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**Analysis of Bank Efficiency
of Chinese Commercial Banks and
the Effects of Institutional
Changes on Bank Efficiency**

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After several years of study and research, here comes my Ph.D dissertation: *Analysis of Bank Efficiency of Chinese Commercial Banks and the Effects of Institutional Changes on Bank Efficiency*.

Just like efficiency is an integrated ultimate results brought about by a number of factors, my dissertation is filled with complex contributions. I would like to take this opportunity to show my sincere gratitude to the following people who have given me great support and guided me to accomplish this study.

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Abstract

This study contributes to the well-established efficiency literature with respect to transition economies and developing countries. Although bank efficiency has been a popular research area in both developed countries and less developed nations, it has been scarce in China mainly due to the lack of data. This study is considered as the first study that comprehensively investigates bank performance using multiple methodologies of financial ratio analysis and stochastic frontier analysis for the period of 1995-2005. The effects of a variety of governance changes have also been differentiated in order to providing policy recommendations for the on-going banking reform. Meanwhile, this study has addressed a number of methodological issues and has developed a more comprehensive stochastic distance function model by combining advantages of existing models, approaches, methods and procedures.

Having experienced fundamental banking reforms for more than a quarter of century, the Chinese banking system has stridden towards a modern banking system with significant improvements in profitability, capitalization, and assets quality. Despite of these observed improvements, the banking system is still associated with relatively low profitability and capitalization, poor asset quality, and less liquidity, when benchmarking to 7 selected international renowned banks. One of the most impressive progresses has been the significant decrease in both outstanding NPLs balance and NPL ratio. However, it has noticed that the threat of NPLs problem to the economy as a whole remains unsolved.

This study has rationalized economic foundations for the banking reform in China being the principal-agent theory and the budgetary constraint theory. The performance of Chinese banks has been improved and the estimated efficiency level is consistently at 75% in terms of technical efficiency, cost efficiency and profit efficiency. Employing the method of Berger et al. (2005), this study has jointly analyzed the static, selection and dynamic effects of governance changes. Joint-stock ownership has resulted in outstanding performance, while state ownership has been associated with low technical efficiency and profit efficiency but high cost efficiency. Foreign banks are more profit efficient but less cost and technical efficient (static effects). Foreign investors have rationally made their investment decisions by

selecting more cost and technical efficient domestic banks, while less profitable domestic banks have been chosen for going public in line with government intension of reforming the unprofitable SOCBs (selection effects).

Attracting foreign strategic investors and encouraging banks going public are two major partial privatization strategies, which have been generally proved as effective reform measures. The former tends to have positive impacts on technical efficiency and cost efficiency, while significant short-term gains in profit efficiency have faded in the long-term. The expected profit advantage of foreign ownership seems to take an even longer time to be realized. Going public strategy has resulted in performance improvement in the long-term after short-term losses (dynamic effects).

We can not form a conclusion on whether the reform has succeeded, while what we can conclude is the reform is on the track with right direction. It is important to construct good corporate governance, but it is more important to ensure the good governance functioning. If those deep-rooted problems, such as government intervention and NPL problem, can not be dealt with properly in the near future, the chance of success is very small. Thus, our policy recommendations include consolidating up-to-date reform achievements, improving bank's managerial and operational skills, and reducing state's share in banks to lessen government interventions.

Estimated efficiency is found to be sensitive to the differences in the definitions of outputs and inputs, especially in the presence of high level of NPLs. The income-based model is superior to the earning assets-based model in the estimation of technical efficiency. Similarly, profit efficiency appears to be more appropriate performance measures over cost efficiency. However, we suggest the use of multiple models and measures to reveal more valuable information. Moreover, in estimating cost function and alternative profit function, market average input prices are found to be more appropriate than banks' specific input prices.

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Acronyms

ABC: Agricultural Bank of China
BOC: Bank of China
CAR: Capital adequacy ratio
CBRC: China Banking Regulatory Commission
CCBC: China Construction Bank Corporation
CCB: City Commercial Bank
DEA: Data envelopment analysis
E/A ratio: Equity to total assets ratio
HSBC: Hong Kong and Shanghai Banking Corporation
ICBC: Industrial and Commercial Bank of China
IFC: International Finance Corporation
IPO: Initial public offering
IMF: International Monetary Fund
JSCB: Joint-stock commercial bank
LLP: Loan loss provisions
LLR: Loan loss reserves
NPL: Non-performing Loans
PBC: People's Bank of China
RCC: Rural Credit Cooperative
ROA: Return on assets
ROE: Return on equity
SFA: Stochastic frontier analysis
SOCB: State-owned commercial bank
SOPB: State-owned policy bank
SOE: State Owned Enterprise
TFP: Total factor productivity
UCC: Urban credit cooperative
WTO: World Trade Organization

Chapter 1 Introduction

1.1 China's economy and financial sector

Since 1978, a reform and open policy initiated by the Chinese government has made significant economic success. China has been playing an increasingly important role in the world economic system. After 28 years of reform and opening up practice, its GDP has increased dramatically by 12 times from only RMB 364.52 billion (\$216.5 billion) in 1978 to RMB 20.94 trillion (\$2.7 trillion) in 2006 and the average GDP growth rate has been kept at about 10 % year-on-year (China Statistical Yearbook, 2006 and Xie, 2007). China has become the fourth largest economy in the world since 2005 by overtaking Britain and has moved closer to Germany during 2006, although the per capita GDP is lagged far behind about only one-fifth of the world average. With a double-digit GDP growth of 10.7 % in 2006, the Chinese economy has been projected to grow at 8 % in 2007 (Hu, 2007), suggesting that the Chinese economy is highly likely to continue a steady and fast growing path during the Eleventh Five-Year Plan (2006-2010).

Further economic growth and prosperity require the financial sector to be modern and efficient. In order to better serve the economy, the Chinese government initiated reforms in financial sector from the early 1980s along with its economic reform. Considerable progress has been made in both the real economic sector and financial sector reforms. According to the International Monetary Fund's (IMF), China's financial sector has become one of the largest financial sectors in the world, not only in relative terms as percentage of GDP but also in absolute terms. Backed by the sparkling achievements and promising perspective of the economy, Chinese financial sector has become more and more influential in the world financial market. For instance, after the successful IPO in both domestic and foreign capital markets in 2006, by August 2007, ICBC has become the largest bank and the third largest listed company in the world in terms of market value, overtaking Citigroup and Microsoft. Notably, during the second half of 2006 and early 2007, the performance of Shanghai and Shenzhen Stock Exchanges has exhibited significant implications on the performance of global capital markets. In less than 18 months, the market value of the listed companies in both the Shanghai and Shenzhen Stock Exchanges rose ten-

fold. Whether there is a big bubble in the stock market is not certain, but the booming size of the equity market in China has been largely led by the IPOs of three large state-owned banks (ICBC, BOC and CCB) and one state-owned insurance company, the PLA (People's Life Assurance).

In China, the financial sector is dominated by the banking system that has performed outstandingly in channelling savings into investment. Banks play a major role in financial intermediation, accounting for 75% of the capital in the economy. The increase in loan financing was equivalent to 23% of GDP, while equity and bond financing only accounted for 1% and 0.3% in 2003 (Maino and Maino, 2007). This situation is unlikely to be changed fundamentally in the near future, although capital and bond markets have been much developed.

On the other hand, the Chinese banking system is rather weak and inefficient. The banking system is dominated by state-owned banks and lacks the experience in credit assessment and risk management. Banking reforms have made progress on improving assets quality and performance, resulting in significant reduction in non-performing loan (NPL) ratio and a dramatic increase in profitability. However, these improvements are largely attributable to the transfer of NPLs from banks to asset management companies and the cleaning up of SOCB's balance sheets, which have an immediate positive impact. Whether the banking reform could succeed and whether Chinese banks could be viable in the long run on their own feet are unknown and will be examined by this study.

In contrast to the significant influence and development of the banking system, the capital and bond markets in China are among the smallest in the world. Equity market is still underdeveloped since the establishment of Shanghai and Shenzhen stock exchange in 1990. Equity market capitalization only accounted for 17% of GDP in 2005 compared with 60% or more in other emerging markets. As the results of the bullish market run and the reform of government owned non-traded "legal person" shares, the share of the equity market capitalization to GDP rose substantially to 50% in 2006. By July 2007, the equity market capitalization surpassed the value of GDP, breaking the record of RMB 21 trillion, due to the rather unexpected bullish performance in the Shanghai and Shenzhen Stock Exchanges. At the time of writing

up this thesis, the Shanghai Stock Exchange Index is marching towards the 5,200 level, which is five times as high as the level in early 2006. The majority of investors pursue capital gains rather than investing in real sectors by speculative trading. Insider trading also prevails in the markets due to ineffective regulations. The corporate bond market is far more underdeveloped, accounting for just 1% of GDP, compared with an average of 50% in other emerging markets. The underdevelopment is largely attributable to the mass and tight regulations, limited variation in interest rates, and more importantly, the required approval from the government.

The financial sector has long been subject to government intervention to finance less productive state-owned enterprises (SOEs), presumably in order to preserve jobs and maintain social stability. Private companies have prospered and contributed to the total GDP by a rapidly increasing proportion over the last two decades. Their productivity is double that of SOEs even after many SOEs have been restructured and become profitable. Nevertheless, private sector has only received 27% of loans and most investments have been channelled to SOEs (Farrell and Lund, 2006). Meanwhile, the limited capital market has been utilized mainly by SOEs. Companies have been selected by state regulators to be listed until early this century. With multiple objectives, rather than pure profitability, the financial sector has inevitably allocated funds less efficiently.

In balance, despite significant progress on banking reforms and impressive performance of the capital market, the Chinese financial sector as a whole is rudimentary and inefficient. Inefficiency is an aggregate result of many factors, such as political pressures on capital allocation to SOEs, inefficient operation of the dominant banking system, and the underdevelopment of bond and equity markets. A good financial sector should balance the development of each component—banking, bond markets, equity markets, the payments system and institutional investors. A modern financial sector should base lending decisions on market conditions in order to allocate funds to more productive projects or sectors and focus on sustainable economic development with a long-term and forward-looking view. There is a large gap between where the financial sector is and where a modern financial sector should be for such an amazing economy. To close this gap, further reforms are required not only from the government but also for the financial institutions.

1.2 China's banking system and its reform

Since 1949, the Chinese banking system had been a mono-banking system, entirely dominated by the People's Bank of China (PBC), the only bank in the country. Along with economic reforms, China has adopted a rehabilitation approach to reforming its banking system, in contrast to most transition economies in Eastern Europe where a shock therapy approach was adopted. One clear aim of the reform is to transform the banking system from a state-owned, monopolistic and policy-driven to a multi-ownership, competitive and profit-oriented one. Despite drastic institutional and structural changes, the pace of banking reform has lagged behind the rapid development in the real economic sectors.

Tang (2005) divides the three-decade banking reform into four periods. The first period, 1979-1984, focused on initial institutional restructuring. PBC was broken up into a central bank and four specialized state-owned banks, namely Agricultural Bank of China (ABC), People's Construction Bank of China (the bank was later changed to 'China Construction Bank' in 1996 and to 'China Construction Bank Corporation' in 2004. It is abbreviated as CCBC in the rest of this thesis), Industrial and Commercial Bank of China (ICBC), and Bank of China (BOC). The primary shape of the two-tier banking system was initially constructed. The second period, 1984-1994, was centred on developing the two-tier banking system. New regional and joint-stock commercial banks were established and they were allowed to compete with state-owned banks in order to create a competitive market environment. Nevertheless, state banks dominated the banking system and they served their designated sector of the economy, which effectively ruled out the competition in the banking market (Wong and Wong, 2001). Moreover, it was a transitional period. State-banks were used as governmental agents to help the reforms of SOEs. Frequent government intervention in banks' operations resulted in mounting non-performing loans.

During the third period, 1994-2003, the government commenced the commercialization process of state-owned banks. State-owned banks were legally defined as state-owned commercial banks (SOCBs) by the commercial bank law enacted in 1995 and their policy lending functions were officially taken away by three

newly established state-owned policy banks. However, commercialized state-owned banks still played important roles in policy lending. As a result, government intervention persisted and banks lending decisions were not truly based on commercial consideration. The banking reform was regarded as unsuccessful by the end of this period.

Since 2003, the banking reform has entered into the fourth reform period by implementing the most radical reforms. The more comprehensive reform was triggered by China's accession to the World Trade Organisation (WTO) in 2001. China committed itself to opening up not only the real economic sectors, but also the financial and banking system completely within a five-year grace period. Under WTO opening up schedule, domestic commercial banks will have to be in face-to-face competition with foreign banks on the basis of an international marketplace without any governmental protection from 2007. Facing these challenges, the government has accelerated and deepened bank reform through ownership restructuring and partial privatization of state-owned commercial banks.

To date, the government has made considerable efforts on banking reform. A series of comprehensive and concrete reform measures have been initiated, such as upgrading prudential regulations, tightening constructive supervisory framework, improving asset quality and provisioning, advancing lending practices, strengthening accounting and disclosure standards, constructing sound capital structure, lessening government intervention, removing credit quota and so on. Given the dominant role of SOCBs, the banking reform has been focused on improving their efficiency in order to transform them into internationally competitive commercial banks.

