to be used instead. One of the most commonly used proxies is the level of concentration in an industry. Consequently, a number of concentration ratios were devised to measure proxies for market competitiveness. For example, the four-firm concentration ratio (CR4), measuring the sum of the market shares of the four largest firms in the industry, and the eight-firm concentration ratio (CR8), focusing on the top eight firms. Other measures include the Herfindhal-Hirschman index (HHI), which looks at the market shares of all firms in that industry, or the Lerner index, which considers the differences between market price (p) and marginal costs (mc), $L=(p-mc)/p$; the higher the Lerner index is, the less is the competition. The Lerner index can be derived as a transformation of HHI and also of the Pazar-Rosse statistic which is covered in detail in Chapter 4. Each of these measures uses the relationship between revenues and costs to make inferences about competition.

According to economic theory, the degree of competition among firms in a market is influenced by the degree of concentration, since a more highly concentrated market structure facilitates more effective collusion. According to the 'collusion hypothesis', high concentration reduced the costs of collusion, resulting in higher rates being charged on loans, lower interest paid on deposits, higher fees, and so on. This hypothesis is originally tested by estimating measures of bank performance as functions of the market concentration. If the estimated regression coefficients on market concentration are statistically significant and positive, then the model provides evidence to support the SCP hypothesis.

Although the SCP model is far from ideal for testing market power and performance due to a number of weaknesses, such as not incorporating direct measure of efficiency and ignorance of firm's conduct (behaviour), it has survived and still enjoys the continuing popularity in industrial organizations for the purposes of competitive analysis. Other newly developed

approaches which improve the SCP model such as Panzar-Rosse model and Berger's test will be considered in Chapter 4 and 6.

3.3 Overview of market structure in Chinese banking industry

3.3.1 Market structure measurement

Market structure describes the state of a market with respect to competition. Market concentration (the number and size distribution of firms), entry barriers and the extent of product differentiation are main elements that explain the competition. Among the three factors, market concentration is considered as the most important and widely used measurement to examine the level of competition in the market. Econometricians usually employ concentration measurements to detect the degree of competition and determine the market form. The most popular and commonly used proxies for market concentration are the concentration ratio and the Herfindahl-Hirschman Index (HHI).

The concentration ratio of an industry is used as an indicator of the relative size of firms in relation to the industry as a whole. This may also assist in determining the market structure of the industry. One commonly used concentration ratio is the three-firm concentration ratio CR_3 , which consists of the market share, as a percentage, of the three largest firms in the industry. In general, the n-firm concentration ratio CR_n is calculated as the percentage of market share (MS) obtained by the n largest firms in the industry where there are N firms in the whole industry. The higher the concentration ratio is, the lower the competition in the market.

$$CR_n = \frac{\sum_{i=1}^n MS_i}{\sum_{i=1}^N MS_i} \quad [3.1]$$

Alternative market forms can often be classified by their concentration ratio as listed in Table 3.1.

Table 3.1: Classification of competition form based on concentration ratio

Market form	Concentration Ratio
Low concentration	a very low concentration ratio or close to 0
Medium concentration	below 40%
High concentration	above 60%
Very high concentration	with a near 100%

Source: The economics of industries and firms

The Herfindahl-Hirschman Index (HHI) indicates the competition among firms in the market. It is widely applied in competition law and antitrust to detect and stop harmful monopolies. It is defined as the sum of squared the market shares of all the firms within the industry. Increases in the Herfindahl index generally indicate a decrease in competition and an increase of market power, whereas decreases indicate the opposite. The major benefit of the Herfindahl index in relationship to such measures as the concentration ratio is that it gives more weight to larger firms, but it requires more information for calculation.

$$HHI = \sum_{i=1}^N MS_i^2 \quad [3.2]$$

A HHI index below 0.1 (or 1,000) indicates an unconcentrated market.

A HHI index between 0.1 to 0.18 (or 1,000 to 1,800) indicates moderate concentration.

A HHI index above 0.18 (above 1,800) indicates high concentration

Source: USA Department of Justice Categories

In the following section, we look at market share, concentration ratio and HHI in terms of total deposits, total loans and total assets, for six main types of commercial banks in China over 10 years (1997-2006), namely state-owned banks, joint equity banks, city commercial banks, urban co-operatives, rural co-operatives and foreign banks.

3.3.2 Market share in Chinese banking sector

3.3.2.1 Market share based on total deposits

Firstly, we consider the market share for total deposits. As illustrated in Table 3.2 below, the ICBC lost the most market share in last ten years by more than 10%. It fell dramatically from 29.4% in 1997 to 19.32% in 2006. Despite the ICBC suffered considerable loss of market share, it still took over the largest part of the deposit market. The share for the CCB also decreased, but with only 2.45% loss. By contrast, the BOC nearly doubled its market share over the investigation period. However, it still has the least proportion compared to the other three banks. The ABC keeps its market share around 15% during the time under consideration, with minor fluctuations.

All joint equity banks follow an increasing trend in their market share of deposits. The Bank of Communications always hold the largest part of the market within this group, and control almost 5% by the end of 2006. The China Merchant Banks obtain the second place and possess 2.71% of deposit market share. It is the fastest growing bank; its market share is four times as big as ten years before. The China CITIC Bank and The China Mingshen Bank

Table 3.2: Market share of total deposits (%) 1997-2006

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Industrial & Commercial Bank of China	29.40	29.06	28.84	28.61	26.06	24.81	24.09	21.17	20.47	19.32
Agricultural Bank of China	15.22	15.50	15.77	15.44	15.60	15.52	15.36	14.70	15.55	15.27
Bank of China	7.98	8.48	8.80	8.73	9.15	9.17	9.49	14.66	14.17	14.08
China Construction Bank	17.08	17.05	17.14	16.73	16.61	16.08	15.20	14.35	14.52	14.63
State-owned banks	69.68	70.09	70.55	69.51	67.42	65.58	64.14	64.88	64.71	63.30
Bank of Communications Co. Ltd	3.66	3.50	3.44	3.57	3.64	3.68	3.82	4.20	4.60	4.92
China CITIC Bank Co. Ltd	0.93	0.92	0.95	1.14	1.42	1.51	1.64	1.86	1.93	2.32
China Everbright Bank Co Ltd	0.41	0.46	0.55	1.12	1.36	1.31	1.71	1.29	1.13	1.31
Hua Xia Bank	0.33	0.39	0.42	0.6	0.75	1.13	0.86	1.1	1.14	1.39
Guangdong Development Bank	0.65	0.71	0.71	0.87	1.04	1.09	1.26	1.28	1.13	1.27
Shenzhen Development Bank	0.25	0.29	0.31	0.39	0.61	0.68	0.70	0.73	0.75	0.81
China Merchants Bank Co Ltd	0.68	0.75	0.92	1.24	1.39	1.93	2.12	2.15	2.28	2.71
Shanghai Pudong Development Bank	0.70	0.73	0.74	0.83	1.05	1.46	1.23	1.67	1.85	1.98
Industrial Bank Co Ltd	0.22	0.26	0.29	0.42	0.61	0.88	1.05	1.27	1.48	1.64
China Minsheng Banking Corporation	0.16	0.19	0.27	0.45	0.80	1.18	1.46	1.67	1.84	2.13

Evergrowing bank	0.05	0.05	0.06	0.07	0.09	0.08	0.12	0.13	0.14	0.16
Joint equity banks	8.04	8.25	8.66	10.70	12.76	14.93	15.97	17.35	18.27	20.64
City commercial banks	n/a	n/a	n/a	n/a	n/a	5.74	6.15	5.62	5.97	6.05
Urban co-operatives	7.32	7.06	6.76	5.98	6.02	0.65	0.67	0.64	0.64	0.63
Rural co-operatives	14.34	14.06	13.48	13.22	13.18	12.82	11.63	10.51	10.02	9.56
Foreign banks	0.51	0.43	0.44	0.48	0.49	0.45	0.48	0.51	0.63	0.82

Source: author's own estimation based on official figures reported in Bankscope

expand quickly as well, both of them acquire more than 2% market share. However, even the rest of joint equity banks achieve reasonable improvement, their market share is below 2%.

There is little change in total market share for city commercial banks and urban co-operatives as a whole; it fluctuated between 6% and 7%. The market share for rural co-operatives gradually decreased over time from 14.34% in 1997 to 9.56% in 2006. It makes the second largest loss in deposit market just behind the ICBC. The foreign banks have the least control in deposits market, but it steadily increased since 2002, even the amount is still negligible.

All in all, even there is increase and decrease in market share within the state-owned banks group, the total market share of deposits for state-owned banks fairly decreased from 1997 to 2006. But they still dominate the deposit market with 63.3%. For joint equity banks, each bank increase marginally over time, but the aggregate market share experienced substantial increase. It rose from just over 8% in 1997 to 20.64% at the end of 2006. On the contrary, the rural co-operatives encounter the big loss of its market share, but it is the third largest player in the deposit business. The overall market share for city commercial banks and urban co-operatives is relatively stable over the previous ten years. The foreign banks got the smallest share in deposits market with minor increase over the sample period.

3.3.2.2 Market share based on total loans

Next, we examine the changes of market share in total loans. As shown in Table 3.3, among state-owned banks, the market share of total loans for the ICBC decreased the most. It fell from 30.93% in 1997 to 17.89% in 2006. Although a reduction of 13.04% in total over the ten years, the ICBC still hold the largest market share in loans market. However, the difference between the ICBC and the other state-owned banks diminished over time, its

Table 3.3: Market share for total loans (%) 1997-2006

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Industrial & Commercial Bank of China	30.93	29.79	29.68	28.24	26.86	24.87	23.81	19.09	18.26	17.89
Agricultural Bank of China	15.89	18.76	19.75	17.10	16.73	16.35	15.88	16.06	16.29	16.13
Bank of China Limited	9.12	8.93	9.31	8.60	8.98	9.20	9.49	13.01	12.55	12.43
China Construction Bank Corporation	16.67	16.11	14.34	15.46	14.95	14.78	14.43	13.64	13.95	13.37
State-owned banks	72.61	73.59	73.08	69.40	67.52	65.20	63.61	61.80	61.05	59.82
Bank of Communications Co.Ltd	2.95	2.95	3.10	3.44	3.43	3.40	3.51	3.97	4.42	4.95
China CITIC Bank Co. Ltd	0.61	0.63	0.77	1.14	1.33	1.60	1.67	1.84	2.09	2.27
China Everbright Bank Co. Ltd	0.38	0.41	0.47	1.05	1.42	1.60	1.71	1.50	1.39	1.42
HuaXia Bank	0.20	0.28	0.34	0.55	0.64	1.13	0.88	1.11	1.33	1.43
Guangdong Development Bank	0.50	0.57	0.64	0.75	0.96	1.03	1.28	1.33	1.23	1.29
Shenzhen Development Bank	0.21	0.24	0.27	0.39	0.51	0.70	0.75	0.76	0.87	0.93
China Merchants Bank CoLtd	0.59	0.63	0.74	1.08	1.15	1.75	2.11	2.15	2.53	2.99
Shanghai Pudong Development Bank	0.51	0.57	0.61	0.79	0.92	1.42	1.58	1.90	2.14	2.64
Industrial Bank CoLtd	0.20	0.21	0.27	0.39	0.75	0.83	1.13	1.25	1.39	1.44
China Minsheng Banking Corporation	0.08	0.14	0.19	0.42	0.77	1.13	1.45	1.80	2.19	2.76

Evergrowing bank	0.04	0.05	0.05	0.07	0.08	0.07	0.10	0.13	0.14	0.15
Joint equity banks	6.27	6.68	7.45	10.07	11.96	14.66	16.17	17.74	19.72	22.27
City commercial banks	n/a	n/a	n/a	n/a	n/a	5.44	5.80	5.80	5.90	6.20
Urban co-operatives	3.13	2.32	2.05	5.54	5.73	0.59	0.61	0.64	0.65	0.68
Rural co-operatives	11.87	11.45	11.73	13.17	13.29	12.91	12.75	12.40	10.82	9.35
Foreign banks	3.69	2.97	2.27	1.82	1.61	1.21	1.06	1.61	1.86	2.13

Source: author's own estimation based on official figures reported in Bankscope

market share is very close to the rest of three at the end of 2006. Following the ICBC, the ABC got the second largest market share in loan business. The market share of ABC slightly increased over the sample period, even there was a little fluctuation during the period, but relatively stable as a whole. Despite the proportion of market share for BOC rose over 3% during the period we considered, it control the least in loan market compared to other three. The market share for CCB dropped from 16.67% in 1997 to 13.37% in 2006, but experienced small fluctuations over the examination period.

Among joint equity banks, the largest market share belongs to the Bank of Communications, its market share increased over time and reached nearly 5% at the end of 2006. Followed by the China Merchants Bank, it achieved 2.99% in loan market in 2006 but started with only 0.59%. China Mingshen Bank, China Pudong Development Bank and China CITIC Bank obtained over 2% market share in loan business. When we look at growth rate of market share, China Mingshen Bank made the fastest progress during ten years, and followed by China Merchants Bank. The lowest growth banks are Guangdong Development Bank and Shenzhen Development bank.

The market share of city commercial banks and urban co-operatives decreased first and then increased to 6.88% in aggregate at the end of 2006. The rural co-operatives' market share of loans fluctuated between 11% and 13%, but decreased to 9.35% in 2006. The market share for foreign banks maximized in the beginning of the sample period and stood at 3.69%. But it continually declined after Asian financial crisis. From 2004, the market share started to rise and reached to 2.13% in 2006.

In sum, the market share of loan for state-owned banks as a whole fell sharply over last ten years compared to market share of deposits. It decreased from a total of 72.61% in 1997 to 59.82% in 2006. Although the “big-four” suffered a dramatic reduction in their market share, they still hold the largest proportion of the market. The second largest player is joint equity

bank; they make impressive progress in loan business during the sample period. There was a considerable increase in aggregate market share. It started with only 6.27% and get hold of 22.27% at the end. But there were different variations of growth rate for each individual bank. Rural co-operatives take the third place in loan market after moderately shrinkage. For city commercial banks and urban co-operatives as a whole, they maintain a relatively stable market share around 6% after they make remarkable growth in 2000. The market share for foreign banks in loan business fell back during Asian financial crisis, and started to climb up since 2003. It is believed that they will have sizeable expansion in the future, after 2006 full open of financial market.

3.3.2.3 Market share based on total assets

Finally, we explore the variations in market share based on total assets. As we can see from Table 3.4, the BOC fell the most in total assets market share, with a total 8% decrease over last ten years. The market share for ICBC total assets also dropped considerably from 25.07% to 19.64%, but it remain the largest commercial bank in terms of total assets. The market share for the rest of the two state-owned banks namely the ABC and the CCB increased marginally and stay around 14% but with small variations during the sample period.

Among the joint equity bank, the Bank of Communications occupies the largest part of the market and it is also one of the fast growth banks. The China Merchant Bank took the second place within this group and hold 2.19% in 2006, which is more than three times as it in 1997. The fastest growth bank is the China Mingshen Bank; its market share is ten times as big as it in 1997. The rest of the peer banks all experienced increase in their market share but with different growth rate.

The market share for city commercial banks and urban co-operatives fell for the pre-entry

Table 3.4: Market share for total assets (%) 1997-2006

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Industrial & Commercial Bank of China	25.07	25.24	24.88	25.16	25.03	23.12	21.77	18.14	19.79	19.64
Agricultural Bank of China	13.51	15.76	15.99	13.83	14.66	14.54	14.52	14.64	14.81	14.93
Bank of China Limited	22.47	19.29	18.40	18.32	15.05	14.19	13.05	15.58	14.73	14.52
China Construction Bank Corporation	13.85	14.99	15.47	16.03	15.96	15.06	14.77	14.26	14.23	14.17
State-owned banks	74.90	75.28	74.74	73.34	70.70	66.91	64.11	62.62	63.56	63.26
Bank of Communications Co.Ltd	3.11	3.77	3.78	3.98	3.83	3.75	3.95	4.17	4.42	4.63
China CITIC Bank Co. Ltd	0.75	1.04	1.11	1.49	1.74	1.64	1.74	1.84	1.90	2.07
China Everbright Bank Co. Ltd	0.42	0.58	1.18	1.31	1.54	1.60	1.64	1.44	1.22	1.15
HuaXia Bank	0.26	0.39	0.43	0.60	0.79	0.87	1.03	1.11	1.11	1.14
Guangdong Development Bank	0.51	0.83	0.86	0.94	1.11	1.07	1.25	1.26	1.07	1.09
Shenzhen Development Bank	0.21	0.30	0.32	0.43	0.70	0.81	0.80	0.75	0.69	0.71
China Merchants Bank CoLtd	0.64	1.11	1.19	1.28	1.45	1.74	1.99	2.03	2.15	2.19
Shanghai Pudong Development Bank	0.62	0.66	0.73	0.66	1.01	1.07	1.54	1.66	1.78	1.81
Industrial Bank CoLtd	0.22	0.28	0.35	0.54	0.72	0.87	1.08	1.24	1.47	1.48
China Minsheng Banking Corporation	0.15	0.20	0.26	0.43	0.81	1.20	1.50	1.62	1.73	1.78

Evergrowing bank	0.06	0.07	0.08	0.09	0.09	0.08	0.10	0.11	0.13	0.17
Joint equity banks	6.95	9.23	10.29	11.75	13.79	14.70	16.62	17.23	17.67	18.22
City commercial banks	n/a	n/a	n/a	n/a	n/a	5.63	6.14	6.29	6.29	6.31
Urban co-operatives	5.02	4.37	4.43	4.30	4.01	0.58	0.62	0.66	0.64	0.58
Rural co-operatives	10.19	8.91	8.71	8.82	9.34	10.77	11.11	11.32	9.86	9.27
Foreign banks	3.17	2.21	1.85	1.80	2.17	1.41	1.38	1.88	1.97	2.35

Source: author's own estimation based on official figures reported in Bankscope

period, but smoothly increased during the post-entry period. It rose by about 2% over the examination period. No clear trend can be identified for market share of rural co-operatives. It fluctuated slightly between 9% and 11% and it is ranked as the third largest financial entities based on total assets behind the joint equity banking group. The market share of foreign banks maximized in the beginning of the sample period with more than 3%, but it decreased due to financial crisis, and started to climb up since 2001 and reached to 2.35% in 2006.

In short, the total market share of total assets for the state-owned banks as a group continually and gradually decreased from 74.9% to 63.26%. It drops by over 11% during the full period under consideration. Even the big four come across the substantial loss of market share in total assets, their dominance position is intact. The market share for joint equity banks as a whole increased enormously. Its market share tripled over last ten years. Followed by the joint equity banks, the rural co-operatives took the third largest market share despite there is a small reduction in its market share. The combined market share for city commercial banks and urban co-cooperatives has a minor increase after a small decrease in early period. The foreign banks obtain the least control over the market, but there is an increase trend in recent years after the Asian financial crisis and the WTO entry.

To sum up, the ICBC is the largest commercial bank in China no matter in absolute values or relative market share, and also no matter the market share calculated by using which criteria, namely total deposits, total loans or total assets. Followed by the ICBC, the ABC is the second largest commercial bank in terms of all measures. The CCB and BOC take the third and fourth place behind the ABC. As a result, the state-owned banks as a group dominated the market in terms of all measures.

However, there is substantial fall in their market share over last ten years, especially for loan market and total assets. Their dominance position has been challenged by the rapid

expansion of other depository institutions, especially joint equity banks. The large proportion of the loss from state-owned banks contributed to the considerable increase in the market share for joint equity banks. All the joint equity banks experienced a steady increase in deposit, loan and total assets in previous ten years. Their overall market share for total loans and total assets tripled and the total deposits more than doubled. However the size of market share is distributed unevenly among those banks. For example, the Bank of Communications is the fifth largest commercial bank in China and the largest among joint equity banks, with a share of 4.63% based on total assets, but the Shenzhen Development Bank has only 0.71%, a fraction of what the Bank of Communications controls.

By contrast to the continuing increase for joint equity banks, rural co-operatives has a general decreasing tendency over the sample period for its market share in all aspects, but it remain the third largest player in the financial markets. For city commercial banks and urban co-operatives, there is overall increase in their entire market share, although the market share contract in early years. The market share of loans, deposits and total assets for foreign banks follow the same trend. Their proportions drop first after Asian financial crisis in 1997, and then start to gain back since 2000.

A number of foreign banks has entered the market and quickly expanded their presence on the domestic banking market. Foreign banks which have already obtained banking license and prepared to enter the market, they are aimed to get a foothold in the market as soon as possible. Even foreign banks expanded significantly after the entry of the WTO, but in total is still marginal compare to domestic banks. Although they have the smallest share of the market in China, their potential growth is formidable, especially after the full openness of domestic financial sector in 2006.

3.3.3 Concentration ratio

To measure the level of concentration in the Chinese banking industry, we employ CR4 and CR8. In other words, we calculate the total market share for the top four and eight largest banks in the market. As demonstrated in Table 3.5, the CR4 in terms of all aspects was always maintained above 60%; despite it decreased from 70% in the beginning of the sample period. The decreasing magnitude for concentration in deposit market is smaller, when we compare it with loans and total assets. The CR4 decreased in loan and total assets by 12% and 11% respectively, but only 6% for deposit market (see Figure 3.2). This may due to the historical reason and size advantage. The big-four has already built up reputation and long term business relationship with customers. Moreover, bigger banks have more branches, so it is easier for them to attract deposits than smaller banks. Although state-owned banks face aggressive competition from other depository institutions, especially from joint equity banks, they still have the absolute advantage and majority control over the market.

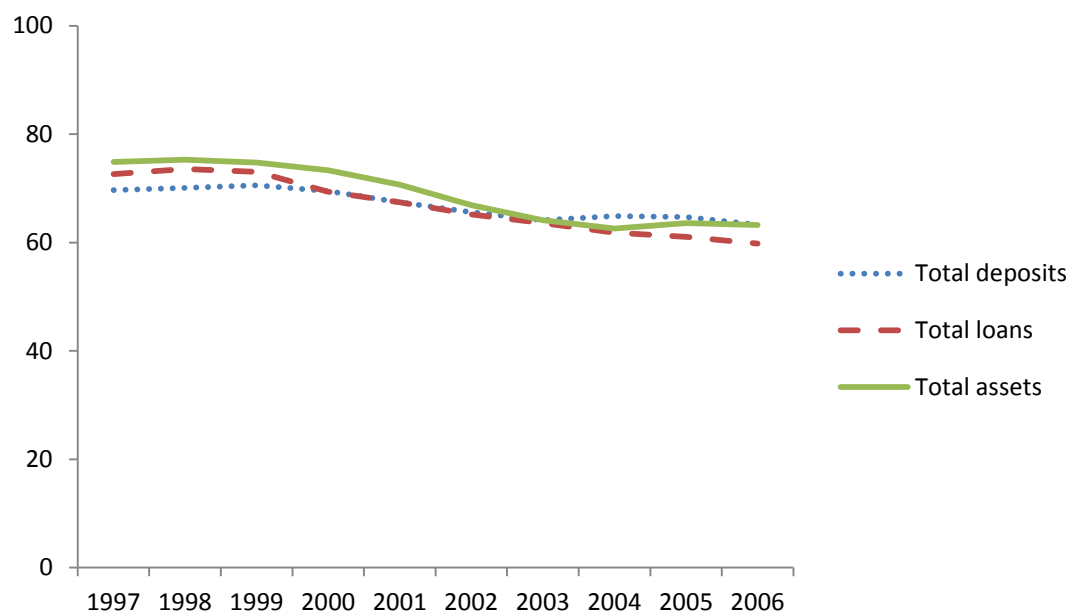
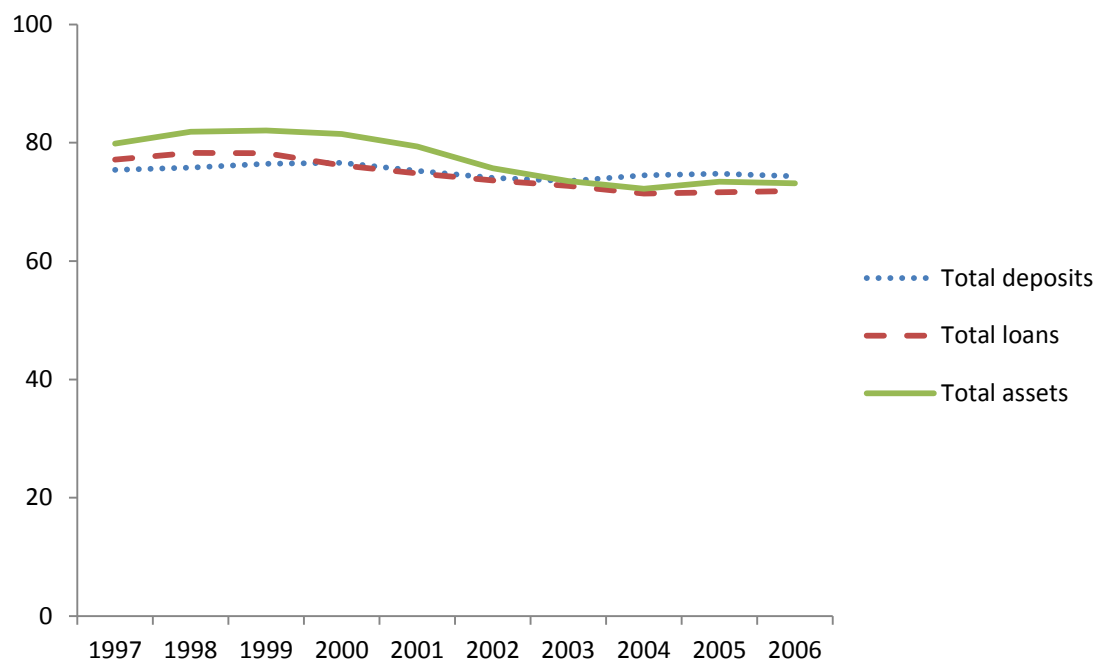
The CR8 follow almost the same trend as the CR4 (see Figure 3.3). The market is highly concentrated and level of concentration is always kept above 70% for the eight largest banks. Particularly, the concentration for deposit market sustained over last ten years, with 1% decrease. However, the market share based on total assets for top eight banks decreased most, nearly 7%.

In short, even after the level of concentration decreasing over time based on all measures, China still has significantly high level of market concentration. Chinese banking market is dominated by a few large banks, who together share roughly 70% of the market in terms of total assets, as suggested by CR4 and CR8. The concentration based on total assets fall the most, but for deposit market fell the least.

Table 3.5: Concentration ratio and HHI 1997- 2006

CR4	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total deposits	69.68	70.09	70.55	69.51	67.42	65.58	64.15	64.89	64.72	63.30
Total loans	72.61	73.59	73.08	69.41	67.42	65.20	63.61	61.81	61.04	59.82
Total assets	74.89	75.28	74.74	73.33	70.70	66.91	64.11	62.62	63.57	63.26
CR8	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total deposits	75.39	75.77	76.44	76.61	75.26	74.04	73.50	74.49	74.77	74.33
Total loans	77.14	78.26	78.21	76.18	74.83	73.61	72.71	71.39	71.63	71.82
Total assets	79.83	81.85	82.07	81.48	79.36	75.71	73.54	72.21	73.39	73.13
HHI	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total deposits	0.173	0.171	0.170	0.165	0.152	0.142	0.137	0.128	0.125	0.121
Total loans	0.174	0.173	0.172	0.163	0.154	0.141	0.135	0.121	0.115	0.113
Total assets	0.166	0.160	0.157	0.154	0.146	0.135	0.127	0.120	0.121	0.118

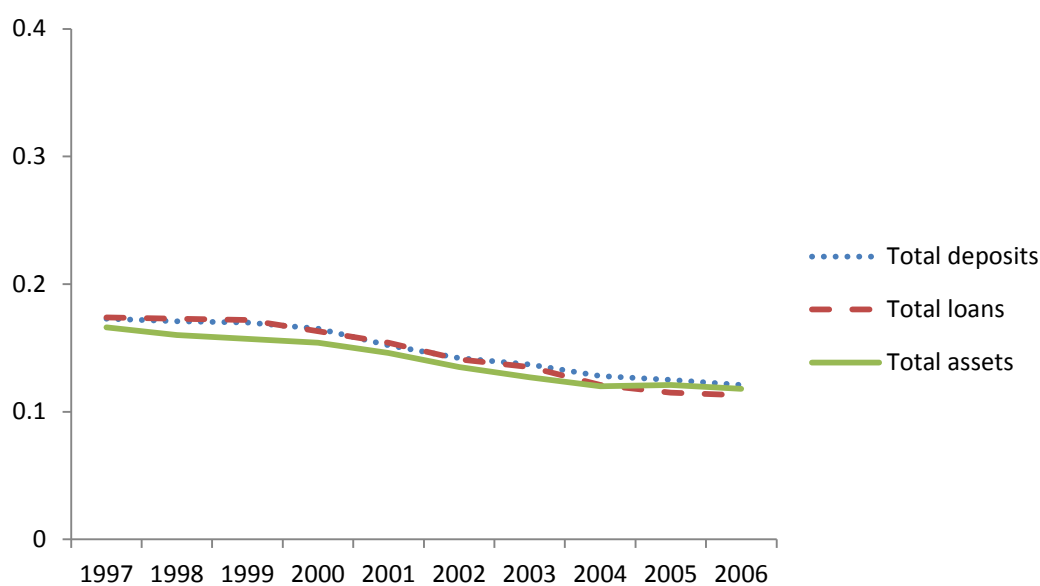
Source: author's own estimation based on official figures reported in Bankscope

Figure 3.2: Concentration ratio four (CR4) 1997-2006**Figure 3.3: Concentration ratio eight (CR8) 1997-2006**

3.3.4 Herfindahl-Hirschman Index (HHI)

Last but not the least, we analyse the market concentration by making use of the Herfindahl-Hirschman Index (HHI). The HHI in Table 3.5 and Figure 3.4 shows apparent decreasing trend in all aspects namely, loan, deposits and total assets. The lasting decreasing tendency in concentration may suggest that large banks have less market power and the market is more competitive than ten years before. Additionally, by the end of sample period, the Chinese banking industry could be characterized as moderately concentrated market, which was highly concentrated in the early sample period, based on the classification from the U.S. Department of Justice.

Figure 3.4: The HHI index 1997-2006



3.3.5 The reason for the presence of concentration in banking industry

After investigating the market structure in Chinese banking industry, we find that the banking sector is highly concentrated in China. However, this is not the only case for China. Actually the presence of concentration in banking industry exists in every country, no matter whether it is developed country or developing country. The only difference is that developing countries generally have higher levels of concentration than in developed countries, as the financing resource solely comes from banks due to under-developed capital market in developing countries, while developed countries has a well-established capital market, which serves as an important alternative channel that provides a major source of funds in addition to banks. So the bank-oriented economies have higher level of concentration than capital market based economies. For example, the concentration level is higher in the bank oriented economies of Germany and Japan than in the US and the UK, although they are all developed economies.

Now, we pause here to ask a natural question, why banking industry is concentrated or why banking market sustain with only a limited number of banks. In the following, we briefly explore the main reason behind the inherited concentration of the banking market.

A large number of literatures (see Allen, Santomero, Llewellyn (1985) and Merton (1995)) have identified that incomplete and asymmetric information is one of the most important factors that determine the market structure of the banking industry. All lenders face uncertainty with regard to borrowers' creditworthiness. They cannot observe borrowers' characteristics and behaviour before and after the lending transaction. The informational incompleteness and asymmetries could cause adverse selection and moral hazard problem which may distort the order of market competition and market force mechanism. However,

the existence of bank or other depository institutions resolve some of the informational problems. In the process of lending, financial institutions serve as intermediaries who are able to collect information about borrowers' creditworthiness on behalf of lenders. Based on these private information, banks can better distinguish between "good" borrowers and "bad" borrowers. And they can screen and monitor borrowers at lower cost because of both scope and scale economies. Therefore, the possession of such proprietary information about borrowers facilitates them with some degree of market power. In other words, the acquisition of these information advantages is already locked in a bank-client relationship. As a result, banks can charge higher interest rate on loan, but pay lower rate on deposit, hence earn profits from interest rate spread as compensation for cost of information collection and analysis process. Moreover, the incomplete and asymmetric information create barriers of entry, preventing potential new competitors from entering the market. Although entry barriers are relatively high and restrictive, it does not suggest there is no competition in banking industry and the banks enjoy quite life. The threat of potential entrants and acquisition by other rivals force incumbent banks fight intensively for market share.

3.4 Literature review

There is a large literature designed to provide empirical evidence on how market structure influences bank performance. The empirical works conducted in the SCP framework enjoy a relatively long history, the earliest study can date back to the 1960's. Discussion of the literature on the SCP studies in banking sector is organized as follows. The first section briefly reviews the development of the SCP model over time, based on different specifications. The second section considers the studies that empirically apply the method. Then we discuss some recent development and methodological issues involved in testing relationship between market structure and bank performance.

3.4.1 Different specifications

Basically, three methods have been developed in an attempt to test the competitive conditions of industries by examining how the underlying structure of an industry is related to, and affects the conduct and performance of firms.

3.4.1.1 The first method

The first method is broadly characterized as testing the traditional SCP hypothesis by only regressing a measure of bank performance on a measure of market concentration. As Gilbert (1984) has provided a full survey paper on previous empirical literatures using this method, we do not attempt to review those studies here. In his paper, 44 studies from 1964 to 1982 which used this method to test the SCP hypothesis (twenty six studies out of forty-four use bank profit rates as performance measures) were summarized for the impact of bank performance to a market concentration. The paper presented a critical analysis and summarized various features of the bank market structure studies. Although the previous bank market structure studies do not consistently support or reject the SCP hypothesis that market concentration influences bank performance, the prominent early studies provide support in favor of the SCP hypothesis. Thirty-two of the forty-four studies Gilbert reviewed found that market concentration significantly and positively affected bank performance.

3.4.1.2 The second method

The SCP hypothesis which states the positive association between market concentration and performance has been challenged by the efficiency hypothesis. The basic foundation of the

efficiency hypothesis is that market concentration is not the cause of a firm's superior performance. Instead, efficiency hypothesis finds that the positive direction of concentration and higher performance is the result of a firm's superior efficiency. It is argued that the higher profits enjoyed by large firms in a concentrated market are the result of economies of scale and the consequences of superior efficiency in larger firms. If a firm enjoys a higher degree of efficiency (in terms of cost and technology) than its competitors, the firm can easily capture a larger market share by lowering its price and earning economic profits. Thus, the driving force behind the process of gaining a large market share, and in turn higher concentration, is the efficiency of the firm. Equally, the most efficient firms will gain market share and earn economic profits. As the rise of the efficiency hypothesis, the innovation of the second method has been developed by adding one more independent variable, market share, as a proxy for efficiency. As mentioned before, the inclusion of market share variable in the SCP paradigm actually test relative market power hypothesis according to Berger's classification.

3.4.1.3 The third method

To take the effects of efficiency directly into account, more recent studies have regressed the profitability on concentration, market share and direct measure of efficiency (X-efficiency and scale-efficiency) rather than use of market share as proxy. Berger (1995) first developed this method that incorporated the direct measures of both market structure and efficiency into one model. This helps distinguish among four hypotheses, namely the structure conduct performance (SCP), relative market power (RMP), X-efficiency hypothesis (ESX) and Scale efficiency hypothesis (ESS). The empirical literature use this Berger's methodology will be reviewed in Chapter 6 later, where we conduct similar analysis in the context of Chinese banking market.

3.4.2 Review of literature on SCP

In this section, we only focus on the empirical literatures that adopted the second method. This approach which tests the two competing hypotheses: the SCP hypothesis and efficiency hypothesis, has been applied extensively in different industries under various economic environment. In the banking sector, the SCP framework has been widely used to evaluate the possible link between market concentration and profits but the conclusions drawn from such studies have been mixed. Most studies focus on the US banking market found that greater concentration does not lead to higher profits and favour the efficiency hypothesis. While others shed light on banking industry in other countries mainly European countries supported the traditional SCP hypothesis.

Smirlock (1985) investigated the interrelationship between profits, market share and concentration for over 2700 unit state banks in the US between 1973 and 1978. He regresses the profit rate on market share, concentration, interaction of the two and a set of additional control variables. The results of his analysis suggest that there is no positive relationship between concentration and profitability, once the link between market share and profitability is controlled. Thus his paper provides the evidence supporting the efficiency hypothesis and asserts that market concentration is not necessary a signal of collusive behaviour but rather the superior efficiency of the leading firm.