The most significant reform efforts made by the government are the two rounds of SOCBs bailouts in the forms of capital injection and NPLs divestment. In order to construct a sound capital structure, the government first injected capital of RMB 270 billion into four SOCBs in 1998 through bonds issuing. Later, the government injected capital of US\$22.5 billion into BOC and CCBC respectively in 2003 and US\$15 billion into ICBC in 2005 by using the state's massive foreign exchange reserves. Meanwhile, in order to clean up a stubbornly high level NPLs on SOCBs' balance sheet, the government implemented two rounds of NPL divestments. NPLs of

SOCBs were transferred to four newly created state asset management companies by the amount of RMB1.4 trillion in 1999, RMB 475 billion in 2004, and RMB 705 billion in 2005.

Having enlarged capital base and cleaned up their balance sheet, SOCBs are to be modernized through partial privatization to construct good functioning corporate governance. The latest strategies include attracting foreign strategic investors and encouraging SOCBs to go public. The former is motivated by the much-needed capital and the expectation of importing superior management and technology from foreign owners, while the latter is encouraged by market disciplining role to solve the agency problem. These measures were intended to fundamentally solve the problems of SOCBs, enabling them to become fully listed commercial banks that can compete and survive in the international financial market.

The strategy of attracting foreign ownership is positively re-acted by foreign investors who aim at having a well-positioned strategic seat before the full opening up of the market. They started with prudent trial investments in domestic banks since 2001, followed by a surge in 2004 and the subsequent years. Surprisingly, SOCBs have also received much attention and have attracted worldwide influential strategic investors. For instance, in 2005, Bank of America acquired a 9% stake in CCB and the Royal Bank of Scotland, together with Merrill Lynch and Li Ka-shing, bought a 10% stake in BOC. Goldman Sachs, Allianz and American Express signed a memo of understanding with ICBC to acquire a 10% stake. By 2006, most international banking giants and financial institutions have acquired equity stakes in domestic banks.

The second strategy of encouraging SOCBs to go public has also been implemented soon after financial restructuring and NPLs divestments. BOC, CCBC and ICBC have successfully made their initial public offering in the Shanghai and Hong Kong Stock Exchanges. The market reaction to these IPOs was highly positive from the second half of 2006. Their share prices rocket by up to 150%, making them among the few largest firms in the Shanghai Stock Exchange. Measured by market values, ICBC became the largest bank in the world measured by market value in August 2007, surpassing that of the Citigroup. These successful IPOs and subsequent extraordinarily performance in the stock markets provide a sound cornerstone for the

overall success of China's bank reform in the future. These remarkable achievements will undoubtedly have far-reaching economic implications, not only for China, but also for the world as a whole.

The banking reform has turned to a corner and the banking system is moving on the track toward modernization. Although considerable progress has been made, challenges, uncertainties and thorny problems remain. Building up good corporate governance is the first step of transforming SOCBs to modern enterprises. What could guarantee the ultimate success of Chinese banking reform is the substantial behavioural changes in management and operations toward that of world class banks. However, Podpiera (2006) finds no clear evidence on whether SOCBs have changed behaviour and have become market oriented in management and operations. Given the most radical reforms of SOCBs only implemented recently, it inevitably needs more time for such fundamental behavioural changes to take root.

Whether behaviour in management and operations could change depends on the extent to which government intervention exists. As long as government could exercise power over bank lending decisions in favour of fulfilling government political goals, there would be no behavioural changes toward modern banking practices and moral hazard problem would lead to inefficiency. Thus, the ultimate success of Chinese banking reform largely depends on whether banks can escape from government intervention.

Existing information and evidence suggest that government intervention in lending decision still persists but less explicitly and it is uncertain whether this implicit intervention could be reversed in near future (Dobson and Kashyap, 2006). The eleventh Five-Year Plan has addressed the growing rural-urban and regional inequality and has projected to balance the urban and rural development through urbanization. Governments obviously need to create more employment to absorb surplus labour force from rural-urban migrants and the role of banks in the achievement of the overall goals is uncertain. SOCBs are more likely to be required to support the development goals and provide necessary finance to politically preferred projects in the sacrifice of the economic objectives of profitability and efficiency as commercial banks. There exists a contradiction between the government

influences on SOCBs to support overall economic development goals and commercial banks' role to allocate credit to more productive borrowers. The implied government influence will defer the process of transforming SOCBs to truly commercial-based banks. Without carefully addressing and dealing with these conflicts, uncertainties and contradictions, the success of the bank reform is doubtful. Dobson and Kashyap (2006) argue that if economic growth slows these contradictions will become apparent and the upshot will be another round of government bailout.

1.3 Underlying theories of the banking reform in transition economies

The importance of a well functioning banking system for economic growth and development has been well appreciated by governments in developing and transition economies (La Porta *et al.*, 2002). As a result, the reform of banking system has become a high priority on the policy agenda of these countries in recent years. Banking systems in transition economies share many commonalities, such as the lack of skills, underdeveloped management and credit analysis system, and poor oversight institutions and legal frameworks. Earlier market-oriented reforms are similar by creating a two-tier system along with deregulation and financial liberalization. Subsequent reform strategies follow different paths concerning the privatization of state-owned banks.

One prominent feature of banking systems in transition economies is the prevalence of state ownership. The argument for the existence of state ownership in banks is that governments are able to channel funds to sectors and projects that cannot attract private capital due to low financial but high social returns. In such a case, profit-oriented private sector is undependable to balance social and economic goals (Huibers, 2005). However, both political and economic theories suggest the association of low efficiency and state ownership for a number of reasons. First of all, political theory suggests that state ownership in banks facilitates government to finance inefficient but politically desirable projects, i.e. SOEs. State-owned banks pursue multiple, often conflicting, goals, which lead to inefficiency. Secondly, the free-rider problem is rather serious in state-owned banks. All citizens are theoretical co-owners while they are unable to effectively influence the management of state banks, leaving the government the only influential agent. Consequently, they have no

incentive to monitor state banks' operations (Huibers, 2005). Thirdly, state-owned banks commonly face a soft-budget constraint that causes moral hazard problems resulting in inefficiency. Finally, the lack of discipline for state-owned banks' managers fosters their pursuit of quiet life and lessens their incentive to operate more efficiently. Empirical studies generally report low level of efficiency for state-owned banks in most developing and transition economies. Consequently banks reform in these countries commonly ends up with the privatization of state-owned banks.

Whatever strategies being used, the main goal of forming a modern market-oriented banking system is to improve efficiency by creating a well-functioning corporate governance structure for banks, especially for state-owned banks. Governments of these countries have implemented banking reform addressing the sources of inefficiency and reform strategies have been well formulated in accordance with two economic theories: the agency theory and the soft-budget constraint theory.

The first theoretical perspective on the banking reform is related to the agency theory developed in 1970s. The principal-agent problem arises in an agency relationship where one party (the agent) acts on behalf of another party (the principal) under principal's delegation. The moral hazard problem refers to the situation that agent (employee or manager) makes low level efforts on work or pursues its own interest because of differences in risk-taking preference and possibly conflicting desires and goals between two parties. When the agent does not bear the appropriate adverse consequences of its actions, the moral hazard problem may arise. It reflects the possible effect of information asymmetry on people's behaviour. The agent possesses more information than the principal does, which makes it difficult or costly to corroborate actual actions taken by the agent and to monitor the behaviour or performance of the agent. The principal-agent problem becomes more prominent in the case of state ownership in banks. Being the only influential representative of principals, the state has multiple and maybe conflicting commercial and social goals to pursue. Its role is ambiguously defined being both the owner and regulator. This rather complex situation makes the agents (the bank managers) unclear regarding what the principal exactly expects from them. Thus, the principal-agent problem is a source of inefficiency. The solution is to provide appropriate incentive so that agents are more likely to act in the best interest of the principal. Bank ownership reform

aims to turn the state-owned banks into joint stock enterprises with multi-ownership to enhance the corporate governance. The changed incentive structure is expected to better solve the agent-principal problem and therefore to improve bank efficiency.

A second theoretical perspective on the banking reform is related to the budgetary constraints theory first introduced by Kornai (1979). When a firm can expect to get financial subsidies in the future in case of financial distress and economic failure, it is considered to face a soft budget constraint. One argument for soft budget constraint is that government bailout appears necessary when the political price of the bankruptcy of firms is high due to unemployment that could lead to social unrest and when the sector, like financial sector, is of strategic importance for stability of the economy. However, it is generally believed that a soft budget constraint is also a major source of inefficiency because it intensifies moral hazard problems in state banks. The theory suggests that the state needs to abandon the role of being the last resort for state-owned banks and should never have to bail banks out in the future.

1.4 Bank efficiency literature

Over the past half a century, banking efficiency has been a hot research topic and extensive literature has been well established. In exploring the sources of inefficiency, earlier studies tended to focus on economies of scale and economies of scope. Economies of scale examines whether costs per unit can be reduced by increasing output, while economies of scope examines whether costs per unit can be lowered by joint production. Empirical studies of scale and scope economies show significant scale economies for medium-sized banks of \$100 million to \$5 billion in assets in the 1980s. Recent studies indicate that scale economies have increased substantially, existing for large banks of \$10 billion to \$25 billion in assets in the 1990s (Saunders, 1999). The recent merger and acquisition in the UK banking sector provides a good example of scale economies involving huge commercial banks. Such examples include the merger of the Royal Bank of Scotland with the National Westminster Bank, the Bank of Scotland with Halifax, and the earlier acquisition of Midlands Bank by HSBC and the merger of Lloyds and TSB. As for scope economies, however, empirical studies reveal small cost inefficiencies.

More recently, efficiency research has shifted to more sophisticated performance measures of efficiency concepts, including technical efficiency, allocative efficiency and economic efficiency. Technical efficiency refers to the ability of optimal utilization of available resources either by producing maximum output for a given input bundle or by using minimum inputs to produce a given output. Allocative efficiency refers to the ability to achieve the optimal combination of inputs and outputs under certain level of prices (Lovell, 1993). The economic efficiency is the product of technical efficiency and allocative efficiency. With price information, cost and profit efficiency are preferred performance measures since they are grounded on economic foundation by taking account of production technology and optimization at a given market prices and competition condition. The cost (profit) efficiency measures how close a bank's costs (profits) to the minimum (maximum) possible costs (profits) of a best practiced bank that produce the same bundle of outputs using the same bundle of inputs under the same conditions (Berger and Mester, 1997 and Kumbhakar and Lovell, 2000).

Well established efficiency literature has been mainly carried out in developed nations like the US and European countries. In general, large inefficiencies have been found in the order of 20% or more of total costs, or about 50% of operational profits (Berger and Mester, 1997). The preferred methodology includes various frontier approaches to estimate an efficient frontier and measure the relative efficiency of financial institutions as performance indicator. Berger and Humphrey (1997) provide a valuable summary on 130 studies of financial institution efficiency in 21 countries during different time periods using different estimation techniques. They find that results from various efficiency methods are inconsistent. Later on, Bauer *et al.* (1998) propose a set of consistency conditions by comparing different frontier efficiency methods with a purpose of regulatory analysis.

The focus of efficiency research in developed countries has been on the implications of efficiency results for financial institutions in the areas of government policy, such as deregulation, bank failure, merger and acquisition, and so on. Estimated efficiency results are regressed against a set of variables in order to identify possible factors that explain the differences in performance across financial institutions. Empirical studies have reached no agreement on the sources of the measured inefficiency differences.

During the last decade, banking reform in developing and transition economies prevail and bank efficiency in these countries has received considerable attention. The reform generally starts with financial liberalization and deregulation, followed by ownership reform through privatization usually in the forms of foreign ownership participation and/or going public. As a result, efficiency studies have focused on examining the effects of various reforms on bank performance. Ownership reform is one of the most important issues. The relationship between industrial ownership and performance has been examined extensively, especially in countries where state-owned banks dominate its banking system. Primary concerns are optimal ownership/management structure and better convergence of management interest with that of owners. Most empirical studies generally show a negative association between state ownership and efficiency (Bonin *et al.*, 2005b and Fries and Taci, 2005).

As to the relationship between privatization and performance, literature has generally documented improved post-privatization performance (Gilbert and Wilson, 1998; Williams and Nguyen, 2005). However, performance has improved only after the government surrendered control in those emerging and developing countries where partial privatization of state-owned banks is pervasive. This result has particular policy implication on the ongoing banking reform in China where the government remains a controlling shareholder of listed banks.

One popular strategy of bank privatization is through attracting foreign strategic investors who are expected to bring in modern banking techniques, superior management skills and advanced technology. Moreover, foreign owners are normally internationally well-known institutions, investment fund or international banks with a high profile that could help privatized banks to attract better clients, hire skilled labour and access cheaper sources of funding (Bonin *et al.* 2005a). Empirical studies (Boubakri *et al.*, 2005; Fries and Taci, 2005; and Bonin *et al.*, 2005a) provide strong evidence supporting this strategy. Another commonly used strategy of bank privatization is through encouraging state banks to go public, based on the premise that market discipline could improve bank efficiency by reducing the principal-agent problem. The theoretical argument has been supported by empirical studies, such as Berger and Mester (1997), Isik and Hassan (2003a) and Girardone, *et al.* (2004).

1.5 Research questions, objectives and contributions

Chinese banking system has experienced drastic and comprehensive reforms for more than a quarter of century. The reform has achieved phased success, while challenges remain. Apparently, there is a need for an in-depth and comprehensive efficiency study to be carried out in Chinese banking. A number of research questions could be asked and this study focuses on questions arising from four main areas. The first area to be explored is the economic rationale of the banking reform. What are the theoretical foundations for the ongoing banking reform in China? Is the banking reform motivated by economic theories of the principal-agent problem or/and the budgetary constraint theory? The second area to be addressed is the status quo of the Chinese banking system and the performance of Chinese banks. What is the current state of the Chinese banking system? Are Chinese banks efficient enough to compete with foreign banks? Has bank performance improved? Which banks have performed better and why? The third area is to examine the effects of various institutional changes in banks on bank performance. Institutional changes involve mainly ownership changes in order to construct good corporate governance thereby improving performance. Does foreign ownership involvement in domestic banks improve performance? Does the going public strategy have positive impacts on bank efficiency? What short-term and long-term effects do these reform strategies have? The fourth area is to explore policy implications regarding the Chinese banking reform. How should future policies be designed to improve competition and efficiency of the Chinese banks after privatization, or partial privatisation?

In answering these questions, this study concentrates on the current key issue concerned by the Chinese government, that is, how to transform its banking system into a modern banking system successfully. The overall success of banking reform depends on the success of SOCBs reform because of their dominant role in the financial sector. At the second National Financial Work Conference in 2002, deepening SOCBs reform was set on the top agenda of the Chinese financial reforms. The reform objective was clearly stated as the joint-stock restructuring of SOCBs in order to transform them into modern financial enterprises. Since then, the government has made breakthrough by sequential reforms of financial restructuring, joint-stock

restructuring and eventually listing three SOCBs on the stock exchanges with the forth SOCB under consideration. For whatever measures, the paramount purpose of banking reform is to build up a better governance and incentive structure to improve efficiency.

Berger and Humphrey (1997) suggest that three groups of people may benefit from bank efficiency studies: (1) policy makers by evaluating the effects of deregulation, mergers and market structure, privatization, etc.; (2) researchers by illustrating and comparing different methodologies; and (3) bankers by identifying the possible sources of inefficiencies against the industrial best-practice. Accordingly, the main objective of this study is to provide recommendations for future bank reform to policy makers. Meanwhile, this study also addresses methodological issues to obtain more precise efficiency estimates, which will enhance the reliability of policy recommendations drawn upon them.

Specific objectives of this study are fivefold. The first objective is to ascertain the theoretical economics grounds for the banking reform in China, answering questions arising from the first research area. To examine whether ownership reform and hardening budget constraints can improve efficiency, two hypotheses will be tested. First, joint stock banks are more efficient than the state-owned banks. Second, banks subject to a harder budget constraint are more efficient than banks subject to a softer budget.

The second objective is to assess the current state of the banking system and the performance of banks after more than 25 years of reform. Using a ratio analysis, this study aims at providing an overall subjective assessment of the status quo of the Chinese banking system. This study also evaluates bank performance and distinguishes well-performing banks from poor-performing ones to identify better governance structure. Frontier analysis method distinguishes the best practice banks against which the relative performance of each bank is derived using a numerical efficiency score and ranking. Employing a stochastic frontier analysis approach, performance is measured by up-to-date efficiency estimates of technical efficiency, cost efficiency and profit efficiency.

The third objective is to make recommendations for future reform by scrutinizing the real impacts of various reform strategies. The evaluation of the effectiveness and successfulness of the reforms could provide timely deviation remedy and faults correction. This is the most important objective of this study since it will ensure the success of the reform in the long term.

The fourth objective is to explore possible relationship between bank performance and bank specific characteristics and managerial differences in order to provide bankers some guidance to operate more efficiently and profitably. By identifying internal factors that are expected to explain the difference in efficiency scores or ranks, bankers are able to address and adjust where necessary these factors in business strategic planning in order to catch up with the best performer. This study addresses the features of risk-taking behaviour using a set of financial ratios to represent capital risk, credit risk, market risk and liquidity risk.

The final objective is to address methodological issues in order to provide information for future research. Issues discussed include efficiency concepts, functional forms, model specifications and the use of market average input prices. The robust estimation of best performing frontier ensures the precision of efficiency estimates, which in turn improves the reliability of findings and conclusions drawn from these estimates.

By achieving these objectives, this study contributes to existing literature on bank efficiency from the perspective of developing and transition countries. Despite the flourishing bank efficiency studies over the last several decades, the efficiency of the Chinese banking industry is sparsely researched. There are only a handful of studies carried out recently, including Yao *et al.* (2007), Fu and Heffernan (2007), Wang *et al.* (2005) and Berger *et al.* (2007), and Chen *et al.* (2005). This study attempts to fill in this gap by providing a comprehensive and in-depth efficiency study for the Chinese banking system.

1.6 Research methodology

In bank efficiency literature, how to define and measure bank inputs and outputs is one of the controversial methodological issues because banks produce multi-outputs using multi-inputs. There are two main approaches: production approach and intermediation approach. The former is more appropriate when studying the cost efficiency of banks by addressing the operating costs while the latter is more appropriate when studying the economic differentiation by controlling overall costs. This study adopts the intermediation approach (Scaley and Lindley, 1977) while it is modified by treating total deposits as an output but interest costs on deposit as an input.

How to determine the best-practice frontier to measure efficiency is another controversial methodological issue. Estimation methods are grouped into non-parametric and parametric methods. Both are well established with no consensus regarding which is superior to another and each fits different research issues. In empirical studies, they are roughly equally employed (Berger and Humphrey, 1997). Non-parametric methods estimate best practice frontier within the dataset and allows efficiency to vary over time. They do not pre-specify a functional form for the best practice frontier and make no assumptions on the distribution of the inefficiencies across observations. This group of methods assumes no random errors influencing bank performance and therefore the effects of omitted errors may be dissolved into efficiency estimates.

In contrast, parametric methods pre-specify a functional form for the best-practice frontier and make assumptions on the distributions of inefficiencies and random errors. Their principal advantage is that they allow for random errors, overcoming the main drawback of the non-parametric methods. However, parametric methods are criticized due to the pre-specification of a functional form for the best-practice frontier. This presumed precondition may lead to an inaccurate efficiency measurement due to a mis-specification of the functional form. Fries and Taci (2005) argue that parametric methods, in particular the stochastic frontier analysis (SFA), is more appropriate over non-parametric methods in efficiency studies in transition economies where the problems of measurement errors and uncertain economic

environments are more likely to prevail. This study adopts parametric method, in particular SFA, to estimate the efficiency of the Chinese banks, given the fact that China has been experiencing a significant transition period with rapid economic development.

Within the SFA framework, a primal approach is used to examine technical efficiency while a dual approach is used to estimate economic efficiency—cost efficiency and profit efficiency. Each approach has its own merits and this study employs both primal approach and dual approach to examining bank performance in order to provide a more complete picture for Chinese banks. The primal approach uses a pre-specified production function as the representation of the production technology of the industry and estimates technical efficiency. The main advantages of primal approach are threefold. First, it makes no behavioural assumptions, such as cost minimization or profit maximization. Secondly, estimated parameters contain economic meanings when estimating standard Cobb-Douglas production function. Dual approach commonly estimates cost or profit function in Translog functional form where first order parameters have no economic meanings because of the inclusion of too many intersect terms. Finally, it does not require input price information, which not only reduces the downside effect of inaccurate data on input prices but also makes research possible when input prices are not available.

The primary approach generally lacks the ability to accommodate the technology of producing multi-outputs using multi-inputs. Traditionally, when examining the efficiency of an industry with multi-outputs multiple-input nature, studies has been done through two compromising ways—either to aggregate multiple outputs into a single index of output or to take each output one time as the dependent variable. Addressing this drawback, a breakthrough has been made by applying a distance function to estimate technical efficiency. The distance function approach is first introduced by Shephard (1953, 1970) after proving the duality between input distance function and the cost function and between the output distance function and the revenue function in 1953 and 1970, respectively. This approach requires no input price information while accommodating a multi-outputs multi-inputs technology. It makes efficiency studies possible for industries employing multi-inputs and multi-outputs technology in the absence of input price information and behavioural

assumptions. Under certain circumstances, it is impossible for the dual approach to estimating cost function or profit function. For instance, price information may be unavailable or inaccurately measured and/or behavioural assumptions may not be appropriate or realistic. As distance function usually takes Translog or more flexible Flouirier functional form, estimated parameters are lack of economic meanings.

This study employs both traditional primal approach and the more advanced distance function approach to estimate technical efficiency of Chinese banking system. Traditional primal approach is used to rationalize the theoretical foundations of the Chinese banking reforms by estimating a standard Cobb-Douglas production function (Chapter 5). The main argument for this choice is that this model distinguishes the impacts of each hypothesis without compounding effects of other factors, such as the appropriateness of behavioural assumptions and the reliability of price information. Moreover, unlike other complex functional form, the interpretation of Cobb-Douglas production function is straightforward and estimated parameters have economic meanings. This would provide adequate information to examine the rationale of Chinese banking reform. This study also employs the recently developed distance function approach to provide more precise technical efficiency estimates for Chinese banks and differentiates the impact of various institutional changes on bank performance (Chapter 6).

Although the primal approach has its merits, a dual approach is preferred to evaluate performance of industries producing multi-outputs using multi-inputs when input price information are reliable and behavioural assumptions are appropriate. A dual approach examines industrial performance in terms of cost efficiency and profit efficiency that are grounded on economic foundation by accounting for not only production technology but also optimization at given market prices and competition condition (Berger and Mester, 1997). When estimating profit efficiency, alternative profit function is particularly chosen by assuming that banks can exercise a degree of market power in setting output prices. An important advantage of the alternative profit function over standard profit function is the proper examination of the profit efficiency when there are no reliable price measurement of certain outputs, such as transactions services and fee-based transactions (Berger and Mester, 1997 and DeYoung and Hasan, 1998). In order to provide more comprehensive information on

the performance of Chinese banks, this study also estimates cost efficiency and profit efficiency using a dual approach (Chapter 7).

Efficiency analysis using SFA commonly consists of two parts. It first estimates a pre-specified cost or profit function and decomposes error terms into a random error and inefficiency. The inefficiencies are assumed to follow an asymmetrical half-normal distribution, while random errors follow a symmetric standard normal distribution. In the second part of the study, the estimated inefficiencies are regressed against a set of variables that are expected to explain the differences in inefficiencies across firms. A commonly employed two-step estimation procedure conducts the two parts of the analysis by two separate steps, while a recently developed one-step procedure simultaneously estimates the best-practice frontier and identifies the possible factors responsible for the variation in efficiency from a single estimation. The former is considered to be inferior to the latter as the former suffers from serious econometric problems due to its contradictory assumptions on the independence of the inefficiency effects in two separate steps (Kumbhakar and Lovell, 2000).

This study uses a one-step estimation model, proposed by Battese and Coelli (1995) in which non-negative cost inefficiencies are a function of firm-specific variables. It assumes that the inefficiency effects are independently distributed as truncations of normal distributions with a constant variance, but with means that are a linear function of observable variables. Berger *et al.* (2005) highlight the importance to analyze all the relevant governance effects in the same model and they propose a method jointly examines static, selection and dynamic effects of governance changes on bank performance. This method is incorporated into the second part of the analysis in this one-step procedure to examine the effects of banks' institutional changes on their performance.

The data on Chinese banks cover the period 1995-2005 and are collected mainly from BankScope produced by the Bureau van Dijk. It is a reputable database, including data on more than 10,000 banks world-wide with monthly update. The latest issue of the BankScope database used in this study is May 2007. Other important complementary data sources include Almanac of China's Finance and Banking (1986-2006), China Statistical Yearbook (1996-2006) and the website of regulatory

bodies and commercial banks. In the awareness of the questionable data quality in China, data have been carefully cross checked where possible and have been adjusted where necessary in order to improve the reliability of research findings. With the best available data, this study provides fruitful and rich information on the performance of the commercial banks and useful policy recommendations for the ongoing banking reform in China.

1.7 The structure of this study

The next chapter traces back the history of the Chinese bank system and portrays its evolution. The purpose is to describe the development process of the banking system and to provide comprehensive background knowledge about the banking system and its on-going reform. It starts with the origin of the banking system and its role in the centrally-planned economy about half a century ago. Then it depicts the reform process that transforms the banking system serving a centrally-planned economy into the one to be viable in a market-based economy. The whole reform process has been divided into four sub-periods. For each sub-period, this chapter discusses in detail the motivation of reform, problems being dealt with, policy responses, objectives and outcomes. It not only provides good understanding on the Chinese banking system, but also identifies remaining problems and new challenges from a forward-looking perspective.

Chapter 3 reviews the bank efficiency literature. This chapter first introduces basic efficiency concepts and frontier estimation techniques and discusses their inherited merits and shortcomings. After a brief review on bank efficiency literature worldwide in general, particular attention is paid to bank efficiency studies in developing countries and transition economies. Banking systems in these nations share many commonalities and most of them are either completed reform or being reformed toward profit-oriented market-based modern banking system. This chapter focuses on reviewing the effects on bank performance of various banking reforms, such as deregulation, privatization, ownership reform, foreign banks entry, and foreign ownership participation in domestic banks. Literature review provides guidance for this study in terms of theoretical foundation, research direction, objectives, and

methodologies. Moreover, critical review of existing literature helps identify gaps to be filled in.

Chapter 4 describes data and assesses the current state of the banking system. It first discusses where data have been collected and how the sample has been constructed. Then it assesses the current state of the Chinese banking system using conventional financial ratio analysis. The assessment provides comprehensive information of the Chinese banking system for the period spanning from 1995 to 2005 when the banking system experienced the most drastic reforms. Borrowing financial indicators from the macro-prudential analysis framework, the performance and financial condition of Chinese banking industry is analyzed in terms of profitability, capital adequacy, asset quality, and liquidity. These indicators are also compared with those of well-know international banks. Any favourable or downside trends will be investigated in depth to reveal underlying reasons and problems. The main purpose of this chapter is to identify strengths and weaknesses of the Chinese banking system from a financial perspective.