Following Smirlock (1985), Evanoff and Fortier (1988) employed a similar model (but exclude the interaction term) to test more than 6300 unit banks located in 30 states of the US in 1984. They find support for the efficient structure hypothesis and limited support for the traditional SCP hypothesis. This implies that the competing hypotheses may actually be complementary theories. Their findings add support to the efficiency hypothesis and propose possible future research is necessary to determine the source of the efficiency.

However, Lloyd-Williams and Molyneux (1994) present a similar analysis, and find support for the traditional SCP hypothesis with respect to the Spanish banking industry for the period 1968-1988. The empirical results suggest that concentration in the Spanish banking market has lowered the cost of collusion between firms and resulted in higher than normal profits for all market participants. This results contrast markedly with those works on the US banking industry which has generally more favourable to the efficiency hypothesis.

Molyneux and Forbes (1995) firstly apply this type of study for the whole European banking market. Their results strongly support the traditional SCP hypothesis as an explanation for the performance of European banks.

The paper by Katib (1998) tested the validity of the SCP framework in the Malaysian banking market. The empirical investigation uses five different measures of concentration to represent market structure (i.e. CR1, CR2, CR3, CR5, and HHI). The tests on a sample of 20 commercial banks over the period from 1989 to 1996 strongly reject the efficiency hypothesis. The empirical findings suggest that market concentration determines profitability in the Malaysian banking industry.

Tu and Chen (2000) conduct empirical tests of the three hypotheses, namely traditional SCP hypothesis, the efficiency hypothesis and “quiet life” hypothesis in the context of Taiwan’s banking market over the period from 1986 to 1999. They examine whether market structure and firm performance in this industry differ in the periods before and after the liberalization policy (revision of the Banking Act) in 1991. Prior to 1991, their results do not support either the SCP or the efficiency hypothesis for Taiwan’s banking industry. It implies the presence of a regulation-induced quiet life type of market structure for this period. The results for the period after 1991 tend to support the competing efficiency hypothesis.

Bos (2004) investigated the existence of market power in the Dutch banking market by

employing three tests, namely traditional SCP model, a simple Cournot model and the modified SCP with efficiency measure. The empirical tests provide evidence in favour of the SCP hypothesis. The results suggest that we cannot reject the existence of market power in Dutch banking sector, although its impact on performance is small.

Athanasoglou et al (2005) examine the relationship between profitability and market structure for banking industry in the South Eastern European over the period 1998~2002. They model the profitability as a function of set of bank-specific, industry-related and macroeconomic determinants. A key result is that the effect of concentration is positive, which provides evidence in support of the SCP hypothesis.

Athanasoglou et al (2008) re-examine the SCP framework to a panel of Greek banks covering period 1985-2001. They include macroeconomic determinants of bank profitability in addition to bank specific and industry specific variables in the empirical model. However, no evidence is found in support of the SCP hypothesis, as the effect of concentration is insignificant.

Samad (2008) perform similar analysis in Bangladesh banking industry for the period 1999-2002. The results of this study support the efficiency hypothesis as an explanation for bank performance in Bangladesh.

Table 3.6 below summarize the empirical literatures we have reviewed.

Table 3.6: Summary of empirical literature using SCP approach

Authors	Country	SCP	Efficiency
Smirlock (1985)	US		Yes
Evanoff and Fortier (1988)	US		Yes
Lloyd-Williams and Molyneux (1994)	Spain	Yes	
Molyneux and Forbes (1995)	European	Yes	
Katib (1998)	Malaysia	Yes	
Tu and Chen (2000)	Taiwan		Yes
Bos (2004)	Netherlands	Yes	
Athanasoglou et al (2005)	SEE	Yes	
Athanasoglou et al (2008)	Greek		
Samad (2008)	Bangladesh		Yes

3.5 Methodology

This section provides a discussion on the model specification and the various measures of performance and concentration used. In addition, control variables utilised for this empirical test are also discussed.

3.5.1 Empirical specification in the SCP literature

The traditional SCP and efficiency hypothesis can be tested by estimating the following equation (Weiss (1974), Smirlock (1985) and Lloyd-Williams et al. (1994)):

$$p_{it} = \alpha + \beta_1 CON_{it} + \beta_2 MS_{it} + \sum \beta_n Z_{it} + \varepsilon_{it} \quad [3.3]$$

where p is performance measurement (ROE or ROA), CON is a measure of market structure (usually a concentration measure), MS is market share of individual banks, Z is a vector of control variables which affect bank's performance and ε_{it} is the stochastic error term.

The equation (3.3) provides the straightforward distinguish between two hypotheses. The traditional SCP hypothesis is favoured if $\beta_1 > 0$ and $\beta_2 = 0$; which implies that market share does not affect firm's profitability and the profitability is the result of concentrated market. On the other hand, the efficiency hypothesis can be verified by finding $\beta_1 = 0$ and $\beta_2 > 0$, which implies that more efficient firms with larger market share can earn higher profits than their rivals. Thus, $\beta_1 > 0$ and $\beta_2 = 0$ supports SCP and $\beta_1 = 0$ and $\beta_2 > 0$ supports efficiency hypothesis.

3.5.2 Empirical specification of SCP used in this study

The complete equation we use to empirically test the two hypotheses for Chinese commercial banks is shown below:

$$ROA_{it} (ROE_{it}) = \alpha + \beta_1 MS_{it} + \beta_2 CON_{it} + \beta_3 TA_{it} + \beta_4 (E/TA)_{it} + \beta_5 (TL/TA)_{it} + \beta_6 (TL/TD)_{it} + \beta_7 (LLP/TL)_{it} + \beta_8 (OE/TR)_{it} + \beta_9 OWN1 + \beta_{10} OWN2 + \varepsilon_{it}$$

[3.4]

ROA=return on assets=net income/total assets

ROE=return on equity=net income/total equity

MS=market share of i th banks based on total assets

$$CON = HHI = \sum MS_i^2$$

TA=total assets

E/TA=total equity/total assets

TL/TA= total loans/total assets

TL/TD=total loans/total deposits

LLP/TL=loan loss provisions/total loans

OE/TR=total operating expense/total revenue

OWN1=ownership dummy for state owned banks

OWN2=ownership dummy for joint equity banks

ε_{it} = error term

3.5.3 Fixed effect and random effect model

Our empirical model (Eq. 3.4) will be estimated by the fixed effect and random effect model.

In this section, we will explain these two common panel data estimation methods. The panel data which data sets combine both time series and cross sections can be estimated by Fixed Effect model or Random Effect model.

$$y_{it} = X'_{it}\beta + \varepsilon_{it}$$

$$\varepsilon_{it} = v_{it} + u_i \quad [3.5]$$

In the Fixed Effects model, FEM, the u_i are treated as n constants specific to each unit of observation. The Least Squares Dummy Variable (LSDV) estimator gives the fixed effect and $\hat{\beta}_{FE}$ is always consistent but not efficient.

$$y_{it} = \alpha_i + X'_{it}\beta + v_{it} \quad [3.6]$$

In the Random Effects model, REM, the u_i are treated as independently distributed random variables with $u_i \sim \text{iid}(\mu, \sigma_u^2)$. The Feasible Generalized Least Square (FGLS) estimator gives the random effect, and $\hat{\beta}_{RE}$ is consistent and efficient if $E(u_i|x_{it}) = 0$.

$$y_{it} = X'_{it}\beta + (v_{it} + u_i) \quad [3.7]$$

To test whether the REM is better than the FEM, we carry out Hausman test:

$$H_0: \widehat{\beta}_{FE} - \widehat{\beta}_{RE} = 0$$

$$H_1: \widehat{\beta}_{FE} - \widehat{\beta}_{RE} \neq 0$$

If Hausman test rejects H_0 : FEM remains consistent but REM is inconsistent, so prefer FEM. If rejects H_1 : FEM and REM are both consistent and REM is efficient so prefer REM.

3.6 Variables specification and data collection

3.6.1 Performance measurement

For performance measurement there is a wide range of proxies used in the literature. The SCP studies generally can be divided into two groups according to the measure of performance. The first group use price as proxy for bank's performance. Different rates of interest of certain banking products and services are commonly used. While another group use profitability measure the performance. No agreement has been achieved to which

measures are superior.

Most of the earlier studies of the SCP framework in banking have focused on the use of prices as performance measures. These price variables are usually ratio of interest on loans to total loans and ratio of interest on deposits to total deposits. Other price measures employed to evaluate performance are service charges on demand deposits, interest on time and savings deposits, interest on certificate of deposits and interest on time savings.

The more recent studies have opted to use profits as the performance measure. Using profit rates will alleviate the problem of wage control since information on prices and costs are embodied in data on profits. Furthermore, individual prices of particular products or services can be quite misleading, particularly in the banking industry. As noted by Molyneux and Forbes (1995), banking is a multiproduct business and banks are often involved in cross subsidization among products and services. Therefore, profitability figures are generally viewed as more appropriate as gains and losses of all products and services are integrated into one single value. Hence, in our study, bank profit is utilized as performance measure.

In the literature, bank profitability is typically measured by the return on assets (ROA) and/or the return on equity (ROE). ROA is the most popular profitability measurement, which reflects the ability of bank generating profits from total assets. However, this proxy has been criticized that, as suggested by Heggstad (1979) and Tu and Chen (2000), assets in most financial statements lack adjustments reflecting their reasonable market values. Further, large proportion of real assets including in total assets is not relevant for profit generation process, so it is better to use ROE, which shows the return to shareholders on their equity and it is the most closely to what owners seek to maximize. However, banks with lower leverage (higher equity) will generally report higher ROA but lower ROE. Since an analysis of ROE disregards the risks associated with high leverage and financial leverage is often determined by regulation, the ROE is not an appropriate measure for profits, as argued by Athanasoglou

et al (2008). Due to ROA and ROE having their own benefits and drawbacks, here, we use both ROA and ROE as profit measure. Moreover, in order to avoid negative ROA or ROE figures in some years, we use $(1+ROA)$ and $(1+ROE)$.

The Herfindahl-Hirschman index (HHI) is chosen as a measure of market concentration, and specific firm market share (MS) is employed to capture firm efficiency. Both market structure measures are explained in Section 3.3.

3.6.2 Bank specific control variables

A number of control variables are included to account for firm specific characteristics such as size, risk, cost, and ownership. For comparison reasons, we employ the most popular control variables.

Bank size measured by total assets (TA) is generally used to capture potential economies or diseconomies of scale in the banking sector. This variable controls for cost differences and product and risk diversification according to the size of the institution. If there are significant economies of scale, this could lead to a positive relationship between size and bank profitability (see Akhavein et al. 1997; Bourke, 1989; Molyneux and Thornton, 1992; Bikker and Hu, 2002; Goddard et al., 2004). Other researchers, however, conclude that few cost savings can be achieved by increasing the size of a banking firm, especially as markets develop (Berger et al., 1987; Boyd and Runkle, 1993; Miller and Noulas, 1997; Athanasoglou et al., 2005). Eichengreen and Gibson (2001), suggest that the effect of a growing bank's size on profitability may be positive up to a certain limit. Beyond this point the effect of size could be negative due to bureaucratic and other reasons. In addition, the negative relationship may be derived from the fact that larger banks can better diversify their risks; the increased diversification implies less risk and less profits. Hence, the

size-profitability relationship may be expected to be negative or positive. In our model, we use banks' total assets to capture the possible relationship between bank size and profitability.

Since performance measure is not risk adjusted, we employ four variables to account for banks' various risks, such as solvency risk, business risk, liquidity risk and credit risk.

Equity capital is one of the most important factors contributing towards the profitability of commercial banks. In our empirical regression, the ratio of equity to asset (E/TA) is included which measures the capitalization and proxy solvency risk. Even though the equity capital has been demonstrated to be important in explaining the performance of financial institutions, its impact on bank profitability is ambiguous. This depends on whether equity is held for prudential reason or regulatory reason. If equity is held to absorb losses (prudent behaviour), equity is chosen optimally to address the issue of risk because equity is the full loss absorbing component of the balance sheet. Therefore if a bank chooses to increase equity it will do so to minimise risk and then should enable it to be more profitable. Hence we would expect a positive relationship. However, if equity is imposed at a higher level by regulatory policy and if this raises the cost of capital to banks then we expect a negative relationship with profitability.

The ratio of loans to total assets (TL/TA) and loans to deposits (TL/TD) are also considered as important determinants of bank profitability, as interest earned from loan is the major source of revenue for bank. The loan market is risky and has a greater expected return than other bank assets, such as government securities. Thus, we would expect a positive relationship between TL/TA ratio and profitability, the higher the loans ratios, the higher the rate of return the banks is expected to earn. However we would expect a negative relationship between TL/TD and profitability, because the higher ratio of loans to deposits, the greater costs associated with raising fund and risks associated with loan defaults.

Changes in asset quality may reflect changes in the health of a bank's loan portfolio, which may affect the performance of the financial institution. Duca and McLaughlin (1990) conclude that variations in bank profitability are largely attributable to variations in asset quality, since increased exposure to credit risk is normally associated with decreased firm profitability. We use the percentage of loan loss provisions to total loans (LLP/TL) as a measure of asset quality. A higher ratio may be associated with more risk and as a result a lower profit.

The operating expenses to total revenue ratio (OE/TR) is included to account for cost differences among banks. The literature argues that reduced operating expenses improve the efficiency and hence raise the profitability of a financial institution, implying a negative relationship between an operating expenses ratio and profitability (Bourke, 1989). However, Molyneux and Thornton (1992) observed a positive relationship, suggesting that high profits earned by firms may be appropriated in the form of higher payroll expenditures paid to more productive human capital (i.e. experienced managers and expertise).

In addition, to account for the different types of bank ownership in our sample, dummy variables are included in the model to test whether the ownership status of a bank is related to its profitability. The relationship between ownership and profitability is examined through the inclusion of two binary dummy variables, namely OWN1 for state-owned banks and OWN2 for joint equity banks. In other words, the reference group is city commercial banks. OWN1 equals to one if the bank is state owned, otherwise zero. OWN2 equals to 1 if bank belongs to joint equity ownership. The coefficients on both OWN1 and OWN2 should be negative because state-owned banks and joint-equity banks are less profitable than city commercial banks due to burden of large amount of non-performing loans. Especially state-owned banks are far less profitable than city commercial banks.

Table 3.7: List of variables specification included in the estimation

Variables	Specification
<i>Dependent variable</i>	
ROA or ROE	Return on asset or Return on equity
<i>Independent variable</i>	
CON	HHI
MS	Market share
TA	Total assets
E/TA	Equity/total assets
TL/TA	Total loans/total assets
TL/TD	Total loans/total deposits
LLP/TL	Loan loss provisions/total loans
OE/TR	Operating expenses/total revenue
OWN1	Ownership dummy for state owned banks
OWN2	Ownership dummy for joint equity banks

3.6.3 Data collection

In our empirical study, we collect annual accounting data for Chinese domestic commercial banks over 10 years from 1997 to 2006. Table 3.8 presents all the commercial banks included in our sample. The data were mainly obtained from Bankscope database and the Almanac of China's finance and banking, which contains annual information on the balance sheet and income statements of all major banks operating in China. All the monetary variables are adjusted by using GDP deflator. The inflation adjusted monetary variables are denoted in the domestic currency which is RMB and quoted in millions. Table 3.9 provides summary statistics of the variables included in our estimation.

Table 3.8: Lists of domestic commercial banks included in the sample

Bank name	Listing status	Years of data available
State-owned banks (4)		
Industrial & Commercial Bank of China (ICBC)	listed	10
China Construction Bank Corporation (CCB)	listed	10
Agricultural Bank of China (ABC)	listed	10
Bank of China Limited (BOC)	listed	10
Joint equity banks (11)		
Bank of Communications Co. Ltd	listed	10
China Merchants Bank Co Ltd	listed	10
China Minsheng Banking Corporation	listed	10
China CITIC Bank Corporation	listed	10
Shanghai Pudong Development Bank	listed	10
Industrial Bank Co Ltd	listed	10
China Everbright Bank Co Ltd	listed	10
Hua Xia Bank	listed	10
Guangdong Development Bank		10
Shenzhen Development Bank	listed	10
Evergrowing Bank Co Ltd		10
City commercial banks(36)		
Bank of Beijing Co Ltd	listed	9
Bank of Shanghai	listed	10
Ping An Bank		6
Bank of Tianjin		9
Huishang Bank Co Ltd		4
Bank of Dalian		6
Bank of Nanjing	listed	10

Bank of Hangzhou Co Ltd		6
Bank of Ningbo	listed	7
Shenzhen Rural Commercial Bank Co Ltd		9
Dongguan City Commercial Bank		8
Harbin Bank		4
Xi'an City Commercial Bank		7
Bank of Chengdu Co Ltd		5
China Zheshang Bank Co Ltd		3
Changsha City Commercial Bank Co., Ltd		5
Bank of Chongqing		8
Jinan City Commercial Bank		6
Xiamen City Commercial Bank		8
Fudian Bank Co Ltd		3
Hankou Bank		6
Bank of Qingdao Co Ltd		6
Nanchang City Commercial Bank		5
Fuzhou City Commercial Bank		4
Bank of Wenzhou Co Ltd		7
Yantai Bank Co Ltd		5
Jinzhou City Commercial Bank		4
Bank of Ningxia Co Ltd		3
Commercial Bank Co Ltd of Luoyang		3
Shaoxing City Commercial Bank Co Ltd		4
Qishang Bank.		5
Laishang Bank Co Ltd		3
Dongying City Commercial Bank		3
Panzhuhua City Commercial Bank Co Ltd		3
Shijiazhuang City Commercial Bank		3

Yangzhou City Commercial Bank Ltd	3	
Nantong City Commercial Bank Co Ltd	6	
Wuxi City Commercial Bank	7	
Zibo City Commercial Bank	5	
Jiujiang City Commercial bank	3	
Total (55)	Total (16)	Total (371)

*Collected data on the four state-owned banks, the eleven joint equity banks are available for the full sample period. As most city commercial banks are established in recent years, so the data is only available for them in later sample period.

Table 3.9: Summary statistics of variables

Variables	Obs.	Mean	Std. Dev.	Min	Max
MS	371	0.036	0.071	0.005	0.196
HHI	371	0.146	0.023	0.118	0.166
TA	371	659655	1306902	6222	7509489
E/TA	371	0.045	0.029	0.117	0.313
TL/TA	371	0.526	0.085	0.277	0.712
TL/TD	371	0.645	0.123	0.320	1.068
LLP/TL	371	0.009	0.007	0.002	0.075
OE/TR	371	0.356	0.113	0.069	0.626
ROA	371	0.005	0.458	-0.007	0.039
ROE	371	0.085	16.421	-0.139	0.123

As we can see from Table 3.9, large dispersions exist among various banks with regard to regression variables. Those summary statistics reflect several underlying features of the banking sector in China. The most noticeable is the significant size difference. The total assets of the largest bank included in our sample is formidable and is far more larger than the

smallest one, indicated by the difference between minimum and maximum value. The second characteristic is that domestic commercial banks have largely insufficient equity capital, revealed by the average low equity to total assets ratio. The average capitalization ratio is only 4.5% for our sample banks, which is below the minimum requirement 8%. Another aspect is that the traditional business remains the major activity for Chinese commercial banks, as shown by the large proportion of loans to total deposits. It also implies that revenue from loan interest is the major source of income for domestic commercial banks in China. Finally, Chinese commercial banks are featured by low profitability, with 0.5% and 8.5% for ROA and ROE respectively.

3.7 Empirical results

The regression results for the sample of Chinese commercial banks between 1997 and 2006 are shown in Table 3.10 below. The table contains the estimated parameters and t-statistics obtained from regression of Eq. (3.4), using ROA and ROE respectively, as the independent variable. The preferred estimation model is the fixed effect model, suggested by the Hausman test. The estimated equations seem to fit the panel data reasonably well, as indicated by the R-squared values 0.511 and 0.239 for ROA and ROE respectively (previous studies normally report R square between 0.5 and 0.2). Other SCP studies (see Gilbert (1984), Goddard et al (2001)) reported even lower values around 0.1. The regression with ROA as profitability measure is statistically preferred over the model with ROE, due to considerable higher R-squared value. Athanasoglou et al (2008) also found that the estimations based on ROE produce inferior results for Greece.

Table 3.10: The SCP estimation results (The panel fixed effect estimation)

Variables	ROA	ROE
MS	0.874 (1.09)	1.190 (0.23)
HHI	-5.995 (-7.75)***	-11.176 (-2.42)**
TA	0.008 (2.06)**	-0.0017 (-0.75)
E/TA	0.027 (4.11)***	0.0866 (2.17)**
TL/TA	0.264 (0.82)	2.405 (1.26)
TL/TD	-0.664 (-3.18)***	-2.807 (-2.25)**
LLP/TL	-12.015 (-5.56)***	-2.602 (-2.02)**
OE/TR	-1.122 (-7.3)***	-1.849 (-2.01)**
OWN1	-0.264 (-1.55)	-4.389 (-0.43)
OWN2	-0.129 (-3.10)***	-2.158 (-1.87)*
R-square	0.511	0.239
F-statistics	27.49***	19.72***

***, **, * indicate significant at 1%, 5% and 10% level respectively

The table shows that during our sample period, the coefficient on MS is insignificant when either ROA or ROE is used as profitability measures, while the coefficient on the HHI is highly significant for both dependent variables. But the sign of the parameter on HHI is negative which is inconsistent with the SCP hypothesis. So the results from our sample do reject both the SCP hypothesis and the efficiency hypothesis. Athanasoglou et al (2008) conducted similar analysis in Greek banking industry and found same result for this negative relationship, although the effect is relatively insignificant. This outcome is also in accordance with other recent studies (Berger (1995)), which claim that concentration is usually negatively related to profitability once other effects are controlled for in the profitability equation.

In theory, as suggested by industrial economists, firms are supposed to be more profitable in highly concentrated market than those in less concentrated one. But our results imply that banks are less profitable in moderately concentrated banking sector in China. We may explore three possible reasons to explain this negative relationship.

First, the reason behind this negative relationship is that the big four state-owned banks accumulated the most assets, loans and deposits, thus control the substantial part of the market. But the state-owned banks are burdened with mountains of non-performing loans result from policy-directed loans to state-owned enterprises during the 1990s. Before the state-owned banks went public, the ultimate aim of state-owned banks was not profit maximization. As a result, lower profitability exists in such high level of concentrated market. Second, the quiet life hypothesis may provide alternative explanation for the negative relationship between market concentration and bank profitability. This hypothesis suggests that banks located in highly concentrated markets may choose to trade off some of their monopolistic profits for a reduction in risk by choosing safer profits. In other words, banks in highly concentrated market may prefer to reduce the variance of their profits rather than increasing the profit itself. The regulation may also offer another alternative explanation, which protect the public interest and prevent monopoly profits from collusive behaviour.

Turning to other explanatory variables, the regression results for control variables are considered below. The effect of bank-specific variables is generally in line with our expectations.

The estimated equation when ROA is the dependent variable shows that the effect of bank size on profitability is positive and statistically significant, while the relationship is negative and insignificant for ROE as dependent variables. The significant positive relationship implies that large banks present economies of scale in Chinese banking sector. The larger the

amount of assets for a bank, the greater advantages bank have, such as more branches and more experienced employees. This enables them to attract more customers and provide more services, so they can make more profits. Moreover, there may be “too big to fail” effect. If the size of the bank is too large, generally there is some implicit assumption that the government will not allow bankruptcy for large banks. Therefore, bank clients are more confident for larger banks than small banks, and large banks can generate more profits. (Because the failure of large banks has serious impact on the national economy. Moreover, the collapse of one large bank may cause public panic and bank run for other banks due to possible domino effects.)

The positive and highly significant coefficient on the ratio of equity to total assets variable suggests that Chinese banks hold equity capital for prudential reasons, because with a sound capital position bank is able to pursue business opportunities more effectively and has more time and flexibility to deal with problems arising from unexpected losses, thus achieving increased profitability. It also implies that through stronger capitalization, Chinese banks can reduce the expected costs of financial distress and credibly transmit the expectation of better performance.

The parameters on the variable (TL/TA) are positive but insignificant in both regressions. The insignificant effect of loans on bank profitability may be explained by the substantial proportion of non-performing loans.

As shown in Table 3.10, the coefficients on the TL/TD in both regressions are consistent with our expectation and are significant. The higher the amount of loans as percentage of deposits, the greater costs associated with raising funds and risks associated with loan defaults, thus banks earn lower ROA and ROE. So the profitability and the proportion of loans to deposits are negatively related in Chinese banking market.

The variable (LLP/TL) is negatively and significantly related to bank profitability, showing that the commercial banks in China should focus more on the credibility assessment, loan monitor, and risk management, which has proved problematic in the recent past. Serious bad loans problems have arisen from policy-oriented loans and the failure of banks to recognise those impaired assets and create reserves for writing-off these assets. Thus, limiting the government intervention and improving the transparency of the financial systems is quite essential, which will assist banks to evaluate credit risk more effectively and avoid problems associated with hazardous exposure.

The operating expenses appear to be an important determinant of profitability. This variable presents a negative and significant effect on banks profitability. This implies a lack of competence in expenses management for Chinese banks, since banks pass part of increased cost to customers and the remaining part to profits, possibly due to the fact that competition does not allow them to “overcharge”. Clearly, efficient cost management is a prerequisite for the improved profitability of the Chinese banking system.

Regarding the ownership variable, the coefficients in two regressions are negative, but only OWN2 is significant. Our findings show that city commercial banks perform better than state-owned banks and joint equity banks in terms of both ROA and ROE. Moreover, the joint equity banks operate more profitably than state-owned banks, when we compare the magnitude of parameters for those two dummies. This finding is not surprising in light of previous research regarding transition economies (see Bonin et al., 2005).

In sum, as the parameter on HHI is negative despite significant, and the coefficient on efficiency proxy MS is insignificant, our empirical results clearly reject the SCP hypothesis and efficiency hypothesis in the context of Chinese banking market during 1997~2006. With regard to control variables, except the ratio of loan to total assets, all the variables are found that they are significant factors for explaining bank performance in the Chinese banking

market.

3.8 Conclusion

A substantial body of empirical research has failed to resolve the ‘collusion versus efficiency’ debate conclusively. According to the ‘collusion hypothesis’, high concentration reduced the costs of collusion, resulting in higher rates being charged on loans, lower interest paid on deposits, higher fees, and so on. The alternative ‘efficiency hypotheses’ explained the relatively high profitability of banks operating in concentrated markets by a tendency for larger banks to operate more efficiently than their smaller counterparts. Therefore it is debatable whether the high profits earned by large banks are a consequence of their operating in concentrated markets and adopting collusive price-setting practices, or of superior production and management techniques (higher efficiency) that reduce costs, resulting in high profitability.

Although there are a large number of studies investigate market structure, conduct and performance in the banking sector for a number of countries, there is hardly such a study that sheds light on China. Thus our study aims to evaluate domestic commercial banks in China under the structure-conduct-performance framework. And provide new evidence to this literature.

In this chapter, we test the validity of these two continuing debate hypotheses in Chinese banking market over the period from 1997 to 2006. Our empirical results reject both the traditional SCP hypothesis and the efficiency hypothesis as explanation for the bank performance in Chinese banking industry. It appears that each of these models is insufficient to understand bank market behaviour, because they fail to give clear econometric results. It is necessary therefore to expand the range of models that can be used to understand the banking market in China. In the next chapter, the study examines a more rigorous and well

developed test of market power based on the new empirical industrial organization literature and due to Panzar and Rosse (1987). On a subsequent chapter the study later uses the encompassing reduced form model of Berger (1995) to clarify the underlying competitive relationships that the SCP and narrow efficiency hypothesis have failed to reveal.

Chapter 4: Market competition in the Chinese banking industry: an application of the new empirical industrial organization (NEIO) Panzar-Rosse approach

4.1 Introduction

As in other industries, the degree of competition in the financial sector can matter for a number of reasons, such as the efficiency and profitability of the production of financial services, the quality of financial products, and the degree of innovation in the sector. In particular, due to the special role played by banks, the competition in banking markets closely relates to the economic stability and growth (Claessens and Laeven 2004). Thus, market competition in the banking industry has been and will always be one of the most discussed topics in economy for researchers, investors and regulators. Especially, as incomplete development of capital market in developing countries, banks play an even more crucial role in their economies, such as China.

There is active debate on the impact of competition on financial stability and fragility, as economic theory provides conflicting predictions about the relationship between the competition and banking system stability and fragility (Canoy et al 2001, Berger et al 2009, Liu et al 2010). The competition-stability view suggests that a more competitive banking sector is more prone to financial crises than a less competitive banking sector. Because the less competitive banking systems have market power to generate high

profits which can provide a “buffer” against adverse shocks and thus reducing the probability of systemic banking crisis. Moreover, the supervision of a few banks is more effective than many banks. However, the opposing view competition-fragility argues that a less competitive banking structure enhances bank fragility. The market power in less competitive banking market could induce banks to engage in risky activities, which increase the system fragility and thus enhance the probability of financial crisis. Therefore, the competition in banking market has very important policy implications.

The Chinese banking industry has gone through a series of significant changes after the first introduction of economic reform in 1979. Perhaps, the banking reform is one of the last but most fundamental aspects in China’s economic reform. Having achieved tremendous progress in restructuring the industrial sector¹⁴, the government has moved decisively to address the difficulties in the banking sector. The creation of a new banking supervisory agency and going-public of state-owned banks have achieved major breakthroughs in the banking sector reform, which have been discussed in Chapter 2.

Since China was successful in joining in the World Trade Organization (WTO) in 2001, the strength of the financial liberalization program has intensified, and the pace has also speeded up to increase the efficiency and competitiveness of domestic banks in order to compete with foreign banks. As a consequence, changes in the nature of the market structure and increased competition in China’s banking industry are expected. Hence, it is worth to investigate the degree of competition and assess the contestability in Chinese banking industry. Moreover, to evaluate whether the banking reform aiming to improve the competition is effective, we compare the level of competition in the banking market

¹⁴ As State-owned enterprises (SOEs) stand as the pillar of the national economy especially in socialist system, Chinese government set SOEs as the first primary target to reform since the introduction of economic reform in 1979. The main objective is to establish the modern corporate system and closing down non-performing enterprises. The SOEs were transformed from state-run to state-owned by letting SOEs taking responsibilities for their own profits and losses, and permitting independent production and management.

before and after the WTO entry. Furthermore, despite a great number of investigations devoted to market competition in banking sector, the emerging countries still are largely ignored. Thus another purpose of this study is to contribute to the existing literatures concerning this issue and to cast some light on China, one of the fast growing world economies.

Two major types of empirical methodologies have been applied for assessing the competition in banking markets. One is the traditional structural approach, based on the theory of Structure Conduct Performance (SCP). Another is the non-structural models that were developed in the context of the New Empirical Industrial Organization (NEIO) approach¹⁵.

Market concentration indicators such as the N-firms concentration ratio and the Herfindhal Hirschman index (HHI) are commonly employed in the traditional structural approach SCP studies. Although the market concentration indicators offer some insight into competitive conditions in market, they say little about the underlying behaviour of market participants. Therefore, a relatively new methodology (non-structural approach) is employed to systematically examine the nature of competition due to both theoretical and empirical drawbacks of the traditional methods¹⁶. In particular, the Panzar-Rosse methodology is preferred for our study. To the best of our knowledge, there is only one previous study that adopted the Panzar-Rosse approach to assess the competitive conditions in the Chinese banking system. Yuan (2006) employed this method to analyse the competition condition for domestic commercial banks in China for the period of 1992-2002. Our study differs from Yuan's study with respect to the estimation period,

¹⁵ Two tests are widely used. One is mark-up test by Bresnahan (1989), and another is H statistic by Panzar-Rosse (1977).

¹⁶ Bresnahan (1989) gives a comprehensive survey of econometric methodologies for measuring the degree of competition. Shaffer (1994) and (2002) provided a detailed analysis of comparison between structural and non-structural models.

improved model specification, and larger sample of banks.

The main objective of this chapter is to extend the previous literature by employing the Panzar-Rosse model to empirically estimate the competitive bank behaviour in China between 1997 and 2006, which has seen fruitful progress in banking reform and experienced the most rapidly growing economy among other countries. We find out that Chinese banking sector is characterized by monopolistic competition in such a highly concentrated market rather than monopoly. Moreover, by dividing the full sample into two sub-samples, we show that the recent reforms are effective in improving the level of competition in the Chinese banking industry, as there is significant increase in the Panzar-Rosse H statistic in post-WTO period compared with that in pre-entry period. However, competition in Chinese banking sector is still weak compared to results from other empirical studies; hence, more fundamental institutional changes are required before China can reap the full benefits of increasing competition following the entry of WTO.

The rest of chapter is organized as follows. Section 4.2 explains the Panzar-Rosse approach. Section 4.3 reviews previous empirical works on banking market competition by using the Panzar-Rosse technique. Section 4.4 describes data collection and presents our empirical methodology. Section 4.5 reports and discusses the empirical results and Section 4.6 summaries the findings and draws conclusion.

4.2 The Panzar-Rosse approach

The Panzar-Rosse approach is an econometric methodology to quantitatively assess the competitive conditions of the market. The empirical test was developed by Panzar and Rosse (1987) to distinguish between monopoly, monopolistic competition and perfect

competition. The idea behind the Panzar-Rosse test is that banks will price differently in response to changes in input prices or any other exogenous economic shock. The ability of pricing depends on the degree of market power it can control and the market structure it operates within. In turn, changes in pricing strategy will finally lead to changes in revenue. Therefore, variation in revenues can reflect the market structure in which they operate¹⁷. In other words, whether banks exercise market power can be measured by the extent to which changes in input prices are reflected into revenues earned by bank itself. So for examining the level of market competition, we can simply analyze how bank's revenue responds to changes in input prices.

The Panzar-Rosse competition test is derived from a reduced form revenue equation at firm level under certain assumptions, like long run equilibrium condition, profit maximization, banks face homogeneous production function, banks are treated as single product firms (De Bandt and Davis, 2000), and higher input prices are not associated with higher quality services that generate higher revenues (Molyneux et al., 1996).

The reduced form revenue equation can be derived in the following¹⁸:

If we have technology T ,

$$T(x,y) = \{x, y : x \text{ can make } y\} \quad [4.1]$$

$$p(x) = \{y : y \in T(x,y)\} \quad [4.2]$$

Then we can choose y to maximize revenue,

$$R(x,p) = \max \{py : y \in p(x)\} \quad [4.3]$$

This is the structural form that revenue depends on inputs x and output prices p .

¹⁷ Two reasons for using revenue instead of profit are i) revenue data is more easily available and more transparent than profit data and ii) exogenous shock is modelled as a vertical shift in the average cost curve, the full response can be inferred from the revenue data alone.

¹⁸ For details of full derivation, please see Lau (1982), Shaffer (1982), Panzar and Rosse (1987).

We choose x to minimize costs given input prices w and exogenous variables z and output y :

$$c(y, w, z) = \min\{w x : x, y \in T(x, y, z) \text{ given } z\} \quad [4.4]$$

Now allow for market power: $p=p(y)$, we can maximize profit:

$$\pi(w, z) = \max\{p(y)y - wx : x, y \in T(x, y, z)\} \quad [4.5]$$

Then we can re-arranged it,

$$R(w, z) = \pi(w, z) + c(\bar{y}, w, z), \text{ where } \bar{y} \text{ is in the long run equilibrium} \quad [4.6]$$

So our reduced form of revenue is a function of input prices w and exogenous variables z .

Then the reduced form revenue equation can be written as in Equation [4.7] below, which generally states that at market equilibrium bank i earn its revenue R is a function of a set of input prices w and a vector of exogenous variables z which affect its revenue.

$$\ln R_{it} = \alpha_0 + \sum_{i=1}^n \beta_i \ln(w_{it}) + \sum_{i=1}^m \delta_i \ln(z_{it}) + \varepsilon_{it} \quad [4.7]$$

The market power is measured by the extent to which a change in factor input prices (∂w_i) is reflected in the change in revenues (∂R_i) earned by bank i . The Panzar-Rosse method assesses the market competition by computation of H statistic which is calculated as the sum of the elasticities of the bank revenue with respect to the bank's input factors,

$$H = \sum_{i=1}^n \frac{\partial R_i}{\partial w_i}. \text{ Then, the Panzar-Rosse H-statistic can be written as } H = \sum_{i=1}^n \beta_i$$

The Panzar-Rosse H statistic represents the percentage variation of the revenues resulting

from one percent aggregate change in the price of input factors used by the bank. The economic interpretation of the H statistic is as follows.

If banks operate as a monopoly in the market, then the H statistic is non-positive (less than or equal to zero). This is because monopolist's revenue will respond in the opposite direction to the change in input prices, as an increase in input prices leads to increase in marginal costs, thus reducing equilibrium output and revenue. Panzar and Rosse (1987) further showed that the H statistic is also negative when the structure is a perfectly collusive oligopoly or a conjectural variations short run oligopoly.

The H statistic is equal to one when the market structure is characterized as perfectly competitive. Under this condition, a proportional shift in all input prices will increase marginal and average costs by the same proportion, without changing the equilibrium output produced by banks. In order to survive the competition, banks will be forced to increase prices until they cover the increased costs. During this adjustment process, the inefficient banks might be acquired by efficient ones or be eventually driven out of the market by competition; the reduction in the number of banks in the industry will reduce the supply of the industry, thereby leading to a rise in output price and revenue by the same amount as costs. H statistic is also unity for a sales-maximizing firm that is subject to breakeven constraint as well as a natural monopoly operating in a perfectly contestable market.

For the situation of monopolistic competition, the H statistic lies between zero and unity. In this case, banks behave like monopolists, but the market entry or exit of other banks with imperfect rival products make them cannot generate abnormal profits as monopoly. Hence, revenue will increase less than proportionally to changes in input prices.

Table 4.1: Interpretations of H statistic

Estimated value	Interpretations
Competition test	
$H \leq 0$	Monopoly, perfectly colluding oligopoly, conjectural variations short run oligopoly
	Monopolistic competition
$0 < H < 1$	H is a decreasing function of monopoly power.
$H = 1$	Perfect competition, natural monopoly in perfectly contestable market, sales maximizing firm subject to a breakeven constraint
Equilibrium test	
$E < 0$	Disequilibrium
$E = 0$	Equilibrium

Source: summarized from previous literatures.

In conclusion, both the magnitude and sign of the H statistic can be informative. Vesala (1995) proved that when H statistic is non-positive, it is a decreasing function of the demand elasticity, that is, a smaller absolute value of H statistic is associated with less monopoly power. However, when H statistic is positive, it is an increasing function of the demand elasticity, that is, the higher H statistic, the less is the market power. Bikker and Haaf (2002) also state that when the value of H statistic is between 0 and 1, it generally increases with the competitiveness of the market. In other words, higher value of H statistic indicates stronger competition than lower values. In empirical application, the rejection of $H \leq 0$ excludes the monopoly model, if we also reject the hypothesis of

$H=1$, which rules out the perfect competition model, that means we are in favour of the only model left, which could be consistent with monopolistic competition. The different interpretations of H statistic from the literatures are summarized in the Table 4.1.

As mentioned before, there are various assumptions need to be satisfied when we apply the Panzar-Rosse methodology. One of the critical conditions is that the H statistic is only viable when the market is in the long run equilibrium. This condition can be tested by the assumption that if market is in equilibrium, the rate of return (profit) should not be significantly correlated with input prices. This is because in long run equilibrium profit is given by the structure of the market and is independent of short run random shocks. As a result, the equilibrium test can be performed by estimating the same model used in competition test but use bank rate of return rather than revenue for dependent variable (Equation (4.8)). Then we calculate the sum of the elasticities of the bank return with respect to the bank's input factors, which denoted by E statistic. A finding of $E=0$ would confirm the equilibrium condition, otherwise indicate disequilibrium. One thing should be noticed here, the equilibrium does not mean that competitive conditions are not allowed to change, but take a gradual approach as argued by De Bandt and Davis (1999).

$$\ln ROA_{it} = \alpha_0 + \sum_{i=1}^n \beta_i \ln(w_{it}) + \sum_{i=1}^m \delta_i \ln(z_{it}) + \varepsilon_{it} \quad [4.8]$$

$$E = \sum_{i=1}^n \beta_i$$

4.3 Literature review

The Panzar-Rosse methodology has been widely applied by a large number of works to empirically analyse the degree of competition and market structure in banking sectors for

both single country and cross country studies. The early research largely focused on single country study for a small number of developed countries, mainly the US and western European countries. The other parts of the world have rarely been investigated. Data problems might be one of the most important limitations for the study of developing country and cross-country comparisons, since little bank level data were available except for those main developed countries. However, recent well-established database allow for better and comprehensive empirical work. Consequently, in later years, a growing body of literatures adopted cross country studies and an increasing attention is given to developing countries. Especially, transition economies from Central and Eastern Europe have received lots of emphasis due to the expansion of the European Union. Equally, an increasing number of works also raised enormous interests on other emerging regions besides Europe such as Latin America, Arabic area and Asian countries.

The empirical studies are different in many aspects, such as country sample, time period, regression variables and estimation methods, so theoretically speaking, it is impossible to compare the results from different papers. The most discussed issue subject to debate is the selection of dependent variables. Different specifications of dependent variables in the Panzar-Rosse model are presented in the banking literature. The choice of the dependent variable in estimating the Panzar-Rosse H-statistic has varied between unscaled and scaled revenue in empirical studies. Previous studies have used a scaled dependent variable i.e. bank revenue divided by total assets (Molyneux et al, 1994; Hondroyiannis et al, 1999; Bikker and Haaf, 2000; Hempell, 2002) with the reason that scaling helps to remove firm level differences as well as provides for a better approximation. Other papers argued that the use of a scaled dependent variable could be interpreted as a lending rate or “price” and therefore can change the nature of the Panzar-Rosse model from being a revenue equation to being a price equation (Vesala, 1995; De Bandt and Davis, 2000; Bikker et al, 2006). Bikker et al (2006) further theoretically and empirically proved that misspecification of using scaled variable and

scaling factor would bias the H statistic towards one.

Besides the controversy about the use of scaled and unscaled revenue, the choice between interest revenue and total revenue also varies in the literature. Traditional approaches in this literature have used interest income alone as dependent variable, which is consistent with the intermediation approach, as financial intermediation is the core business in banking revenue. In the current study, total income is considered instead. As banks operate in a more competitive environment for survival, the distinction between interest and non-interest income becomes less relevant, competition being equally vigorous for both. Cross subsidization and accounting differences across countries are additional arguments suggesting it is better to have a comprehensive view of bank revenues.

Table 4.2 presents a brief summary of the previous literatures using the Panzar-Rosse methodology to assess the competitive condition in different banking markets. Literatures are divided into three groups based on different specifications for dependent variable, namely scaled revenue, unscaled revenue and mixture use of both.

Table 4.2: Brief summary of literatures using the Panzar-Rosse method

Authors	Countries	Period	Result
<i>Dependent variable: Unscaled revenue</i>			
Shaffer (1982)	US	1979	MC
Shaffer (2002)	US	1984-99	MC
Shaffer (2004)	US	1984-94	MC
Nathan & Neave (1989)	Canada	1982-84	MC(1982 PC)
Molyneux et al. (1996)	Japan	1986,88	M 1986, MC 1988

Vesala (1995)	Finland	1985-92	MC(1989-90 PC)
Gischer and Stiele (2004)	Germany	1993-02	MC
Coccoresse (2004)	Italy	1997-99	MC
Chan et al. (2006)	New Zealand and Australia	1996-05	MC: NZ M: Australia
Gunalp and Celik (2006)	Turkey	1990-00	MC
Yuan (2006)	China	1996-00	MC
De Bandt & Davis (2000)	Germany, France, Italy	1992-96	Large banks MC in all Small banks M (MC Italy)
Murjan & Ruza (2002)	9 Arab Middle Eastern	1993-97	MC

Dependent variable: scaled revenue

Hondroyiannis etal.(1999)	Greece	1993-95	MC
Hempell (2002)	Germany	1993-98	MC
Matthews et al (2007)	UK	1980-04	MC
Rozas (2007)	Spain	1986-05	MC
Ducan (2005)	Jamaica	1989-02	MC
Majid andSufian (2006)	Malaysia	1998-05	MC
Molyneux et al. (1994)	5 European countries	1986-89	MC (Italy M)
Bikker & Groeneveld (2000)	15 European countries	1989-96	MC
Bikker & Haaf (2002)	23 developed countries	1988-98	MC

Yildirim&Philippatos (2002)	14 Central and Eastern Europe countries	1993-00	MC (M for the FYR of Macedonia & Slovakia)
Casu and Girardone(2006)	EU 15 countries	1997-03	MC
Staikouras et al. (2006)	EU 25 countries	1998-02	MC
Mamatzakis et al. (2005)	7 South Eastern European countries	1988-92	MC
Al-Muharrami et al (2006)	6 Arab GCC countries	1993-00	MC: Qatar, Bahrain, Oman PC: Kuwait, Saudi Arabia UAE
Claessens & Laeven(2004)	50 countries	1994-01	MC
<i>Dependent variable: both scaled and unscaled revenue</i>			
Buchs & Mathisen(2005)	Ghana	1998-03	MC
Trivieri (2007)	Italy	1996-00	MC
Gelos & Roldos (2004)	8 European & Latin emerging countries	1994-99	MC (Argentina & Hungary PC) M: 28%
Bikker et al. (2006)	101 countries	1989-04	MC:34% PC:38%

* M: monopoly, MC: monopolistic competition, PC: perfect competition

However, the Panzar-Rosse's H statistic for monopolistic competition has been imprecisely interpreted in the literature, which classify the monopolistic competition if H statistic is found between 0 and 1. However, in Panzar-Rosse's (1987) original paper, they

claim that monopolistic competition requires $H \leq 1$. This suggests that market with any value of H statistic under the unity can be classified as monopolistic competition; if we find $H=1$ exactly this is compatible with perfect competition with undifferentiated products, alternatively if there are differentiated products, $H=1$ is also compatible with strongly competitive monopolistic competition. Finally if $H < 0$, this finding is compatible with the long run equilibrium properties for monopoly. In other words, monopolistic competition embraces both perfect competition and monopoly, they are just two special cases of monopolistic competition. Thus, in any empirical application, rejecting the hypothesis of $H \leq 1$ implies the rejection of all three models. The different interpretation of H statistic between previous literature and Panzar-Rosse are illustrated in the Figure 4.1 and 4.2.

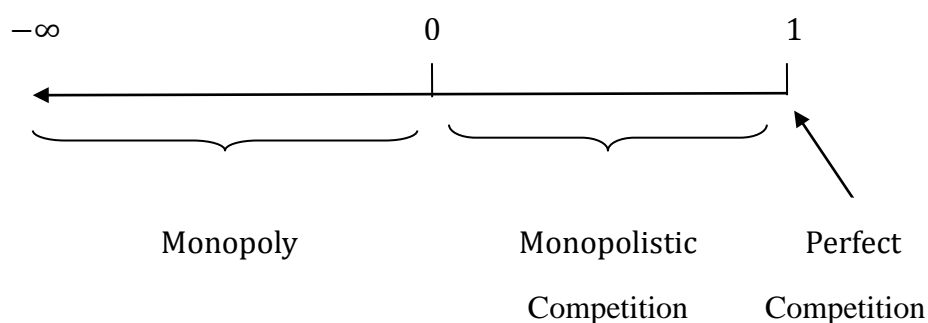
Literature interpretation:

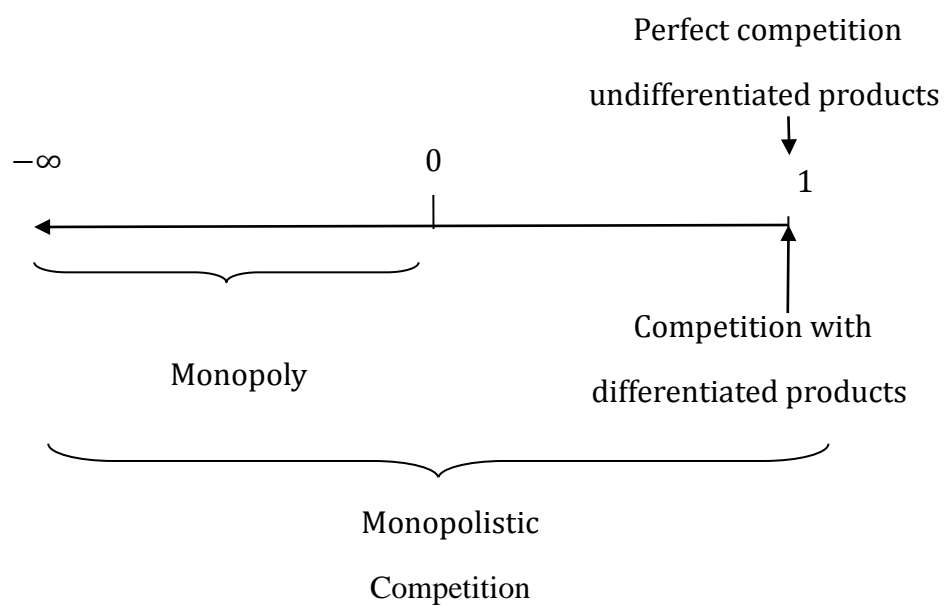
$H \leq 0$: Monopoly

$0 < H < 1$: Monopolistic Competition

$H = 1$: Perfect Competition

Figure 4.1: Literature interpretation of H statistic



Panzar-Rosse's interpretation: $H \leq 0$: Monopoly $H \leq 1$: Monopolistic Competition $H = 1$: Perfect Competition**Figure 4.2: Panzar-Rosse's interpretation of H statistic**

4.4 Methodology and data

4.4.1 Empirical model specification

4.4.1.1 Competition test

In order to apply the Panzar-Rosse methodology to the Chinese banks, the following equation is estimated in our empirical study, which the bank revenue is explained by three main input factor prices, three bank specific control variables and time trend. Those variables follow the similar definitions used in previous studies.

$$\begin{aligned} \ln(R_{it}) = & \alpha + \beta_1 \ln(PF_{it}) + \beta_2 \ln(PL_{it}) + \beta_3 \ln(PK_{it}) \\ & + \gamma_1 \ln(TL_{it} / TA_{it}) + \gamma_2 \ln(E_{it} / TA_{it}) + \gamma_3 \ln(LLP_{it} / TL_{it}) + \delta_1 T + \varepsilon_{it} \end{aligned} \quad [4.9]$$

where the subscript i denotes bank i, the subscript t denotes year t.

R=bank revenue, ($R_{it} = IR_{it}, TR_{it}, IR_{it} / TA_{it}, TR_{it} / TA_{it}$)

IR=interest revenue, interest income from making loans

TR=total revenue, calculated as interest income plus other operating income, such as fee income, commission income and other non-interest income

TA=total assets

PF=price of fund, the ratio of interest expense to total deposits

PL=price of labor, the ratio of personnel expense to total number of employees

PK=price of capital, the ratio of other operating expense to fixed assets

TL=total loans

E=equity capital

LLP=loan loss provisions

T=time trend

ε_{it} is the error term.

The Panzar-Rosse H statistic is calculated as the sum of coefficients of three input price variables: $H = \hat{\beta}_1 + \hat{\beta}_2 + \hat{\beta}_3$

As we discussed in Section 4.3, the specification for dependent variable differs in the choice between unscaled revenue (the absolute level of revenue) and scaled revenue (the ratio of revenue to total asset), as well as varies in using total revenue or interest revenue. As the four alternatives are commonly used in empirical models, and there is no consensus on the single best proxy for bank revenue, we employ all four different specifications ($R_{it} = IR_{it}, TR_{it}, IR_{it} / TA_{it}, TR_{it} / TA_{it}$) for endogenous variable in our empirical competition test model to see whether these four specifications give different results for our sample.

For the independent variables, there seems to be common agreement on the inputs used by banking firms, namely deposits, labor and physical capital, which are in line with the intermediation approach¹⁹. There are great similarities concerning the choice of proxy for input factor price variables. We follow the similar definitions used in previous work for the three input factors prices: the ratio of interest expense to total deposits as proxy for price of funds (PF), the proxy for price of labor (PL) is the ratio of personnel expense to total number of employees and the ratio of other operating expense to fixed assets is used as proxy for capital price (PK). The expected signs of the coefficients for input variables hold conflicting theories, so we do not have a priori expectations.

¹⁹

The inputs are determined according to intermediation approach where banks are viewed as financial intermediaries providing financial services rather than producers of loan and deposit accounts suggested by production approach.

In addition to the three main input prices, different bank specific variables are also included in our empirical test. The choices of additional control variables vary according to authors' preference and consideration. Basically, choices of bank specific variables are intended to catch differences in risk, size and business mix. In our study, three additional explanatory variables are incorporated to control for differences in risks and costs, which may affect bank's revenue. The first one is the ratio of total loans to total assets (TL/TA); this is concerned about the risk associated with loans made by banks. The expected sign of coefficient should be positive. Since the more loans bank can make, the more interest income bank can earn, so the more revenue they can generate. The second bank specific variable is the ratio of equity to total assets (E/TA) which considers the leverage effect and known as solvency risk. The coefficient is expected to be negative, because more equity means more reserve required, so less money can be loaned out, leading to lower revenue. However, in Gunalp and Celik's (2006) paper, they pointed out that the relationship between capital adequacy ratio and the income generation ability of banks is not very straightforward and strong.

The third additional variable is the ratio of loan loss provision to total loans (LLP/TL). As explained in Chapter 2, a substantial amount of non-performing loans (NPLs) were accumulated by Chinese banks due to previous government policy directed loans. Except one-off disposal of problem loans from government capital injection; banks make use of the provision of loan loss reserves to write off bad loans by themselves. So the NPL is another major factor that affects banks revenue. The expected sign of this variable should be negative, because more loan loss provision required to write-off the bad loans, less revenue bank can obtain. Finally, a time dummy is included, which takes into account yearly macro effects and technology change.

The test equations are specified in log-linear functional form which helps computation of elasticity and improves the regression's goodness of fit. The panel data are estimated by

the fixed effect method, as Hausman test suggested the fixed effect panel regression appears to be more appropriate than the random effect estimation.

4.4.1.2 Equilibrium test

As we explained above in Section 4.2, since the Panzar-Rosse model is only valid when the market is in long run equilibrium, we need test this condition before conducting the competition test. The following equations are estimated for the equilibrium test:

$$\begin{aligned} \ln(ROA_{it}) = & \alpha + \beta_1 \ln(PF_{it}) + \beta_2 \ln(PL_{it}) + \beta_3 \ln(PK_{it}) \\ & + \gamma_1 \ln(L_{it} / TA_{it}) + \gamma_2 \ln(E_{it} / TA_{it}) + \gamma_3 \ln(LLP_{it} / TL_{it}) + \delta_1 T + \varepsilon_{it} \end{aligned} \quad [4.10]$$

$$\begin{aligned} \ln(ROE_{it}) = & \alpha + \beta_1 \ln(PF_{it}) + \beta_2 \ln(PL_{it}) + \beta_3 \ln(PK_{it}) \\ & + \gamma_1 \ln(L_{it} / TA_{it}) + \gamma_2 \ln(E_{it} / TA_{it}) + \gamma_3 \ln(LLP_{it} / TL_{it}) + \delta_1 T + \varepsilon_{it} \end{aligned} \quad [4.11]$$

$$E = \hat{\beta}_1 + \hat{\beta}_2 + \hat{\beta}_3$$

The long-run equilibrium test is performed by re-estimating the reduced form revenue equation in the competitive test, but using bank return (i.e. ROA and ROE) as dependent variable instead of revenue measures, where ROA is the return on asset and ROE is the return on equity. The use of both ROA and ROE reflects usage common in the literature. ROA is the most commonly used measure of relative profitability in general industry studies, but ROE is also widely used in the banking sector because of the key leverage properties of equity capital.

The equilibrium test is carried out by testing whether E statistic is equal to zero or not, which is defined as the sum of coefficients on three input variables. E=0 indicates the

market is in equilibrium, otherwise disequilibrium. The intuition behind this test is based on the assumption that in equilibrium, returns on assets should be significantly uncorrelated with input prices.

4.4.2 Data collection

In our empirical study, we collect annual accounting data for domestic commercial banks in mainland China (i.e., excluding Hong Kong, Macao and Taiwan) over 10 years from 1997 to 2006, giving 371 observations in total. Table 4.3 provides some summary statistics of the variables included in our estimation.

Table 4.3: Summary of descriptive statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
ROA	371	0.005	0.458	-0.007	0.039
ROE	371	0.085	16.421	-0.139	0.123
IR	371	24575	63544	41	726170
IR/TA	371	0.040	0.016	0.017	0.136
TR	371	28910	41679	49	781435
TR/TA	371	0.035	0.016	0.016	0.193
PF	371	0.027	0.023	0.006	0.227
PL	371	0.004	0.001	0.002	0.010
PK	371	0.697	0.403	0.151	2.684
TL/TA	371	0.526	0.085	0.277	0.712
E/TA	371	0.045	0.029	0.117	0.313
LLP/TL	371	0.009	0.007	0.002	0.075

Source: author's own estimation from sample data

The data are mainly obtained from Bankscope database and the Almanac of China's finance and banking, which contains annual information on the balance sheet and income statements of all major banks operating in China. Individual bank annual report used as complementary sources for checking any missing values. Although our sample of Chinese banks is much smaller than the total number of banks in China, the banks included in our sample hold approximately 90% assets of the whole banking sector. Therefore, it is believed that our sample is a good representation of the overall Chinese banking industry. All the monetary variables are adjusted by using GDP deflator. The inflation adjusted monetary variables are denoted in the domestic currency RMB and quoted in millions.

4.5 Empirical Results

4.5.1 Empirical results from full sample (1997-2006)

The estimated results using the entire panel data (1997-2006) for different specifications of the dependent variable are presented in the Table 4.4 below.

Firstly, a critical assumption of the Panzar-Rosse methodology is that the competition test of H statistic must be undertaken under the condition of long-run equilibrium. The Table 4.4 reports the results for the equilibrium test. The values of E statistic are insignificantly different from zero for both ROA and ROE. Therefore, we do not reject the null hypothesis of long run equilibrium. The hypothesis of equilibrium ($E=0$) is confirmed for our sample means that our sample data satisfy the long run equilibrium condition and thus the Panzar-Rosse H statistic can be meaningfully interpreted.

Table 4.4: Estimation results of equilibrium test and competition test for 1997-2006

<i>Equilibrium test</i>				
ROA	E=0.360 (0.820)			
ROE	E=0.180 (0.490)			
<i>Competition test</i>				
	Unscaled revenue		Scaled revenue	
	IR	TR	IR/TA	TR/TA
PF	0.647*** (16.19)	0.635*** (13.8)	0.588*** (22.40)	0.567*** (14.46)
PL	0.180*** (2.63)	0.192*** (2.71)	0.155*** (3.50)	0.173*** (2.82)
PK	-0.170 (-1.21)	-0.173 (-1.01)	-0.175 (-0.92)	-0.178 (-1.26)
TL/TA	0.454*** (7.09)	0.435*** (5.93)	0.396*** (5.20)	0.376*** (3.28)
E/TA	-0.105** (-2.11)	-0.077** (-1.94)	-0.061* (1.84)	-0.048* (1.87)
LLP/TL	-0.150** (-2.41)	-0.138** (-2.45)	-0.018 (-1.29)	-0.012 (-1.64)
T	0.127*** (28.78)	0.113*** (23.92)	0.108*** (3.83)	0.104*** (6.50)
R-square	0.787	0.814	0.724	0.748
H	0.657	0.654	0.570	0.562
H=0	0.657*** (5.71)	0.654*** (3.58)	0.570*** (11.98)	0.518*** (6.66)
H=1	-0.343*** (-5.19)	-0.346*** (-6.08)	-0.430*** (-5.9)	-0.482*** (-6.23)

The values in parentheses are t-statistics.

* Significant at 10% ** Significant at 5% *** Significant at 1%

With regard to competition test, the first two columns of the table report the estimations for unscaled revenue as endogenous variable. The other two columns give the results using scaled revenue as dependent variable. Moreover, differences in estimated parameters between interest revenue and total revenue can be compared as well. The first and the third column list the estimated figures when interest revenue is used, the regression results with total revenue are shown in the second and fourth column. It is worth noticing that alternative specifications generally report similar estimated parameters. The only difference between the choices of scaled or unscaled revenue and interest revenue or total revenue is the magnitude and significance level of the estimated parameters when we compare estimation results for different pairs of specifications.

As we can see from the table, the estimated parameters for the price of funds (PF) are always positive and highly significant for all specifications of the dependent variable. It is consistent with most studies which found positive relationship between bank revenue and price of funds. This significant positive relationship suggests that the higher the price of funds, the larger the bank revenue, other things being equal. The intuition behind this is very clear: more interest expenses paid by banks reflect more deposits they absorbed, taking more deposits facilitate bank make more loans, thus earn more revenue. Moreover, the price of funds contributes the most to the explanation of bank revenue among the three input factors, which is hardly surprising given the fact that interest expense is the main factor in the function of bank revenue. Especially, in China, the traditional business remain the dominant composition of the total revenue, as the off balance sheet activity is relatively tiny.

Furthermore, we notice that the size of coefficients on the price of fund is larger for interest revenue than total revenue. This reflects that cost of funds contribute more to interest revenue than total revenue, as total revenue include both core business and off balance sheet activities such as fee-based services and other operating revenues. The

same case was also found in Italy by Coccorese (2004) and Trivieri (2007) as well as Mamatzakis et al. (2005) in Southern Eastern Europe.

The parameters for the price of labor (PL) are always positive and highly significant in four alternative specifications. The positive relationship between the price of labor and bank revenue suggests that higher labor cost can help bank generate more revenue. The higher labor cost reflects better quality staff employed by bank, thus more experienced expertise provide higher quality and more specialized services enable bank earn more revenue.

In the case of price of capital (PK), the parameters are always negative but the effect on both the unscaled revenue and scaled revenue appears to be negligible compared to other two input prices, as the level of parameters is minimal and it is statistically insignificant in all specifications. These results are consistent with previous studies, which found that the impact of the capital factor input price varied by countries and it was the least important component of the H statistic (Molyneux et al. (1996), Bikker and Haaf, (2002), Coccorese (2004) and Matthews et al. (2007)). In particular, Shaffer (2004) re-estimated the model by excluding the factor of physical capital when he found out insignificant effect from the price of capital, and similar results were reported when the factor was excluded. This actually is consistent with the fact that fixed asset investments for banks often take up a very small portion of total asset and the poor quality of capital expenses and fixed assets data. Therefore, the price of capital may not contribute to the explanatory power of the bank revenue, as the major source of revenue is from deposit and loan.

After discussion of the three input prices, we turn to consider the parameters on three bank specific variables. The results show that the ratio of total loans to total assets (TL/TA) have the expected positive sign and are highly significant at 1% for both unscaled and scaled revenue as dependent variable. This significant positive effect

indicates that higher fraction of loans to total assets generate greater income. This is because more loans bank can make, more interest income bank can earn, so more revenue they can generate. An alternative explanation based on risk and return can also be provided. The great uncertainty for the possibility of default make bank loan risky; the more loans reflect more risks associated with banks, so higher revenue should be compensated for the higher risk bear by bank. This result is consistent with the findings reported by Mamatzakis et al (2005), Gunalp and Celik (2006) and Trivieri (2007).

The estimated coefficient of the equity to total assets ratio (E/TA) is reported with the expected negative sign for all specifications. It is moderately significant at 5% only when we use unscaled revenue as the dependent variable and become marginally significant at 10% for scaled variables. Gunalp and Celik (2006) also found significant negative relationship with the absolute level of revenue in Turkey. The negative sign reflects that higher ratio of equity to total asset generate less revenue. This is because more equity bank reserve, less fund they can lend out, thus smaller leverage effect reduces the bank revenue it can earn. It can be noted that the equity ratio variable (E/TA) has a regression coefficients sign that differ depending on whether revenue (as here) or ROA and ROE (profitability in Chapter 3) are used as dependent variable.

The coefficients on the ratio of loan loss provision to total loans (LLP/TL) are always negative but only moderately significant at 5% for unscaled revenue. When scaled revenue is used as dependent variable, the effect on bank revenue become insignificant. The parameter has an expected negative sign which suggests that more provisions make for possible loan loss, the less revenue bank can earn. The same resulted are reported by Mamatzakis et al.(2005), Al-Muharrami et al. (2006) and Matthews et al. (2007).

Finally, the coefficients on time trend are always positive and statistically significant for all specifications. This suggests technical progress in the revenue generating business in

the sample.

The value of R square generally indicates the good fit of our models. For example, in the case of models with unscaled revenue, the estimated regression equations explain 78.7% of the variability in the interest revenue and 81.4% in the total revenue equation. The higher R square for total revenue (no matter scaled or unscaled) suggests that equation with total revenue add more explanatory power and better fit the model, thus confirm its appropriateness of inclusion. Moreover, the R square is higher for unscaled bank revenue when we compare with scaled revenue. This seems to indicate that my sample data can better explain the change in absolute level of revenue than the ratio of revenue to total asset. Broadly speaking, although there are some variations in R squares for models with different specifications, our regressions generally explain well for all the specifications.

After discussing the parameters on each variable, now we move to consider the core element of this research, the estimated values of the Panzar-Rosse H statistic. The computation of the H statistic is the sum of parameters on three input prices, which is reported in Table 4.4. Generally speaking, the values of H statistics are qualitatively similar but only differ in the magnitude for alternative specifications used for bank revenue. As shown in Table 4.4, the estimated values of the H statistic are significantly different from both zero and unity. Therefore, the hypotheses of banks enjoy monopoly power and compete perfectly are clearly rejected. Thus the results lead us to conclude that Chinese commercial banks operate under the condition of monopolistic competition during our estimation period (1997-2006), which is the most common type of market structure found in other countries by the previous empirical literature. Our conclusion is in line with the result reported by Yuan (2006) who also employed the Panzar-Rosse method to analyse the competition condition for commercial banks in China for the period of 1992-2002.

Moreover, regressions with the unscaled variables give higher value of H statistic than scaled ones. Except the magnitude difference in the H statistic, there is little qualitative difference between the choice of scaled and unscaled dependent variables. Furthermore, the estimated values of H statistic are higher with interest revenue than total revenue. This suggests a higher degree of competition in traditional business. The same situation was also presented in papers by Mamatzakis et al. (2005), Gunalp and Celik (2006) and Trivieri (2007). It is consistent with the fact that traditional business is the core activities for commercial banks in China, every bank fights for deposits and loans. Although there is substantial increase in fee-based revenue, the traditional business maintains the dominated position for banks in China, as the revenue from off-balance sheet activities contribute less than 10% to the total revenue.

In sum, all estimated parameters have the expected sign and are generally significant except the price of capital. Although there are several variations in estimated parameters with respect to size and the level of significance when we look at different specifications, all the alternative specifications generally give similar estimated values of H statistic which lead to the same conclusion: the Chinese banking market is characterized by monopolistic competition during the period of 1997-2006.

4.5.2 Empirical results from two sub-samples

In order to test whether the current banking reform is effective on improving the market competition, we divide the whole sample into two sub-samples. This division is motivated by the entry of WTO in 2001. The first sample is between 1997–2001 (known as pre-entry period) and the second period from 2002 till the end of 2006 (known as post-entry period). The empirical results of the tests for both sub-periods are given in the following Table 4.5 and 4.6.

Table 4.5: Estimation results of equilibrium test and competition test for 1997-2001

<i>Equilibrium test</i>				
ROA	E=0.036 (1.11)			
ROE	E=0.080 (1.14)			
<i>Competition test</i>				
	Unscaled revenue		Scaled revenue	
	IR	TR	IR/TA	TR/TA
PF	0.639*** (9.22)	0.635*** (3.72)	0.622*** (13.06)	0.616*** (3.25)
PL	-0.139*** (-2.81)	-0.136*** (-2.63)	-0.132*** (-3.33)	-0.122*** (-2.72)
PK	-0.037 (-0.48)	-0.080 (-1.03)	-0.043 (-0.36)	-0.085 (-0.42)
TL/TA	0.612*** (3.52)	0.619*** (4.21)	0.604*** (2.96)	0.590*** (3.34)
E/TA	-0.196*** (-5.34)	-0.180*** (-2.79)	-0.160*** (-2.61)	-0.138*** (3.07)
LLP/TL	-0.013 (-0.41)	-0.017 (-0.38)	-0.020 (-1.21)	-0.010 (-0.33)
T	0.127*** (7.93)	0.151*** (3.92)	0.129*** (3.14)	0.147*** (5.27)
R2	0.706	0.661	0.685	0.624
H	0.463	0.419	0.447	0.409
H=0	0.453*** (3.14)	0.416*** (3.58)	0.477*** (8.69)	0.409*** (6.66)
H=1	-0.547*** (-3.04)	-0.584*** (-4.64)	-0.523*** (-5.20)	-0.591*** (-6.23)

The values in parentheses are t-statistics.

* Significant at 10% ** Significant at 5% *** Significant at 1%

Table 4.6: Estimation results of equilibrium test and competition test for 2002-2006

<i>Equilibrium test</i>				
ROA	E=0.035 (0.86)			
ROE	E=0.079 (0.84)			
<i>Competition test</i>				
	Unscaled revenue		Scaled revenue	
	IR	TR	IR/TA	TR/TA
PF	0.437*** (7.71)	0.426*** (5.41)	0.417*** (8.66)	0.404*** (5.73)
PL	0.210*** (2.46)	0.212*** (2.92)	0.214*** (3.99)	0.226*** (5.27)
PK	-0.060 (-1.56)	-0.070 (-1.35)	-0.040 (-1.41)	-0.050 (-1.15)
TL/TA	0.452*** (4.61)	0.466*** (3.34)	0.463*** (6.34)	0.470*** (4.92)
E/TA	-0.045*** (-2.89)	-0.050*** (-3.46)	-0.041*** (-2.20)	-0.048*** (-3.15)
LLP/TL	-0.120 (-1.30)	-0.104 (-0.44)	-0.123 (-1.31)	-0.130 (-0.21)
T	0.117*** (24.28)	0.119*** (26.78)	0.135*** (5.34)	0.137*** (6.63)
R2	0.884	0.891	0.715	0.678
H	0.587	0.568	0.591	0.580
H=0	0.587*** (5.60)	0.563*** (4.51)	0.512*** (7.10)	0.510*** (5.94)
H=1	-0.413*** (-4.51)	-0.437*** (-6.53)	-0.488*** (-6.64)	-0.490*** (-10.07)

The values in parentheses are t-statistics

* Significant at 10% ** Significant at 5% *** Significant at 1%

In general, the estimation results from the two sub-samples depict similar pictures to those from the full period; but except some of the parameter estimates have changed their signs, and significance levels.

The parameters on the price of funds (PF) are always positive and highly significant in all specifications for both sub-periods. When we compare the magnitude of the parameters between two periods, we find that banks increasingly reduce their reliance on traditional business, as indicated by the lower level of coefficients in post entry period contributed to the revenue when compare with pre entry period. This may be due to the intensive competition in the deposit and loan market and substantial growth in off balance sheet services.

The parameters of the price of labor (PL) are negative in the pre entry period, but become positive in the post entry period. The sign of the coefficient for the price of labour can be justified for both directions. The negative parameters suggest that higher labor cost causes decrease in bank revenue. This can be explained as personnel expenses are regarded as cost to bank, hence more cost means less revenue, other things being equal. This negative relationship implies that cutting personnel expense is one way to save cost and increase revenue. Gunalp and Celik (2006) and Matthews et al. (2007) also report negative signs on price of labor in Turkey and UK respectively. The change of sign in price of labor suggests that the quality of employees become more important after the entry into the WTO. The value of human resources is not bank's cost any more but bank's precious assets. If domestic banks want to compete with foreign rivals and maintain the growth in fee-based activities, they should put more emphasis on staff quality, as higher employee expense lead to higher bank revenue.

The effect of price of capital (PK) on bank revenue remains negative and insignificant for all specifications in two sub-samples.

In the case of three bank specific variables, two sub-samples generally provide consistent estimations with that from the full period sample.