Chapter 5 examines whether concrete banking reform measures initiated by the government are based on the agency theory and budgetary constraints theory. The purpose is to uncover the economic rationale of the ongoing bank reform in China. SFA and Cobb-Douglas production function are employed to test two hypotheses. First, by hypothesizing that joint-stock banks are more efficient than state-owned banks, it tests whether ownership reform would better solve the agent-principal problem and thus improve bank performance. Secondly, by hypothesizing that less capitalized banks (facing a hard budget constraint) are more efficient than well capitalized banks (facing a soft budget constraint), it tests whether hardening budget constrains could improve banks performance. Empirical evidence supports two hypotheses and justifies the economic motivation of bank reform.

Chapter 6 evaluates bank performance in term of technical efficiency to examine whether the performance has improved after more than two decades of unremitting reform efforts. The impacts of various institutional changes on bank performance are differentiated using static, selection, and dynamic governance indicators. Two important reform strategies are of particular research interest, namely the attracting

foreign ownership strategy and going public strategy. The purpose is to examine the impacts of these strategies on bank performance and therefore to evaluate the successfulness of ongoing reform in terms of technical efficiency. Results show more favourable impact of foreign ownership participation than the IPO strategy. This chapter also contributes to the development of research methodology. Concerning the frontier estimation, this chapter develops a comprehensive stochastic distance function model by constructively and innovatively combining the advantages of existing model, procedure and method. This will enhance the reliability and improve the precision of estimation results. Exploring the sensitivity to the definition of inputs and outputs, this chapter compares results from income-based specifications and earning assets-based specifications, providing valuable suggestion for efficiency study in banking systems with high level of non-performing loans.

Employing a dual approach, Chapter 7 estimates cost efficiency and alternative profit efficiency of Chinese banks to assess bank performance from more concrete aspects. When price information is available and behavioural assumption is appropriate, these economic efficiency concepts are preferred because of their economic foundations. Similar to Chapter 6, the impacts of various reform strategies are differentiated in order to probe policy implications and to provide recommendations for future reform. Evidence is mixed but generally supporting privatization strategies under review. Meanwhile, this chapter also addresses two issues concerning methodology of the estimation of cost efficiency and profit efficiency. The purpose is to choose better functional form and input price proxy to improve the quality and precision of estimated results and usefulness of policy implications and recommendations. It examines the influences of using different functional forms as presentation for cost and profit function. By comparing results from the standard translog functional form and Fourier flexible functional form, the latter is preferred because of slightly better estimation. Another issue is the use of bank specific input prices in most cost and profit efficiency studies, which violates the assumption of exogenously determined input prices for cost minimization and profit maximization to be held. This chapter compares bank specific input prices and market average input prices and find that market average input prices lead to better estimation results.

Chapter 8 draws conclusions by summarizing comprehensive findings of this research that have been discussed in detail throughout the thesis. It first looks at the soundness and stability of the Chinese banking system and point out its strengths and weaknesses by looking at bank profitability, capital adequacy, NPL problem, and liquidity. Having justified economic rationale for the banking reform policy, this chapter provides an overall performance assessment for the banking system as a whole and for different types of banks taking into account all of technical efficiency, cost efficiency and alternative profit efficiency. The impacts of different reform strategies on bank performance measured by different efficiency concepts are summarized. These findings have important policy implications. By taking full account of the Chinese reality, three policy recommendations are made for future banking reform. This chapter also summarizes findings concerning mythologies, which provides valuable suggestion for future efficiency research not only for developing countries and transition economies but also for other countries in the world.

Chapter 2 the Chinese banking system

2.0 Preamble

This chapter attempts to draw an overall picture for the Chinese banking system in order to provide background information for this research. It starts with a brief review on the history of the banking system in section 2.1. Since 1978, the banking system has entered a reforming period, which can be divided into four sub-periods. Section 2.2 to section 2.5 go through each sub-period with detailed discussion on reform purposes, challenges, outcomes, remaining problems, and necessary policy responses, respectively. As the results of more than a quarter of century of comprehensive reform, the former policy-driven banking system has been transformed much closer to a market-based modern banking system. Section 2.6 sketches the status quo of this system and points out possible future challenges when taking full account of the China's speciality and reality.

2.1 A brief history of Chinese banking system

The new China's banking system was established in 1949, when the People's Republic of China (hereafter China) was founded. Over half a century, the banking system has gone through two distinctive evolutionary periods: mono-banking period (1949—1978) and reforming period (1979—now). The mono-banking system was a highly centrally-planned unitary banking system, dominated by the PBC, the only bank in the country. PBC was in charge of nearly all financial functions: the conduct of monetary policy, exchange policy, foreign reserve management, deposit taking, commercial lending and investment. The PBC essentially combined the roles of the central bank and the commercial banks. Its operation was subject to strict cash and credit plans set in accordance with the production plans projected by the State Planning Commission (Wong and Wong, 2001).

Although a few banks were established during this period, the structure of the banking system was unchanged and the dominant status of PBC was never challenged. The People's Construction Bank of China was founded in 1954 but it was a subsidiary of Ministry of Finance. BOC, initially founded in 1912, became a

subsidiary of the PBC dealing with foreign currency transactions exclusively since 1950's. ABC was established in 1951 but lately ceased.

These banks were wholly state-owned and served the state centrally-planned production projects. Under central planning, banks passively collected household savings and channelled funds in accordance with national production plans. They were merely accounting agencies, keeping track of the financial transactions on planned allocations. Banks' operations were driven by government needs rather than profit. Thus, the banking system played only a limited role in promoting economic growth. Normal commercial banking skills, such as risk management and project selection, were totally ignored (Yang, 2002).

This centrally-controlled mono-banking system had lasted until 1978 when Deng Xiaoping started his reform and open up policy in China. Since then, the banking system has entered a gradual reform period and has experienced drastic institutional changes toward a market-based banking system. Along with China's comprehensive economic reforms, the government has launched a series of concrete reforms with respect to its banking system in order to transform it into a more open and competitive banking system. According to Tang (2005), the reform period can be divided into four sub-periods: (1) the period of initial institutional restructuring during 1979—1984; (2) the period of state-owned specialized banks during 1984—1994; (3) the period of commercialization during 1994—2003; and (4) the period of modernization since 2003 onward.

2.2 The period of initial institutional restructuring during 1979—1984

Since the economic reform started in 1979, the centrally-planned banking system was no longer fitted for the need of economic development. This called for institutional reform to separate commercial banking operations from the regulatory and supervisory body of the central bank. This institutional reform was kicked off in 1979 by the introduction of a two-tier banking system. This was regarded as the first milestone in the transformation of the mono-banking system into a modern one. The government removed the monopolistic position of PBC by breaking up PBC into two arms: the central bank and the commercial operations. The central bank retained the

name of PBC. The primary objective of the central bank was clarified as maintaining price stability, enforcing strict supervision over financial institutions, conducting clearance, and issuing bank notes. The headquarters were also in charges of issuing and implementing monetary policy, formulating a credit plan in accordance with the national economic plan.

The commercial operations of PBC were stripped off to four specialized state-owned banks. The ABC reopened in 1979 and took over PBC's rural wholesale and retail banking businesses and responsibilities for supervising a network of rural credit cooperatives (RCCs) that had been providing small-scale rural banking. The People's Construction Bank of China was specialized in dealing with medium to long-term credit for fixed assets investment of the government and urban large construction projects in the 1980's. It was lately renamed as China Construction Bank in 1996 and was restructured as China Construction Bank Corporation in 2004. BOC was specialized in handling foreign currency transactions and trade finance in 1979. ICBC was established in 1984, taking over commercial banking activities in urban areas from PBC and it used to be the major financier of funds to China's urban areas and manufacturing sector (Yang, 2002). BOC and ICBC were also restructured as joint-stock banks in 2004 and 2005, respectively.

These four state-owned banks provided services mainly to SOEs within a designated sector of the economy. They operated as well-encapsulated monopolistic institutions, with no responsibilities and incentives to penetrate and compete across regions and sectors. Each of them had provincial and local branches and each branch operated within a designated region under the administrative control and guidance from the respective local authority. As a result, all banks and their local branches had their own serving niches, effectively ruling out any possibility of free competition.

The achievement in this period was the breaking-up of mono-banking system replaced by a central bank and four specialized state-owned banks. This represented the first step to establish a two-tier banking system where four state-owned specialized banks were the mainstay. They were designed to serve different sectors of the economy and they were the official source of financing for state-owned enterprises (SOEs) within each assigned serving realm. There was no stock and

corporate bond market, leaving the entire role of financial intermediation to them. A soft-budget constraint was common practice, even more explicit for state-owned banks since they financed SOEs inherently as a government agent regardless of their profitability. They hardly had autonomy to make lending decisions, so no chance to make such decisions based on commercial considerations. There was no competition at all in the banking industry.

2.3 The period of state-owned specialized banks during 1984—1994

During this period, the reform purpose is to transform the policy-driven banking system to a market-oriented one. The government advanced institutional restructuring in an attempt to increase competition in the banking system and to create a market competitive atmosphere. Two major reform measures include the allowance of foreign bank and new domestic bank entry to inject new source of competition into the market and the removal of the restrictions on state-owned specialized banks' business scope to release state banks for competition.

In the 1980s and 1990s, the majority of nationwide or regional joint-stock commercial banks (JSCBs) were launched. The most important feature of these banks is the shareholding ownership structure, which was an institutional breakthrough in the Chinese banking industry. In 1986, the Bank of Communications was re-launched as the first national wide JSCB. It was originally founded in 1908 and merged by PBC and People's Construction Bank of China in 1949 except for operations in Hong Kong. Afterward, JSCBs burgeoned and most JSCBs were established during this period, including CITIC Industrial Bank, China Merchants Bank, Shenzhen Development Bank Co., Ltd, Industrial Bank Co. Ltd, Guangdong Development Bank, China Everbright Bank, Huaxia Bank, and Shanghai Pudong Development Bank.

JSCBs were operated as commercial banks with the main objective of profit maximization. In this period, the central bank has given JSCBs more room to develop their business scopes and geographical presence in order to accelerate the emergence of market discipline. For example, JSCBs were allowed to boost their size and obtain capital through listing on stock exchanges. It is arguable to distinguish JSCBs from state-owned specialised banks since the key shareholders of JSCBs were still local

governments and the state-owned or state-controlled enterprises. However, JSCBs were more competitive, and more profit-oriented, and more performance-conscious because of less government intervention, flexible personnel management as well as better overall management (Wong and Wong, 2001).

RCCs and urban credit cooperatives (UCCs) were also set up in the 1980s to diversify the banking system and to channel funds to projects in areas where resources were scarce. The main business of RCCs and UCCs were to finance small and medium-sized rural or urban enterprises and individuals. Their lending policies were governed by the local public authorities. Thousands of RCCs played an important role in mobilizing rural household savings, channelling funds to town and village enterprises, agricultural activities, and other development projects in rural areas. These financial institutions were supplementary to the banking system.

In 1985, the authorities removed the restriction that specialized state banks had to serve their respective designated economic sector in order to increase competition in the banking system. The four state-owned specialized banks were permitted to enlarge their business scope and to compete with each other as well as JSCBs across their original boundaries. State-banks were institutionally released and had same opportunities to compete for attracting deposits and extending loans to better quality clients as JSCBs (Wong and Wong, 2001).

By 1994, the initial institutional restructuring of banking system was completed. The two-tier banking system took shape, which was dominated by state-owned banks, along with joint-stock commercial banks as growth engine and UCCs and RCCs as supplementary. However, the reform failed to achieve the main goal of transforming a policy-driven banking system to a market-oriented system. Competition in banking market was increased but insufficient to create a market-based banking atmosphere. The banking system remained as policy-driven while the role of state-owned banks became rather vague and contradictory. Banks were officially expected to compete with each other as well as JSCBs and to be profit-driven institutions. This expectation was overwhelmingly diminished by the strong role of governmental agencies responsible for promoting macroeconomic stability and maintaining economic growth. State-owned banks still acted as government arms to help implement production plans

projected by the State and Regional Planning Commissions. Banks' operations were frequently intervened by the central and local governments. The local branches were under government control and much of their lending activities were still driven by the needs of policy makers.

Policy-driven banking system extended loans to SOEs on the basis of fulfilling the national and regional production plans and to maintain employment, regardless of profitability. Although SOEs reform had made some progress on improving enterprises profitability, about two-thirds of SOEs were still loss maker during this economic transition period, of which one-third were even unable to generate sufficient earnings to cover interest payments. The pace of SOEs reform was constrained by the concerns over social stability and public support for reforms, and the rather poor performance of SOEs (Karacadag, 2002).

An inevitable result was a huge amount of non-performing loans and losses for their financing banks—state-owned banks. These NPLs and losses were regarded as the costs of institutional transition of the economy and the state were expected to be responsible for cleaning them up. Thus state banks were implicitly guaranteed by the government and enjoyed a soft budget constraint when SOEs were subject to hardening budget constraints. Commercial banking practice and skills were hardly developed, given the prevalence of policy lending practice. These problems stood on the way of successfully transforming the banking system to a market-oriented system.

2.4 The period of commercialization during 1994—2003

Banking reform was considered as unsuccessful in contrast to the rapid economic development to date, suggesting the commercialization of state-owned banks could no longer be postponed. Furthermore, after joining WfO in December 2001, China committed itself to opening up not only the real economic sectors, but also the financial and banking system completely within five years. The domestic commercial banks would have to compete with foreign banks and other overseas financial institutions on the basis of an international marketplace. However, the banking system in China at that time was still under enormous financial stress due to the high prevalence of non-performing loans (NPLs), low capitalization and poor management.