Finally, the Panzar-Rosse H statistic is significantly different from zero and one in both sub-samples. Thus we can conclude that commercial banks in China are operated in the monopolistic competition in the two separate periods. The computation of the H-statistic is reported around 0.4 in the pre entry period and increase to approximately 0.5 in the post entry period. As mentioned in before, the value of the H-statistic is an increasing function of the competitiveness level that means the higher value of H statistic indicates more competition. Thus according to our results, we find out that there is an increasing in the competitiveness in the Chinese banking market after the WTO entry in 2001. It supports that the recent banking reform is effective and successfully improve the market competition in Chinese banking industry.

4.6 Conclusion

Over last ten years, the Chinese banking industry has gone through dramatic changes, especially, after China successfully joined the World Trade Organization (WTO) in 2001. In order to fulfill the commitment of the entry into the WTO and enable domestic banks to compete with foreign banks, the pace of banking reform has been accelerated and the strength of financial liberalization program has been intensified following the WTO entry. A series of reforms have been carried out for domestic commercial banks, in particular more emphasis placed on the state-owned banks. During the period covered by our study, the state-owned banks have seen their monopoly position weakening with the rapid expansion of the joint equity banks and city commercial banks, indicated by a similar decrease trend in both CR4 and HHI, despite the state-owned banks still dominate the banking sector in China. This issue raised an important question that whether the

decreased concentration in the Chinese banking sector lead to an increase in competition. In other words, we would like to find out that whether the recent reform is effective to make Chinese banking market more competitive.

Our study assesses the competitive condition in the Chinese banking industry by using the Panzar-Rosse methodology. As there is much debate about the choice between the use of scaled and unscaled revenue as dependent variable, both of them are employed in our model. Moreover, in order to take into account the growing trend of the off-balance sheet revenue, total revenue is also included in addition to interest revenue as proxy for bank revenue. Hence four different specifications in total for dependent variable are used in our regression equations.

In the empirical estimation for the whole sample period, all the parameters have expected signs and are significant in general. The estimation results show that all the alternative specifications give similar values of the Panzar-Rosse H statistic with only minor variation in the magnitude. The values of H statistic are all highly significant different from both zero and unity. The hypothesis of monopoly and perfect competition are strongly rejected, thus the Chinese banking market is characterized by monopolistic competition. This type of competition is consistent with the findings of the previous study investigated by Yuan (2006) as well as findings of most previous studies performed for other countries. This suggests that Chinese banking industry is moderately competitive, even the market is still moderately concentrated, and competition seems to have increased post WTO entry.

By dividing the whole sample into the two sub-samples, we find out that the level of competitiveness in the Chinese banking market increased after the WTO entry in 2001. It supports that the recent banking reform is effective and successfully improved the market competition in Chinese banking industry. Moreover, by comparing the estimated

parameters from the two sub-periods, we observe that domestic commercial banks increasingly reduce their reliance on traditional business. Furthermore, the employee quality becomes a more important factor in generating bank revenue.

Although a substantial fall in the CR4 and HHI as well as significant increase in the H statistic indicate great improvement in the market competition for Chinese banks, the level of competition is much lower than other countries, which have H statistics range from 0.6 to 0.8 (Claessens and Laeven (2004)), compared to average figure of 0.6 in Chinese banking market. This implies that there is still much room for improvement of competition condition in Chinese banking sector. This sort of conclusion may help policy makers and regulators in making more efforts for improving efficiency of the banking system by further liberalizing and creating a more suitable environment for competition. We also believe that our study could have general application to emerging countries whose financial system undergoes structural changes. The finding of this study, however need to be interpreted cautiously given the full market liberalization process of the Chinese banking system is an ongoing process, not fully completed yet.

Chapter 5: SROE and cost efficiency in the Chinese commercial banks during 1997-2006

5.1 Introduction

The production theory in economics includes the concept of optimization, which states producers aim to maximize their feasible outputs given the production technology in place and levels of input resources. They also attempt to minimize the production costs under current technology and input prices they face, as well as to maximize profits, given the technology and output and input prices. However, not all producers are successful in achieving the optimization. Some producers fail to maximize output expansion given the resources they have or minimize the input utilization given the output level they set to produce. To study producers' behaviour of failure of optimization, a theory of efficiency has been developed.

During the last two decades, the banking sector has become one of the most extensively investigated industries in efficiency literature. This is not only because of its vital importance in economics but also due to the rapid change in banking operation, competition and regulatory structure all over the world.

Banks act as financial intermediaries and play a critical role in economic stability and growth, such as risk diversification, capital mobilization and resource allocation. Bank efficiency is one of the most important competitive advantages in global intensive competition. Also it becomes critically important in enhancing banks' core competency. Thus bank managers, investors and regulators are increasingly concerned about how efficiently banks transform their expensive inputs (such as deposits, capital and labour) into various financial products and services (such as loans, mortgage, investment and fee-based service), especially in a rapidly changing financial market worldwide.

Moreover, events like large waves of inter-country and cross border mergers and acquisition in the US and the European Union, along with banking reforms such as deregulation, and the privatization process in developing countries, trigger economists' interest to evaluate the performance of financial institutions on purpose to assess the effectiveness of government policy, such as deregulation and privatization on efficiency, and address research issues such as effects of mergers, non-performing loans, market structure, employment of different methodology on efficiency, and also improve managerial performance by identifying the most efficient producers and their driven contributing factors.

Although bank efficiency has been heavily investigated by researchers, the vast majority of work concentrates on banks in developed countries such as the US and the European Union, no matter whether a parametric or non-parametric method is adopted. Compared to the large volume of the US and European studies, the number of banking efficiency studies in developing countries is relatively small. In Berger and Humphrey's (1997) excellent international survey paper, they review 130 X-efficiency studies from 21 countries and various types of financial institutions. They observed that there is an enormous imbalance of the focus in the efficiency literature. They reported that about 95% in general of the studies on banking efficiency focus on the banks in developed countries and in particular the US banks attracted most attention (about 70%). Their paper indicated possible directions for future research; suggest that more work is needed in measuring and comparing the efficiency of banks and other financial institutions from different countries, especially developing countries. Inspired by Berger and Humphrey (1997), this is one of the motivations for this study, which carries out analysis of bank efficiency in one of the most fast growing economy China. Therefore, this literature gap brings the intuitive motivation for this study.

During the last few decades, there were continuous legal, structural and institutional changes in the Chinese banking sector. A series of banking reforms was introduced to establish a modern western style banking system and promote financial market development and stability. Especially after the WTO entry in 2001, under the pressure of full openness to foreign banks, the pace and strength of recapitalization and liberalization process has been accelerated and intensified. With these reforms, all four state-owned banks were listed, a new regulatory agency was established, interest and foreign exchange rates were freed, and new financial products and institutions were permitted. Competition dramatically increased as a result of the expansion of the joint equity banks, new entry of city commercial banks, deregulation of interest rates, and

the removal of both geographic and business barriers to foreign banks. The changing nature of competition resulting from recent banking reform suggests that there should be some potential impacts on the efficiency of banks in China. Because in order to survive in this increasingly competitive environment, banks have to enhance their core competency, improving the efficiency is a sustainable and vital way to achieve this.

The key objective of this chapter is to investigate the level of efficiency in the Chinese banking industry from 1997 to 2006, as well as changes over the ten years time. We also compare the efficiency for different groups of banks based on ownership. A particular interest is focused on the effect of recapitalization on the shadow return on equity.

Previous study on efficiency in the Chinese banking industry is insufficient to match its importance in the global financial market context. There have been only a few studies on the Chinese banking efficiency and results are inconsistent. The main incentive behind carrying out this empirical study is to help fill literature gap and add the latest evidence in the empirical literature on bank efficiency in China. Our paper differs from other Chinese banking efficiency papers in several aspects. First, our efficiency scores are estimated from six different models under the stochastic frontier approach, namely the fixed effect model, random effect model, Pitt and Lee (1981) model, Battese and Coelli (1992) model, Battese and Coelli (1995) model and conditional mean conditional variance model. The reason for this is that measured efficiency sometimes differs according to the model used, and the aim is to find a consistent set of results. Second, the number of banks included in this study exceeds the sample size adopted in other empirical studies investigating the efficiency of Chinese banks. Additionally, the time period covered by our study is more recent, thus shedding some light on the latest efficiency level of commercial banks in China.

The rest of the chapter is organized as follows: Section 5.2 briefly explains and illustrates different concepts of efficiency. Section 5.3 reviews previous studies of bank efficiency, which place emphasis on cross country comparison and empirical studies focus on Chinese banks. Section 5.4 explains the methodology and models employed in our study. Section 5.5 describes the issues on variables selection and data collection. In Section 5.6, empirical results are presented and discussed. Section 5.7 concludes this chapter.

5.2 Different concepts of efficiency

Each individual study on measuring efficiency differs from another in so many different dimensions. Efficiency scores often vary substantially across studies mainly due to different efficiency concepts as well as different measurement methods used in the studies. In this section, we begin by discussing the efficiency concepts and then explain the different methodologies in the next section.

For measuring efficiency, a fundamental question that must first be solved is to determine which type of efficiency to estimate. As a firm may be technically efficient, but they may possibly be allocatively inefficient in the sense of their failure to allocate their inputs in a cost-minimizing manner, given the input prices they face. This may contribute further to cost inefficiency as the failure to minimize expenditures in output production. Furthermore, even if some producers are cost efficient, not all of them can be profit efficient because of misallocation of outputs in a revenue-maximizing manner, given the output prices, which will result in failure to maximize profits. Here, we will discuss three most popular concepts which have been widely examined in the empirical studies, namely, X-efficiency (cost efficiency and profit efficiency), technical efficiency and allocative efficiency. Each concept may provide different information value and insights about firm efficiency.

The X-efficiency was initiated by Leibenstein (1966) and is usually known as managerial efficiency or overall economic efficiency. There is no standard definition for X-efficiency, but it generally refers to the ability of firm to select the input and/or output levels and combination of the two to optimize an economic goal, such as cost minimization or profit maximization.

The X efficiency derived from the cost function is known as cost efficiency. Cost efficiency gives a measure of how close a bank's cost is to what a best practice bank's cost would be for producing the same output bundle under the same conditions. That is, it measures how close is the bank's cost to the minimum cost determined by the best practice banks in the sample. It is derived from estimating a cost function in which total cost (TC) is regressed as a function of outputs (y), price of inputs (w), environmental variables (z), random noise (v) and inefficiency (u), written in log terms as:

$$\ln TC = \ln f(y, w, z) + v + u \quad [5.1]$$

Cost efficiency is calculated as the ratio of the minimum costs that could have been spent to produce a given output bundle to the actual costs spent, and theoretically it falls between zero and unity, and equals one for a best practice bank within the observed data. If a cost efficiency ratio 0.8 would indicate that the bank is 20% less efficient in terms of costs relative to the best practice bank operating under the same condition.

$$X - efficiency_{cost} = \frac{\hat{C}^{\min}}{\hat{C}_i} = \frac{\hat{u}^{\min}}{\hat{u}_i} \quad [5.2]$$

\hat{C}^{\min} = the predicted minimum costs used by the best practice bank

\hat{C}_i = the estimated actual costs of each specific bank

\hat{u}^{\min} = the minimum of the \hat{u}_i across all banks in the sample

\hat{u}_i = the estimated actual cost inefficiency of a specific bank

Alternatively, X efficiency can also be derived from profit function and known as profit efficiency which measures how close a bank is to produce the maximum possible profit. Two kinds of profit efficiency measures exist in the literature. One is the standard profit efficiency and the other is the alternative profit efficiency.

Standard profit efficiency measures how close a bank is to achieve the maximum profit given a certain level of input prices and output prices. The standard profit function, written in log terms, is

$$\ln(\pi + \theta) = \ln f(p, w, z) + v - u \quad [5.3]$$

where π is the profits of banks measured as revenues minus costs; θ is added as a constant to ensure the natural log is taken on a positive number; p and w are the vectors of output prices and input prices, respectively, while v and u are random noise and inefficiency.

Standard profit efficiency is measured as ratio of actual profits to the maximum possible profits

earned by the best practice bank in the sample. A standard efficiency ratio of 0.8 indicates that the bank is losing 20% of its profits that could be achieved because of excessive cost used or insufficient revenue raised.

$$X - \text{efficiency}_{profit} = \frac{\hat{\pi}}{\hat{\pi}_{\max}} \quad [5.4]$$

where $\hat{\pi}$ is estimated actual profits, $\hat{\pi}_{\max}$ is maximum estimated profits generated by the best practice bank in the sample

The alternative profit efficiency measures how close a bank is to achieve maximum profit at a given output level rather than output prices in standard profit efficiency concept. The alternative profit function written in log terms is

$$\ln(\pi + \theta) = \ln f(y, w, z) + v - u \quad [5.5]$$

which is identical to standard profit function except that y replaces p in the function. The alternative profit efficiency is also measured as ratio of actual profit to the possible maximum profit earned by the best practice.

The main difference between standard and alternative profit model is that the alternative profit model applies more easily to cases where market power may be present. Because standard profit model assumes perfect competition, i.e. firms are price takers, while alternative profit model permits imperfect competition, i.e. firms can be price makers.

As argued by Berger and Mester (1997), profit efficiency provides a better measure than cost efficiency when evaluating banks' overall performance. Cost efficiency accounts for errors only on input side while profit efficiency takes accounts of errors not only on input side but also on output side. Cost efficiency is based on economic objective of cost minimization that requires bank manager to focus on reducing operating costs. However profit efficiency is based on a more accepted economic objective of profit maximization under which bank managers need to pay an equal amount attention to raise marginal revenue as to reduce marginal cost. Moreover,

unlike cost efficiency, profit efficiency can be negative.

No matter whether cost efficiency or profit efficiency is adopted, they all suffer a limitation which is that the efficiency is a relative measure against the best practice bank within the sample. The best practice bank itself may not be efficient when compared to banks outside the sample.

We have discussed that X-efficiency can be estimated from both cost and profit perspective based on cost and profit function. Next we will take a look at the decomposition of X-efficiency. No doubt, Farrell (1957) firstly proposed the efficiency decomposition. Based upon his work, cost efficiency can be decomposed into two separate components, namely technical and allocative efficiency.

Technical efficiency refers to the ability to avoid waste by maximizing outputs for a given set of inputs or minimizing inputs for a given set of outputs. Allocative efficiency refers to the ability to combine inputs and outputs in optimal proportions given prevailing prices, so it is also known as price efficiency. Therefore X-efficiency is a multifaceted concept with several meanings depending on which perspective to look at it. It is worthwhile briefly explaining each component.

Farrell (1957) illustrated his idea using a simple example involving firms that use two inputs (x_1 and x_2) to produce a single output (y). If the isoquant of the benchmark efficient firm is known, the efficiency of any firm can be calculated by comparing observed and optimum cost, subject to the appropriate constraints on quantities and prices.

Farrell's decomposition of efficiency can be illustrated in the following graph. In Figure 5.1 the isoquant is represented by SS' , which plots the minimum combinations of two inputs (x_1 and x_2) needed to produce a unit of output y . Every combination along the isoquant (like point Q and Q') is considered as technically efficient while any point above or to the right of it defines a technical inefficient producer since it can contract the use of inputs without reducing the output level. Iso cost line AA' , the slope of which equals the ratio of two input prices, measures the minimum cost to secure unit output.

If a firm uses quantities of two inputs defined by P to produce the output, the firm is regarded as

technology and their abilities to control the prices. Therefore, the use of different efficiency concepts may give significantly different efficiency scores and rankings, even under the same approach.

Another key contribution of Farrell is that he built up an efficient frontier which is a benchmark to measure the relative performance of productive units. This underlying idea has been widely spread by other researchers from then, known as frontier analysis

In our study, we examine the efficiency from the cost perspective, because at current stage of development, Chinese commercial banks are more concerned about cost minimization rather than profit maximization. Moreover, it is a more commonly specified and accepted efficiency concept in the literature, so it can enable us to make possible comparison under the same concept.

5.3 Brief review of the efficiency literature

There exists a copious number of methodological and empirical literatures concerning about developing and improving methods of efficiency measurement, and estimating and comparing the level of efficiency in different industries and cross countries. In the following, we will first briefly describe various methodological approaches on efficiency estimation. Then we will highlight recent empirical researches involved cross country studies on bank efficiency. Finally, we will summarize research findings focusing on the Chinese banking efficiency.

5.3.1 Methodological studies on efficiency measurement

We have mentioned that efficiency scores vary across studies mainly due to two reasons, namely different concepts and estimation methods. We have explained different efficiency concepts in previous section. In this section, various approaches used to measure the efficiency will be discussed. Generally speaking, there are two broad approaches employed in the literature to estimate efficiency, namely the traditional non-frontier approach and frontier

approach.

Earlier, non-frontier methods such as financial ratio analysis were used to measure the bank performance as proxy for efficiency. However, this approach suffers a lot of drawbacks. For example, there is no consensus on the benchmark ratios which level of the ratio is the best (the most efficient). Moreover, financial ratios taken from balance sheet only give a snapshot view, so it is a short run measure and may be inappropriate for describing the actual level of efficiency for a bank in the long run (Oral and Yolalan, 1990). Furthermore, financial ratios provide only a restricted and incomplete picture and fail to account for the interactions between the different factors which affect efficiency (Mukherjee et al. 2002). Besides, financial ratios do not enable carrying out any statistical test. In addition, these ratios cannot identify sources of bank efficiency such as technical efficiency and allocative efficiency. Therefore, non-frontier method is not an accurate and appropriate way to measure efficiency. As a result, frontier analysis becomes the most commonly used technique to measure efficiency.

The history of theoretical developments in frontier analysis of producers' performance went back to the pioneer work of Michael Farrell, who was the first to measure economic efficiency. Farrell (1957) also introduced a method to decompose the overall efficiency into its technical and allocative components. His work influenced the development of data envelopment analysis (DEA) by Charnes *et al.* (1978) and stochastic frontier analysis (SFA) by Aigner *et al.* (1977) and Meeusen and van den Broeck (1977). The DEA and SFA are by now well-established and widely used as non-parametric and parametric efficiency measurement techniques in the literature of efficiency measurement. The main difference between non-parametric and parametric approach is that non-parametric models based on linear programming while parametric estimations by specifying econometric functions.

Since the pioneer paper of Farrell (1957) that introduced a frontier method to measure firms' economic efficiency, there have been numerous efficiency studies in financial institutions and mostly banks. Some studies focused on empirical application and tried to inform government policies by assessing the effect of deregulation, loan quality, risk factor, market structure and mergers and acquisitions on firms' performance as well as report to managers by identifying the "best" and "worst" practice. While others concentrated on improving the frontier methodology to obtain consistent and more accurate efficiency estimates.

Early attempt to measure efficiency based on the frontier analysis mainly focus on economies of scale and economies of scope, implicitly assuming that banks were approximately equally X-efficient. Economies of scale arise if average production costs decline as output increases. Economies of scope exist if two or more products can be jointly produced with lower cost than independent production. In short, economies of scale are associated with firm size, while economies of scope are related to the joint production of more than two products. Studies of economies of scale and economies of scope in banking include Berger (1987), Clark (1988), Ferrier and Lovell (1990), Berger and Humphrey (1991).

Later studies give more emphasis on X-efficiency which involves superior management and technology resources. The frontier models estimating X-efficiency can further be divided into non parametric methods and parametric methods. Nonparametric efficiency is calculated by employing linear mathematical programming techniques; whereas parametric efficiency is derived from a particular function such as Cobb–Douglas production function, cost function, revenue function or distance function. Comprehensive methodological surveys exist in Bauer (1990), Greene (1993), Lovell (1993), and Charnes et al. (1994).

The most common parametric estimation technique is the stochastic frontier approach (SFA) which was originated by Aigner, Lovell and Schmidt (1977). The fundamental benefit of the SFA is that it allows for idiosyncratic error²⁰. In the SFA, the inefficiency and idiosyncratic error term are disentangled by making different assumptions about their distributions. The inefficiency term is assumed to follow an asymmetric distribution, such as half-normal and truncated half normal, while the idiosyncratic error term is assumed to follow a symmetric distribution, usually the standard normal distribution. The main disadvantage of the parametric methods is that they have to impose particular structure on (i) the shape of the frontier by specifying a functional form for the relationship among inputs outputs and other influential factors, such as Cobb-Douglas production function and translog cost function, and (ii) the specification of the error component distributions. Recent Fourier-Flexible specification improves the cost function by adding more flexibility, even though it still not solves the entire problem and has the cost of making economic interpretations obscure.

²⁰

Idiosyncratic error here refers to measurement error, sampling error and specification error, i.e. v in the cost or profit function. Both idiosyncratic error v and inefficiency u are components of random error.

The most familiar nonparametric technique is the data envelopment analysis (DEA). The DEA is a linear programming technique developed by Charnes, Cooper and Rhodes (1978). It was originally designed to measure efficiency in public sector and non-profit entities where typical economic behavioral assumptions, like cost minimization or profit maximization may not apply, such as police force, healthcare and education. Sherman and Gold (1985) were the first to apply the DEA to banking industry which is reviewed in Berger (1997). Since the first use of the DEA by Charnes, Cooper and Rhodes (1978), there has been a large number of papers which have applied and extended this methodology. For example, Lovell (1993) and Seiford (1996) offered extensive reviews of this literature, and Cook and Seiford (2009) presented recent methodological development.

As Berger and Humphrey (1997) summarized, the primary advantage of the non-parametric techniques is that they do not require the specification of a particular functional form for the cost or production function for the inefficiency. So it imposes very little structure on the shape of the efficient frontier. It also makes no prior assumption regarding the form of the distribution of inefficiencies across observations. The key drawback of the nonparametric techniques is that they usually do not incorporate idiosyncratic error and attribute all the difference to the inefficiency. This may overstate the true level of inefficiency and mislead the conclusion, if the difference is due to measurement errors, luck or exclusion of important regressors.

For this reason, the parametric approach is usually found to compute higher efficiency values than the non-parametric approach. However, Resti (1997) found little difference between those techniques. Other papers compared efficiency estimates using two approaches, the results were mixed. Nevertheless, as two broad category approaches based on different estimation techniques and different data requirement, it is not necessarily comparable. Parametric methods employ statistical regression, while non-parametric methods utilize linear programming.

As the non-parametric and parametric methods have their own advantages and disadvantages, there is no consensus about the single best estimation methodology for efficiency measurement. The recent developments of frontier analysis aim to improve the efficiency estimates mainly focus on two aspects. One is to provide a statistical foundation for the non-parametric methods and developing a stochastic version of the DEA by incorporation of error term. The other is to relax the functional form and assumptions in the SFA (Berger, 1997).

5.3.2 Empirical studies on banking efficiency: international comparison

There has been a considerable body of literatures empirically investigating the efficiency of financial institutions, by using non-parametric or/and parametric frontier models. The first extensive survey of efficiency studies in financial institutions was provided by Berger *et al.* (1993), in which the authors mainly reviewed scale and scope efficiencies in banking, along with discussions of mergers, efficiencies in governmental financial institutions and insurance companies, and determinants of efficiency for financial institution. It was clear that up to that date, the banking efficiency literature was dominated by studies of scale and scope efficiencies rather than X-efficiencies. The second and most exhaustive empirical survey was provided by Berger and Humphrey (1997). They provided an excellent and comprehensive survey of 130 X-efficiency studies from 21 countries and various types of financial institutions. They critically reviewed and discussed various frontier efficiency methods with improvement suggestions. This paper also outlined potential directions for future research such as improvement of frontier efficiency techniques and research issues of providing more evidence in developing country and cross-country comparison and determinants of efficiency estimates.

As most of the studies on banking efficiency reviewed in this paper focused on single country, here we do not repeat to review those studies surveyed by Berger and Humphrey (1997). We focus on more recent papers on examining bank efficiency, particularly those studies engage in cross country comparison. Maybe inspired by suggestion of Berger and Humphrey (1997) who propose that more research is needed in measuring and comparing the efficiency of banks in different countries, we find that the majority of early studies focus on individual countries, but a growing number of studies examine cross-country samples in recent years. In the survey by Berger and Humphrey (1997), there were only three cross country studies. But Pasiouras (2008) claimed that they identify 38 cross-country studies and half of them being published after year 2003. Therefore, in the following, we review recent evidence from international comparison on banking efficiency. For interests of previous banking efficiency in individual country, please see survey paper of Berger and Humphrey (1997), Goddard et al (2001), Berger (2007), Hughes and Mester (2010), Fethi and Pasiouras (2010).

Before we summarize the studies that compare efficiency levels among different countries, one thing should be always bear in mind when we consider cross-country studies. Theoretically speaking, if a country-specific frontier is estimated, it is truly non-comparable for different countries with their efficiency scores, as different countries have different frontiers and each country's efficiency is compared separately to its own frontier which is different from other countries. Even when a common frontier is estimated, it is still quite difficult to compare efficiency levels internationally, because it is challenging to control for very different economic environments which banks operate in different countries, such as regulation, political regime, taxation system, accounting standards, and quality of products and services. In addition, as efficiency is continuously changing, different sample periods and different stages of development yield different efficiency levels. So the cautious and careful interpretation is needed when we make comparison cross different countries, especially from different regions.

Although conclusion and inference drawn from international comparison is limited, it can help depict a general picture and provide some valuable information. In particular, bank operations across international boundary increasingly become a common trend as a result of increasing financial globalization and intensive competition. For example, banks in the nations with the most efficient institutions would acquire institutions in the nations with the least efficient organizations. In the following, we focus on recent empirical studies providing international comparison of bank efficiency using a common frontier.

Numerous empirical studies evaluate the differences in bank efficiency among different nations, by measuring the efficiency of each bank relative to a common best practice frontier. Most of these studies compare efficiency of banks within the European Union. This is possibly because data in those countries is easily obtainable. And also relatively fewer control variables are needed for comparison within the EU, as banks compete under similar economic environment. There are some studies compare the EU members with other industrialized countries mainly the US. A few latest works also include banks from developing countries in Eastern Europe as a result of the recent expansion of the EU.

Early cross-country studies initially start common frontier comparison between the EU members and the US, as well as within the EU. But the efficiency estimates appear to show mixed or even conflicting results. There is no consensus achieved for which country is the most efficient, and which is the least. For example, Allen and Rai (1995) estimated the X-efficiency

for banks in 15 developed countries and found average inefficiency measures were greatest in France, Italy, the U.K. and the U.S. Financial institutions in Japan, Germany, Denmark, Sweden, and Canada were, on average, the most efficient in the world. However, results obtained by Pastor et al. (1997) indicated that efficiency was low in Italy and high in Denmark, Spain, Germany, and France. Interestingly, Maudos et al (1999) found Portugal and the UK were the least cost efficient countries, but their position in the ranking changed completely in terms of profit efficiency, where they were the most efficient.

A possible partial explanation for mixed results suggested by Berger et al (2007) is that econometric analyses do not control well for the differences in economic environments across nations. Different results may primarily reflect differences in the economic environment rather than differences in efficiencies. Recent studies (Dietsch (2001), Lozano-Vivas et al (2002), Maudos et al (2002), Pasiouras (2008)) improve earlier researches by incorporating better and more comprehensive control variables for different economic environment. Those include country specific variables measuring market structure, regulation and macroeconomic condition. The effects of those environmental variables on efficiency are also examined to assess the direction and magnitude of each environmental factor on explaining differences in measured efficiency among countries.

By incorporating additional environmental variables, a number of studies offer a European cross-country comparison of bank efficiency, mainly on the EU 15 (Cavallo and Rossi (2002), Vivas et al. (2002), Casu and Molyneux (2003), Casu and Girardone (2006)). However, there is still no consensus achieved regarding the most efficient and the least efficient country in the EU. And Casu and Molyneux (2003) reported that the efficiency gap among countries grew even wider and country-specific factors are still important determinants in explaining differences in bank efficiency levels across Europe.

As a result of the EU enlargement process, some recent studies concentrate on the comparison of transition countries within the Eastern Europe as well as between the Eastern and Western Europe (Fries and Taci (2004), Bonin et al (2005), Rossi et al (2005), Yildirim and Philippatos (2007)). Similarly, no agreement is obtained concerning about efficiency rankings among Eastern European countries. Weill (2004) compared the cost efficiency of banks from Western European countries with Eastern European countries. He observed that Western banks are more cost-efficient than Eastern banks. The results also reveal that there exists a gap in bank

efficiency between Eastern and Western European countries.

Comparisons of studies concentrating on one particular geographical area would not really be considered international; Maudos and Pastor (2001) extended the efficiency cross-country comparison by including European countries as well as Japan and the US. The results obtained generally indicate that banks in the US are the most efficient, Japanese banks are the least, and European banks stand in the middle. More recent empirical evidence from Bos and Kolari (2003) is consistent with Maudos and Pastor (2001) findings. The estimated results suggest that the US banks are both profit and cost efficient than European banks in general.

To our best knowledge, Pasiouras (2007) provided the most comprehensive international comparison, in terms of geographical coverage. The paper estimates bank efficiency in 95 countries. The results show the most efficient region appears to be Asia Pacific, while the least efficient region is Latin America and Caribbean.

5.3.3 Empirical studies on banking efficiency in China

After reviewing these cross country studies, it is not surprising that we can observe that like single country studies, the majority of international comparisons on bank efficiency give more emphasis on developed countries, which is not truly international. Although in recent years, there is increase in the number of works including emerging countries, China is still neglected. So next, we summarize some findings of researches focusing on banking efficiency in China.

Before the beginning of this century, there are few papers written in English on the efficiency of banks in China. But after the WTO entry and the listing of the state owned banks, Chinese banks start to attract worldwide attention and bank efficiency in China has become a popular area of research in recent years. But there still quite limited papers employed frontier analysis for investigating bank efficiency in Chinese banking sector, even relatively smaller number of papers compare with other developing countries, such as India and Turkey. To our best knowledge, there are seven published papers on examining bank efficiency in mainland China²¹,

²¹ A number of studies in Chinese banking efficiency have been published in Chinese scholarly journals, but to date there have

including Chen et al (2005), Matthews et al (2006), Fu and Heffernan (2007), Kumbhakar and Wang (2007), Berger et al (2007), Ariff and Can (2008) and Shen et al (2009). In the following, each study will be reviewed in turn.

Chen et al (2005) using non parametric DEA approach examined the cost, technical and allocative efficiency of 43 Chinese banks over the period 1993 to 2000. Their results show that technical efficiency (around 70%~80%) consistently dominates the allocative efficiency (around 50%~60%) of Chinese banks. Moreover, they investigated efficiency based on size difference and found that the large banks and smaller banks are more cost efficient than medium sized banks. In addition, the financial deregulation in 1995 was found to improve cost efficiency levels including both technical and allocative efficiency.

However, by using parametric SFA approach (input distance function is employed), Kumbhakar and Wang (2005) found completely different results from Chen et al (2005). By examining technical efficiency of 14 national banks over the period 1993–2002, their results indicate that larger banks tend to be less efficient. In particular, the large four banks (0.47) are less efficient than the medium banks (0.9). Both studies also appear to have contradictory implications regarding the effects of deregulation. Kumbhakar and Wang (2005) found no evidence to support the view that deregulation improved efficiency significantly. In addition, they examined the role of bank characteristics and environmental factors in explaining technical efficiency and reported that private ownership in joint-equity banks was found to improve technical efficiency. Similarly, a higher capital adequacy ratio was associated with higher efficiency

Matthews et al (2006) employed a non-parametric approach using the bootstrap technique to estimate cost efficiency for the 4 state owned banks and 11 joint-stock banks over the period 1997-2004. They claimed that a protected banking market in China not only encourages weak management and X-inefficiency but also public ownership and state directed lending encourage moral hazard and bureaucratic rent seeking. Thus they decomposed cost efficiency into X-inefficiency and rent-seeking inefficiency. They found that a significant cause of bank inefficiency in China was ‘rent seeking’ behavior rather than X-inefficiency. The paper also

been only a few studies that are available to non-Chinese readers.

found evidence of declining trend in both types of inefficiency and suggested that reduced inefficiency was due to the competitive threat of entry of foreign banks into the Chinese market, which lead to improved management and result in higher technical efficiency and lower cost-inefficiency. In addition, X- inefficiency is significantly higher for the state-owned banks (36.4%) than joint stock banks (31.3%).

By employing the stochastic frontier approach, Fu and Heffernan (2007) investigate cost efficiency of 4 state-owned and 10 joint stock banks in China's banking sector over the period 1985–2002. Their results show that cost efficiency in China's banking sector ranged between 41% and 52%. On average, the joint-stock banks are found to be more cost efficient than the state-owned commercial banks, which is consistent with results obtained by Kumbhakar and Wang (2005) using the same parametric approach. The improvement in efficiency suggests that deregulation has a positive impact on bank efficiency in China.

More recently, Berger et al (2007) analyzed both profit and cost efficiency of banks in China over 1994-2003 with different majority and minority foreign ownership structures. The results report the mean profit and cost efficiency level are 0.476 and 0.897 respectively. The key findings are that the Big Four state-owned banks are the least efficient, and that minority foreign ownership of other banks is associated with significantly improved efficiency. These findings suggest that minority foreign ownership of the Big Four and other reforms that allow foreign banks to play larger roles will likely improve the performance of the Chinese banking sector, with positive effects on economic growth.

Following Berger's et al (2007) study, Ariff and Can (2008) also investigated both profit and cost efficiency over similar time period but using non parametric approach. Consistent with Berger's (2007) finding, their cost efficiency (0.798) is well above the profit efficiency (0.505). Their findings are also consistent with prior evidence from Berger et al (2007) on ownership and efficiency: the joint-stock banks on average appear to be more cost and profit efficient than the state-owned banks.

The latest work carried out by Shen et al (2009) which compare cost efficiency of ten major Asian banking industries from 1998 to 2005 by using the SFA. Based on their findings, overall cost efficiency level of Chinese banks is around 0.586 and ranks in the fifth place, suggesting that Chinese banks need further development of the banking system if they are to compete

strongly against foreign banks.

To sum up, there is not only little research evidence on the Chinese banking sector's efficiency, but also the few existing studies have limited and mixed results on the relative efficiency among different groups based on ownership and size as well as on the effects of regulatory reforms. Even their results are inconsistent; they provide preliminary and valuable information on banks efficiency in China. Although previous studies have not achieved agreement on the level of efficiency, most of findings support that huge wastes exist in operation of Chinese banks and they are largely inefficient compared to western banks and still very low efficiency among developing countries. Table 5.1 summarizes the empirical literature we reviewed on Chinese banking efficiency.

Table 5.1: Reviewed studies on Chinese banking efficiency

Authors	No. of banks	Period	Inputs	Outputs	Methods	Results	Size/ownership	Regulation
Chen et al (2005)	43	1993-00	deposits, fixed asset	loans, deposits, non-interest income	DEA	TE:70%~80% AE:50%~60%	Large and small banks more efficient than medium banks	Positive effect
Kumbhakar and Wang (2005)	14	1993~02	labour, fixed asset, deposits	loans, other earning assets	SFA	TE:78.94%	Larger banks are less efficient than medium banks	No effect
Matthews et al (2006)	15	1997~04	labour, fixed asset, deposits	loans, other earning assets, other operating income	DEA	X-eff: 92.9% Rent seeking:91.4%	Joint banks are more efficient than state-owned banks	Positive effect

Fu and Heffernan (2007)	14	1985~02	labour, fixed asset, deposits	loans, deposits, non-interest income, investments	SFA	X-eff:41%~52%	Joint-stock banks are more X-efficient than state-owned banks	Negative effect
Ariff and Can (2008)	28	1995-04	labour, fixed asset, deposits	loans, investment	DEA	Profit eff:50.5% Cost eff: 79.8%	Joint stock banks are more efficient than state-owned banks	na
Berger et al (2009)	38	1994~03	fixed asset, deposits	loans, deposits, liquid asset, other earning assets	SFA	Profit eff:47.6% Cost eff: 89.7%	State-owned banks are the least efficient	Positive effect
Shen et al (2009)	48	1998-2005	Fund, labour, fixed assets	Loans, other earning assets, non-interest income	SFA	Cost eff: 58.6%	Joint stock banks are more efficient than state-owned banks.	na

5.4 Methodology

5.4.1 Discussion of the SFA and functional form

As discussed in Section 5.3.1, there is no single best estimation method; each of those approaches has its individual strengths and weaknesses. Despite there is no consensus on the “best” frontier method, we favour the stochastic frontier approach because of its virtue of allowing random noises that are outside control of firms and comprising measurement error, specification error and sampling error.

The Stochastic Frontier Approach (SFA) was originally developed by Aigner et al. (1977). After the stochastic frontier approach was first proposed, it has been widely used in the efficiency literature. The main advantage of this approach is the allowance for inefficiency, and also take into account the fact that random shocks outside the control of producers. By forming a composed error term, they separate the error term from the inefficiency by using different distribution assumption. Therefore, inefficiency would not be contaminated by the random noise that should not be considered as inefficiency. Although the stochastic frontier approach is criticized for imposing a strict functional form that presuppose the shape of an unknown frontier, I think the risk of misspecifying the true frontier is less than the risk of completely ignoring it. Moreover, the risk of misspecification could be controllable by running statistical and econometric test on the model, the use of explanatory variables and test on theoretical properties of the presumed functional form. Therefore, the SFA is employed in this empirical study.

However, the main difficulty in implementing the parametric methods is to specify a certain functional form. The existing efficiency literature has witnessed the utilization of more flexible functional forms developed from the previously prevailing Cobb-Douglas functional form to widely employed translog function and more recently developed the Fourier flexible function.

Translog functional form is one of the most widely used functional forms in the empirical

literature on bank efficiency. In line with most of the bank efficiency literature, we adopt a translog functional form rather than a more flexible form such as the Fourier-Flexible (FF) specification. There are three reasons motivated our choice.

Firstly, for consistency, as most of the efficiency studies in banking employ translog cost function, following the same functional form enable us making comparison, even the result is not truly comparable. Secondly, the FF specification requires more degrees of freedom, but the number of observations available in our study is limited. Thirdly, Berger and Mester (1997) argue that the improvement obtained through the use of the FF specification is insignificant from an econometric viewpoint. The average improvement in goodness of fit is relatively small, indicating both functional forms yield basically the same measure of efficiency. Moreover, Wheelock and Wilson (1995) point out that although the FF specification increases the flexibility, it raises several problems, such as how many terms should be included is appropriate for estimation. Besides, Altunbas and Chakravarty (2001) indicate the predictive ability of the FF form is worse than the translog form. Finally, the FF form has no simple economic interpretation for the estimated coefficients. As a result, the translog cost function is preferred due to the data limitation and the fact that difficult coefficient interpretation and little improvement in empirical use of the FF specification.

5.4.2 The Stochastic Frontier Approach

To explain the SFA, the typical theoretical cost frontier model for panel data can be written as:

$$\ln TC_{it} = \alpha_0 + \sum_{m=1}^M \beta_m \ln y_{mit} + \sum_{j=1}^J \gamma_j \ln w_{jit} + v_{it} + u_{it} \quad [5.6]$$

where $\ln TC_{it}$ stands for total costs for firm i ($i=1 \dots N$) at time t ($t=1 \dots T$), $\ln y_{mit}$ and $\ln w_{jit}$ represents the m th ($m=1 \dots M$) output and the input price for the j th ($j=1 \dots J$) input for firm i at time t , respectively. $u_{it} \geq 0$ represents cost inefficiency while $v_{it} \sim \text{iid}(0, \sigma_v^2)$ stands for the random errors that are beyond the control of firms.

If cost efficiency is time-invariant, the fixed-effects (FE) and random-effects (RE) model can be adopted and Equation (5.6) will be modified as

$$\ln TC_{it} = \alpha_0 + \sum_m \beta_m \ln y_{mit} + \sum_j \gamma_j \ln w_{jit} + v_{it} + u_i \quad [5.7]$$

Under FE estimation, u_i is treated as fixed, it becomes the bank specific intercept to be estimated with β_m and γ_j . The Equation (5.7) then can be modified as

$$\ln TC_{it} = \alpha_{0i} + \sum_m \beta_m \ln y_{mit} + \sum_j \gamma_j \ln w_{jit} + v_{it} \quad [5.8]$$

where $\alpha_{0i} = \alpha_0 + u_i$.

However, the FE model suffers a drawback that the estimates are not efficient. The problem could be solved with random effect (RE) model, although it requires strong assumption that u_i is uncorrelated with the regressors. The RE model can be written as

$$\begin{aligned} \ln TC_{it} &= [\alpha_0 + E(u_i)] + \sum_m \beta_m \ln y_{mit} + \sum_j \gamma_j \ln w_{jit} + v_{it} + [u_i - E(u_i)] \\ &= \alpha_0^* + \sum_m \beta_m \ln y_{mit} + \sum_j \gamma_j \ln w_{jit} + v_{it} + u_i^* \end{aligned} \quad [5.9]$$

where $E(u_i)$ is the mean of cost inefficiency

So far, no distributional assumption is made on inefficiency term u , and the FE model is estimated by the least square dummy variable (LSDV) method and the RE model is estimated by the feasible generalised least square (FGLS). If such distributional assumption is tenable, the maximum likelihood estimation (MLE) can be used to estimate the efficiency. Pitt and Lee (P&L) (1981) made the following normal and half-normal distributional assumption on the error components in panel data stochastic frontier model. The distributional assumptions are:

- (i) $v_{it} \sim \text{iid } N(0, \sigma_v^2)$
- (ii) $u_i \sim \text{iid } N^+(0, \sigma_u^2)$
- (iii) u_i and v_{it} are distributed independently of each other, and of the regressors

However, it is inappropriate and unrealistic to assume cost inefficiency to be time-invariant in a long time period, especially in this rapidly changing financial market. The longer is the time period the more desirable it is to relax this time-invariant assumption. Therefore, this desire leads to the development of time-varying panel data models in which efficiency is allowed to change over time. In the literature, a number of studies have adopted Battese and Coelli (1992) model, which try to relax the assumption of time-invariant inefficiency by introducing the additional term $u_{it} = \exp(-\eta(t-T))u_i$ into the model. The inefficiency is said to decrease if $\eta > 0$ and increase if $\eta < 0$, or remain the same if $\eta = 0$ which returns to the time-invariant model.

Although the Battese and Coelli (1992) model resolve the time invariant problem, it creates another problem that the specific structure $u_{it} = \exp(-\eta(t-T))u_i$ artificially imposed by the model make inefficiency always increase or decrease. Later, Battese and Coelli (1995) modified previous model by not only relaxing the specific structure of time effect imposed on inefficiency, but also incorporating more variables that can affect inefficiency. Battese and Coelli (1995) model specifies that inefficiency is a function of any variables z may influence it $u_{it} = h(z_{it})$.

Moreover, Battese and Coelli (1995) model is also known as one-stage estimation. Because this model enables us to evaluate the level of inefficiency and access factors which affect inefficiency at the same time. The one stage estimation is preferred over the two stage estimation. In the two stage estimation, we compute inefficiency as usual first, and then run a separate regression for those factors may influence inefficiency obtained from the first stage. The two stage estimation method receives critics because it suffers the drawback that it assumes variables not included in the first stage are uncorrelated with composite error term. But in the second stage, we regress some of the variables on one of the composite error term- inefficiency and assume they may correlate with it. So there is obvious built-in conflict within the two stage estimation.

Furthermore, as Battese and Coelli (1995) only considered the factors that may affect the mean of inefficiency, other researchers proposed that those factors may also affect the variance of inefficiency. Consequently, Battese and Coelli (1995) model has been further improved by specifying the same function of a set of variables on both mean and variance, which is known as conditional mean conditional variance (CMCV) model. $E(u_{it}) = h(z_{it})$ and $Var(u_{it}) = h(z_{it})$

5.4.3 Empirical model specification

In this study, the translog cost functional form with equity as a fixed input and permitting weak disposability of the production technology is adopted and can be written as

$$\begin{aligned}
\ln(TC_{it}) = & \alpha + \sum_{m=1}^3 \beta_m \ln y_{mit} + \frac{1}{2} \sum_{m=1}^3 \sum_{n=1}^3 \beta_{mn} \ln y_{mit} \ln y_{nit} \\
& + \sum_{j=1}^3 \gamma_j (\ln w_{jit}) + \frac{1}{2} \sum_{j=1}^3 \sum_{k=1}^3 \gamma_{jk} \ln w_{jit} \ln w_{kit} + \sum_{m=1}^3 \sum_{j=1}^3 \delta_{mj} \ln y_{mit} \ln w_{jit} \\
& + \theta_1 t + \theta_2 t^2 + \sum_{m=1}^3 \varepsilon_m \ln y_{mit} t + \sum_{j=1}^3 \rho_j \ln w_{jit} t + \phi_1 \ln z_0 + \phi_2 \ln z_0^2 \\
& + \sum_{m=1}^3 \lambda_m \ln y_{mit} \ln z_0 + \sum_{j=1}^3 \xi_j \ln w_{jit} \ln z_0 + \omega \ln z_0 t + v_{it} + u_{it}
\end{aligned} \tag{5.10}$$

where total costs of bank $\ln TC_{it}$ ($i=1, \dots, N$) observed for t times, are given as a function of three outputs $\ln y_{mit}$ ($m=1, \dots, 3$), three input prices $\ln w_{jit}$ ($j=1, \dots, 3$), time t and control variable $\ln z_0$.

All variables in the above equation are expressed in natural logs. Following the intermediation approach (see next section), we use three basic inputs, which are funds, labor and capital, and three outputs, measured as loans, other earning assets and non-interest income. The outputs and inputs are defined and discussed in detail in Section 5.5 later. A time trend included in the analysis intend to capture technological change in the period examined. Equity capital is included to account for risk since equity capital may influence the probability of banks' failure. Also, a bank's capital level will directly affect costs by providing an alternative funding source. The reason for only considering equity capital as control variable is that we are particularly interested in the recapitalization effect on the shadow return on equity as recapitalization is one the most important reform carried out in the recent banking reform. Other factors affect bank efficiency will be included in the additional functions that affect mean and/or variance of inefficiency in B&C 95 model and CMCV model. All the variables will be defined and discussed later in Section 5.5. The standard assumption: half-normal and normal distributions on the inefficiency and random error are imposed, since these are the most common

assumptions in the efficiency literature.

To ensure cost efficiency estimates are truly estimated from the cost function, following properties of cost function suggested by McFadden (1978) and Kumbhakar and Lovell (2000) should be satisfied:

(i) non-decreasing in y , as $\frac{\partial \ln TC_{it}}{\partial \ln y_{mit}} \geq 0$

(ii) non-decreasing in w , as $\frac{\partial \ln TC_{it}}{\partial \ln w_{jit}} \geq 0$

(iii) homogenous of degree one in w

(iv) concave in w

By imposing property (iii), the cost function for estimation can be modified as:

$$\begin{aligned} \ln(TC_{it} / w_1) = & \alpha + \sum_{m=1}^3 \beta_m \ln y_{mit} + \frac{1}{2} \sum_{m=1}^3 \sum_{n=1}^3 \beta_{mn} \ln y_{mit} \ln y_{nit} \\ & + \sum_{j=2}^3 \gamma_j (\ln w_{jit} / w_1) + \frac{1}{2} \sum_{j=2}^3 \sum_{k=2}^3 \gamma_{jk} \ln(w_{jit} / w_1) \ln(w_{kit} / w_1) + \sum_{m=1}^3 \sum_{j=2}^3 \delta_{mj} \ln y_{mit} \ln(w_{jit} / w_1) \\ & + \theta_1 t + \theta_2 t^2 + \sum_{m=1}^3 \varepsilon_m \ln y_{mit} t + \sum_{j=2}^3 \rho_j \ln(w_{jit} / w_1) t + \phi_1 \ln z_0 + \phi_2 \ln z_0^2 \\ & + \sum_{m=1}^3 \lambda_m \ln y_{mit} \ln z_0 + \sum_{j=2}^3 \xi_j \ln(w_{jit} / w_1) \ln z_0 + \omega \ln z_0 t + v_{it} + u_{it} \end{aligned} \quad [5.11]$$

To ensure the symmetry condition (i.e. the property of the continuity of the cost function), following restrictions $\beta_{mn} = \beta_{nm}$ and $\gamma_{jk} = \gamma_{kj}$ are imposed. Monotonicity properties (i) and (ii)

are checked by calculating the elasticities of output $ey_m = \frac{\partial \ln TC_{it}}{\partial \ln y_{mit}}$ and elasticities of input

price $ew_j = \frac{\partial \ln TC_{it}}{\partial \ln w_{jit}}$. Concavity condition (iv) of cost function in input prices w is satisfied

when the Hessian matrix of cost function with respect to input prices w is negative semi-definite. It is derived as $H(w) = \Gamma - \hat{s} + ss^T$, where Γ is the matrix of second order coefficients of input prices in the cost function. s is the column matrix of share equations

$s_j = \partial \ln TC_{it} / \partial \ln w_{jit} = ew_j$ (the Shephard's lemma) and $s^T = [s_1, \dots, s_j]^T$. \hat{s} is the diagonal matrix with the share s_j on the main diagonal.

As explained in section 5.4.2, Equation 5.11 will be estimated under six models for methodological cross check, comparison and consistency. This is because that efficiency results are sensitive to the composed error specification used; this is particularly true for panel data stochastic frontier studies. Therefore by comparing six composed error specifications, the consistency of the regression results can be compared across different specifications and the arbitrary choice of one possibly distorted specification can be avoided.

Table 5.2: Summary of estimated models

Model	Estimation method	Data type	Time dimension	Error component distribution
FE	LSDV	Panel	Invariant	$v_{it} \sim \text{iid}(0, \sigma_v^2)$ u_i random distributed intercept
RE	FGLS	Panel	Invariant	$v_{it} \sim \text{iid}(0, \sigma_v^2)$ $u_i \sim \text{iid}(\mu, \sigma_u^2)$
P&L	MLE	Panel	Invariant	$v_{it} \sim \text{iid N}(0, \sigma_v^2)$ $u_i \sim \text{iid N}^+(0, \sigma_u^2)$
B&C 92	MLE	Panel	Variant	$v_{it} \sim \text{iid N}(0, \sigma_v^2)$ $u_{it} \sim \text{iid N}^+(\mu_{it}, \sigma_u^2)$ $\mu_{it} = u_i \exp(-\eta(t-T))$
B&C 95	MLE	Pooled	Variant	$v_{it} \sim \text{iid N}(0, \sigma_v^2)$ $u_{it} \sim \text{iid N}^+(\mu_{it}, \sigma_u^2)$ $\mu_{it} = \delta_0 + z_{it}' \delta_1$
C MCV	MLE	Pooled	Variant	$v_{it} \sim \text{iid N}(0, \sigma_v^2)$ $u_{it} \sim \text{iid N}^+(\mu_{it}, \sigma_u^2)$ $\mu_{it} = \delta_0 + z_{it}' \delta_1$ $\delta_u^2 = \delta_0 + z_{it}' \delta_1$

More specifically, when we estimate the B&C 95 model and CMCV model, the inefficiency

term u , is assumed to be half-normally distributed with its mean (and variance) dependent on exogenous variables (\mathbf{z}) including size, ownership dummy and equity capital ratio²². In the case of size, we use total assets as a measure for bank size. For ownership dummy, we classify our full sample of banks into two categories, namely state-owned banks and non state-owned banks. The equity capital ratio is calculated by the ratio of total equity to total assets.

The Battese and Coelli (1995) model on inefficiency distribution:

$$u_{it} \sim iid N^+(\mu_{it}, \sigma_u^2) \text{ with } u_{it} \geq 0 \text{ and} \quad [5.12]$$

$$\mu_{it} = \alpha + \delta_1 \text{Total assets} + \delta_2 \text{Ownership dummy} + \delta_3 \text{Equity ratio}$$

The conditional mean conditional variance model on inefficiency distribution:

$$u_{it} \sim iid N^+(\mu_{it}, \sigma_u^2) \text{ with } u_{it} \geq 0 \text{ and}$$

$$\mu_{it} = \alpha + \delta_1 \text{Total assets} + \delta_2 \text{Ownership dummy} + \delta_3 \text{Equity ratio} \quad [5.13]$$

$$\sigma_u^2 = \alpha + \delta_1 \text{Total assets} + \delta_2 \text{Ownership dummy} + \delta_3 \text{Equity ratio}$$

5.4.4 Methodology development on SROE

We develop a model of banking system activity that takes account of the equity capital requirements that must be met by banks and especially how increased capital requirements may impose additional costs on the efficient allocation of resources. The starting point is the definition of the production technology in terms of the input requirement set for a sample of multi-product firms producing R outputs from K inputs:

$$I(\mathbf{y}, t) = \{ \mathbf{x} : \mathbf{x} \text{ can make } \mathbf{y} \text{ at time } t, \mathbf{x} \in R_+^K, \mathbf{y} \in R_+^R \} \quad [5.14]$$

We assume that this production technology has the properties of convexity, and weak

²²

Several other factors have been included in trial estimation, such as equity, loan loss provision, loan loss provision ratio, because of insignificance and lower likelihood ratio, we exclude them from presentation.

disposability. It is the weak disposability assumption that is critical to our analysis. Formally this is represented as:

$$\mathbf{x}^0 \in I(\mathbf{y}, t) \Rightarrow \lambda \mathbf{x}^0 \in I(\mathbf{y}, t) \text{ for some but not all } \lambda \geq 1 \quad [5.15]$$

If the efficient boundary of the input requirement set is represented by a transformation function: $F(\mathbf{x}, \mathbf{y}, t) = 0$ then weak disposability implies that the first derivatives, $F_k \equiv \partial F / \partial x_k$, $F_r \equiv \partial F / \partial y_r$ are not restricted in sign. This will permit the model to accommodate both positive and negative shadow prices in the dual cost function. The parametric frontier dual cost function that we will use is based on K variable inputs: $\mathbf{x} = (x_1, \dots, x_K)$ with input prices: $\mathbf{w} = (w_1, \dots, w_K)$ and R outputs: $\mathbf{y} = (y_1, \dots, y_R)$, and an additional input which may be a fixed input in the short run but is variable in the long run; for clarity, we symbolise this particular input as z_0 , with input price: w_0 . The interpretation of this fixed input will be critical in the analysis of a banking industry sample since it captures the importance of the level of equity capital. Following the arguments in Hughes, Mester and Moon (2001), we write the long run cost function, with all inputs including z_0 treated as variable, in the form:

$$c(\mathbf{y}, \mathbf{w}, w_0, t) = \min_{\mathbf{x}, z_0} \{ \mathbf{w}'\mathbf{x} + w_0 z_0 : (\mathbf{x}, z_0, \mathbf{y} \in I) \} \quad [5.16]$$

The short run cost function on the other hand, with input z_0 treated as fixed, is:

$$c(\mathbf{y}, \mathbf{w}, z_0, t) + w_0 z_0 = \min_{\mathbf{x}} \{ \mathbf{w}'\mathbf{x} + w_0 z_0 : (\mathbf{x}, z_0, \mathbf{y} \in I) \} \quad [5.17]$$

The envelope theorem confirms that long run total cost defines the envelope of short run total cost:

$$c(\mathbf{y}, \mathbf{w}, w_0, t) = \min_{z_0} \{ c(\mathbf{y}, \mathbf{w}, z_0, t) + w_0 z_0 \} \quad [5.18]$$

Therefore the envelope theorem implies that for any slight deviation of the level of the fixed

input above or below the optimal level, $z^*_0 = z^*(\mathbf{y}, \mathbf{w}, w_0, t)$, there will be no reduction in total cost and the long run total cost function is tangential to the short run total cost function:

$$c(\mathbf{y}, \mathbf{w}, w_0, t) = c(\mathbf{y}, \mathbf{w}, z^*_0, t) + w_0 z^*_0 \quad [5.19]$$

Consequently, the following derivative result holds in the neighbourhood of the optimal level of the fixed input:

$$\partial c(\mathbf{y}, \mathbf{w}, w_0, t) / \partial z_0 = 0 = [\partial c(\mathbf{y}, \mathbf{w}, z^*_0, t) / \partial z_0] + w_0 \quad [5.20]$$

Rearranging this last result gives the critical interpretation of the shadow price of the fixed input:

$$-[\partial c(\mathbf{y}, \mathbf{w}, z^*_0, t) / \partial z_0] = w_0 \quad [5.21]$$

This form of the envelope theorem is particularly useful when, in addition to an input being fixed, there is no explicit information on its price. The negative of the derivative of the variable cost function with respect to this fixed input is the input's shadow price. So far we have assumed that the short run constraint on the firm is to maintain a level of the fixed input; however the constraint may take the form of a pre-determined ratio of the input to one (or more) outputs: e.g. $z_0 \geq y_m [\min(z^*_0 / y_m)]$. The derivation of the cost function is unchanged irrespective of whether the constraint is written in terms of the level of the fixed input or in terms of the ratio to an output form, but in an econometric estimation there may be a different specification depending on whether, in moving to the long run equilibrium, the firms adjust the level of the fixed input or its ratio to one or more outputs.

There are two implications that are particularly important in the analysis of banking systems, and these concern the measurement of the shadow price away from equilibrium and the measurement of returns to scale. The fixed input in our model of the banking system technology is the level of equity capital, held for both prudential and regulatory reasons. The analysis above confirms that close to equilibrium the negative of the derivative of short run total cost with respect to the level of equity capital is a measure of the shadow price of equity; when the cost function is expressed in log form we interpret the negative of the log derivative as the shadow

return on equity. Consequently, by including equity capital as a fixed input in the cost function we are able to examine several possible outcomes. Banks which are over-leveraged or reliant on debt and under-use equity capital can be expected to show a relatively high shadow return on equity (negative elasticity with a relatively high absolute value), while banks which are less leveraged are likely to show cost elasticity with respect to equity that is lower in absolute value. Banks which are far from long run cost minimising equilibrium, for example because they are undergoing major re-capitalization with current equity capital levels well above the long run equilibrium, i.e. $z_0 > z^*(\mathbf{y}, \mathbf{w}, w_0, t)$ may be expected to show a very low possibly severely negative shadow return on equity in the recovery phase from financial crisis. Negative values of the shadow input price or return on the fixed input would arise if, for example, the firm was operating in the uneconomic region of the production function²³.

5.5 Variables selection and data collection

No matter what kind of frontier analysis technique is used and no matter what kind of models or functions is adopted, obtaining accurate and reliable efficiency estimates heavily relies on the quality of data and variables used in the regression. In the following, we will discuss our variables selection and data collection.

5.5.1 Issues on input and output variables

‘Reliable’ efficiency estimation requires appropriate definitions regarding the measurement of input, output and input price variables. Therefore, to estimate efficiency, we should first determine what constitutes banks inputs and outputs. No general consensus exists concerning the precise definition of what banks produce or how one can measure banks’ products.

In literature on the theory of banking, there are two main competing approaches to measure the

²³

The translog specification used in this paper was developed in order to allow operation in the uneconomic region of the technology, see Kumbhakar and Lovell (2000).

outputs provided by banks. One is the production approach and another is the intermediation approach. Other approaches such as dual approach and value-added method have been discussed by Berger (1997) and Lozano-Vivas (1997).

Under the production approach, banks are treated as firms which employ capital and labor to produce services for both deposit and loan account holders. From this point, the output should be accounted as the amount of documents and transactions processed in a given period. Unfortunately, such transaction data is typically proprietary and inaccessible. Moreover, the production approach indicates only physical inputs are needed to perform transaction and process documents, so physical inputs such as labor and fixed assets should be included. And the total costs under this approach are expenses spent on labor and fixed assets, but interest expense is not included.

Under the intermediation approach, banks are regarded as financial intermediaries between borrowers and depositors rather than producers of loan and deposit account services. Funds are essential to conduct financial intermediation function. Under this treatment, the value of loans and investments is the appropriate measure of bank output, while deposits and costs involving in the production process such as capital, labour should be measured as inputs. Consequently, the operating costs and interest expense are measured as the total costs.

Until today, there is no agreement on the standard definition and measurement of banks' inputs and outputs. As argued in Berger and Humphrey (1997), neither production approach nor intermediation approach successfully covers the dual roles of banks as: (i) performing transactions and processing documents for customers; (ii) intermediating funds between depositors and borrowers. Nevertheless, each of the approaches has some advantages. Berger and Humphrey (1997) pointed out that, although there is no 'perfect approach', the intermediation approach may be superior for evaluating the efficiency at the bank level as it reflects the nature of the bank, and what the bank really does, while the production approach is more appropriate for measuring at branch level as branches primarily perform transactions and process customer documents and branch managers typically have little influence over bank funding and investment decisions.

As we aim to evaluate efficiency for entire banks, following many previous studies on banking efficiency we adopt the intermediation approach in this study. In addition, our database lacks the necessary data for implementation of the production approach, as outputs are measured

under this approach by the number of deposit and loan transactions processed over a given time period.

Although the intermediation approach is adopted, different outputs and inputs are selected in banking literatures under the same approach. There is no disagreement on the loan been treated as output, but there is a longstanding controversy about whether deposits should be counted as output or input. As deposits have both input and output characteristics, classifying deposits as either input or output cannot fully captures the dual role of the deposits. Therefore, as argued by Berger and Humphrey (1997), the treatment of deposits in efficiency models can affect the efficiency estimates and thus deposits should be considered as both inputs and outputs, which is known as dual approach.

Even though the dual approach can take into account both input and output characteristics for deposits, we classify deposits as input rather than output in our analysis due to both empirical and statistical reasons. Empirically, the Chinese banks treat deposits as the base and derivation of loans, and pay more attention to the input characteristics of deposits than the output ones. Moreover, from statistical point of view, although the dual approach is well explained in theory and applied in empirical studies, including deposits for both inputs and outputs does not satisfy the monotonicity condition (Shen et al (2009)). Based on these facts, it is more appropriate to consider the deposits as input alone in our study.

5.5.2 Specification of outputs and inputs prices

After solving the deposits issue, we need to define the specific inputs and outputs elements. Within the intermediation approach, the exact set of inputs and outputs used in empirical studies depends largely on data availability and author's choices. In our study, the variables are selected based on previous studies for consistency and the availability of data. And all data have been deflated to year 1997 price.

There are three outputs included in the study, namely total loans, other earning assets and non-interest income. Bank loans are widely considered as the most important output for commercial banks which works as financial intermediaries that collect deposits from customers

and lend to investors. The total loans (y_1) include short term loans, trade bills, discounted bills, medium and long term loans, and other loans. Except profits generated from bank loans (interests), bank also conduct several investments which can further contribute to bank profits. Therefore, in addition to bank total loans, other earning assets (y_2) are included, such as short term and long term investment, deposits with central bank and other banks. To account for recent substantial growth in fee-based service and asset-backed securitisation, we also include non-interest income as proxy for off-balance sheet activities, although compared to banks in Western countries, Chinese banks are far less active in the off-balance sheet business. Non-interest income (y_3) comes from fee, commission and other operating income.

There are also three inputs included in our analysis, namely funds, labor, and capital. Funds (x_1) are defined by the total deposits, which includes short term and long term deposits from both individual and corporate customers, and other short term and long term funding. Labour (x_2) is specified as the registered full time employees in banks and physical capital (x_3) is often termed as fixed assets, which provide the essential materials for bank operation. Correspondingly, the input prices are defined as follows.

The price of fund (w_1) is calculated as the ratio of interest expenses to total deposits. The price of labor (w_2) is calculated as the ratio of personnel expenses to total number of employees. The price of fixed assets (w_3) is measured by the ratio of other operating expenses to the fixed assets.

The inputs and outputs variables are also defined in Table 5.3 below. Moreover, descriptive statistics for all variables used in this study are summarized in Table 5.4. As there is large deviation in our sample of banks, we group those descriptive statistics based on ownership difference, namely state-owned banks, joint equity banks and city commercial banks.

Besides those three inputs and outputs, one additional variable is included to control for risk. In theory, comparison of bank's performance should be conducted among banks with the same quality and riskiness. However, each bank is different in quality, and thus has different risk characteristics. These differences may not be captured by the input and output included in the model. Therefore, as suggested in Mester (1996) that '*unless quality and risk are controlled for, one might easily miscalculate a bank's level of inefficiency.*' Hughes and Mester (1993) also argued that the quality of a bank's asset and the probability of a banks' failure could influence a

bank's cost in a variety of ways. Two variables are usually used for measuring risk among banks, one is non-performing loans, and another is equity capital.

Table 5.3: Definitions of outputs, inputs, input prices and other variables

Outputs	
y1	Total loans: include short term loans, trade bills and bills discounted, medium and long term loans, other loans
y2	Other earning assets: short term and long term investment (securities & bond), deposits with central bank and other banks
y3	Non-interest income: fee, commission and other operating income
Inputs	
x1	Funds (total deposits)
x2	Labour (personnel expense)
x3	Capital (fixed assets)
Input prices	
w1	Price of fund: interest expense/total deposits
w2	Price of labour: personnel expense/total number of employees
w3	Price of capital: other operating expenses/fixed assets
Total costs	Sum of interest expenses, personnel expenses and other operating expenses
Z0	Equity capital (fixed input)

In empirical studies, the volume of non-performing loans (Hughes and Mester (1993) and Mester (1996)), nonperforming ratio (the ratio of nonperforming loans to total loans) (Altunbaş *et al.* (2000) and Huang (2000)) and loan loss provision (Hasan and Marton (2003)) are used to control for asset quality. However, Berger and DeYoung (1997) suggest that whether it is appropriate to include nonperforming loans and loan loss provisions in estimating the bank's cost function depends on the extent to which these variables are exogenous.

Non-performing loans and loan loss provisions would be exogenous if caused by negative economic shocks or unpredicted events ("bad luck"), but they could also be endogenous, because of the poor management in managing and monitoring the loan portfolio and controlling for the operating expenses ("bad management"). As argued by Berger and DeYoung (1997),

'under the bad luck hypothesis, loan quality is driven by external events, and as such efficiency measurement should control for nonperforming loans in cost and profit functions. Under the bad management hypothesis, however, loan quality is driven by internal events. As a result, controlling for nonperforming loans in cost and profit functions will artificially increase measured efficiency'. Therefore, this study will not employ nonperforming loans in the cost function for the reason that nonperforming loans in the Chinese banking system are generally considered endogenously due to poor risk management in assessing, screening and monitoring loans.

Another control variable usually employed in efficiency measurement is equity capital. There are two reasons why equity capital should be taken into account. First of all, it may influence the probability of banks' failure, known as insolvency risk. Equity capital acts as cushion, which can fully absorb the losses of nonperforming loans. Apart from concerns of risk, a bank's capital level will directly affect interest costs by providing an alternative funding source of loans as a substitute for deposits or other funding sources. Moreover, we are particularly interested in the recapitalization which enhances the equity level in Chinese domestic banks. As a result, the level of equity capital is included in our model.

5.5.3 Data collection and sample

As discussed before, there are various types of deposit taking institutions in China. In this study, we only focus on three major types of domestic commercial banks, namely state-owned commercial banks, joint equity commercial banks and city commercial banks. Policy banks are excluded as they are responsible for government policy implementation such as loan issue to state-owned enterprises and subsidise certain industries. They hardly take deposit, and do not compete in the retail market. Foreign banks are also excluded, as they do not operate under the same market condition as domestic commercial banks. They are still subject to several regulatory controls during our examination period, even though the restrictions are reduced largely after the WTO. Moreover, we do not consider both rural and urban cooperatives, as they are too small, the information is not fully available and information credibility may be suspicious due to looser publication requirements.

The time span considered in this empirical study is from 1997 to 2006. The selected time period covers the latest round banking reform. This stage of banking reform is induced by the Asian financial crisis in 1997 and intensified due to fulfill the WTO entry requirements in 2001. The reform continues to be strengthened by the going-public of the state-owned banks in 2005 and full openness of financial market in 2006.

There are 371 observations in total with maximum 55 banks in 2006 and minimum 17 banks in 1997. Although the sample data does not include all the Chinese commercial banks, our sample of banks show good representation of the whole banking market in China, as banks in the sample cover 95.2% assets, 93.7% deposits and 94.3% loans of the aggregate banking sector in China. Moreover, the number of banks included in this study exceeds sample size adopted in other empirical studies which focus on Chinese banks. The fact that our sample covers the majority of the banking market suggests that our empirical findings will present a major image of how efficiently the Chinese banking system has been operated.

Annual data is mainly collected from Bankscope database which provides detailed financial information for banks all over the world. Whenever Bankscope does not provide enough information or has missing/questionable values, we carefully collect or double-check the data from other alternative data sources as best as we can, such as annual issues of Almanac of China's Finance and Banking, 1997-2006; and China Statistical Yearbook, 1997-2006. We also use annual reports provided by individual banks via their official websites as complementary sources in tracing missing or unavailable data points. All financial variables are measured in the Chinese domestic currency Renminbi (RMB), and denoted in millions. Since all original data are collected on the nominal value, all the monetary values are deflated by using GDP deflators which are collected from the World Bank with the year 1997 as reference.

All of the data in the fitted regressions are log-mean-corrected; i.e. expressed as deviations from the sample means after having been transformed to natural logarithms. This has three advantages: it ensures that the translog function which is an approximation to an arbitrary second order function has the point of approximation at the sample mean; it allows us to check the properties of the fitted translog function at the sample mean by examining the first order estimated coefficients; and it enables computation of the variance of linear functions of the estimated coefficients around the sample mean from the variance-covariance matrix of the regression coefficients.

Table 5.4: Summary of descriptive statistics for all variables

Variables	Obs	Mean	Std. Dev.	Min	Max
<i>State-owned banks</i>					
Total assets	40	3413023.00	1026720.00	1573947.00	6216693.00
Total costs	40	131903.60	105155.40	81314.65	758195.00
Total loans	40	1912308.00	533463.80	1014225.00	2925586.00
Other earning assets	40	1353113.00	579835.70	476685.00	3137090.00
Non-interest income	40	10730.21	7621.36	2048.77	36185.93
Total deposits	40	3061104.00	980742.00	1430983.00	5541498.00
Interest expense	40	84282.09	107718.60	37165.60	728672.00
Personnel expense	40	15640.16	6618.27	5238.90	29097.92
Other operating expense	40	25622.27	10450.20	9519.31	53326.46
Fixed assets	40	60049.80	13850.45	29049.00	95928.40
<i>Joint equity banks</i>					
Total assets	110	296909.90	252209.20	18380.00	1423465.00
Total costs	110	9221.48	7359.27	672.00	40248.16
Total loans	110	168407.90	143664.20	5106.00	753593.10
Other earning assets	110	117540.10	103723.20	12226.00	631659.80
Non-interest income	110	1133.68	1533.79	27.00	12039.00
Total deposits	110	256743.00	224394.10	15939.00	1274425.00
Interest expense	110	4933.71	3749.72	485.00	20480.88
Personnel expense	110	1222.40	1148.42	64.75	6118.60
Other operating expense	110	2256.89	1962.52	122.25	9789.60
Fixed assets	110	3924.40	3951.52	356.00	21759.08
<i>City commercial banks</i>					
Total assets	221	38357.66	43068.58	2516.00	225976.00
Total costs	221	1253.71	1194.56	94.09	5781.67
Total loans	221	18685.06	20653.76	1175.00	103916.90
Other earning assets	221	17599.23	21808.75	1138.00	117330.50
Non-interest income	221	162.59	192.86	0.85	1071.08
Total deposits	221	32904.09	39567.69	2142.00	204418.10
Interest expense	221	703.84	715.22	42.04	3819.96
Personnel expense	221	188.26	163.10	20.82	985.14
Other operating expense	221	352.63	288.17	26.56	1635.82
Fixed assets	221	536.69	447.93	71.07	2318.47

*All variables are measured in the Chinese domestic currency RMB, and denoted in millions, at constant prices.

5.6 Empirical results

This section presents the main results of the analysis undertaken. The results are analysed in detail in the following subsections, the first of which presents results concerning regression estimation, such as estimated coefficients, elasticities and scale economies. The next subsection discusses efficiency scores for whole sample and sub-samples based on ownership difference. The third subsection explains the robustness tests.

5.6.1 Estimation results

5.6.1.1 Estimated coefficients

Table 5.5 and 5.6 below presents the parameter estimates for panel data models and pooled data models respectively. On the whole, the statistics such as R-square, F-statistic and Likelihood ratio show goodness of fit for our regressions. And the signs of the major estimated parameters are consistent with our expectation and generally in line with other studies and the theory.

The estimated parameters for all three outputs are positive at the sample mean. The coefficient estimates of the total loan (Y1) and other earning assets (Y2) are highly significant at 1% level. While the coefficient estimate of non-interest income (Y3) is statistically insignificant. This can be explained by the fact that the traditional business still dominates in the Chinese banking sector, which accounts for about 55% of the total banking costs. However, the amount of fee-based activities is quite trivial; even though there is substantial growth in recent years. The sum of the parameters on the three outputs is less than one, indicating increasing returns to scale at the sample mean. Moreover, the parameters on the interaction term for Y1Y2 and Y2Y3 are negative indicate that there might be some scope economies in the joint production of loans with other earning assets, and other earning assets with off-balance sheet activities, despite they are statistically insignificant.