Indeed, its low efficiency and mounting NPLs made the reform more and more difficult and challenging. In the ominous words of Gordon Chang (2001), WTO membership would lead to bankruptcy of domestic banks and would shut down the national credit system.

Facing these challenges and opportunities, Chinese authorities initiated the second wave of banking reform, centring on the separation of commercial lending from policy lending and the management of NPLs. Comprehensive and concrete reform measures emphasized four aspects: (1) Legal environment and institutional restructuring; (2) financial restructuring of SOCBs; (3) financial liberalization and opening up; (4) strengthening prudential regulatory and supervisory framework.

2.4.1 Legal environment and institutional restructuring

In the recognition that policy lending practice of state-owned banks was detrimental to the health of the whole banking system, the government established three policy-banks to take over policy lending activities from state banks in 1994. They were expected to focus on long-term development finance and other policy-lending activities. The intention was to move the state-owned specialized banks away from being driven by policy towards being driven by profit and competition.

Three policy banks include the China Development Bank, the Import-Export Bank of China, and the Agricultural Development Bank of China. The China Development Bank, the largest policy bank, was designed to deal with long- and medium-term lending to finance construction projects in infrastructure and strategic industries. Later, it also planned to launch a new policy to provide financial support to promising SMEs in collaboration with city commercial banks in order to promote SMEs expansion and employment. The purpose is to mitigate the impact of China's entry to WTO that unemployment would raise in the short run because WTO would accelerate China's structural reforms and urbanization process. Import-Export Bank of China was responsible for providing loans to import and export companies. Agricultural Development Bank of China was supposed to finance the procurement of agricultural products and development projects determined by central government. The main capital sources of these policy-lending banks were borrowings from PBC and issuing of bonds domestically and internationally, although the Agricultural Development Bank of China accepted deposits on a

limited scale. These three policy-lending banks were guided by individual charters rather than the Commercial Bank Law enacted in 1995. Since their establishment, policy banks expanded quickly. For example, total assets of three policy banks increased from RMB 747 billion in 1995 to RMB 3369 billion in 2005. They played an important role in the rapid development of the Chinese economy

The objective of establishing policy bank is to improve state banks' performance by freeing the Big Four from extending policy loans to loss making SOEs. Notwithstanding this purpose, the Big Four still played a significant role in policy lending activities. The roles of the commercial banks and the policy banks were not well defined in actual practice. In theory, the Big Four became commercial banks governed by the Commercial Bank Law erected in 1995 and they were granted with operational autonomy. The Big Four were expected to operate on a pure commercial basis. However, in practice, the serving and lending capacity of the policy banks were unable to meet the need for policy lending previously provided by the Big Four due to the lack of a branch network and capitals. Taking total fixed asset as a rough indicator of the network serving capacity, total fixed asset of policy banks expanded from RMB 0.75 billion in 1995 to RMB 13.6 billion in 2005, while that of the Big Four was RMB 103 billion and RMB 329 billion in 1995 and 2005 respectively. Therefore, the Big Four were frequently subject to pressure from both the central and regional authorities to make loans to their preferred sector and enterprises with less consideration of the profitability and recoverability of loans. On the other hand, policy banks, except for the Agricultural Development Bank of China, actually served more profitable sectors of the economy. For example, the China Development Bank provided finance to industries and infrastructure projects such as electricity, energy, roads and telecommunications. The Import-Export Bank of China aimed to support export and import firms in order to promote profitable foreign trade. Those losing-making SOEs previously served by the Big Four were still left in their hand although less explicitly.

Meanwhile, the four specialized banks and the urban credit cooperatives were transformed into commercial banks. In 1995, the Law of the People's Republic of China on Commercial Banks enacted and laid foundations for commercially oriented banking institutions. The four state-owned specialized banks were legally defined as

wholly state-owned commercial banks (SOCBs). They were expected to operate under the principles of profitability, safety, and liquidity and were responsible for their own profits and losses. They were supposed to be operationally independent and have the freedom to choose the clientele on a pure commercial basis. Although efforts were made to release SOCBs from being government agents, they still played a significant role in policy lending to support the economic development and to maintain social stability.

In the same year, PBC was legally confirmed as the central bank by the Law of the People's Bank of China. However, the central bank still was not an independent regulatory body. It was ultimately overseen by the State Council (the cabinet)—the central government. Local governments also had the right to appoint senior managers for the local branches of PBC and the SOCBs. Thus, governments had the power to force banks to lend in accordance with their preference and government intervention in SOCBs' operations was common practice at that time. In order to eliminate government intervention, the central bank was reorganized at the end of 1998. Provincial-level branches were merged into nine large regional branches, located in Shenyang, Tianjin, Jinan, Nanjing, Shanghai, Guangzhou, Wuhan, Chengdu, and Xi'an. This reorganization made local governments no longer had such strong power to intervene SOCBs' lending decisions and commercial banks were released (Wong and Wong, 2001).

Since the mid-1990s, City Commercial Banks (CCBs) were created by the way of restructuring and consolidating former urban credit cooperatives. CCBs adopted a shareholding ownership structure and were restricted geographically within their own localities. Capital was provided by urban enterprises and local government. CCBs serve mainly the small and medium-sized enterprises, collective and local residents in their municipalities. In the meantime, rural credit cooperatives were restructured as independent financial institutions. By then, the second layer of the banking system consisted of two parts: (a) commercial banks subject to prudential regulations and PBC's supervision, including JSCBs, CCBs, SOCBs, foreign banks, and rural credit cooperatives and urban credit cooperatives; and (b) three state-owned policy banks.

2.4.2 Financial restructuring of SOCBs

By the end of the 20th century, SOCBs became financially insolvent because of a stubbornly high level of accumulated NPLs and resultant low capitalization. The Chinese economy experienced overheating and transitional reform of SOEs was deepened in the 1990s. NPLs in SOCBs grew even faster accompanied by steadily declining capital adequacy ratios. By 1999, the total amount of NPLs in SOCBs was estimated as RMB3.3 trillion under four-category loan classification system, accounting for 41% of GDP for the year. Capital adequacy ratios were unavailable to public until 2004 but they were estimated to be much less than international standards of 8% in the 1990s (See chapter 4 for more detail). The banking system became rather weak and vulnerable.

Low capitalization and massive NPLs constituted a direct threat to the Chinese banking system. The threat must be dealt with carefully since any failure would cause a financial crisis and jeopardize social stability. A financial crisis could tremendously damage the economy and wipe out years of economic achievements, as clearly demonstrated by the Asian Crisis in 1997. As discussed before, SOCBs bore the costs of the structural transition of the economy from a centrally-planned to market-oriented economy, and the costs of any misconduct in the economic development. Hence, the government was responsible for making this worsening situation good and restoring the health of the banking system. Perhaps alerted by the Asian financial crisis in 1997, bank reform was postponed to the 1990s. In 1998, in order to control NPLs growth, the authorities had introduced 'lifetime responsibility system' to penalize bank managers responsible for bad loans even after their retirement.

During 1998-1999, the central government, as expected, commenced the first round of SOCBs bailout in the forms of capital injection and NPLs off-loading. In 1998, RMB 270 billion was injected into four SOCBs through issuing long-term treasure bonds. The fresh capital raised SOCBs capital adequacy ratios to 8%, in line with the requirement of the Basel Capital Accord. In 1999, in dealing with NPL problem, Chinese government created four asset management companies (AMCs), namely Cinda Asset Management Company, China Great Wall Asset Management Company, Oriental Asset Management Company, and China Huarong Asset Management

Corporation, paired with CCBC, ABC, BOC and ICBC, respectively. Subsequently, NPLs worth RMB 1.4 trillion (about 15.6% of the combined total of outstanding loans) were transferred from SOCBs to AMCs at book value. This action beautified SOCBs' balance sheets and prevented the four SOCBs from having to write-down large amount of NPLs in their loan portfolios. AMCs were expected to repackage the NPLs into viable assets and sell them off to the investors so that maximize NPLs recoveries. They adopted recovery methods including debt-for-equity swap, restructuring of debt terms, debt collection, sale or lease of real property, direct sales of packaged or individual NPLs, and securitizations.

NPLs problem, in fact, was unsolved and the government merely put this 'hot potato' into AMCs' pocket. However, AMCs faced a number of institutional and operational plights preventing them from successfully disposing of NPLs. First, the governance structure of AMCs was problematic. As non-banking financial institutions, they were heavily supervised by a multiple political agencies with Supervisory Board Members from the CBRC, the Ministry of Finance, and the China Securities Regulatory Commission. However, they had their own agenda and none of these individually powerful bodies took the overall responsibility, leaving AMCs much less regulated in practice. Moreover, the President of the Big Four also involved in the operations of their corresponding AMC by serving as the Party Secretary. With this intertwining relationship with banks, AMCs were unlikely to act as independent commercial entities to dispose of NPLs. Furthermore, AMCs themselves were wholly state-owned companies, suffering from agent-principal problem and moral hazard problem which generally resulted in poor performance and low efficiency.

Second, the transfer price of the NPLs in 1999 was far from their true value. The recovery ratio was estimated to be below 20 percent, resulting in an inevitable significant loss for the AMCs and therefore provided no incentive for them to maximize the recovery price. This situation changed from 2004 when AMCs were allowed to purchase NPLs from state-owned banks through an auction. For example, in July 2004, Cinda (an AMC originally paired with CCBC) won an auction to purchase RMB 278.7 billion of NPLs from CCB and BOC. Cinda paid 50 percent of the face value and promised to recover 33 to 34 percent by the end of 2005. Although the transfer price remained higher than the estimated recovery value, it was a right step towards providing the proper incentives to

AMCs. Moreover, the Chinese government provided cash incentives to AMCs for maximizing returns and accelerating recovery rate, which would further help increase the commercial orientation of these entities. The Chinese government also encouraged AMCs to partner with internationally reputable foreign investors and advisors with substantial expertise in management of distressed assets in order to maximize NPLs recovery.

Third, AMCs were government vehicle companies with no real resources to finance their operations independently. Each of them had only 10 billion capital paid by the State when they were established in 1999, which was too small in contrast to the scale of NPLs they were handling. Their purchases of NPLs were financed by central bank lending and the issue of special bonds guaranteed by the Ministry of Finance. AMCs had no resources to repay principal (even interests) that would probably turn out as bad debt in the future. AMCs' managers had no means to make it better and therefore they understood they would not be responsible for losses, giving rise to the moral hazard problem.

Fourth, the transparency of AMCs' operations was deficient. In fact AMCs were exempt from external audits by independent parties. Compounded with above factors, problems such as corruption and inadequate controls were widespread at the AMCs, very similar to or even worse than their banking counterparts. The Chinese National Audit Office had discovered illegal practices in AMCs including collusion, insider trading, connected transactions, improper appraisal processes, fraudulent bidding and auction processes, lack of internal controls, embezzlement and mismanagement of assets.

Over the last few years, Chinese authorities have realized these problems and undertaken other proactive measures to solve the NPLs problem. Now China has started making progress in improving its legal framework, setting more reasonable NPL transfer price to AMCs, and revamping the cultures of AMCs.

Despite of unsolved NPL problems in AMCs, financial restructuring of SOCBs had improved the soundness and stability of the banking system. As immediate results, the total amount of NPLs of SOCBs decreased to RMB 1.9 trillion, accounting for 22% of GDP in 2000. The rapid declining return on assets (ROA) and return on

equity (ROE) was also stabilized. Capital adequacy ratios of SOCBs were increased to the minimum requirement of 8% of the Basel Accord 1988. However, the process of restoring financial health was far more complicated than expected. Favourable outcomes of this reform were short-lived and problems of high level of NPLs and low capitalization re-visited the Chinese banking system shortly. In 2001, the total amount of NPLs rebounded to RMB 2.3 trillion under the newly adopted five-category loan classification system. The increase of NPLs level was partially due to the change from the four-category classification system before 2001 to the five-category loan classification system afterward. The former was estimated to underestimate NPLs by 14% suggested by a PBC internal study since it provides leeway to retain NPLs unreported. Capital adequacy ratio of SOCBs and JSCBs dropped to 4.6 % and 6.83% respectively in September 2003. The real capital adequacy ratios may be even lower when allowing for the deficiency of provisions for loan losses (Luo, 2003).

However, the main reason was that this round of bailout only solved the non-fundamental problems without addressing the deep-rooted causes of these problems. SOCBs' major clients were still SOEs of which the majority remained inefficient and unprofitable. Despite progress being made, SOEs suffered from deep-rooted problems, such as weak enterprise management and low operational efficiency, limited outside governance mechanisms and excessive workforce (Karacadag, 2002). Moreover, this round of bailout seemed to send out a message that the government was the last resort of help once banks are in distress. Hence, a soft budget constraint was still in place and the moral hazard problem remained. Given the high demand for capital in the rapidly growing economic environment, bank managers lent relentlessly or even colluded with clients, resulting in loans that would never be recovered.

2.4.3 Financial liberalization and opening up

During this period, financial liberalization was started by removing the credit quotas and reducing direct lending in 1998. The credit plan for both working capital loans and fixed investment loans was abolished. Instead, an indicative non-binding target was activated as a reference for commercial banks to plan their business. It was regarded as another milestone of the Chinese banking system reform since SOCBs were granted more responsibility and autonomy in making lending decisions.

Government intervention in commercial lending activities was explicitly forbidden (Wong and Wong, 2001).