Table 5.5: Estimated parameter coefficients for panel data models

Parameters	Time invariant				Time varying			
	GLS		RE		MLE		B&C 92	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
Y1	0.515***	16.760	0.590***	19.230	0.593***	20.140	0.589***	24.130
Y2	0.124***	4.490	0.207***	7.630	0.208***	8.060	0.202***	8.340
Y3	0.010	0.880	0.021	1.770	0.018	1.580	0.020	1.940
W2	0.281***	12.460	0.260***	11.660	0.251***	11.000	0.223***	10.770
W3	0.106***	5.310	0.101***	4.880	0.105***	5.200	0.116***	6.830
Y11	0.002	0.040	-0.009	-0.210	-0.011	-0.260	-0.022	-0.580
Y22	0.092**	2.200	0.095**	2.120	0.092**	2.150	0.064**	2.020
Y33	0.012*	1.840	0.013*	1.890	0.012*	1.820	0.010*	1.840
Y1Y2	-0.061	-0.870	-0.054	-0.710	-0.044	-0.600	-0.002	-0.040
Y1Y3	0.029	1.250	0.059***	2.450	0.059***	2.540	0.061***	2.920
Y2Y3	-0.026	-1.070	-0.029	-1.160	-0.028	-1.140	-0.030	-1.310
W22	-0.003	-0.190	-0.026*	-1.740	-0.026*	-1.840	-0.022*	-1.740
W33	0.022	1.040	0.005	0.230	0.007	0.310	0.013	0.660
W2W3	0.035	1.250	0.062***	2.110	0.059***	2.080	0.018	0.720
Y1W2	0.025	0.780	-0.014	-0.420	-0.024	-0.760	-0.043	-1.540
Y1W3	0.068**	1.970	0.079**	1.980	0.084***	2.070	0.090***	2.440
Y2W2	-0.054*	-1.820	-0.030	-0.950	-0.027	-0.880	-0.031	-1.090
Y2W3	0.001	0.030	0.000	-0.010	-0.001	-0.030	-0.007	-0.170
Y3W2	-0.001	-0.110	0.003	0.220	0.005	0.410	0.012	1.060
Y3W3	-0.010	-0.620	-0.016	-0.910	-0.018	-1.090	-0.016	-1.110
T	-0.011	-1.480	-0.029***	-5.380	-0.028***	-5.070	-0.049***	-5.130
TSQ	0.003***	2.040	0.005***	2.950	0.005***	3.020	0.004***	2.080
Y1T	-0.022***	-2.340	-0.031***	-3.150	-0.032***	-3.310	-0.031***	-3.540
Y2T	-0.012	-1.300	-0.008	-0.770	-0.008	-0.880	0.003	0.390
Y3T	0.002	0.710	0.003	0.920	0.003	0.900	-0.001	-0.240
W2T	-0.004	-0.770	-0.010***	-2.080	-0.010***	-2.200	-0.011***	-2.140
W3T	-0.009	-1.510	-0.005	-0.800	-0.005	-0.740	-0.003	-0.530

Z0	0.016	0.740	0.063***	2.940	0.063***	3.040	0.035**	1.980
Z00	0.004	1.210	0.011***	2.880	0.011***	3.100	0.009***	2.630
Y1Z0	0.106***	2.610	0.108***	2.500	0.110***	2.650	0.107***	2.780
Y2Z0	-0.115***	-2.570	-0.121***	-2.510	-0.125***	-2.700	-0.116***	-2.740
Y3Z0	-0.032	-1.610	-0.046***	-2.180	-0.045***	-2.220	-0.042***	-2.250
W2Z0	0.039	1.670	0.037	1.520	0.040	1.700	0.036	1.650
W3Z0	-0.066***	-2.150	-0.069***	-2.110	-0.069***	-2.200	-0.057***	-2.000
Z0T	0.024***	3.440	0.030***	4.180	0.031***	4.480	0.029***	4.630
constant	-0.089***	-2.270	-0.174***	-3.700	0.210***	2.770	0.109***	2.280
R square	0.967		0.989					
Sigma u	0.598		0.222		0.064		0.156	
Sigma v	0.096		0.096		0.010		0.008	
gamma	0.947		0.841		0.865		0.950	
eta							0.138***	7.610
LLR					236.778		263.324	

All variables are in log terms.

***, **, * indicates statistically significant at 1%, 5%, 10% significance level respectively.

The estimated parameters on price of labour (W2) and price of capital (W3) are both positive at the sample mean and highly significant at 1% level. Moreover, we observe that coefficient estimate of time trend (T) is negative and statistically significant, suggesting that Chinese banks experienced technical change over the sample period, which shift down the cost frontier. Furthermore, the significant positive parameter of equity (Z0) indicates that holding equity capital is costly for Chinese banks. The elasticity of cost with respect to equity can also be interpreted as negative of the shadow return on equity (see Hughes, Mester and Moon (2001)). The positive coefficient indicates that the shadow return on equity is negative at the sample mean. This negative shadow return on equity result (permitted using the assumption of weak disposability of the production technology) implies that at the sample mean the Chinese banks were showing relatively high level of capitalization. This was likely to be a response to the recent banking reform and to indicate the recapitalization carried out in preparation for the entry to WTO. The derivation of the property of negative shadow return under recapitalization is demonstrated in Fethi et al (2011). This will be discussed in more detail later.

The estimate for gamma indicates that about 90% of the total error's variance is accounted for by cost inefficiency rather than by the random error, providing compelling evidence that the estimation of the cost function as a frontier is appropriate. In addition, the estimate for eta is found to be statistically significant, which suggest that time varying models might be more suitable.

Except those results discussed above, the estimation results from B&C 95 and CMCV model presented in Table 5.6 provide additional information. Highly significant estimated coefficients on three environmental variables show that size, ownership and equity capital ratio affect both mean and variance of inefficiency term.

Table 5.6: Estimated parameter coefficients for pooled data models

Time varying				
	B&C 95		C MCV	
Parameters	Coefficients	t-ratio	Coefficients	t-ratio
Y1	0.466***	11.620	0.513***	9.970
Y2	0.130***	3.840	0.184***	3.400
Y3	0.004	0.310	0.014	0.700
W2	0.162***	7.950	0.162***	5.660
W3	0.135***	6.620	0.156***	4.700
Y11	0.010	0.200	-0.061	-0.840
Y22	0.060**	1.970	0.121***	2.660
Y33	0.003	0.330	0.001	0.110
Y1Y2	0.060	0.650	-0.074	-0.670
Y1Y3	-0.004	-0.130	-0.022	0.580
Y2Y3	0.015	0.530	0.027	0.810
W22	-0.036***	-2.480	-0.017	-0.920
W33	0.003	0.130	0.036	1.210
W2W3	0.039	1.210	0.008	0.200
Y1W2	-0.045	-1.090	0.008	0.150
Y1W3	-0.027	-0.500	0.056	0.740
Y2W2	0.060	1.610	0.081	1.600

Y2W3	-0.034	-0.660	-0.141**	-1.990
Y3W2	0.009	0.600	-0.012	-0.660
Y3W3	-0.009	-0.450	0.019	0.760
T	-0.022***	-4.460	-0.011***	-2.460
TSQ	-0.001	-0.390	-0.005***	-2.850
Y1T	-0.014	-1.140	0.008	0.580
Y2T	-0.001	-0.060	0.023*	1.920
Y3T	-0.001	-0.350	-0.003	-0.600
W2T	-0.015***	-2.560	-0.012*	-1.720
W3T	0.013*	1.880	0.010	1.140
Z0	0.486***	8.940	0.274***	7.350
Z00	0.021***	3.710	0.008	1.130
Y1Z0	0.036	0.580	0.215***	2.150
Y2Z0	-0.201***	-3.030	-0.222***	-2.090
Y3Z0	-0.004	-0.140	-0.028	-0.690
W2Z0	-0.055	-1.390	-0.121***	-2.410
W3Z0	0.067	1.440	0.073	1.080
Z0T	0.026***	2.590	-0.014	-1.040
Constant	-0.294***	-6.880	-0.127***	-3.720
TA	-0.222***	-7.060	-0.215***	-2.400
DS	-0.439**	-1.980	2.215***	2.150
ER	-20.703***	-8.510	-64.684***	-35.480
Constant	1.002***	9.910		
TA			-0.876***	-3.530
DS			5.880***	4.210
ER			-129.105***	-10.230
LLR	169.610		75.037	

All variables are in log terms.

***, **, * indicates statistically significant at 1%, 5%, 10% significance level respectively.

5.6.1.2 Elasticities

Next we access annual elasticity results for each output, input price, equity and time, which are illustrated in Table 5.7 below. Figures 5.2-5.9 also plot the trend of elasticity's change over the sample period. As eta (see Table 5.5) suggests the time varying model is more appropriate, and all three time varying models give similar results. Here B&C 95 model is chosen to illustrate the results because it includes time varying inefficiency and is the most general specifications of the composed error model apart from the CMCV specification; however the CMCV specification has a lower value for the likelihood function. The elasticity can be obtained by differentiating the log of total costs with respect to the log of each output, input price, equity and time. In the following, we discuss each in turn.

Table 5.7: Annual elasticity for outputs, input prices, equity and time

Year	ey1	ey2	ey3	ew1	ew2	ew3	ez0	et
1997	0.916	0.141	0.015	0.601	0.322	0.077	-0.143	-0.059
1998	0.851	0.142	0.008	0.613	0.302	0.085	-0.101	-0.056
1999	0.794	0.145	0.017	0.629	0.272	0.099	-0.068	-0.059
2000	0.731	0.165	0.014	0.638	0.249	0.113	-0.039	-0.058
2001	0.675	0.181	0.028	0.660	0.223	0.117	-0.009	-0.058
2002	0.627	0.206	0.028	0.660	0.208	0.132	0.006	-0.058
2003	0.596	0.202	0.028	0.670	0.207	0.123	0.038	-0.049
2004	0.519	0.235	0.032	0.674	0.183	0.143	0.075	-0.051
2005	0.514	0.230	0.030	0.693	0.170	0.137	0.095	-0.042
2006	0.512	0.217	0.027	0.717	0.153	0.130	0.121	-0.033
Average	0.673	0.186	0.023	0.655	0.229	0.116	-0.002	-0.052

The elasticity of outputs can be calculated as $ey_m = \frac{\partial \ln TC_{it}}{\partial \ln y_{mit}}$ ($m=1, 2, 3$), which are shown in

the first three columns of the Table 5.7 and Figure 5.2. As shown in the Table and in the Figure, there is a clear continuous decreasing trend for the elasticity of bank loans (ey1) throughout the ten years under study. While the elasticity for other earning assets (ey2) and non-interest

income (ey3) experience small increase over the sample period.

Figure 5.2: Annual elasticity of outputs

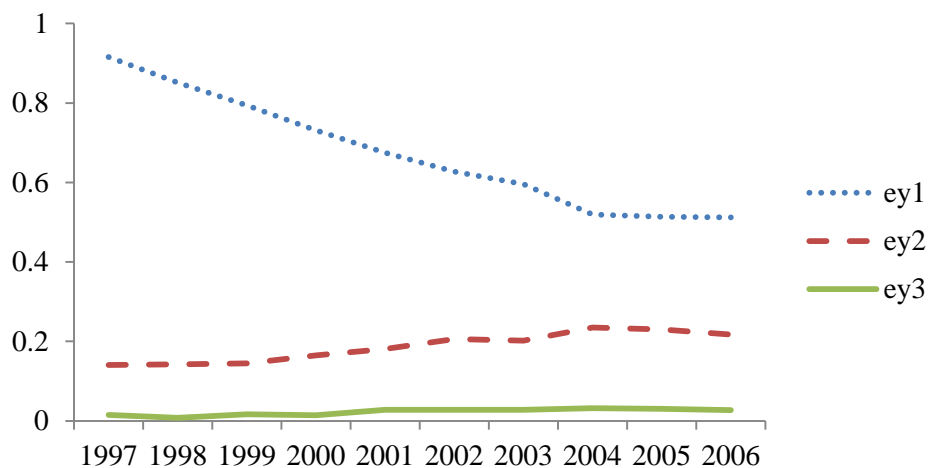
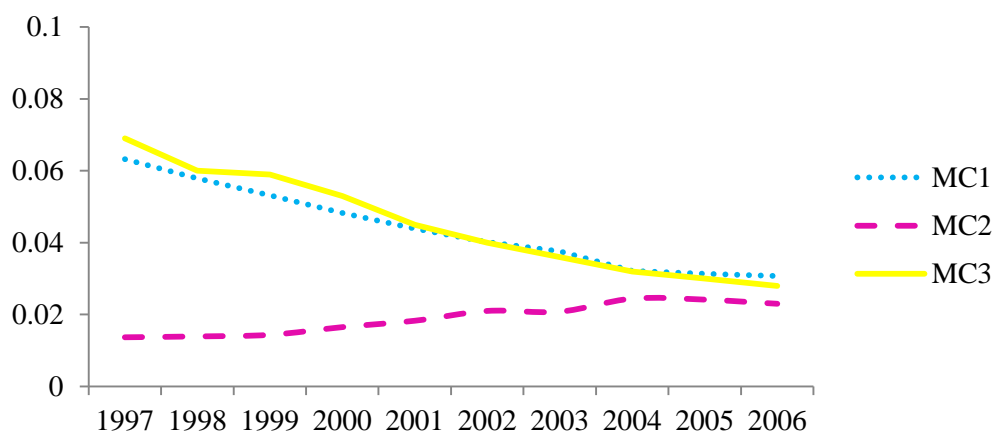


Figure 5.3: Marginal costs of outputs



Note that elasticity above can help obtain bank marginal costs $MC_m = (ey_m) \left(\frac{\overline{TC}}{\overline{y}_m} \right)$ for loans,

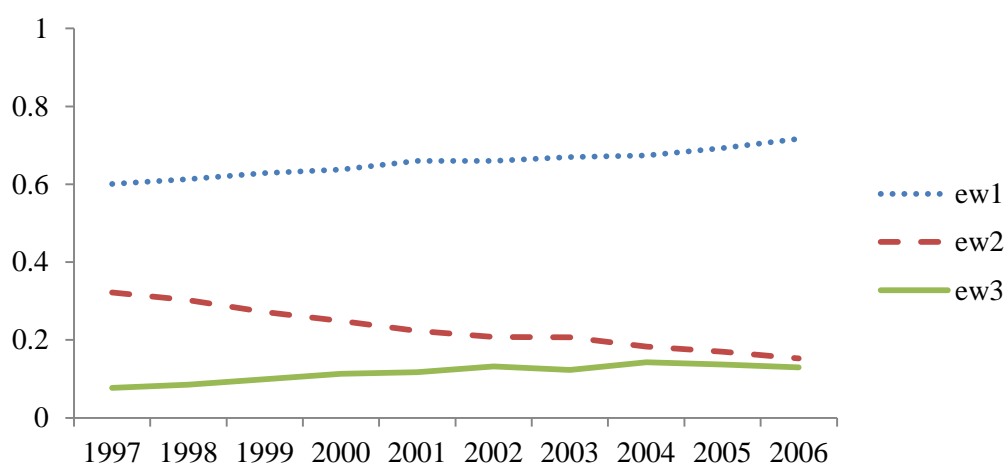
other earning assets and non-interest income, which are plotted in the Figure 5.3 below. As we can see from the graph, there is continuous decrease in marginal cost for both loans and non-interest income, while marginal cost of other earning assets enjoy small increase. Decreasing marginal cost of loans and non-interest income suggest banks are becoming more efficient at providing loan services and off balance services as we would expect in an evolving successful banking system. The increasing marginal cost of other earning assets indicates that taking loan and government debt on to the balance sheet was becoming a more expensive

operation for the banks over the sample period. Despite the marginal cost of bank loan experiences dramatic drop over last ten years, it has been generally higher than that of other two outputs. This indicates that it is more resource consuming to provide an additional loan than it is to invest in securities and fee-based services, which should be related with the screening and monitoring costs involved in granting loans. However, the difference among three outputs has become small through time.

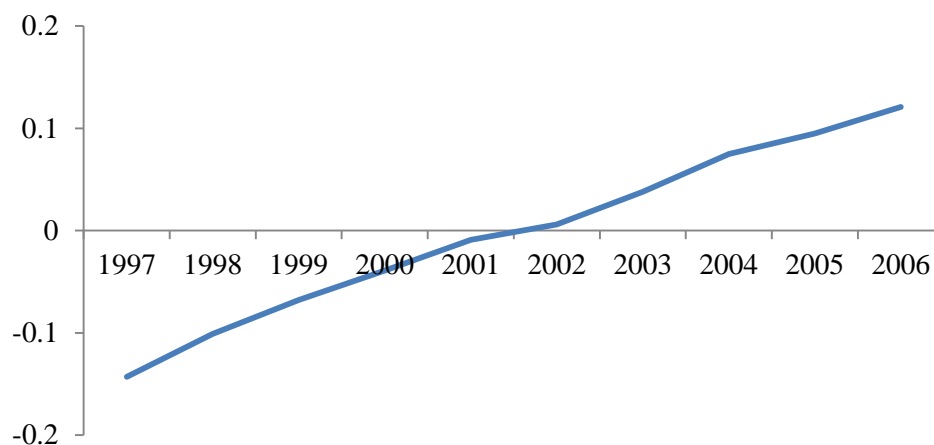
The elasticity of input prices can be calculated by $ew_j = \frac{\partial \ln TC_{it}}{\partial \ln w_{jit}}$, (j=1, 2, 3) which are

documented in the fourth, fifth and sixth column of the Table 5.7 and also plotted in the Figure 5.4 below. Both table and figure show that the elasticity for price of labour (ew2) decrease over time, while the elasticity for price of loan (ew1) and fixed assets (ew3) presents an opposite trend. This may suggest that banks reduce their budget on employees but invest more in traditional business and fixed assets, such as buildings, offices and other facilities. This may coincide with the fact that the Chinese banks get redundancy in last decades but expand their branches and offices to increase their market shares on the ground of increasingly intensive competition. It also suggests that banks are becoming more capital intensive and less labour intensive over time.

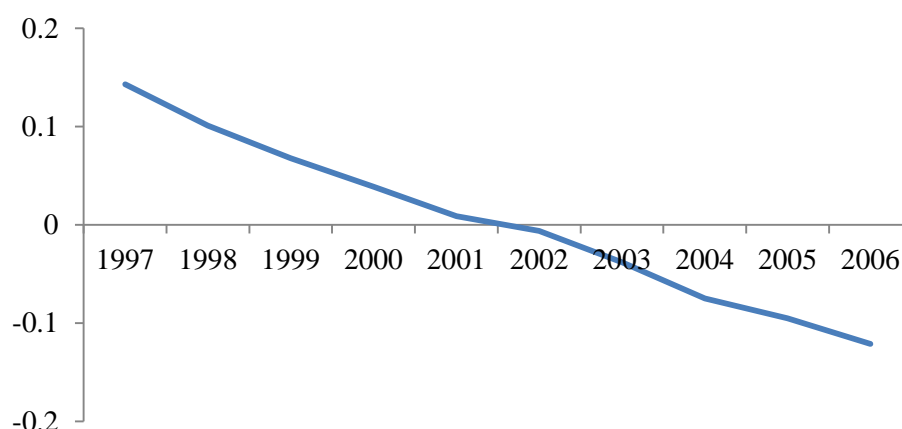
Figure 5.4: Annual elasticity of input prices



The elasticity of equity capital can be computed by $ez_0 = \frac{\partial TC_{it}}{\partial z_{0it}}$, which are listed in the seventh column of the Table 5.7 and plotted in Figure 5.5.

Figure 5.5: Annual elasticity of equity capital

The elasticity of equity capital (ez_0) allows us to evaluate the shadow return on equity (SROE) which is calculated from the negative of the elasticity of a bank's total cost with respect to the level of equity capital derived in section (derived in section 5.4.4), $SROE = -\frac{\partial TC_{it}}{\partial z_{0it}}$. The result is presented in Figure 5.6. The SROE provides a measure of how much banks are willing to pay for the equity, since it indicates the amount that bank would save in other costs as a result of an increase in the level of equity.

Figure 5.6: Annual shadow return on equity

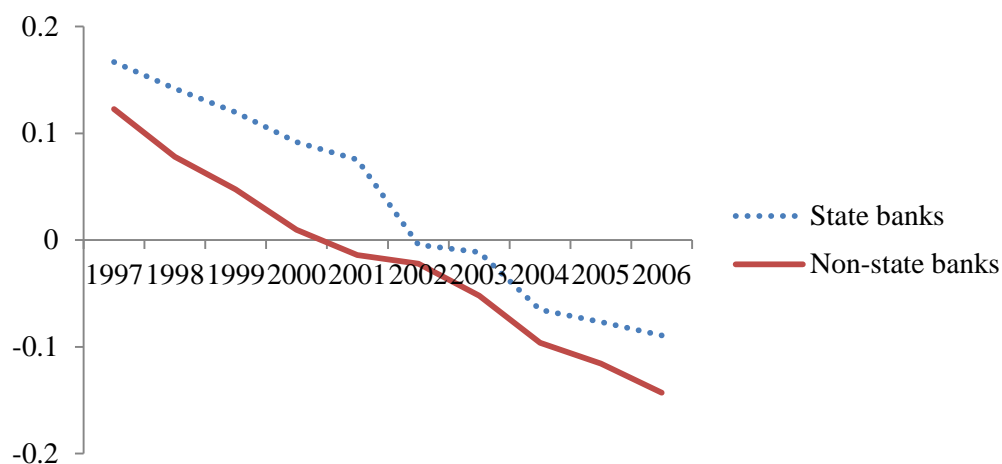
As shown in Figure 5.6, there is a clear decreasing trend for the shadow price of equity capital. It is interesting to identify that the sign of SROE is positive for the first half of sample period,

but becoming negative since 2002 after the WTO entry. The change of sign can be explained by increase in capital ratio in the Chinese banks under the WTO requirement which requires domestic banks to fulfill Basel II. To achieve the target, on the one hand, the state directly injected equity capital to recapitalize domestic banks; on the other hand, the central bank placed quotas on the amount of loans a bank can issue, which act as an indirect way of increasing capital ratio as assets has been reduced.

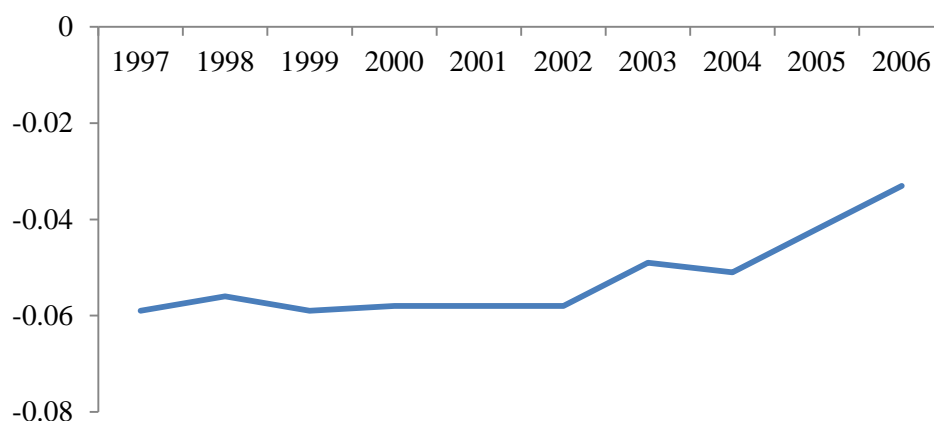
Fethi et al (2010), in applying a similar model to the massive recapitalization of the banking industry in Turkey in the period following that country's financial crisis of 2001, discovered that the recapitalization was associated with the shadow return on equity turning negative. There seems to be as clear policy lesson here: massive recapitalization, for example as practiced in China in preparation for WTO entry, has a short run impact of reducing the shadow return on equity and may possibly cause it to turn negative; this is consistent with the banking firms being required to hold levels of equity input well above the long run equilibrium level so that they are effectively operating during the adjustment period in an uneconomic region of the production function. This finding has implications for many transition economies and even developed economies in the aftermath of banking crisis.

In short, recapitalization process imposes short run adjustment cost which makes the shadow return on equity turn to negative. This suggests policy makers must be aware that gains in efficiency improvement may be offset by the recapitalization costs.

Moreover, by comparing the shadow return on equity between two sub-groups based on ownership difference, we find out that on average the state owned banks tend to have a higher shadow cost of equity than non state-owned banks, which is shown in Figure 5.7. This suggests that the state-owned banks are relatively under capitalized and more leveraged, which reflects the need for government direct injections of capital.

Figure 5.7: Annual shadow return on equity for two ownership groups

The elasticity of time can be obtained by $et = \frac{\partial TC_{it}}{\partial t}$, which are tabulated in the last column of the Table 5.7 and also plotted in the Figure 5.8 below. The value calculated from equation above can be interpreted as the technological progress, which can shift the cost frontier down by adoption more efficient production techniques. The negative sign of the elasticity of time indicates there is technological progress for Chinese banks under the period we considered, which shift the cost frontier down by 5.2% per year on average.

Figure 5.8: Annual elasticity of time

5.6.1.3 Scale economies

This subsection assesses the presence of scale economies which has been the subject of extensive discussion in the early efficiency literature. Identification of scale economies has many empirical implications. For example, the existence of scale economies is usually considered as powerful supporting evidence for merger and acquisition by bank managers; it also allows inference on market structure and competition. The measure of scale economies can be classified into short run measure and long run measure.

The difference between those two measures is that the short run measure assumes the level of equity is held fixed, while the long run measure allows for the level of capital to change in response to changes in output. The short run measure implies that any increase in output must be totally financed by interest bearing debt, so that the cost of debt is forced to increase more than would be realistic. Furthermore, since the definition of total costs employed here does not include the cost of equity, the measure of short run scale economies is likely to overestimate the true scale parameter. Alternatively, Hughes, Mester and Moon (2001) derive a measure of scale economies assuming that the observed level of equity capital minimizes economic cost at the shadow price of equity, usually known as long run scale economies.

The short run scale economies is typically obtained by

$$SE_{it} = \left(\sum_{j=1}^3 \frac{\partial \ln TC_{it}}{\partial \ln y_{jit}} \right)^{-1} \quad [5.22]$$

The long run scale economies can be calculated as

$$SE_{it}^e = \left(1 - \sum \frac{\partial \ln TC_{it}}{\partial \ln z_{0it}} \right) / \sum_{j=1}^3 \frac{\partial \ln TC_{it}}{\partial \ln y_{jit}} \quad [5.23]$$

If the SE is smaller (larger) than one, it indicates the presence of scale economies (diseconomies). The first column of Table 5.8 below shows short run yearly scale economies, the average scale economies is 1.291, suggesting diseconomies of scale in the Chinese banking industry during the period under examination. This implies that all else being equal, an increase in banks size leads a more than proportional increase in costs. The second column of the Table

5.8 lists long run annual scale economies, which is consistent with the result from the short run equation, also suggesting that Chinese banks experience diseconomies of scale. For the first half of our sample period, both short run and long run scale economies provide similar figures. However, for the second half of the sample period, as we expected, the long run scale economies are lower than that from short run calculation which overestimate the scale economies. On average, the short run scale economies report 1.291, while the long run scale economies state 1.246.

Figure 5.9: Long run and short run scale economies

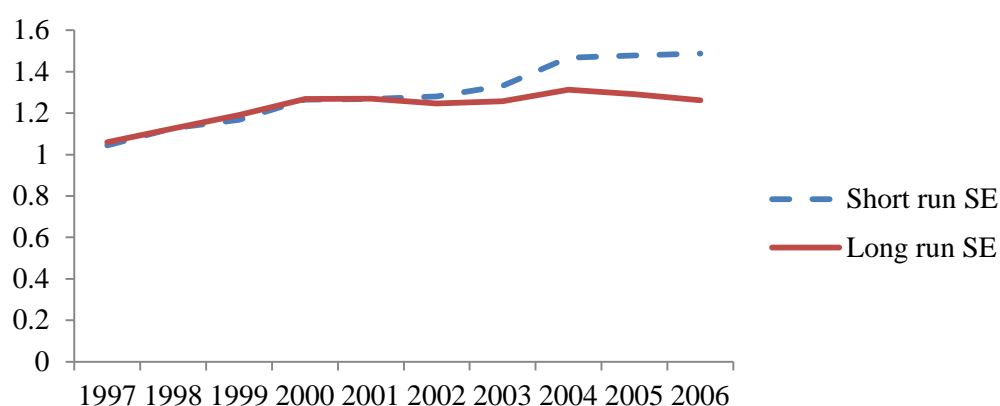


Table 5.8: Long run and short run scale economies

Year	Short run SE	Long run SE
1997	1.044	1.059
1998	1.128	1.126
1999	1.168	1.191
2000	1.265	1.268
2001	1.268	1.269
2002	1.280	1.247
2003	1.331	1.257
2004	1.467	1.313
2005	1.479	1.291
2006	1.487	1.262
Average	1.291	1.246

5.6.2 Efficiency scores

This section will discuss aggregate cost efficiency scores across the whole sample first, and then look at annual efficiency change for full sample. After that, annual efficiency scores for sub-samples based on ownership difference will be considered next. Lastly, we will look at robustness test.

5.6.2.1 Overall cost efficiency for full sample

Table 5.9 below presents overall cost efficiency of the Chinese banks between 1997 and 2006 for each individual model we employed. The aggregate estimates for cost efficiency are different under various models. The fixed effect (FE) model reports the lowest cost efficiency with the highest standard errors among all models, this might be due to the fact that the FE model is very sensitive to outliers (Sickles, 2005). The evidence from the FE model suggests that Chinese banks could save costs up to 70% if they operate on the cost frontier. There is a considerable difference in efficiency scores obtained with the fixed effect (FE) model and the random effect (RE) model. More specifically, the level of cost efficiency estimated by the random effect model is as twice as that produced by the fixed effect model, which is 68.6% and 32.9% respectively. As we expected, the fixed effect model reports lower efficiency scores than that from the random effect model. Moreover, the random effect model produces lower standard errors than the fixed effect models. Furthermore, both RE and P&L model estimated under different methods report similar level of cost efficiency, approximately 70%, which suggest domestic banks in China waste 30% costs. But the P&L model gives lower standard errors.

Those three models discussed above are time invariant. In the following we will discuss three time varying models. Generally speaking, the time varying models report 10%-20% higher efficiency scores with lower standard errors than that from the time invariant models. As reported in Table 5.5 above, the parameter for the change in cost efficiency through time are found to be statistically significant, which suggests that efficiency change across time. So the time varying models might be more appropriate for our sample.

Table 5.9: Aggregate efficiency scores from full sample

Models	Mean	Std.Dev	Min	Max
FE	0.329	0.169	0.067	1.000
RE	0.686	0.129	0.304	1.000
P&L	0.714	0.125	0.315	0.967
B&C 92	0.852	0.113	0.459	0.987
B&C 95	0.871	0.105	0.465	0.988
CMCV	0.908	0.087	0.427	1.000

The B&C 92 model which specifies inefficiency is a function of time alone produces roughly similar levels of cost efficiency to the B&C 95 model which specifies the mean of inefficiency is a function of a set of environmental variables (here are total assets, ownership dummy and equity capital ratio). Both of them report that the Chinese banks are about 86% cost efficient. But the B&C 95 model reports lower standard errors than the B&C 92 model.

The conditional mean conditional variance (CMCV) model improves the B&C 95 model by specifying a set of environmental variables which not only affect the mean of inefficiency, but also influence the variance of inefficiency. It reports the highest level of cost efficiency with the lowest standard errors among all models. The level of cost efficiency obtained by the CMCV model lies just above 90%, suggesting that the Chinese banks could theoretically have produced the same output while incurring only 90% of their actual costs.

5.6.2.2 Annual cost efficiency for full sample

After discussing the aggregate cost efficiency, now we would like to consider annual efficiency scores across the sample, which enable us to identify the trend of efficiency changes over the time. Table 5.10 below presents annual efficiency scores under various models, and Figure 5.10 depicts the trend line of those efficiency levels against time.

Table 5.10: Annual efficiency scores from full sample

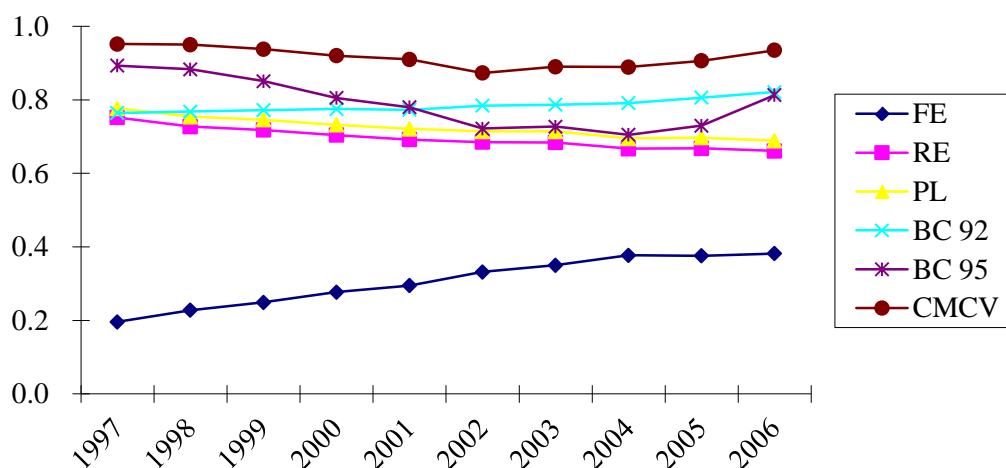
Year	FE	RE	P&L	B&C92	B&C95	CMCV
1997	0.196	0.752	0.777	0.764	0.893	0.952
1998	0.228	0.727	0.754	0.768	0.883	0.950
1999	0.249	0.718	0.746	0.772	0.851	0.938
2000	0.277	0.704	0.732	0.775	0.805	0.920
2001	0.295	0.692	0.721	0.773	0.780	0.910
2002	0.332	0.685	0.714	0.784	0.722	0.873
2003	0.350	0.684	0.714	0.787	0.727	0.890
2004	0.377	0.667	0.695	0.791	0.705	0.889
2005	0.376	0.668	0.697	0.806	0.730	0.906
2006	0.382	0.661	0.689	0.821	0.813	0.935

Six models show different trend of changes in efficiency levels. As we can see from the Figure 5.10, the FE model and B&C 92 model clearly show a continuous increase in cost efficiency through the sample period. However, the RE and P&L shows an opposite trend. The B&C 95 model and CMCV model illustrate there is a continuous decrease in efficiency level from the beginning of sample period to the year of 2004, but cost efficiency start to rise since 2005.

Although six models show inconsistent trend of efficiency changes across the time, there are two main reasons for us to believe the B&C 95 and CMCV model give more reliable efficiency level and trend. One is from statistical aspect, significant eta suggests that the time-varying models are more appropriate. But the structure specified by the B&C 92 model artificially imposes the trend on efficiency change, either always increase or always decrease. Thus the trend obtained by the B&C 95 model and CMCV are more close to the true efficiency changes for our sample of banks. In addition, the B&C95 and CMCV models have lower standard errors. This suggests that there is small deviation in efficiency among our sample of banks. Another is from empirical aspect, the trend shown by the B&C 95 model and the CMCV model is consistent with the fact that the Chinese banks suffer decrease in their cost efficiency because of the impact of the Asian financial crisis in our early sample period and massive nonperforming loans write-off after the WTO entry in 2002. Since the recapitalization and liberalization, commercial banks in China experience increase in their cost efficiency, which can be explained

by better capital structure, better asset quality and better management from introduction of foreign strategic investors.

Figure 5.10: Annual efficiency scores from full sample



5.6.2.3 Overall cost efficiency by ownership

After looking at the efficiency for our sample of banks as a whole, now we consider the level as well as the changes of efficiency for three sub-groups of banks based on ownership difference, namely state-owned banks, joint equity banks and city commercial banks. As indicated above, eta the parameter for the change in cost efficiency through time are found to be statistically significant, so in the following we mainly focus on results from the time varying models, namely B&C 92, B&C 95 and CMCV model. The annual mean efficiencies for each sub-group are presented in Table 5.11 below, and Figures 5.11-5.13 describe the yearly movement under each model

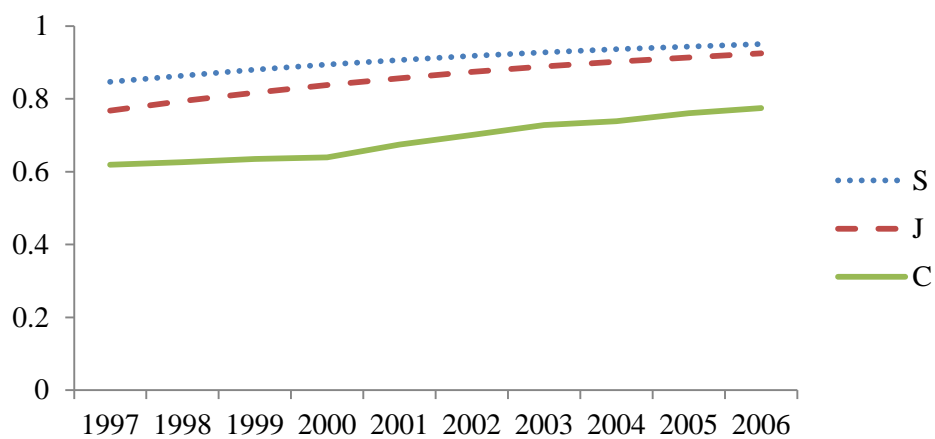
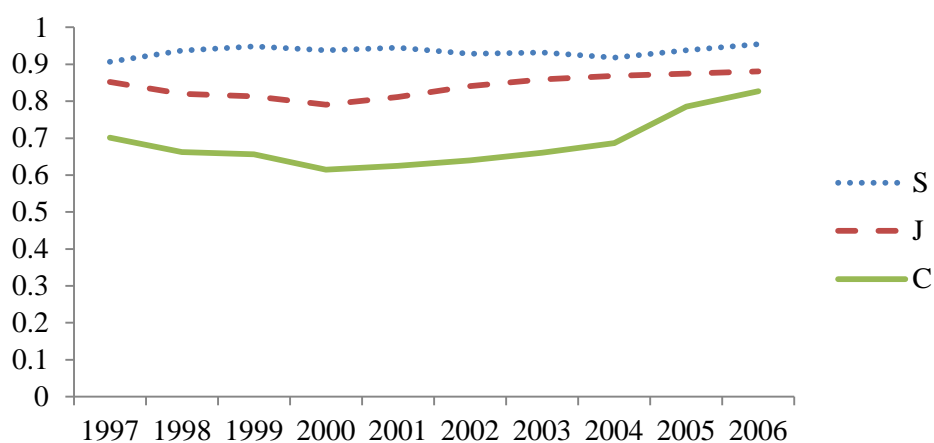
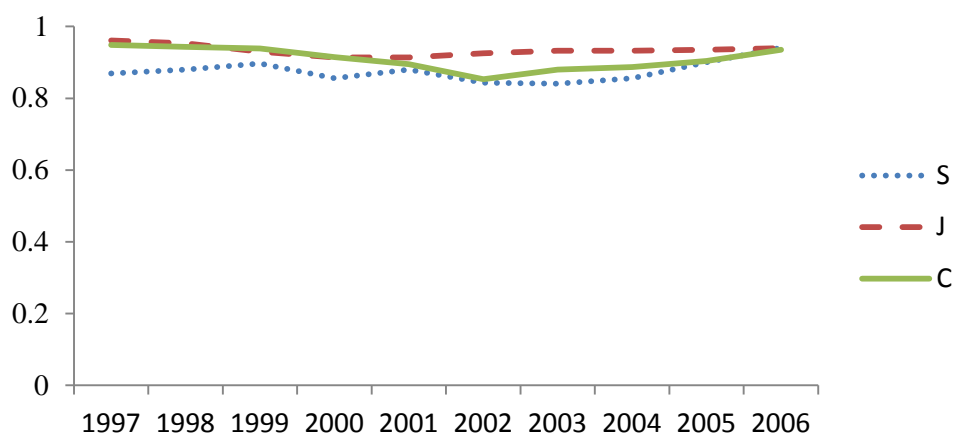
Table 5.11: Annual efficiency scores from sub samples

	B&C 92			B&C 95			CMCV		
	S	J	C	S	J	C	S	J	C
1997	0.847	0.768	0.619	0.907	0.852	0.701	0.869	0.961	0.949
1998	0.864	0.794	0.626	0.937	0.820	0.662	0.880	0.953	0.943
1999	0.880	0.817	0.635	0.948	0.813	0.656	0.897	0.930	0.939
2000	0.894	0.838	0.639	0.938	0.791	0.615	0.856	0.914	0.915
2001	0.907	0.857	0.675	0.945	0.811	0.625	0.880	0.914	0.895
2002	0.918	0.874	0.701	0.928	0.841	0.640	0.843	0.925	0.853
2003	0.928	0.889	0.728	0.932	0.859	0.661	0.841	0.933	0.880
2004	0.937	0.902	0.739	0.918	0.869	0.687	0.856	0.933	0.887
2005	0.944	0.914	0.761	0.938	0.875	0.785	0.900	0.935	0.904
2006	0.951	0.925	0.775	0.954	0.881	0.827	0.941	0.940	0.935
Average	0.907	0.846	0.735	0.935	0.866	0.753	0.897	0.943	0.911

*S: state-owned banks, J: joint-equity banks, C: city commercial banks

With respect to the level of efficiency, the results derived from the B&C 92 and B&C 95 models achieve a consensus that the state-owned banks are the most efficient from cost perspective, and the city commercial banks are the least efficient. The efficiency levels shown in the Figure 5.11 and 5.12 also clearly demonstrate that the trend line of the state-owned banks always stand at the top and the city commercial banks always locate at the bottom over the entire ten-year period. However, it is interesting to notice that the CMCV model suggests a different ranking. It indicates that the joint equity banks are the most cost efficient banks; while the state-owned banks are the least efficient ones. This finding is consistent with Fu and Heffernan (2007), Kumbhakar and Wang (2005), Berger et al (2009) and Shen et al (2009).

In the case of the change of efficiency level, although yearly movement represented in the Figures 5.11-5.13 appear to be different, they actually show the same trend as a whole. The overall trend is increasing in cost efficiency for three types of banks. Furthermore, not only all three types of banks improve their efficiencies, the difference in efficiency levels among them is finally reduced at the end of our sample period, especially the state-owned banks and joint equity banks achieve at a similar level of efficiency in the end.

Figure 5.11: Annual efficiency scores from sub samples (B&C 92)**Figure 5.12: Annual efficiency scores from sub samples (B&C 95)****Figure 5.13: Annual efficiency scores from sub samples (CMCV)**

5.6.3 Robustness tests

5.6.3.1 Rank Correlation

As different estimation approaches generate different efficiency estimates, the choice of models may affect the regulatory policy and manager's decision that are drawn from the result analyses. Therefore, it is more important to consider the efficiency rankings rather than efficiency levels, when we compare the results from different models. In other words, those efficiency estimates derived from the different approaches should be consistent with each other in identifying the best and worst practice. If various models rank institutions in similar order, then decision makers such as regulators, managers, investors are more confident about the robustness of the result and could draw reliable conclusions for the best-practice and the worst-practice and thus design their policies accordingly. For evaluating ranking consistency for our results, we carry out both Spearman's and Pearson's correlation tests.

Table 5.12-5.13 below contain the Spearman's and Pearson's correlation coefficients showing how close the rankings of banks are among each model. In general, all of these correlation coefficients from both Spearman and Pearson test are positive and statistically significant at 5% level, even though the strength of correlation is different between different methods. As both Spearman and Pearson test generate similar size of correlation coefficients, in the following, we take correlation coefficients from the Spearman test as an example for explanation purpose.

It would be expected that the rankings between same types of models (i.e. time invariant and time varying) would be fairly high. Indeed, the rank order correlations among three time invariant models namely FE, RE and P&L model are quite strong. The correlation coefficient between FE and RE is 0.785, and the same level of correlation between FE and P&L. A substantial higher level of correlation (0.991) is found out between the RE and P&L.

A comparatively weak correlation is observed among three time varying models, namely the B&C 92, the B&C 95 and the CMCV model. We observe that B&C 92 has relatively low correlation with another two time-varying models. But we find out high correlation between the

B&C 95 and CMCV model. Although B&C 95 and CMCV model suggest different ranking based on ownership in section 5.6.2.3, this is not necessary to be inconsistent with high correlation between those two models. The ranking for ownership is based on group of banks, while the ranking test here is based on individual bank.

Table 5.12: Spearman's correlation coefficients

	FE	RE	P&L	B&C 92	B&C 95	C M-V
FE	1.000*					
RE	0.785*	1.000*				
P&L	0.784*	0.991*	1.000*			
B&C 92	0.764*	0.843*	0.871*	1.000*		
B&C 95	0.402*	0.570*	0.574*	0.549*	1.000*	
CMCV	0.377*	0.361*	0.395*	0.478*	0.735*	1.000*

*indicates significant at 5% significance level.

Table 5.13: Pearson's correlation coefficients

	FE	RE	P&L	B&C 92	B&C 95	C M-V
FE	1.000*					
RE	0.779*	1.000*				
P&L	0.767*	0.997*	1.000*			
B&C 92	0.721*	0.876*	0.885*	1.000*		
B&C 95	0.488*	0.478*	0.460*	0.456*	1.000*	
CMVV	0.386*	0.402*	0.475*	0.497*	0.783*	1.000*

*indicates significant at 5% significance level.

All in all, the correlation tests show that our results under different models are generally consistent with each other by ranking the efficiency level, especially within the same model group. This implies that although the levels of cost efficiency estimates under different frontier models are quite different across banks, it is still possible that these methods will generate similar rankings for banks by their efficiency scores across frontier methods. As discussed

above, identifying the rough ordering of which financial institutions are more efficient than others is usually more important for policy decision making than measuring the level of efficiency itself.

5.6.3.2 Monotonicity and concavity tests

As discussed in Section 5.4.2, properties of the translog cost function need to be satisfied to ensure that cost efficiency estimates are reliable. For this reason, we carry out monotonicity and concavity tests. Here, we show the test results from the B&C 95 model as illustration. These test results are reported in Table 5.14, with all the required properties checked at the sample mean and across the whole sample.

As we can see from the table, monotonicity conditions are strongly satisfied at the sample mean, where the elasticities of outputs and input prices are statistically significantly higher than zero, suggesting that the cost function is non-decreasing in \mathbf{y} and \mathbf{w} . In addition, they are satisfied at the majority of the sample points.

Concavity condition is satisfied at the sample mean and across 95.5 percent of the sample points, since the Hessian matrix with respect to the input prices is negative semi-definite. The satisfaction of both monotonicity and concavity properties indicates that our fitted model is a true cost function and that cost efficiency estimates are reliable.

Table 5.14: Properties (monotonicity and concavity) of the fitted cost function at the sample mean and across the whole sample

Monotonicity	Elasticity	Parameters	Standard error	% of sample points with cost increasing in outputs and input prices
at the sample mean	ey1	0.589	0.038	99.2
at the sample mean	ey2	0.202	0.016	99.7
at the sample mean	ey3	0.021	0.012	88.4
at the sample mean	ew2	0.223	0.041	99.2
at the sample mean	ew3	0.117	0.027	100

Concavity	Objective function	Principle minors	Values	% of sample where H(w) is negative definite
at the sample mean	H(w)	First order	-0.208	95.2
			-0.196	
		Second order	-0.075	94.1

5.7 Conclusion

Over the past several decades, substantial research efforts have gone into measuring the efficiency of financial institutions, particularly commercial banks in a small number of developed countries, especially heavily concentrated on the US and Western Europe. Recently, although there is an increasing number of works examining bank efficiency in developing countries, China, one of the fast growing economies, is still left behind.

China has experienced significant banking sector reform over the last ten-years. Especially

since the WTO accession in 2001, the pace and strength of banking reform has been intensified, which mainly focus on the recapitalization and liberalization. The recent banking reform greatly enhances the competition and thus we believe that it may have some potential impacts on bank efficiency. The main objective of this chapter is to fill in these gaps and contribute the latest evidence in the literature to evaluate the level of efficiency and its changes.

This chapter using the latest banking data attempts to investigate the efficiency level from cost perspective in the Chinese commercial banking market during the period from 1997 to 2006. In our study, we employ six models under the stochastic frontier approach to ensure the robustness of our results, namely, the fixed effect model, random effect model, Pit and Lee model, Battese and Coelli 1992, Battese and Coelli 1995, and conditional mean conditional variance model.

We first assess the level of efficiency and its changes for our sample of banks as a whole over the entire ten-year period. The fixed effect model reports the lowest efficiency level (33%) with the highest standard errors, while the conditional mean conditional variance model generates the highest efficiency levels (90%) with the smallest deviations. The other four models report the overall mean cost efficiency for Chinese commercial banks around 70%-80% indicating that banks in the sample on average could reduce their costs up to 30%-20% by comparing their performance with the best-practice bank in the sample. In the case of the variation of efficiency level for the sample as a whole, although there are some fluctuations during the sample period, the cost efficiency finally improved in the end compared to its initial level.

Moreover, we examine the efficiency based on ownership difference. It is interesting to find that apart from the conditional mean conditional variance model, all the models achieve a consensus that the state-owned banks exhibit the highest cost efficiency, while the city commercial banks report the lowest level of efficiency. However, the conditional mean conditional variance model finds the opposite evidence that the state-owned banks are the least efficient and the joint equity banks are the most efficient.

Furthermore, the gap among three sub groups is narrowed over the last ten years. Especially the difference between the state-owned banks and the joint equity banks is reduced, and achieving similar level of cost efficiency in the end.

Another important finding is that we find that shadow return on equity is positive for the first

five years, but becoming negative since 2002 after the WTO entry. The change of sign can be explained by increase in capital ratio in the Chinese banks under the WTO requirement which requires domestic banks to fulfill Basel II. To achieve the target, on the one hand, the state directly injected equity capital to recapitalize domestic banks; on the other hand, the central bank placed quota on the amount of loan a bank can issue, which act as an indirect way of increasing capital ratio as assets has been reduced.

As the levels of efficiency estimates under different frontier methods are quite different across banks, it is usually more important to consider the efficiency rankings rather than efficiency levels, when we compare the results from different models. As a consequence, we carry out both Spearman's and Pearson's rank order tests. The correlation coefficients show that efficiency estimates from different approaches are consistent with each other, which ensure the robustness of our results. Furthermore, we check the properties of the translog cost function by conducting monotonicity and concavity tests. Both conditions are strongly satisfied at the sample mean and cross the whole sample, which indicate our fitted models are true cost functions and that cost efficiency estimates are reliable.

In conclusion, these empirical results show clear evidence that the cost efficiency of the Chinese commercial banks is greatly enhanced over our examination period, and the gap among different ownership types of banks has shrunk. The improved cost efficiency enjoyed by the Chinese banks show that they react positively to recent banking reform which focus on improving their asset quality, capital adequacy and competitiveness.

Chapter 6: Explaining profitability in the Chinese banking industry: the structure performance hypothesis vs the efficient structure hypothesis

6.1 Introduction

There is overwhelming evidence that a well-functioning financial system is essential for both economic growth and stability, as it plays an important role in capital allocation (due to scarce resources), fund mobility and investment. Until today, the capital market in China is still underdeveloped and incomplete. Thus China's banking sector is the most important component of the financial system, with 76% of total assets in financial market in 2006. As the Chinese financial system is mainly bank-based, firms and individuals heavily rely on indirect financing channel from banks. In order to sustain the phenomenon of continuous and rapid economic growth in China, we need ensure that the Chinese banking sector is healthy and profitable.

As explained in Chapter 2, the Chinese banking sector has been characterized by high concentration, low profitability, poor efficiency and massive non-performing loans for quite a long period of time. In 1997, the Chinese government started a new phase of comprehensive banking reform with the objective of transforming domestic banks into market-functioning and profitable institutions, in order to cope with challenges posed by full openness of the financial market in 2006 under the WTO agreement. Although the banking reform is still ongoing, some fruitful outcomes have been achieved such as greater competition (lower concentration), better asset quality, higher equity capital ratio and improved efficiency.

As the recent banking reform aimed to enhance both the efficiency and competition as a way of improving the overall performance and competitiveness of the banking sector in China, it is worth analyzing the impact of banks' efficiency and market structure on performance of the banking firms in China. Moreover, the success of the banking reform is very important for China's economic growth and sustainability in the future, so our conclusions, even if very tentative, might serve as useful suggestions on the future direction of the ongoing reform.

A large number of empirical studies in the industrial literature find that a firm's profitability is positively related to market power (measured by either market concentration or market share). However, there is no consensus about the causation. There are two major explanations for this universally agreed positive relationship; one is the traditional structure conduct performance hypothesis (Bain, 1951), and another is the efficient structure hypothesis (Demsetz, 1973).

Studies that advocate the structure performance hypothesis simply assert that a firm with greater market power (price maker) can earn higher profit (monopolistic rents). However, studies that support the efficient structure hypothesis argue that profit differentials are the result of differences in efficiencies among firms. That is, efficiency is the underlying driving force for profitability, where a firm with greater efficiency has lower cost and allows it to gain a greater market share through price competition or acquisition of less efficient firms, and becoming more profitable. Therefore, in the efficient structure paradigm, the positive relationship between profits and market structure is spurious, because efficiency is the principal determinant of both profitability and market power.

According to Berger (1995), the above two hypotheses can be further divided into two sub-hypotheses; hence there are four hypotheses in total. That is, the structure performance hypothesis can be decomposed into the structure conduct performance (SCP) and the relative market power (RMP), which has been tested in Chapter 3 and no evidence to support both hypotheses. The SCP states that firms in a more concentrated market can obtain higher profit as

collusion is easier and less costly in that market. Therefore, the firm is able to set prices more favourable to itself (in the case of banking, higher loan rates and lower deposit rates) and gain more profits. The RMP declares that only those firms with greater market share and well differentiated products are able to exercise market power and earn abnormal profits. The difference between the two sub-hypotheses under the structure performance hypothesis is that the SCP emphasizes the overall market concentration and suggests that all firms in the market can benefit from the high concentration, whilst the RMP focuses on the relative individual market share of firm and implies that only large firms can take advantage of market power.

Further, the efficiency can be in the form of X-efficiency or scale-efficiency, so the efficient structure hypothesis can be broken down into X-efficiency hypothesis (ESX) and Scale efficiency hypothesis (ESS). The ESX shows that firms with superior management and/or production technologies have lower costs and therefore generate higher profits. Whereas, the ESS assumes that firms have equally good management and technology (same X-efficiency), but some firms simply produce at the optimal scale of operation, and therefore have lower unit cost and hence earn higher unit profit than the remaining incumbent firms.

However, some contemporary studies have challenged the acceptability of the positive relationship predicted between efficiency (or market share) and profitability; this can be explained by the quiet life (QL) hypothesis (Hicks, 1935). The quiet life hypothesis assumes that the managers of firms with relatively large market power have less pressure to efficiently use resources since they can make profits using their price-setting power. This hypothesis predicts that large firms in the market use their market power to be unchallenged in the market and earn profits without improving their productivity and efficiency (non-competitive behavior). Thus, an increase in market power comes with a deterioration of efficiency which makes firms unable to earn higher profits. The quiet life hypothesis also provides an explanation in the case of a weak or the absence of a presumed positive relationship between profitability and efficiency/market structure (Smirlock, 1985).

The purpose of this chapter is to examine the profit-structure (efficiency) relationship by identifying key determinants of profitability in the Chinese banking industry over the period 1997-2006 under the debate of structure performance hypothesis and the efficient structure hypothesis. There are three objectives to be fulfilled. First, to implement Berger's (1995) test to see which hypothesis is favoured by the banking sector in China. Second, to examine the evidence for the Hicks (1935) quiet life hypothesis. Third, to fill a gap in the empirical literature applied to China about the performance-market structure relationship in banking industry.

We innovate this study by employing the shadow return on equity (see Chapter 5) as an alternative measure of bank profitability. Besides, only macroeconomic variables are included as additional factors that may influence bank performance. Bank specific variables which are usually included in previous literature are not considered in our study (see Section 6.4 below for an explanation).

This chapter is structured into six sections. Section 6.2 provides an overview of the literature on the performance-market structure relationship, with emphasis on empirical studies applied Berger's (1995) methodology. Section 6.3 details the methodological framework and specifies tested hypotheses. Section 6.4 considers variables selection and describes the data. Section 6.5 presents and discusses the empirical findings and finally Section 6.6 concludes.

6.2 Literature review

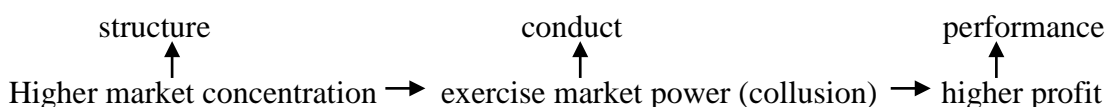
The ability of firms to exercise market power by setting prices is a major concern to both economists and policymakers. A considerable number of empirical studies has examined the nature of the relationship between the structure of the market in which firms operate (concentrated vs competitive markets) and their performance. Two main research streams can be distinguished: the market structure paradigm and the efficiency paradigm.

The relation between firm performance and market structure (or efficiency) has been tested extensively in the banking industry, with most of the research focusing on the US and the EU, recently on emerging economies. The results, however, appear mixed and there is no conclusive evidence to indicate the superiority of one explanation over another.

In the following, we first briefly review the major theoretical literatures concerning the structure performance relationship. Then we will focus on the empirical literatures in banking sector which apply the methodology proposed by Berger (1995).

6.2.1 Theoretical background of performance structure relationship

Early attempts to evaluate the relationship between the market structure and firm performance are explained by the Structure-Conduct-Performance (SCP) hypothesis, which basically states that the structure of the market can affect firms' performance through their conduct. The key idea of the SCP hypothesis is that markets characterized by a structure with relatively limited number of firms and high barriers to entry will conduct pricing strategy aiming at achieving joint profit maximization through collusion, price leadership, or other tacit pricing arrangements. This type of price conduct should in turn yield profits and prices that are greater than under the competitive competition. In other words, the market concentration lowers competition and increases profit by fostering (explicit or tacit) collusion in the market. The bulk of the empirical banking studies broadly come to the conclusion that concentration positively influences profit levels which consequently results in higher loan pricing and lower deposit rates (Gilbert, 1984; Molyneux and Forbes, 1995). This SCP hypothesis has been explained in detail and tested in Chapter 3.

The SCP hypothesis:

However, Shepherd (1982) found not all market participants in the concentrated market can benefit and earn higher profits. He asserted that only firms with large market shares and well-differentiated products are able to exercise market power and make supernormal profits, which is referred to the Relative-Market-Power hypothesis (RMP). He emphasized the importance of price discrimination, as most markets are believed to contain submarkets with a unique demand elasticity, so that only firms with a large market share can exercise market power and influence prices. Therefore, the RMP hypothesis stresses the individual market share which provides direct market power, whereas collusion represents indirect market power. This gives strong incentives for merger and acquisition activities. That is, gaining market share through acquiring another firm (external growth) could provide a direct and much quicker way to expand and obtain market share than internal growth, thus generate higher profits.

The RMP hypothesis:

Larger market share → greater market power → higher profit

Thus, the major difference between the two sub-hypotheses under the structure performance paradigm is that the SCP focuses on the overall concentration of the market, while the RMP stresses the individual market share. Although both hypotheses have different emphasis, they indicate that the market structure (or market power) is the underlying driving force behind the profitability.

An alternative hypothesis which emerges from criticism of the structure performance

hypothesis is the efficient structure (ES) hypothesis. Demsetz (1973) and Peltzman (1977) first challenged the structure performance hypothesis and argued that a positive relationship between profit and market concentration stems not from market power, but from the greater efficiency of firms with a larger market share, which then produces both higher concentration and greater profitability. If one controls for efficiency, the link between profitability and market structure variables will become insignificant and thus economically meaningless. Therefore, under the efficiency hypothesis, efficiency drives both profit and market concentration.

More efficient firms have lower costs, which enable them to gain bigger market share and higher profits and in turn leads to greater concentration in the market. Firms that operate more efficiently may adopt two different strategies to achieve higher profits. The first alternative is to maximize their profits by maintaining existing levels of output, but setting a higher price. The second alternative is to maximize their profits by reducing prices and expanding their operations, which may be achieved either through internal growth or by acquiring less efficient counterparts in the market (external growth). As a consequence, gaining market share by efficient firms is the driving force behind the process of market concentration.

The efficient structure hypothesis:

Larger market share → higher market concentration (endogenous)
 ↑
 Superior efficiency → lower cost → higher profit

The efficient structure (ES) hypothesis has been usually proposed in two different forms, depending on which type of efficiency being considered. In the X-efficiency form, firms with superior management and/or production technologies have lower costs and therefore generate higher profits. In the Scale-efficiency form, it suggests the same relationship described above but focuses on economies of scale rather than differences in the quality of management or production technology. Larger firms can explore scale economies and obtain lower unit costs.

Thus, according to the ES hypotheses, a positive correlation between concentration and profitability does not necessarily indicate a causal economic relationship, but could be spurious.

Although the two competing broad categories of hypotheses (structure performance vs efficiency structure) have a very different understanding of the direction of causality between market structure and performance, they indeed reflect the same positive relationship between market power and profitability. They just differ in the aspect of how market power can be obtained in the first place. That is, the structure performance hypothesis takes market power as exogenous, which is derived from market concentration or market share, and the direction of causality runs from the market structure of an industry to firm profitability through firm behaviour such as collusion or pricing strategy. By contrast, the market structure is not exogenously determined under the efficiency hypothesis, but rather that it is the result of the superior efficiency. The efficiency hypothesis takes firm-specific efficiency as given; the market power is acquired by maintaining or improving such efficiency. Under this hypothesis, we would see causality running from an individual firm's efficiency to profitability via market share, as more efficient firms will be able to increase their market shares, resulting in higher concentration. Hence, the efficiency hypothesis claims that greater market concentration is not necessarily a consequence of the collusive behaviour of firms but a consequence of the firm's enhanced efficiency.

The relationship between firm performance and market structure is not only empirically interesting; it also has profound policy implications. The two hypotheses suggest different implications for merger and antitrust policy as well as regulatory work. If the structure performance hypothesis is favoured, the enlarged market share and increased market concentration will enable firms to set prices less favourable to consumer. So antitrust policy and regulatory action for preventing accumulation of market power would be necessary. However, if the evidence supports the efficiency hypothesis, mergers and acquisitions that are motivated

by greater efficiency should be encouraged, which should increase consumer and producer surplus. Thus, advocates of the structure performance hypotheses believe antitrust and regulatory policy is socially beneficial (lower unit cost, more favourable price and greater output), while the efficient structure hypotheses supporters consider it is socially costly. As a consequence, given that the banking system affects economic development and growth as well as poverty alleviation, it is important to identify the policy which is conducive to its efficient operation.

An additional hypothesis, the Quiet Life hypothesis is not a necessary part of the standard structure performance relationship, but it is often discussed within this framework. It is mainly used to explain the weak or possible absence of a significant profit-structure relationship. The reasoning of this argument is that as firms have more market power, either through market share or concentration, the management is less focused on improving efficiency, since setting prices at more favorable levels will increase revenues. The quiet life hypothesis states that firms do increase revenues as a result of increased market power, but because of higher inefficiencies, this does not lead to higher profitability. Berger and Hannan (1998) found that the quiet life effects in the banking sector appeared to be several times larger than social losses associated with the mispricing of products from market power. If the quiet life hypothesis holds, then the positive profit-structure relationship is partially offset by cost increases from poorer efficiency which may explain why the profit-structure relationship is so weak in many banking papers (see the survey by Gilbert, 1984).

The Quiet Life hypothesis:

Larger market share → lower efficiency → lower profits

6.2.2 Empirical evidence from Berger's methodology

6.2.2.1 Early evidence before Berger's method

A significant amount of empirical work conducted by many researchers in developed countries (with most of the research focusing on the US and the EU, more recently in emerging economies) has been devoted to quantifying and estimating the relationship between profit levels, concentration, and market share. However, empirical results concerning this relationship are inconclusive to indicate the superiority of one hypothesis over the other.

Gilbert (1984) reviewed early profit concentration studies in banking sector and concluded that they presented a mixed set of results and found a weak relationship, and tend to suffer from a variety of methodological flaws. Gilbert noted that the primary shortcoming of these early studies may be misspecification due to omitted variables and the failure to distinguish between market power and efficiency as a source of concentration and profitability.

It is worth noting that the previous literatures examined the competing hypotheses without including direct measures of efficiency. The common approach employed in the early empirical studies is that firm's market share is used as a proxy for a firm's efficiency, and no distinguish between X efficiency and scale efficiency. For more details, please see Chapter 3. The finding of a significant positive coefficient of concentration and an insignificant coefficient of market share supports the structure performance hypothesis, and vice versa (supports the efficiency hypothesis). However, using market share as a proxy for the efficiency effect causes ambiguity in interpreting the result and thus indicates the significant limitation of early approach.

6.2.2.2 Empirical evidence from the US using Berger's test

Berger (1995) first tackled the problem by explicitly incorporating two efficiency measures as explanatory variables in the regression equations, namely the X-efficiency and scale efficiency. By incorporating the direct measure of efficiency, it can help to distinguish among four alternative hypotheses in explanation of structure-performance relationship and by nesting all four hypotheses in the specification simultaneously, can avoid ambiguity. This specification thus allows stronger conclusions to be drawn about any causal relationship between market structure and profitability.

Using an extensive US data set, Berger (1995) investigated performance-structure relationship for the US banks. The empirical result provided some support for the X efficiency and relative market power hypothesis. However, the explanatory power of the tested model was very low, as the efficiency and market power variables explained relatively little of the variance of profitability. And he suggested that future research should look beyond the simple market structure and efficiency variables for explanations of the variation in bank profitability and recommended adding some control variables that may affect profitability.

Later Berger and Hannan (1997) replicated four approaches used in the previous literature, and added several innovations. For example, both profit rates and price levels were employed as the dependent variables to proxy for banks' performance. Other factors such as the population, branching restrictions and the business failure rate were included in the estimation to control for the differences in market size, regulatory restrictions and business conditions respectively. In contrast with Berger's (1995) finding, they found more support for the structure-conduct performance hypothesis than for the relative market-power or efficient-structure hypotheses. Berger and Hannan (1997) also tested the 'quiet life' hypothesis and their findings supported the quiet life hypothesis.

Following Berger (1995), Frame and Kamerschen (1997) also employed direct measures of bank efficiency in examining the profit structure relation. But unlike Berger (1995), who used a nationwide bank sample, Frame and Kamerschen (1997) only focused on a sample of legally protected rural banks, as they believed that the existence of entry barrier was critical to study structure performance relationship. Moreover, their empirical test only distinguished between the X-efficiency hypothesis and relative market power hypothesis. They found support for the relative market power hypothesis but reject the X-efficiency hypothesis for their sample of data.

More recently, Tregenna (2009) analyzed the effects of structure on profitability for banks in the US during the pre-crisis period from 1994 to 2005. In the empirical analysis, efficiency was not found to be a strong determinant of profitability, suggesting that banks high profits during this period were not earned through efficient performance. Robust evidence was found that concentration increases bank profitability. This was held even when the largest banks were excluded from the sample. The analysis has important policy implications relevant to the current crisis, in particular the need for much strong a regulation of the market structure, pricing behavior and use of profits.

6.2.2.3 Empirical evidence from the EU using Berger's test

Similarly, some the EU studies also apply Berger's (1995) method to investigate the structure performance relationship outside the US.

Berger's (1995) study was first followed in the EU by Goldberg and Rai (1996) who studied the structure performance relationship in the European banking industry by employing data on banks across eleven European countries over the period 1988–1991. Goldberg and Rai (1996) found evidence favouring the relative market power hypothesis for all banks except for those located in countries with low concentration ratios, where the evidence supported the X

efficiency hypothesis.

Punt and Rooij (1999) later applied the Berger's approach and provided an empirical evaluation of profit-structure relationship in eight European banking sectors for the period 1992 – 1997. Testing results revealed that X-efficiency was the crucial factor explaining the profit-structure relationship. Some support was also found for the structure-conduct-performance hypothesis, although not as convincing as for the former hypothesis. Moreover, there were no indications of unfavorable price setting behavior as a result of increased market power.

Aguirre and Lee (2001) examined the structure-performance relationship for banks operating under different regimes (separated vs universal banking) in ten developed countries during the period of 1985-1999²⁴. The results showed support for the efficient structure hypothesis and suggested that in an ever growing integrated financial system, banks can benefit significantly from the implementation of a universal banking system.

Responding to the wave of consolidation in the Euro area in 1990s, Kapopoulos and Siokis (2005) examined whether the consolidation process should be rationalized on the basis of the benefits of efficiency or it should be attributed to the attempt of banks using greater market power to generate monopoly rents. The empirical results supported three of the four distinct hypotheses, but did not support the SCP hypothesis. It implies that the European banking industries did not favor collusion, and gave limited support to the RMP hypothesis that only banks with large market share and well differentiated products are able to exercise market power in pricing and consequently enjoy higher profitability. Moreover, the empirical results provided strong evidence for the efficiency hypothesis. This suggested that the rising concentration resulting from merger and acquisition activities were attributed to the faster growth exhibited by the more efficient banks.

²⁴

Canada, France, Germany, Italy, Spain, Switzerland, and the U.K. are classified as universal banking countries while Belgium, Japan, and the U.S. are classified as separated banking countries.

6.2.2.4 Empirical evidence from the developing countries under Berger's test

Recent research testing the market structure and the efficient structure hypotheses have expanded to various regions in the world including developing nations. But still a limited number of those studies involve direct measures of X and scale efficiencies in the emerging countries.

Al-Obaidan (2008) distinguished between the market structure paradigm and the efficiency paradigm by incorporating a direct measure of technical inefficiency in the six Arab GCC banking markets during 1996-2005. The empirical results confirmed the efficiency hypothesis. And it suggested that more technically efficient banks earned higher profits and consequently gained higher market share. The results also supported the view that restricting internal and/or external growth affected the economic efficiency of commercial banks.

Following Al-Obaidan (2008), Al-Muharrami and Matthews (2009) conducted similar research to examine the profit structure relationship in the GCC banking industry over the period from 1993 to 2002. But they found that the banking industry in the Arab GCC countries was best explained by the SCP hypothesis. The evidence clearly supported the view that concentration was the principal structural determinant of profitability.

Using the same approach, Fu and Heffernan (2009) carried out the first Berger's test of market structure and bank performance in China for the period 1985-2002. The empirical results found the relative market power hypothesis best described the Chinese banking sector during the first reform stage (1985-1992). In the second phase (1993-2002), although the results supported the X-efficiency version of the efficiency hypothesis, there was no evidence that efficiency has a positive effect on market structure. In addition, there was no evidence to support the quiet-life hypothesis, probably because strict interest rate controls prevented the domestic banks from earning monopoly profits.

Chortareas et al. (2011) advanced the existing literature by testing the market power and efficient structure hypotheses for nine Latin American countries over 1997-2005. They produced evidence supporting the efficient structure hypotheses. The findings were particularly robust for the largest banking markets in the region, namely Brazil, Argentina and Chile. Also capital ratios and bank size were found to be the most important factors in explaining profits for Latin American banks.

Table 6.1: Recent studies on hypotheses explaining the performance-structure relationship

Author	Country	SCP	RMP	ESX	ESS	QL
Berger (1995)	US	-	+	+	-	na
Berger and Hannan (1997)	US	+	-	-	-	+
Frame and Kamerschen (1997)	US	na	+	-	na	na
Tregenna (2009)	US	+	-	-	-	na
Goldberg & Rai (1996)	EU	-	+	+	-	na
Punt and Rooij (1999)	EU	+	-	+	-	na
Aguirre and Lee (2001)	developed countries	na	-	+	+	na
Kapopoulos and Siokis (2005)	EU	-	+	+	+	na
Al-Obaidan (2008)	GCC countries	-	-	+	+	na
Al-Muharrami and Matthews (2009)	GCC countries	+	-	-	-	na
Fu and Heffernan (2009)	China	-	+	+	-	-
Chortareas et al. (2011)	Latin America	-	-	+	+	na

Note: a '+' marks empirical support for the hypothesis, a '-' marks lack of support, and 'na' means the hypothesis was not tested.