Interest rate had been fixed by the manipulation of the monetary authority in China. From 1996, interest rate liberalization started from wholesale markets in which Interbank Offered Rate and repurchasing and trading interest rates of treasuries, for example, were allowed to be determined in accordance with the market conditions. In 1998, floating range on lending interest rates were raised to 20% for financial institutions and 50% for rural credit cooperatives, giving more room for varying lending rates charged on different clients (Berger *et al.* 2007). Also during this period, reserve requirement for commercial banks were lowered from 20% to 8%, further down to 6% (Herrero and Santabarbara, 2004). However, the pace of liberalization was too slow. Commercial banks were still subject to an interest rates ceiling for deposits and a floor for lending, slowing down the development of a market-based banking system.

The most crucial milestone of financial liberalization was China's accession to the WTO in 2001. Chinese government committed itself to fully open up the banking market to foreign banks after a five-year grace period, which had prominent influence and implications for the banking reform. Under the opening up schedule of the WTO accession, foreign banks were allowed to conduct foreign currency business for foreign clients immediately and for domestic clients one year later. In 2003, foreign banks were allowed to carry out domestic currency business at wholesale level. By the end of 2006, foreign banks started to enjoy national treatment without any restrictions.

Foreign banks had grown at a snail's pace in Chinese banking market although Chinese economy was growing at about 10% per year. In early 1980s, Chinese government opened the door of financial market just a crack to foreign financial institutions. Foreign banks were first allowed to open representative offices and were subsequently permitted to open operational branches in Special Economic Zones. This geographical restriction was extended to 23 coastal cities during the first half of the 1990s and foreign banks were allowed to open branches across China in 1996.

However, there were high entry barriers and business restrictions for foreign banks, such as geographic restrictions and entry requirements. Foreign bank operations were restricted within some designated geographical zones. They must have launched and operated a representative office for two years before it could apply for establishing branches. Even being granted to operate, foreign banks were restricted to serve foreign companies and residents and to conduct foreign currency business only. Given about 2% share of the banking total assets and limited geographical presence, foreign banks were not competitive to domestic banks. China's entry into WTO implied a fastened removal of the barriers and restrictions blocking foreign bank entry.

In fact, China's WTO membership has twofold implications. On the one hand, it represents challenges to the Chinese banking system. These challenges are not only real and imminent, but also threatening in many aspects to domestic banks, both state-owned and non-state-owned. Foreign banks had played a positive but rather limited role in the Chinese banking system in the past. Now they have accelerated the pace of integration in China by launching branches (representative offices) or/and establishing alliances with domestic banks. For instance, HSBC acquired 8% stake in Bank of Shanghai in December 2001. On the other hand, the WTO accession presents an unprecedented opportunity to expedite the building up of a modern and internationally viable banking system. Foreign banks are advantageous at high technology and operational skills and expertise. Foreign banks could induce more competition in Chinese banking market and accelerate the "catching-up" process of Chinese banks.

2.4.4 Tightening prudential regulation and supervision

The regulation and supervision of financial sector in China had been far behind international standards. With deepening banking reform, prudential regulations and accounting standards were tightened to help formulate a well functioning market based banking system. Capital adequacy requirement was first introduced in 1995 in Shenzhen. Since 1998, the central bank started to internally monitor bank capital adequacy in accordance with the Basel Capital Accord, until 1 March 2004 the Regulation Governing Capital Adequacy of Commercial Banks came into effect.

Commercial banks were given a transition period up to 1 January 2007 to meet the minimum capital adequacy requirements.

Authorities shortly found these requirements to be unenforceable due to the inability of banks to raise capital. There is a huge gap between capital demand to meet the capital adequacy requirements and funds availability. Half of JSCBs raised capital in the capital market, but SOCBs were unable to raise funds in the capital market because of its low profitability and high level NPLs. Since SOCBs were owned by state and could, in theory, only rely on the state provision of capital, which would result in a soft budget and low efficiency. The only possible way out of this dilemma was the fundamental ownership reform of SOCBs after cleaning up their balance sheets. This was effectively triggered the first round of SOCBs bailout during 1998-1999 and the second round of bailout started in 2003 in preparation for a further reform to list the SOCBs on the stock markets.

In 1995, in accordance with the newly enacted commercial bank law, authorities redefined commercial banks business scope. Commercial banks were required to divest investment banking affiliates and were prohibited from engaging in investment banking business, such as securities trading and underwriting, investment in non-bank financial enterprises and productive enterprises, and investment in trust business. The separation of commercial banking activities from investment banking activities aimed to reduce risk taking and protect depositors.

In order to better control asset quality, the authorities introduced an internationally accepted five-category loan classification system in 1998 by a trial application in Guangdong province. Although it was applied to all commercial banks national wide since 2002, few banks followed this prudential norm. Most banks continued to use a conventional Chinese-style four-category classification system as it classified loans based on the length of arrears and tended to underestimate non-performing loans. Later, authorities had to reinforce the application of five-category loan classification system and all banks were required to fully comply with it by the end of 2005.

In April 2003, China Banking Regulatory Commission (CBRC) was established as a regulatory and supervisory body in order to strengthen regulatory and supervisory

framework and introduce modern banking managerial practices. It took over the responsibility and functions from the central bank to regulate and supervise all the banking institutions. CBRC became in charge of the strength of banks, capital adequacy issues and reform of the banking system. PBC started to be responsible for monetary policy and liquidity of the financial sector by managing the interest rate bands for loans and deposits, the reserve requirement and other instruments. This separation highlighted the importance of well functioning supervisory and regulatory framework in improving internal management, risk control, and governance of banks. This also reflected the government's resolution to ensure safe, sound and efficient operation of the banking industry through strengthened supervision and enhanced risk control capacity (www.cbrc.gov.cn).

In short, during the past decade, some progress had been made on banking commercialization, but notwithstanding government's considerable efforts. One important reason is that China adopted a gradual approach to economic reform rather than a shock therapy approach. The government had to balance between rehabilitating the banking system and maintaining social stability and economic growth. By 2003, the banking system was still characterized by poor asset quality, high level of NPLs, deteriorated solvency ratios, low profitability, the lack of risk management skill, and so on. The reform was far away from complete and the tough nut of reform remained to be cracked. Incoming WTO challenges were real and called for more comprehensive and radical reform of SOCBs.

In the face of the increasing challenges from globalization and WTO, Chinese authorities set the reform of SOCBs on the top agenda of financial reform at the second National Financial Work Conference in 2002. The objective of SOCBs reform was clearly defined as "To transform these banks into internationally competitive joint-stock commercial banks with appropriate corporate governance structures, adequate capital, stringent internal controls, safe and sound business operations, quality services as well as desirable profitability (Liu, 2005)." Concrete reform strategies covered issues on recapitalization, existing and generating new NPLs, and corporate governance. Changing SOCBs' corporate governance of SOCBs became the paramount issue. The goals for next step reform were outlined as: (1) diversifying ownership structure preferably with the participation of foreign strategic investors; (2)

properly defining responsibilities for the shareholders, board of directors, and board of supervisors; (3) maximizing profits; (4) restructuring the existing organizational structure to fit the change (Luo, 2003).

2.5 The period of modernization since 2003 onward

Since late 2003, the government has accelerated and deepened banking reform through two main strategies—attracting foreign strategic investors in domestic banks and encouraging domestic banks to go public, ahead of the full opening of its financial industry. The joint-stock reforms of SOCBs have been implemented progressively step by step following a three-phase roadmap. The first phase is the financial restructuring to resolve the NPLs burden accumulated for historical reasons. The second phase is to transform SOCBs into modern financial enterprises with optimized corporate governance structure and mechanisms. The third phase is to list SOCBs on the capital market, subjecting their operations to market discipline. These reform strategies not only solve problems like high level NPLs and low capitalization, but also focus on the rooted causes of these problems (Tang, 2004).

At the end of 2003, BOC and CCBC were selected as pilot banks to undergo financial restructuring. The government commenced the second round of capitalization and this long-awaited bailout was in the form of capital investment by Central Huijin Investment Company Limited, a government vehicle company. Each of BOC and CCBC received half of the total capital infusion of \$45 billion out of the country's abundant foreign-exchange reserves. This was the boldest and toughest decision of the government to convert SOCBs into truly commercial institutions to date. This gift provides banks with highly liquid tier 1 capital, resulting in an increase in capital adequacy ratio close to international minimum capital requirement of 8%. Following staged success in two pilot banks, the same measure was applied to ICBC that received a capital injection of \$15 billion in April 2005. It was argued that the capital infusion into SOCBs had the effect of killing two birds with one stone—recapitalizing SOCBs and reducing the pressure of the Chinese currency appreciation.

As part of financial restructuring, the government conducted the second round of NPLs divestment from SOCBs. NPLs were off-loaded from BOC and CCBC by

RMB 475 billion in 2004 and from ICBC by RMB 705 billion in 2005. BOC and CCBC finished financial restructuring in 2004 and ICBC in 2005. The assets quality improved significantly and balance sheets were strengthened. For instance, NPL ratio of SOCBs dropped to 10% in 2005 from 20% in 2003 and the total amount of NPLs shrunk to RMB 1 trillion accounting for 6% of GDP in 2005 from RMB 1.9 trillion and 17% of GDP in 2003 (See more detail in Chapter).

After financial restructuring, the reform of SOCBs has moved on to the second phase of joint-stock restructuring. The reform has addressed “three transformations”—the transformation of ownership, the transformation of corporate governance structures and mechanisms, and the transformation of internal controls (Liu, 2005). The main purpose is to improve corporate governance, risk management and internal control, and the management of finance, debt and human resource. BOC and ICBC have been restructured as Bank of China Ltd. and Industrial and Commercial Bank of China Ltd. respectively, while CCBC has been decomposed into two entities, namely China Jianyin Investment Co. Ltd. and China Construction Bank Corporation. Thus, they have been organizationally transformed into modern enterprises, which have paved the way for forging ahead partial privatization through ownership diversification strategies of attracting foreign ownership and going public.

Attracting foreign strategic investors for domestic banks has been a common reform strategy to privatize state-owned banks in developing countries and transition economies. Prior to 2004, there were only a few foreign institutions acquiring shares in domestic banks. In 1996, Asian Development Bank acquired 1.9% share in China Everbright Bank made the latter the first domestic bank with foreign ownership. This practice was followed by a few foreign institutions, such as International Finance Corporation (IFC), Hong Kong and Shanghai Banking Corporation (HSBC), and Citigroup, which acquired equity stakes in carefully selected JSCBs and CCBs.

Motivated by the desire of attracting foreign strategic investors for domestic banks, the authorities have relaxed the provisions relating to business cooperation and equity links between the Chinese and foreign banks. At the end of 2003, the maximum equity share of the total overseas investment in any Chinese financial institution was increased to 25%, of which the maximum equity share of a single overseas investor

was 20% (www.cbrc.gov.cn). This particular policy has been welcomed, resulting in a surge of foreign direct investment in domestic banks in 2004 and the following years. For instance, British-based HSBC bought 19.9% of Bank of Communications for \$1.74 billion and Newbridge Capital became the biggest shareholder of Shenzhen Development Bank in 2004. In 2005, total foreign investment in Chinese banks reached \$24 billion (including \$8 billion and \$1.9 billion raised by CCBC and the Bank of Communications in their IPOs in Hong Kong stock exchange). Among others, the most significant achievement in this year was three newly joint-stock restructured SOCBs having successfully attracted foreign strategic investors. CCBC was acquired by Bank of America, BOC by the Royal Bank of Scotland, Merrill Lynch and Li Ka-shing, and ICBC signed the MOU with Goldman Sachs, Allianz and American Express signed.

Meanwhile, to honour WTO commitments, the CBRC has been continuously speeding up the opening up of the banking system, in an attempt to create a level playing field for both domestic and foreign banks. Since 2003, CBRC has gradually loosened geographical customer and business restrictions imposed on foreign banks. Foreign banks have been given greater access to the local market by (1) allowing them to conduct local currency business with local companies from 1 December 2003; (2) lowering the minimum capital requirement to RMB 500m for foreign financial institutions to set up a full-service branch; (3) expanding to 18 cities that have been fully opened to foreign bank engagement in local currency business.

Given a favourable environment, foreign banks have prospered in the Chinese banking market, attracted by the rapidly growing financial services markets and the promising prospective of the economy. As of September 2003, there were 191 foreign banking institutions granted licenses to operate in China. Foreign banks only accounted for about 13% of the foreign currency lending market (Luo, 2003). Only two years later, as of end-September 2005, 69 foreign banks from 20 countries established 232 operational entities. The market share of the foreign exchange lending rose to about 20 % (Liu, 2005).

In contrary to opening own branches, the majority of foreign investors have chosen to acquire equity stake in domestic banks. The strategy is rationalized by the immediate

access to well-developed distribution networks and the hope to well-position a strategic seat before full opening up of the banking market. Although foreign banks and institutions will be granted a full range of banking services and financial products to domestic customers in 2007, most of them have chosen to acquire equity stake in domestic banks as means of entering this emerging and attractive markets. By doing so, foreign investors avoid suffering from low efficiency generally associated with foreign-owned banks in developing and transitions countries. They also avoid significant investment in establishing a branch network sufficient to serve their customers.

Foreign strategic investors come from more than 20 countries around the world, targeting all types of Chinese domestic commercial banks. They are also trying to participate in the management of the partner bank and exert influence on the business development. Chinese banks, on the other hand, benefited by obtaining much needed capital, advanced technology, management skills, operational expertise, good corporate governance structure, and so on. To date, twenty-five Chinese commercial banks have teamed up with 18 overseas strategic investors, attracting equity capital of more than \$18 billion. Obviously, the opening up policy have achieved a “win-win” situation between the Chinese and foreign banks.

Shortly after joint-stock restructuring and attracting foreign strategic investors, the joint-stock reform of SOCBs was proceeded with to the third phase of going public. The going public strategy is motivated by the much-needed capital to improve capital adequacy. This institutional change of diversifying ownership helps build up a good corporate governance structure and harden the budgetary constraints faced by SOCBs. The strategy is also encouraged by the role of market discipline to better solve the agent-principal problem and thus improve efficiency. CCBC and BOC have been successfully listed on Hong Kong Stock Exchange in 2005 and 2006 when they raised USD\$8 billion and \$9.7 billion through their initial public offering (IPOs), respectively. ICBC was simultaneously listed on both Shanghai Stock Exchange and Hong Kong Stock Exchange on 27 October 2006. It raised about US\$21.9 billion in Hong Kong (H-shares) and Shanghai (A-shares), becoming the world’s largest IPO to date. The market reactions were unexpectedly positive. At the end of 2006, ICBC

outstandingly became the second largest bank in the world measured by market value. By July, 2007, ICBC became the world's largest bank in terms of market value.

The authority understood that listing SOCBs on stock exchange to raise new fresh capital is not the end of the reform but a short run goal. The long run goal is to transform SOCBs into modern and internationally competitive banks with good corporate governance in place. Building up well-functioning corporate governance is the key to the success of Chinese banking reform since it ensures improvement in performance sustainable in the long term. CBRC set out ten requirements for good corporate governance benchmarking the top 100 largest banks globally. Against these benchmarks, CBRC monitors the pace of SOCBs moving toward modern enterprises and their performance. These requirements cover corporate governance structure, diversified ownership, goal of profit maximization, prudent accounting practices, market-oriented human resource management, etc. CBRC has further tightened prudent regulation by setting out seven performance indicators to monitor the SOCBs performance. These indicators include ROA, ROE, the cost/income ratio, the NPL ratio, the largest exposure, and the NPL provisioning coverage ratio (www.cbrc.gov.cn).

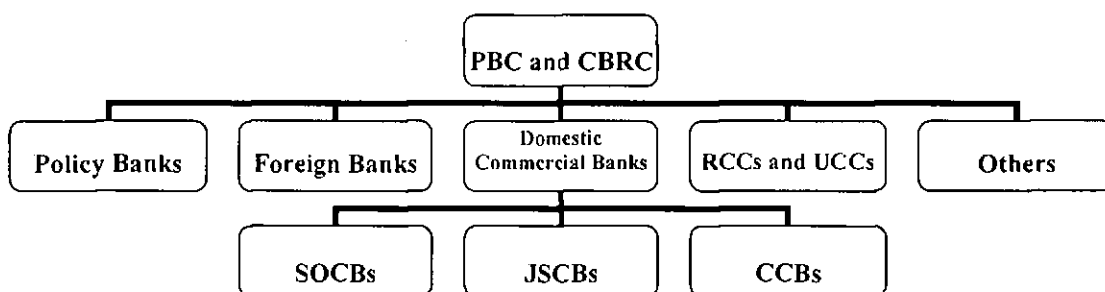
Synchronously, the reform of the RCCs has been carried out since 2004, based on the experiences drawn upon the trial RCCs reform in eight provinces and municipalities. The reform covered 29 provinces, municipalities and autonomous regions across the country with only Hainan province and Tibet autonomous region not being included. The trial experiences show improvement in RCCs capability to better serve rural households and agricultural production (www.cbrc.gov.cn). It goes without saying that the government has made every effort on banking reform, ranging from SOCB to CCBs and RCCs to prepare for the full opening of the banking market by the end-2006.

2.6 The status quo and future challenges

China's unremitting efforts on banking reform have resulted in a comprehensive and multi-layered banking system. The structure of the present banking system is illustrated in Figure 2.1. PBC and CBRC are two supervisory bodies at the top of the

banking system. The former is China's central bank formulating and implementing monetary policy under the oversight of the State Council. It maintains the banking sector's payment, clearing and settlement systems, manages official foreign exchange and gold reserves, and oversees the State Administration of Foreign Exchange. CBRC is in charge of the regulation and supervision of banks, asset management companies, and trust and investment companies as well as other deposit-taking financial institutions in order to maintain a safe and sound banking system (www.cbrc.gov.cn). SOCBs, together with other banking institutions of various types, provide a full range of banking products and services to the economy.

Figure 2.1 The structure of the Chinese banking system



Notes: PBC = People's Bank of China, CBRC = China Banking Regulatory Commission, RCC and UCC = rural and urban credit cooperatives, SOCB = state-owned commercial bank, JSCB = joint stock commercial bank, CCB = city commercial bank.

According to a recent CBRC report, as of 2005, the banking industry is made up of more than 30,000 institutions, including 3 policy banks, 4 state-owned commercial banks, 13 joint-stock commercial banks, 115 city commercial banks, 54 rural commercial and cooperative banks, 681 urban credit cooperatives, 30,000-plus rural credit cooperatives, 225 foreign bank branches and subsidiaries, 4 asset management companies, 59 trust and investment companies, 74 finance companies, 12 financial leasing companies, 5 automobile financing companies, as well as a large number of postal savings institutions.

SOCBs are the key players in the Chinese financial sector. Despite co-existence of various financial institutions, the banking system dominates the financial sector, which in turn is overwhelmingly dominated by SOCBs in terms of total asset, deposits, branch network and employees. By September 2005, the banking system

controlled 90% of the total financial assets in China, amounting RMB 42 trillion. While their market shares are declining, SOCBs still dominate the banking system by possessing more than half of the total assets and liabilities of the banking sector. After more than two decades of development, JSCBs have grown steadily, accounting for 16% of the total assets of the banking industry.

Table 2.1 gives an overview of a highly concentrated market structure of the Chinese banking system in which SOCBs, JSCBs and CCBs control 74% of total fixed assets. Despite rapid growth, the total assets of foreign banks only accounted for 2%. Other banking institutions, including rural commercial banks, urban credit cooperatives, rural credit cooperatives, finance companies, trust and investment companies, financial leasing companies and postal savings, together accounted for 24%.

Table 2.1 The distribution of banking assets by groups (in September 2006)

	Total assets (RMB billion)	Share %
SOCBs	21,950	52
JSCBs	6,637	16
CCBs	2,421	6
FBs	830	2
Others	51,913	24
Total	42,085	100

Source: www.cbrc.gov.cn

Notes: SOCB = state-owned commercial bank, JSCB = joint-stock commercial bank, CCB = city commercial bank, FB = foreign bank.

Needless to say, significant progress has been made in the modernization of the Chinese banking system. By the end of 2006, the average NPL ratio notably dropped to 7.5% and more than 100 Chinese banks met the capital adequacy requirement of 8%. In April 2007, three restructured and listed SOCBs were among the world's top ten banks in terms of market capitalization (Tang, 2007). After drastic institutional changes, basic governance structure has been in place and started functioning, supported by strengthening risk management and prudent operation. The soundness of supervisory framework and effectiveness of supervisory approaches have been improving. CBRC has committed to comply with all the essential elements of the Basel Core Principles for effective banking supervision by the end of 2006 and a broad compliance with the Basel Core Principles 6 years later.

As Tang (2007) concludes that “China’s banking system reform as a whole has made a success but it still needs to proceed deeper and wider.” Despite impressive progress, the banking system still faces a few difficulties. Most Chinese banks are weak in corporate governance, risk management capacity, innovations in human resource management, and pricing skills. Moreover, external environment in terms of credit culture, accounting standards and taxation arrangements are less favourable. While promising future of the Chinese economy provides unprecedented opportunities and greater chance for banking reform to be successful, challenges remain. It will be particularly difficult and demanding for future reform, regarding how to prevent the rebound of the NPLs, how to consolidate the outcome of reforms, and how to improve the performance to maximize shareholders wealth in the long term. Fortunately, they have been well addressed by CBRC in its future reform plan.

However, these challenges and difficulties by themselves may not be serious obstacles to a successful banking reform. What is more problematic is the partial privatization of SOCBs in which the government remains majority shareholder. An absolute controlling stake enables the government to exert political pressure on banks that may lead to less productive SOEs in order to reduce unemployment pressure and maintain social stability. Chinese banks, especially SOCBs, have conflicting objectives. On the one hand, they are required to transform themselves into commercially viable modern corporate entities with a profit maximization goal. On the other hand, they are under pressure to sustain employment and maintain social stability (Dobson and Kashyap, 2006).

World class commercial banks typically evaluate and manage risks based on market principles and make credit decisions accordingly without political consideration and personal connections. When proceeding with future banking reform, Chinese authorities need to address and solve this contradiction rather than ignoring it. Without clear clarification of the government role in the bank operation and objectives, it is more likely to disappoint the expectation that banks will behave like commercial banks.

The fate of the Chinese domestic banking institutions, especially SOCBs, would be determined by their economic performance and market viability, rather than by the willingness and power of the government. In the process of this intense and challenging reform, how to improve banking productivity and efficiency is one key objective of the future banking reform programmes. Therefore, from our review on Chinese banking reform, the ultimate success remains to be seen and the reform is going to be a long and challenging process.

Chapter 3 Literature review

3.0 Preamble

Over more than 40 years, efficiency research has been extensive, highlighting the importance of efficiency study. This has resulted in a well-established literature on fundamental efficiency concepts and methodological framework. In this broad context, substantial researches have evaluated the efficiency of financial institutions, providing fruitful information not only serving the purposes of regulation and management, but also contributing to the development of research methodology. Berger and Humphrey (1997) provide an outstanding survey that summarizes the main conclusions of 130 financial institutions' empirical efficiency studies in 21 countries employing different efficiency estimation methods.

This chapter reviews literature on bank efficiency by referencing a number of classical and recent innovative papers. It also consults with books on efficiency research, including Kumbhakar and Lovell (2000), Coelli *et al.* (1998), Ray (2004), and Cooper *et al.* (2000). It will provide a theoretical background and a methodological framework for this study.

This chapter is organized as follows. Section 3.1 introduces basic concepts in efficiency study. Section 3.2 reviews literature on efficiency estimation techniques, including the ways of defining inputs and outputs, and incorporating internal specific characteristics and external environmental variables. Section 3.3 reviews bank efficiency literature in general and on developing countries and transition economies in particular.

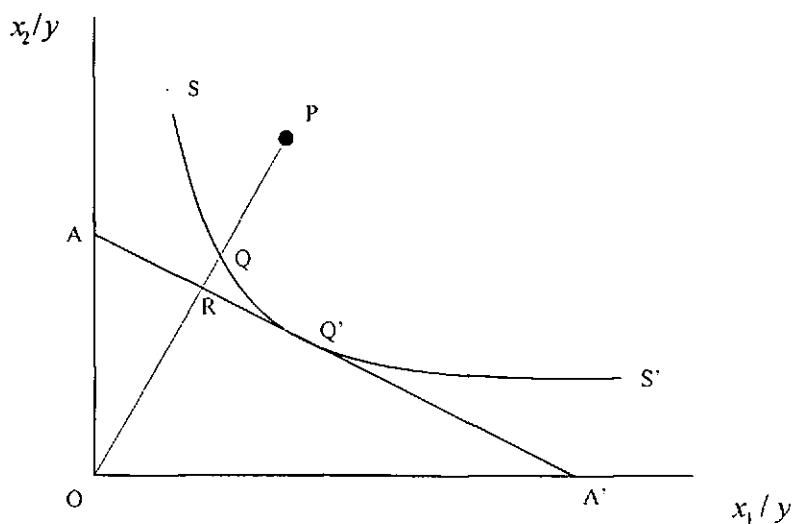
3.1 Basic concepts

Farrell (1957) proposes a path-breaking way of measuring operational efficiency (economic efficiency) of a firm, which is defined as the product of technical efficiency and allocative efficiency. Technical efficiency, also called technological efficiency, refers to the ability of optimal utilization of available resources either by producing maximum output given an input level or by using minimum inputs given

an output level. Allocative efficiency reflects the ability to achieve the optimal combination of inputs and outputs for a given level of prices.

In Farrell's simple example, firms produce a single output (y) using two inputs (x_1 and x_2), assuming constant returns to scale. The technical inefficiency of a firm that uses inputs to produce a unit of output at the point P can be expressed by the distance QP shown in Figure 3.1. All inputs could be proportionally reduced by the distance QP without affecting output level. The technical efficiency of a firm is defined as the distance to a production frontier that provides the upper boundary of production possibilities. In particular, technical efficiency is measured by the ratio OQ/OP in Figure 3.1 that is less than 1. Isoquant of SS' represents fully efficient firms and used as a benchmark to measure technical efficiency of other less efficient firms (Coelli *et al.*, 1998).