SCP: Structure Conduct Performance, RMP: Relative Market Power; ESX: X-efficient Structure; ESS: Scale Efficient Structure; QL: Quiet Life

Overall, although Berger's (1995) approach has been applied to many countries, it seems that a relatively few number of studies focus on the determinants of bank performance in developing countries, especially only one study on China, thus a lot more efforts are required. Moreover, as these studies differ in methodology used to estimate efficiency (parametric vs non parametric) as well as control variables in the estimation, the results documented in the existing literature with respect to the different hypotheses are not very consistent. Table 6.1 summarizes the evidence of reviewed studies, which explored the performance-structure relationship under the Berger's (1995) approach.

6.3 Methodology and tested hypotheses

6.3.1 Testing models

In our empirical testing procedure, we closely follow Berger's (1995) methodology in testing the relationship between market structure and bank performance in the Chinese banking sector. Berger's test model combines all four hypotheses (namely SCP, RMP, ESX and ESS) together into one testing regression and includes a set of exogenous variables which account for factors explaining the profitability variation. Berger's approach attempts to distinguish among all four competing hypotheses by using direct measures of both market structure and efficiency, and all four hypotheses are represented by different variables separately.

The standard Berger's test model equation basically regresses a measure of bank performance (price or profitability) on variables measuring concentration, market share, X efficiency, scale efficiency and a vector of exogenous variables which affect bank performance. Generally speaking, a significantly positive coefficient for one variable (e.g. market concentration), and in

which the coefficients of other variables are either insignificant or small, indicates the corresponding hypothesis (e.g. the SCP) is valid. Note that all four hypotheses may be valid simultaneously, that is, the four key variables have significant positive coefficients, and this may be taken as evidence of the marginal contribution of all four hypotheses. The basic testing model can be expressed as:

$$\pi_{it} \text{ or } p_{it} = f^1(CON_t, MS_{it}, X - EFF_{it}, S - EFF_{it}, Z_{it}) + \varepsilon_{it} \quad [6.1]$$

π =a measure of profitability, such as ROA or ROE

p =a measure of bank output price, such as interest rate

CON =a measure of market concentration, such as N-firm concentration ratio or Herfindahl-Hirschman index (HHI)

MS = individual market share of a bank

$X-EFF$ = a measure of X efficiency

$S-EFF$ = a measure of scale efficiency

Z = a vector of exogenous variables

ε = random error

Moreover, for the validity of two efficiency hypotheses (EXS and ESS), a necessary condition has to be satisfied. That is the market structure variables (both concentration and market share) must be positively related to efficiency estimates (both X-efficiency and scale efficiency). This is because that the efficiency hypotheses claim that efficiency is the underlying driving force for profitability, where a firm with greater efficiency allows it to gain a greater market share and in turn lead to higher concentration and profit. To test this condition, two additional equations are estimated and test whether the coefficients on X-efficiency (X-EFF) and scale efficiency (S-EFF) are significantly positive in Equations (6.2) and (6.3).

$$CON_t = f^2(X - EFF_{it}, S - EFF_{it}, Z_{it}) + \varepsilon_{it} \quad [6.2]$$

$$MS_{it} = f^3(X - EFF_{it}, S - EFF_{it}, Z_{it}) + \varepsilon_{it} \quad [6.3]$$

As we have discussed before, the relationship between bank performance and market structure variables is not necessary to be positive, it could be negative or absent. This is what Hicks' (1935) quiet life hypothesis claims that firms with greater market power opt for a more relaxed environment in which less effort is made for maximising efficiency, at the expense of somewhat lower profits. As a result of this slack management, firms with greater market power are inefficient. The following Equations (6.4) and (6.5) are employed to test Hicks' (1935) quiet life hypothesis. For the hypothesis to be held, the coefficients on concentration (CON) and market share (MS) should be negative and statistically significant.

$$X - EFF_{it} = f^4(CON_t, MS_{it}, Z_{it}) + \varepsilon_{it} \quad [6.4]$$

$$S - EFF_{it} = f^5(CON_t, MS_{it}, Z_{it}) + \varepsilon_{it} \quad [6.5]$$

However, when estimating our testing equations above, we may face an important challenge. That is simultaneous equation bias problem, if you look at Eq. (6.1) - (6.3). Actually there is no simultaneous equation bias, as the Berger's model is recursive. If we substitute Eq. 6.2 and 6.3 into Eq. 6.1, we will have:

$$\pi_{it} \text{ or } p_{it} = f^1[f^2(X - EFF_{it}, S - EFF_{it}, Z_{it}, \varepsilon_{it}), f^3(X - EFF_{it}, S - EFF_{it}, Z_{it}, \varepsilon_{it}), X - EFF_{it}, S - EFF_{it}, Z_{it}] + \varepsilon_{it}$$

Re-write in a compact form:

$$\pi_{it} \text{ or } p_{it} = f^6(X - EFF_{it}, S - EFF_{it}, \bar{Z}_{it}) + \bar{\varepsilon}_{it}$$

And it shows only involves exogenous variables, therefore the OLS or panel Fixed effect

estimates are consistent for this recursive system.

6.3.2 Empirical testing model specification

In the empirical testing model, each of the two alternative measures of profitability is regressed on four key explanatory variables, namely the concentration, market share, X-efficiency and scale efficiency. And four additional exogenous variables are also included, which are real GDP growth rate, real GDP per capita, annual inflation rate, and state ownership dummy. All variables will be explained later in Section 6.4.

The following equation is used to empirically test the validity of the four hypotheses in the Chinese banking industry:

$$\begin{aligned} \pi_{it} = & \alpha + \beta_1 CON_t + \beta_2 MS_{it} + \beta_3 X - EFF_{it} + \beta_4 S - EFF_{it} \\ & + \beta_5 GDPG_t + \beta_6 GDPP_t + \beta_7 INF_t + \beta_8 DS_i + \varepsilon_{it} \end{aligned} \quad [6.6]$$

π = ROA or SROE

CON = Herfindahl-Hirschman index based on total assets

MS = individual market share of a bank based on total assets

X-EFF = a measure of X-efficiency (SFA)

S-EFF = a measure of scale efficiency (SFA)

GDPG = real annual GDP growth rate

GDPP = real annual GDP per capita

INF = annual inflation rate

DS = dummy of state ownership

ε = error term

6.3.3 Tested hypotheses

In the following, we consider each of five tested hypotheses in turn.

Hypothesis 1- the structure conduct performance hypothesis (SCP):

Hypothesis 1 is related to the relationship between market concentration and profitability. Under the SCP hypothesis, bank profitability is significantly positively related to market concentration. If the coefficient for concentration (CON) β_1 is positive and statistically significant in equation (6.6), then the SCP hypothesis is supported. In this case, the positive and significant coefficient for concentration signifies that higher market concentration is associated with higher profits for banks.

Hypothesis 2-the relative market power hypothesis (RMP):

Under the RMP hypothesis, market share (MS) is the key variable in equation (6.6), and bank profitability should be significantly positively related to market share. With positive and significant coefficient for β_2 indicating that larger individual market share is associated with higher bank profits. Thus positive and significant coefficient for market share would support the RMP hypothesis.

Hypothesis 3-the X-efficiency hypothesis (ESX):

Hypothesis 3, the X-efficiency hypothesis suggests that bank profitability is significantly positively related to X-efficiency. This hypothesis is supported if the coefficient β_3 for

X-efficiency (X-EFF) is positive and statistically significant in equation (6.6). This would imply that more X-efficient banks are more profitable.

Hypothesis 4-the scale efficiency hypothesis (ESS):

The scale efficiency hypothesis states that bank profitability should be significantly positively related to the scale efficiency. If the coefficient for scale efficiency (S-EFF) β_4 is significantly positive in equation (6.6), this is in favour of the scale efficiency hypothesis. It would suggest that bank operate on optimal scale would generate higher profit.

A necessary condition for the efficient-structure hypotheses (both ESX and ESS) to hold is that efficiency estimates have positive effect on market structure variables (concentration and market share), that is λ_1 and λ_2 in Equation (6.7) and δ_1 and δ_2 in Equation (6.8) should be significantly positive. To establish the presence, two equations are estimated below:

$$CON_t = \lambda_0 + \lambda_1 X - EFF_{it} + \lambda_2 S - EFF_{it} + \lambda_3 GDPG_t + \lambda_4 GDPP_t + \lambda_5 INF_t + \lambda_6 DS_i + \varepsilon_{it} \quad [6.7]$$

$$MS_{it} = \delta_0 + \delta_1 X - EFF_{it} + \delta_2 S - EFF_{it} + \delta_3 GDPG_t + \delta_4 GDPP_t + \delta_5 INF_t + \delta_6 DS_i + \varepsilon_{it} \quad [6.8]$$

Hypothesis 5-Quiet life hypothesis (QL):

The quiet life hypothesis is not a necessary part of the performance-structure paradigm, but the failure to account for the possibility of the quiet-life effect may lead to biased results in testing the above hypotheses. If the quiet life hypothesis holds, it tends to offset the positive profit-structure relationship, since gains from market power are partially offset by cost increases from the poorer efficiency. This could help explain why the profit structure relationship is not present or so weak in many pervious banking studies. To test the quite life hypothesis, the following two additional equations are estimated.

$$X - EFF_{it} = \gamma_0 + \gamma_1 CON_t + \gamma_2 MS_{it} + \gamma_3 GDPG_t + \gamma_4 GDPP_t + \gamma_5 INF_t + \gamma_6 DS_i + \varepsilon_{it} \quad [6.9]$$

$$S - EFF_{it} = \theta_0 + \theta_1 CON_t + \theta_2 MS_{it} + \theta_3 GDPG_t + \theta_4 GDPP_t + \theta_5 INF_t + \theta_6 DS_i + \varepsilon_{it} \quad [6.10]$$

According to the quiet life hypothesis, the signs of the coefficients γ_1 and θ_1 on CON and/or γ_2 and θ_2 on MS should be significantly negative in equation (6.9) and (6.10). Thus, banks with greater market power are less efficient due to a relaxed environment and slack management.

All the above equations are estimated by pooled ordinary least square (OLS) method and panel fixed effect method. Prior to estimate the equations, Hausman test has been conducted, and it suggests that the fixed effect is preferred over the random effect.

6.4 Variables specification and Data collection

6.4.1 Selection and specification of regression variables

6.4.1.1 Dependent variable: profit vs price

One main issue to be addressed in the market structure and performance research is selecting an appropriate measure to represent a firm's performance. Bank performance is measured in many different ways in the empirical literature. Two measures of performance are commonly used in the empirical studies testing the structure performance relationship. One is the price or net interest margin (the difference between loan rate and deposit rate) of particular banking products and services in order to capture the performance of the bank, while another is the

profitability measure, such as return on assets (ROA) or return on equity (ROE). Evanoff and Fortier (1988) suggested a number of reasons why the profit measure is preferable to price measure. Firstly, using the price of a single banking product as a measure of performance may be misleading because banking is a multi-product business. Secondly, profit measures may be more informative, where all products profits and losses are consolidated into one figure, and they avoid the problem of cross subsidization. Thus, profit is more suitable for the measure of bank performance as a comprehensive performance indicator since it integrates both cost and revenue into one measure.

There are two alternative measures of profitability which have been used extensively in the literature, namely return on assets (ROA) and return on equity (ROE). The ROA reflects management's ability to utilize the bank's assets to generate profits, specifically, it measures the profit earned per currency of assets. This ratio depends mainly on the bank's policy as well as some external factors related to the general state of economy and government regulations. The ROE reflects the effectiveness of management in utilizing shareholders' funds. In other words, it measures profit generated by per currency of equity capital. Although two measures reflect different aspect of profitability, the ROA is preferred as measure of bank profitability in our study. This is because the equity in Chinese banks has suffered important artificial changes due to the State's recapitalization programs during our examination period, which lead to large variation in the ROE figure, and result in poor regression fitness and insignificant estimates. Instead of using ROE, this study innovates by employing the shadow return on equity (SROE) as an alternative measure of bank profitability, which is obtained from the result in Chapter 5. The advantages of using the SROE is that the SROE is estimated from the cost minimization function which is more reliable and more close to the true return on equity, while ROE is calculated from accounting figures in bank statement, which can be easily influenced and manipulated.

6.4.1.2 Market structure variables

Two market structure variables are employed in this study, namely market share and market concentration. Market share is defined as the proportion of individual bank's total assets to total

assets of all sample banks in a given year: $MS_{it} = \frac{TA_{it}}{\sum_{i=1}^N TA_{it}}$

Consistent with many industrial organization studies, the Herfindahl–Hirschman index (HHI) is used to measure market concentration. The HHI is defined as the sum of the squared market

share of total assets for each bank: $HHI_t = \sum_{i=1}^N (MS_{it})^2$. Generally speaking, the more banks

there are in a market, the lower is the value of the HHI, other things being equal. The HHI is preferred over the N-firm concentration ratio as it takes into account both the number of banks and the inequality of market shares. It includes all banks present in the market, so in principle it captures all movements of concentration. But the concentration ratio only includes the market shares of a few largest banks in the data set and, thus, only captures some of the movements in the market.

6.4.1.3 Efficiency variables

In this empirical study, efficiency measures are derived from a translog cost function by using the Stochastic Frontier Approach (SFA). Efficiency measures (both X-efficiency and scale efficiency) used in our test are obtained from the results in Chapter 5.

X-efficiency is estimated under the Battese and Coelli (1995) (B&C 95) model and the conditional mean conditional variance (CMCV) model (please see detail in Chapter 5). The

reason for choosing efficiency estimates from these two models is that statistical estimation in Chapter 5 suggests that the time varying model is more appropriate. And other time varying model B&C (92) impose strict structure on efficiency trend, so we do not consider here.

Scale efficiency indicates whether banks with similar production and management technology are operating at optimal economies of scale. Following Hughes, Mester and Moon (2001), scale efficiency is calculated from the parameters of the translog cost function.

$$S - EFF_{it} = (1 - \sum \frac{\partial \ln TC_{it}}{\partial \ln z_{0it}}) / \sum_{j=1}^3 \frac{\partial \ln TC_{it}}{\partial \ln y_{jit}}$$

If $S - EFF < 1$, indicating banks are operating below the optimal scale levels and have the ability to lower costs by increasing output further, while if $S - EFF > 1$ then banks are required to downsize in order to achieve the optimal input combinations.

6.4.1.4 Control variables

In addition to the key variables used to test four specific hypotheses, other factors that might influence bank profit are also included in the regression. Unlike previous studies, bank specific variables such as size and risk are not incorporated in our model, because we believe efficiency measures which reflect the bank specific differentials already take into account those effects. Therefore, we only incorporate three macroeconomic variables and one dummy variable.

Three macroeconomic variables are selected to control general economic environment and accounted for influence of economic cycles, namely the real GDP growth rate, real GDP per capita and annual inflation rate.

One dummy variable is employed to proxy the impact of ownership structure on bank performance. The type of bank which is captured by the state ownership dummy (DS) reflect the degree of government influence and difference in corporate governance as well as type of activity that a bank conducts. We test whether the state ownership affects bank performance, it equals to 1 if the bank is state-owned, and 0 for non-state owned.

Table 6.2 below summarizes the definition and specification of variables used in our regression models.

Table 6.2: Variables used in the regression

Variables	Definition	Specification
<i>Dependent variable:</i>		
ROA	Profitability	Ratio of net income to total assets
SROE	Profitability	-(Elasticity of total costs with respect to equity)
<i>Explanatory variable:</i>		
CON	Market concentration	HHI based on total assets
MS	Individual market share	Share of total assets by each bank
XEFF	X efficiency	B&C 1995, CMCV model
SEFF	Scale efficiency	Hughes, Mester and Moon (2001) method
<i>Control variable:</i>		
GDPG	GDP growth rate	
GDP	GDP per capita	
INF	Inflation rate	
DS	Ownership dummy	State banks=1, non-state banks=0

6.4.2 Data collection

Annual bank level data is mainly collected from Bankscope database. Whenever Bankscope does not provide enough information or has missing/questionable values, we collect or double-check the data from other official sources as best as we can, such as annual issues of Almanac of China's Finance and Banking, 1997-2006; and annual issues of China Statistical Yearbook, 1997-2006. We also use annual reports provided by individual banks via their websites as complementary sources in tracing missing or unavailable data points, in some cases. All financial variables are measured in the Chinese domestic currency RMB and at constant price by using the GDP deflators.

Table 6.3 provides some summary statistics of the variables included in our estimation. It is worthy to discuss some of the key variables.

Table 6.3: Summary statistics of dependent and explanatory variables

Variables	Obs	Mean	Std. Dev.	Min	Max
ROA	371	0.005	0.458	-0.007	0.039
SROE	371	-0.035	0.117	-0.335	0.325
MS	371	0.036	0.071	0.005	0.196
CON	371	0.146	0.023	0.118	0.166
S-EFF	371	1.259	0.250	0.760	2.008
X-EFF95	371	0.771	0.105	0.465	0.988
X-EFFCMCV	371	0.908	0.087	0.427	1.000
INF	371	0.026	0.006	0.016	0.034
GDPG	371	0.094	0.012	0.071	0.111
GDPP	371	10890	3193	6038	16084

6.5 Empirical results

The main research question in this study is to test which is the driving force determining the bank performance in China, market power or efficiency. This section presents the findings of our empirical analysis. First, we consider the evidence for four main hypotheses in Berger's test, and then we discuss the results for quiet life hypothesis.

6.5.1 Estimation results for Berger's test

The regression results based on the ROA and the SROE under two estimation methods are documented in Table 6.4. Because using X-efficiency measures from the B&C 95 model and the CMCV model give similar regression estimates, here we only show results based on the B&C 95 model for illustration.

Table 6.4 shows that no matter which estimation technique is used, the coefficient on concentration (CON) is positive and significant when the ROA is used as the dependent variable, but insignificant under the SROE. Therefore, the SCP hypothesis is partially supported, which suggest that banks in a concentrated market can earn higher return on asset.

Similar to estimates on CON, the estimated coefficients on market share (MS) are also significant under the ROA, but insignificant under the SROE, either the OLS or the FE estimation is considered. Thus the RMP hypothesis is held under the ROA, although the coefficient is not correctly signed. The sign of coefficient on MS is negative; it indicates that banks are less profitable with larger market shares, which is inconsistent with the RMP hypothesis. This negative relation can be explained by the fact that banks with larger market

Table 6.4: Estimation results for market power hypothesis vs efficiency hypothesis

<i>Dependent variables</i>	OLS			FE				
	ROA	SROE		ROA	SROE			
	Coef.	t	Coef.	t	Coef.	t	Coef.	t
CON	15.641***	5.160	0.722	1.270	16.757***	5.920	0.229	0.440
MS	-3.950***	-3.590	0.552	1.620	-12.240***	-7.150	0.075	0.110
SEFF	0.210	1.502	0.132***	4.620	0.132	0.300	0.906**	1.820
XEFF95	0.559	1.200	0.095***	2.910	0.063	0.210	0.402**	1.900
INF	-5.412	-1.020	0.931	0.760	-5.897	-1.200	0.646	0.590
GDPG	6.802*	1.850	0.408	0.410	8.492	1.210	0.316	0.340
GDPP	0.007**	2.290	0.004	0.650	0.005***	2.760	0.003	0.110
DS	-0.432	-1.600	-0.033	-0.510				
Constant	-3.702***	-4.160	-0.097	-0.650	-3.252***	-3.250	-0.207	-1.370
R ²	0.392		0.478		0.412		0.528	

***, **, * indicates statistically significant at 1%, 5%, 10% significance level respectively. One tailed test for efficiency estimates.

share are mainly state-owned banks, they suffer low profitability due to massive accumulated NPLs, although the amount has been reduced substantially in recent years.

For the scale efficient structure (ESS) hypothesis, the estimated coefficients of scale efficiency (S-EFF) are found to be positive under all specifications, but only significant in the SROE regression. Therefore, the ESS hypothesis is only favored when the SROE is dependent variable. This suggests that more scale efficient banks will have higher SROE.

Similar to the ESS hypothesis, the acceptance of the X-efficient structure (ESX) hypothesis also appears to depend on the SROE based regression. The significant positive coefficients on X-efficiency (X-EFF) show that the ESX hypothesis is held when the regression is estimated using the SROE under both OLS and FE estimation. However, under the ROA neither the OLS nor FE is applied, the estimated coefficients on X-EFF are insignificant though is positive.

In sum, our empirical results show that the decision about which hypothesis is favoured is subject to which profitability measure is used. The evidence under the ROA based estimations shows that market power is the driving force to explain the bank profitability in China, as the SCP hypothesis is supported when the ROA is used as dependent variable. When the SROE is used as dependent variable, the efficiency hypotheses (both X-efficiency and scale-efficiency) are favoured, which suggest that the SROE is mainly efficiency driven. That is, banks with higher efficiency can generate higher SROE.

The other control variables do not provide much insight into the questions being addressed in this study, as most of estimates are insignificant. This can also partially explain why the value for R^2 is relatively low, since the set of selected control variables do not give significant explanatory powers. But it is interesting to find that regression based on the SROE has higher R^2 than the ROA.

Although some macroeconomic factors are insignificant, the annual inflation rate, real GDP growth rate and GDP per capita are all found to be positively related to banks' profitability. This indicates that in a good economic environment banks are more capable of generating higher profits. The coefficient on the ownership dummy (DS) shows the non-state banks are more profitable than state banks, although the relationship is statistically insignificant.

In addition, Table 6.5 below shows the results for the test of the necessary condition for efficiency hypotheses, which are specified in Eq (6.7) and (6.8). The signs on the coefficients for both X-EFF and S-EFF are significantly positive, and indicate the satisfaction of the necessary condition, which states that efficiency has positive effect on market power.

6.5.2 Estimation results for Quiet Life Hypothesis

In addition to the four main market power and efficiency hypotheses, the quiet life hypothesis is also tested in our study. The Table 6.6 shows the results of the test for the quiet life hypothesis. To satisfy the hypothesis, the signs of the coefficients on CON and/or MS should be significantly negative in the estimation of Eq. (6.9) and (6.10).

As shown in Table 6.6, the coefficients on both MS and CON are significantly negative when scale efficiency (S-EFF) is used as dependent variable. It shows that the presence of anti-competitive behavior adversely affects the scale efficiency. That is, the banks with greater market power are less scale efficient. However, those estimates are significantly positive under the X-efficiency (X-EFF) based regression. This suggests that, even though some big banks enjoyed some market power, there is no evidence to show banks are less X-efficient at the expense of profit. In summary, quiet life hypothesis is favored if scale efficiency is considered but not supported under X efficiency.

Table 6.5: Estimation resultsof necessary conditions for efficiency hypothesis

<i>Dependent variables</i>	OLS				FE			
	MS		CON		MS		CON	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t
SEFF	0.029***	7.090	0.002**	1.860	0.034***	5.330	0.018**	2.540
XEFF	0.009**	1.830	0.014***	5.050	0.008**	1.860	0.017***	3.570
INF	0.110	0.620	0.519***	5.270	0.091	0.980	0.466***	4.450
GDPG	-0.003	-0.010	-0.477***	-4.980	-0.012	-0.130	-0.471***	-4.660
GDPP	-0.001	-0.900	-0.001***	-13.370	-0.001*	-1.910	-0.001***	-11.400
DS	0.180***	58.610	0.001	0.380				
Constant	0.041***	2.940	0.240***	30.550	0.070***	6.630	0.215***	17.930
R²	0.944		0.865		0.411		0.859	
	(p-value=0.000)		(p-value=0.000)		(p-value=0.000)		(p-value=0.000)	

***, **, * indicates statistically significant at 1%, 5%, 10% significance level respectively. One tailed test for efficiency estimates.

Table 6.6: Estimation results of Quiet Life hypothesis

<i>Dependent variables</i>	OLS				FE			
	SEFF		XEFF		SEFF		XEFF	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t
MS	-5.014***	-8.240	2.227***	4.190	-2.533***	-5.260	0.054	0.070
CON	-0.504***	-2.440	4.849***	4.840	-1.745***	-4.100	2.986***	4.510
INF	1.955	0.850	-0.995	-0.490	1.419	1.690	-0.203	-0.160
GDPG	0.767	0.340	1.031	0.530	0.223	0.270	1.668	1.310
GDPP	0.001	0.340	0.001**	2.510	0.001*	1.860	0.001***	2.730
DS	0.519***	4.240	-0.266**	-2.490				
Constant	1.482***	4.540	-0.388	-1.360	1.065***	8.840	-0.056	-0.300
R²	0.434		0.309		0.406		0.379	
	(p-value=0.000)		(p-value=0.000)		(p-value=0.000)		p-value=(0.000)	

***, **, * indicates statistically significant at 1%, 5%, 10% significance level respectively. One tailed test for efficiency estimates.

6.6 Conclusion

The banking sector in China has undergone dramatic changes over the last ten years, as a result of financial deregulation and liberalization under the recent banking reform. The ultimate objective of the recent banking reform is to promote competition and efficiency as a way of improving the bank performance. This has been primarily induced by the WTO entry, which bring about full openness of financial market in China.

Rapid changes in the market structure of the Chinese banking industry raises questions about the consequences of these developments for the relationship between the structure of the banking industry and bank profits. Empirical studies often find a positive relationship between market structure and profitability. Broadly speaking, two main explanations for the existence of this positive profit-structure relationship have been brought up in the literature, namely the market power hypothesis (the traditional structure-conduct-performance (SCP) and relative market power theories) and the efficiency hypothesis (Scale efficiency (ESS) and X-efficiency (ESX)). In other words, an increase in profits could be a result of a rise of market power or improvement in efficiency.

This profit-structure relationship is frequently explored within industrial as well as financial economics. However, most previous studies examined the profit-structure relationship without incorporating direct measure of efficiency. Berger (1995) first solved the problem by employing direct measures to distinguish different hypotheses. Hence, Berger (1995) model results in this chapter have much stronger statistical properties than the traditional SCP model used in Chapter 3; consequently the Berger's version of the analysis is strongly preferred. In this study, we apply Berger's approach and examine the validity of different explanations for the profit-structure relationship in one of the fast growing economies - China. In addition, the quiet life hypothesis and the effects of macroeconomic factors on bank performance are also

assessed.

This study has mainly addressed three related issues for the banking sector in China using an unbalanced panel data set over the period 1997 – 2006: the existence of a profit structure relationship in the Chinese banking sector, explanations for this relationship and effects of other factors on bank performance.

By investigating which of those possible determinants (market structure and efficiency) of profitability is dominant in the Chinese banking sector, our empirical results support the market power explanation when the profitability is measured by the ROA. However, the efficiency justification is favored if alternative performance measure SROE is considered. Thus, it may suggest that the ROA is mainly market power driven, but the SROE is efficiency determined. Moreover, by examining the effect of macroeconomic factors, banks are found to be more capable of generating higher profits in a good economic environment. And non state owned banks are more profitable than state owned banks suggested by the state ownership dummy.

In addition to the four market power and efficiency hypotheses, the quiet life hypothesis is also tested in our study. The quiet-life hypothesis claims that firms with greater market power are less efficient due to the relaxed environment that produces no incentives to minimize costs. It is interesting to find that banks in China with greater market power are less scale efficient but more X-efficient

Chapter 7: Conclusion

7.1 Summary of findings

Over last three decades, the Chinese banking sector has experienced significant changes since the economic reform initiated in China in 1978. Especially after the entry into the WTO in 2001, which brought full openness of Chinese financial market to foreign competitors, the pace and strength of the banking reform have been accelerated and intensified. Hence, a new round of banking reforms has been launched from 1997 to 2006, which designed to modernise the Chinese banking sector and enable domestic banks to compete with foreign banks.

We believe that the banking reform implemented by the Chinese government under this critical period, such as recapitalization, liberalisation and deregulation, have a potential impact on the competition, efficiency and performance of the Chinese banking sector. In such a context, regulators and policy makers and bank managers are concerned whether the banking reform is effective in improving the competitiveness and cost efficiency as a way of improving the overall bank performance. Therefore, the primary objective of this thesis is to provide empirical analysis to evaluate whether the recent banking reform can effectively achieve these targets during crucial period under our consideration.

To fulfil our objectives, we employ an unbalanced panel dataset which covers 55 domestic commercial banks in China with total 371 observations during the reform period from 1997 until 2006. We firstly estimate the level of market competition in the Chinese banking sector by using both traditional structure conduct performance (SCP) and new empirical industrial organization approach (NEIO) Panzar-Rosse method.

We find out that with this approach the Chinese banking market is still moderately concentrated and that it is dominated by the state-owned banks, despite the state-owned

banks having seen their monopoly position weakening with the rapid expansion of the joint equity banks and city commercial banks, indicated by the decreased trend in both CR4 and HHI. Moreover, the Panzar-Rosse H statistic suggests that Chinese banks operate under a condition of monopolistic competition rather than monopoly in such a moderately concentrated market as China. By dividing the whole sample into two sub-sample periods (1997-2001 and 2002-2006), the empirical results show that there is an increase in Panzar-Rosse H statistic indicating Chinese banking market become more competitive and suggests recent banking reform is effective in improving market competition.

Under the traditional SCP method, two continuing debate hypotheses (SCP vs efficiency) are tested for the explanation between market structure and bank performance. Our empirical results find no support for the SCP hypothesis in Chinese banking industry.

As the traditional SCP method employs market share a proxy for efficiency, we adopt Berger (1995)'s method which improves the SCP method by incorporating a direct measure of efficiency. Therefore, in order to implement Berger's test as well as assess whether the banking reform has a positive impact on the efficiency, we measure the cost efficiency for Chinese banks. In our study, six models are estimated under the stochastic frontier approach to ensure the consistency and robustness of our results, namely fixed effect model, random effect model, Pitt and Lee model, Battese and Coelli (1992) model, Battese and Coelli (1995) model, and conditional mean conditional variance model.

We first assess the level of efficiency and its changes for our sample of banks as a whole over the entire ten-year period. The fixed effect model reports the lowest efficiency level (33%) with the highest standard errors, while the conditional mean conditional variance (CMCV) model generates the highest efficiency level (90%) with the smallest deviation. The other models report the overall mean cost efficiency for Chinese commercial banks around 70%-80%. In the case of change of efficiency level for the sample as a whole, although there are some fluctuations during the sample period, the overall cost efficiency generally improved by the end of our sample period.

Moreover, we examine the efficiency based on ownership difference, namely state-owned banks, joint equity banks and city commercial banks. It is interesting to find that apart from the CMCV model, all the models achieve a consensus that the state-owned banks exhibit the

highest level of cost efficiency, and the city commercial banks report the lowest level. However, the CMCV model finds the opposite evidence that the state-owned banks are the least efficient and the joint equity banks are the most efficient. Although the ranking appears differently under alternative models, all models show that the efficiency difference among three sub groups narrowed over the period under our consideration. One explanation for the difference in result is that the CMCV model ensures that all conditioning effects are used to determine the inefficiency difference whereas the other models use the conditioning effect to determine the position of the frontier itself.

Furthermore, an important finding is that we find the shadow return on equity is positive for the first half of our sample period, but becoming negative since 2002. The change of sign can be explained by the increase in the capital ratio in the Chinese banks under the WTO requirement which requires domestic banks to fulfill Basel II. This suggests that policy makers should be aware of that gains from efficiency increase could be offset by the recapitalization cost.

After obtaining the efficiency estimates, we carry out Berger's test which examines the validity of different explanations for the structure performance relationship as well as assess the quiet life hypothesis and the effects of macroeconomic factors on bank performance.

By investigating which of these possible determinants (market structure and efficiency) of profitability is dominant in Chinese banking sector, the empirical evidence provide mixed results which depend on performance measurement (dependent variable). The results support the market power explanation (the SCP) when the profitability is measured by the ROA. However, the efficiency justification is favored if alternative performance measure SROE is used. Thus, this may suggest that the ROA is mainly market power driven, while the SROE is efficiency determined. Moreover, the quiet life hypothesis which claims that firms with greater market power are less efficient due to the relaxed environment that produces no incentives to minimize costs, is held when scale efficiency is considered, while not accepted under the X efficiency. Furthermore, by examining the effect of macroeconomic factors, banks are found to be more capable of generating higher profits in a good economic environment. In addition, state-owned banks are found less profitable than non state-owned banks.

In short, banking reform in China implemented before and after the from 1997 to 2006 greatly enhances the capital ratio, improves the asset quality, as well as increases the competition and efficiency, hence enabling Chinese domestic banks to compete with foreign banks after the full openness of financial market.

7.2 Policy recommendation

7.2.1 Policy recommendation from competition study

The empirical findings of this study not only fill the gap in the literature; we also believe that our study could have general application to emerging countries whose banking system undergoes reform changes. More importantly, the empirical findings of this study have fundamental implications for policy makers, regulators and bank managers. The policy implications from this study are summarised as follows.

Firstly, we look at a possible policy suggestions derived from our competition study. A substantial fall in the CR4 and HHI as well as significant increase in the Panzar-Rosse H statistic indicates great improvement in the competition in Chinese banking market after the WTO entry, but the level of competition is much lower than other countries, which have H statistics range from 0.6 to 0.8 (Claessens and Laeven (2004)), compared to the figure of 0.6 in Chinese banking market. This implies that there is still much room for improvement of competition condition in Chinese banking sector in the future. More fundamental institutional changes may be required before China can reap the full benefits of increasing competition following the entry of the WTO. This sort of conclusion may help policy makers and regulators make more efforts for improving competition of the banking system by further liberalizing and creating a more suitable environment for competition.

For example, to increase the number of banks, the government should facilitate entry of foreign banks into the Chinese banking market, and make the whole process smoother and easier. Moreover, the government should encourage private banks which are founded by

wealthy enterprises and individuals, because there is very few private bank in China so far. Furthermore, the central authority should design more incentives for city commercial banks to operate in other cities. This will help enhance competition and improve city commercial banks' efficiency from effectively spreading risk and achieving economies of scale.

Apart from increasing the number of competitors in the market, government can also encourage the innovation and diversity of financial products and services. The more products and services banks can offer, the more choices customer can have, the more competitive the market is. In addition, although the government has liberalized most of interest rates and deregulated several business segments, the government should reduce the intervention further in order to make banks truly look after interests for the shareholders rather than government, and let market mechanism play dominant role.

7.2.2 Policy recommendation from efficiency study

Our empirical findings of efficiency study indicate that Chinese banks exhibit diseconomies of scale. This suggests that banks are too large to efficiently use their resources and earn profits. Chinese banks, especially state-owned banks which are considerably over-sized, could improve their scale efficiency by reducing the size. Moreover, the evidence also shows that state-owned banks are less cost efficient than non state-owned banks. This suggests that the ownership structure need to be further diversified. The foreign and private capital need to be absorbed to dilute the dominated state ownership.

More interesting, we find a negative shadow return on equity after the re-capitalization process, which drives the level of equity capital away from the long run equilibrium. In other words, banks are required to hold higher level of equity capital than they should in long run equilibrium. As a consequence, holding excessive equity impose significant cost for bank, which will in turn reduce the profitability and efficiency. Therefore, policymakers and regulators should be cautious that benefit gained from increased capital adequacy ratio and improved balance sheet could be offset by the cost of re-capitalization.

The finding of this study, however need to be interpreted cautiously and carefully given the full market liberalization process of the Chinese banking system is an ongoing process, not fully completed yet.

7.3 Direction of future study

Arising from the research done in this thesis, we can suggest potential directions for future work.

The Boone indicator is a new measure of competition. It was first introduced and applied by Boone (2000, 2004) and Boone et al. (2004), and now it is being broadly applied to measure competition in both financial and non-financial sectors. The main idea behind the Boone indicator develops the idea that when competition becomes more intense, less efficient firms are punished more harshly than more efficient firms. There will be a negative relationship between profitability or market share and marginal cost. The strength of this relationship (i.e. the profit elasticity with respect to cost) will vary with the intensity of competition.

Productivity growth is a major source of economic growth; thus, an understanding of how and why productivity measures change is of great interest to economists and policymakers. We can extend the study of efficiency in Chapter 5 to estimate Total Factor Productivity (TFP) change and decompose it into scale efficiency change, cost efficiency change and technological change (see Bauer (1990), Orea (2002), Lovell (2003) and Fethi et al (2009)). The advantage of TFP decomposition allows the researcher to determine the source of productivity growth and distinguish between shifts in the frontier and movements of firms towards the frontier.

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