Figure 3.1 Farrell efficiency (Coelli *et al.*, 1998)



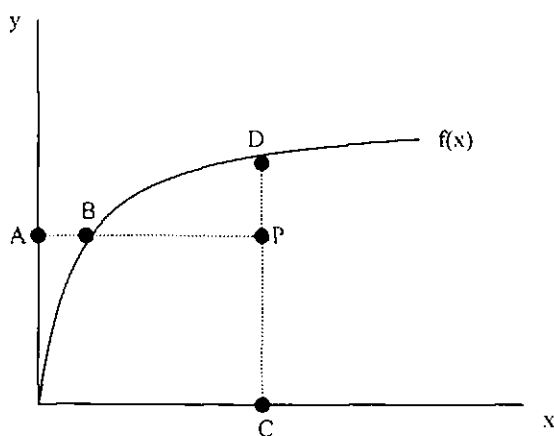
When input price information is available, the allocative efficiency of the firm located at point P is represented by the ratio OR/OQ . It captures inefficiencies due to a sub-optimal input combination picked by the firm for given input prices. It requires the use of right input mix in producing the correct output mix in the light of their respective prevailing prices. The economic efficiency is defined in a similar fashion being the distance to an economic frontier. Assuming that SS' represents a cost

frontier in Figure 3.1, cost efficiency is measured by the ratio OR/OP , suggesting a theoretical possible cost reduction by the amount of RP (Coelli *et al.*, 1998).

It is important to distinguish efficiency concepts when studying efficiency. Economic efficiency requires both technical efficiency and allocative efficiency. Technically efficient firms could be economically inefficient and vice versa, due to the differences in managers' ability to use best technology and their abilities to respond to market price conditions (Bauer *et al.*, 1998). Siems and Barr (1998, p13) have figuratively summarized that "technical efficiency is about doing things right, allocative efficiency is about doing right things, and economic efficiency is about doing right things right."

Efficiency concept is closely related to the concept of input and output orientation. An input-orientated efficiency measure addresses input conservation without changing the output quantities produced, while an output-orientated measure focuses on output augmentation without altering the input quantities used. The difference between the input-orientated measure and output-orientated measure can be demonstrated graphically in Figure 3.2. Assuming that a firm uses one input producing single output under decreasing returns to scale technology $f(x)$, the Farrell input-orientated measure of technical efficiency is represented by the ratio of AB/AP , while the output-orientated technical efficiency measure being the ratio of CP/CD .

Figure 3.2 Input- and output-orientated efficiency measures (Coelli *et al.*, 1998)



Input-oriented and output-oriented efficiency measures can be derived from models with the same respective orientation. Essentially, the output- and input-orientated models estimate exactly the same frontier and identify the same set of best-practice firms but the efficiency measures of inefficient firms may differ (Coelli *et al.*, 1998). Selection of the orientation depends on over which quantities the managers have most control. Input-orientated efficiency measure is more frequently chosen arguably because the input quantities are the primary decision variables.

The development of duality theory provides a framework for economic representations of production technology using cost, revenue, and profit functions. When information on input and output prices is available and a behavioural assumption is appropriate, economic efficiency can be explored. In particular, cost efficiency, revenue efficiency and profit efficiency, can be derived against cost, revenue and profit frontiers, respectively. Economic concepts are commonly used in efficiency studies for industries employing multi-inputs and multi-outputs production technology.

Cost efficiency is defined as the ratio of minimum feasible costs to observed actual costs. It is bounded between zero and unity, reflecting the proportion of costs or resources is used efficiently. The estimated cost inefficiencies can be further decomposed into input-oriented technical inefficiency reflecting for using more inputs to produce the same output bundle and input allocative inefficiency for not optimally using inputs mix given inputs prices. Cost efficiency concept is most commonly used in efficiency research. The majority of 130 efficiency studies reviewed by Berger and Humphrey (1997) have concentrated on cost efficiency.

Cost efficiency is derived by estimating a cost function. In a cost function, total costs is a dependent variable and explanatory variables are exogenously given variables, including output quantities, input prices, netput quantities (fixed inputs or fixed outputs), environmental factors, and a composite error term that consist of bank managerial inefficiency and random errors. A general version of a cost function in a natural log form is shown in Equation (3.1)

$$\ln C = f_c(\ln q, \ln w, \ln z, \ln d) + (\ln u_c + \ln v_c) \quad (3.1)$$

where f_c represents a particular functional form for the cost function, such as Cobb-Douglas, translog form, or Fourier-flexible functional form; C is total costs (including both operating and interest expenses); q is a vector of output quantities; w is a vector of input prices; z is a vector of netputs' quantities; d is a vector of economic and environmental variables that may influence cost performance; $(\ln u_c + \ln v_c)$ is a composite error term comprising an inefficiency factor u_c where u_c denotes an inefficiency factor that induces the bank's cost above the minimum feasible costs, and random error v_c .

According to Berger and Mester (1997), the cost efficiency of a specific bank is defined by Equation (3.2)

$$Cost\ Eff^b = \frac{\hat{C}^{\min}}{\hat{C}^b} = \frac{\exp[\hat{f}(q^b, w^b, z^b, d^b)] \times \exp(\ln \hat{u}_c^{\min})}{\exp[\hat{f}(q^b, w^b, z^b, d^b)] \times \exp(\ln \hat{u}_c^b)} = \frac{\hat{u}_c^{\min}}{\hat{u}_c^b}, \quad (3.2)$$

where \hat{u}_c^{\min} is the minimum of the \hat{u}_c^b across all sample firms.

When assuming that producers face output prices and seek to maximize revenue for a given level of input, revenue efficiency can be measured against revenue frontier. Revenue efficiency is defined as the ratio of actual revenue of a firm to maximum revenue that could be raised if the firm is fully efficient. It is bounded between unity and zero. Revenue efficiency can also be decomposed into the output-oriented technical efficiency and allocative efficiency of inefficient outputs production in the light of their prevailing prices (Kumbhakar and Lovell, 2000). Revenue efficiency is rarely used alone in practice and it is essentially incorporated into profit efficiency.

It is more common to assume profit maximization which requires costs minimization as well as revenue maximization. Profit efficiency is defined as a ratio of actual profit to maximum attainable profit. It cannot be greater than unity but can be below zero because of possible negative actual profit. A firm's profit efficiency reflects the proportion of maximum profit the firm has earned (Kumbhakar and Lovell, 2000).

Profit efficiency is an integrated performance measure and it is considered to be superior to cost efficiency and revenue efficiency. It takes into account both the efficiency in raising revenue and the efficiency in reducing costs. To maximize profit, a firm needs to be technically efficient, allocative efficient, and to require scale efficiency (Berger and Mester, 1997). The decomposition of estimated profit efficiency is more complicated than those of cost efficiency and revenue efficiency, depending on the orientation of technical efficiency measures. Despite the prevailing application of cost efficiency concept, profit efficiency has attracted increasing attention. Many studies employ profit efficiency as a performance measurement in the recent literature, including Bonin *et al.* (2005), Hasan and Marton (2003), Humphrey and Pulley (1997), Berger and Mester (2003), Williams and Nguyen (2005), and Patti and Hardy (2005).

Subject to different exogenous business conditions, profit efficiency has two variants, namely standard profit efficiency and alternative profit efficiency. Standard profit efficiency measures the extent to which a firm produces the maximum possible profit for a given level of input and output prices. Producers are assumed to face exogenously determined input and output prices in competitive factor markets. They have to make decisions on the mixture of inputs to use and the mixture of outputs to produce.

Standard profit efficiency is derived from a standard profit function where profits are the only dependent variable and the right-hand side variables usually include input prices, output prices, netputs quantities, environmental factors, and a composite error that consists of bank managerial inefficiency and random errors. A general version of the standard profit function in log form is given in Equation (3.3)

$$\ln(\pi + \theta) = f(p, w, z, d) + (\ln u_{\pi} + \ln v_{\pi}) \quad (3.3)$$

where f_c , w , z , d , and $(\ln u_{\pi} + \ln v_{\pi})$ are defined as in the cost function; π represents the profit of a bank; θ is a constant added to every firm's profit to ensure that natural logarithm is taken on a positive number in case there is a negative profit figure; p is a vector of output prices.

Likewise, standard profit efficiency of a specific bank can be defined by Equation (3.4) (Berger and Mester, 1997).

$$Std \pi Eff^b = \frac{\hat{\pi}^b}{\hat{\pi}^{\max}} = \frac{\exp[\hat{f}(p^b, w^b, z^b, d^b)] \times \exp(\ln \hat{u}_{a\pi}^b) - \theta}{\exp[\hat{f}(p^b, w^b, z^b, d^b)] \times \exp(\ln \hat{u}_{a\pi}^{\max}) - \theta} \quad (3.4)$$

where $\hat{u}_{a\pi}^{\max}$ is the maximum of the $\hat{u}_{a\pi}^b$ across all sample firms.

Alternative profit efficiency measures the extent to which a firm earns maximum profits when facing exogenously determined input prices and output quantities. Output prices are no longer taken as given as in the standard profit maximization scenarios. Instead, firms are assumed to have some degree of pricing power over their output markets and both output prices and quantities are to be determined under the market demand conditions. Only input prices are part of external conditions (Kumbhakar and Lovell, 2000).

Alternative profit efficiency is derived from a profit function which is identical to the standard profit function except for output prices replaced by output quantities (Berger and Mester, 1997). The alternative profit function in log form is given in Equation (3.5).

$$\ln(\pi + \theta) = f(y, w, z, d) + (\ln u_{a\pi} + \ln v_{a\pi}) \quad (3.5)$$

where all variables are the same as defined in the standard profit function except for y , which is defined as in the cost function.

The alternative profit efficiency is defined in Equation (3.6) (Berger and Mester, 1997).

$$Alt \pi Eff^h = \frac{a \hat{\pi}^b}{a \hat{\pi}^{\max}} = \frac{\exp[\hat{f}(y^b, w^b, z^b, d^b)] \times \exp(\ln \hat{u}_{a\pi}^b) - \theta}{\exp[\hat{f}(y^b, w^b, z^b, d^b)] \times \exp(\ln \hat{u}_{a\pi}^{\max}) - \theta} \quad (3.6)$$

where $\hat{u}_{a\pi}^{\max}$ is the maximum of the $\hat{u}_{a\pi}^b$ across all sample firms.

3.2 Literature on methodology

Performance appraisal has been carried out using conventional ratio analysis. With the development of estimation techniques, performance is evaluated by more sophisticated techniques, such as least-squares econometric production models, total factor productivity (TFP) indices, and efficiency frontier. The former two methods assume that all firms are technically efficient and provide measures of technical change and/or TFP, largely based on aggregate time-series data. The efficiency frontier approach provides performance measures of both technical change and efficiency change, without making such an assumption and using panel data set (pooled time-series and cross-section). The approach can explore the difference in efficiencies across firms and identify possible factors causing the differences (Coelli *et al.*, 1998). The frontier approach is increasingly preferred because it objectively quantifies relative performance by removing the effects of many exogenous factors affecting the standard performance ratios (Bauer *et al.*, 1998).

Efficiency measures are defined by the distance departing from the best-practice frontier that in practice is unknown. How to estimate the efficient frontier from the sample data is one of the controversial issues in the efficiency literature. Farrell (1957) has suggests two broad directions for estimating efficiency, resulting in two main methods to estimate the best-practice frontier. Following the first direction, a piecewise-linear convex isoquant is constructed under a non-parametric mathematical programming framework. The second direction suggests a parametric, stochastic, statistical framework to construct the best-practice frontier by fitting a pre-specified parametric function. Parametric methods can be sub-classified into three main approaches: SFA, distribution free approach, and thick frontier approach, while non-parametric methods can be divided into data envelopment analysis (DEA) and free disposal hull. These approaches distinguish from each other by different assumptions with respect to the shape of the efficiency frontier, the treatment of random errors, and the distributing assumptions imposed on random errors and inefficiency (Berger and Humphrey, 1997).

3.2.1 The estimation of best-practice frontier: parametric methods

All parametric methods specify a functional form but they distinguish from each other by the shape imposed on the frontier and the distributional assumptions imposed on random errors and inefficiency. Distribution free approach does not make specific distributional assumption on efficiency but it requires a panel data set. It assumes “core” efficiency or average efficiency for each firm that is stable over time and assumes that random errors are averaged out over time (Berger and Humphrey, 1997). Criticism comes from these arbitrary assumptions because of the danger that persistent influence on costs of other factors may be counted as inefficiency (Bauer, *et al.*, 1998). The efficiency of each firm is measured as the difference between its mean residual and the financial institutions’ mean residual on the frontier, truncating the extreme residuals. Empirical applications of the distribution free approach include Clark and Siems (2002), Berger and Hannan (1998), Berger and Mester (1997), Nikiel and Opiela (2002), and Patti and Hardy (2005).

The thick frontier approach first runs regression using only the ostensibly best performers in the data set, and then uses these estimated parameters to estimate the best-practice for the data set as a whole. It imposes no distributional assumptions on inefficiency and random errors. Instead, the thick frontier approach assumes that inefficiencies differ between the highest and lowest quartiles and random errors exist within these quartiles. In particular, it assumes that (1) random errors are represented by the deviations from the predicted efficiency within the lowest and highest quartiles of observations (stratified by size); (2) inefficiencies and exogenous differences in the regressors are represented by the deviations in the predicted performance between the lowest and highest quartiles (Berger and Humphrey, 1997).

Firms in the lowest average cost quartile are assumed to have above-average efficiency and to form a “thick frontier”. Measured inefficiencies are embedded in the differences in the predicted costs between the lowest and highest cost quartiles. Estimates from the thick frontier approach provide an overall level of efficiency rather than point efficiency estimates for individual firms. It is of limited use when firm level efficiencies are concerned. Moreover, arbitrary assumptions that the lowest average cost quartile within each size class is an adequate “thick frontier” of efficient

firms make the estimated levels of efficiency susceptible. This approach has been employed in studies of Humphrey and Pulley (1997), Casu *et al.* (2004) and Bauer, *et al.* (1993).

SFA specifies a functional form for the frontier and assumes a composite error term consisting of random errors and inefficiency. These two components are separated by making two different distributional assumptions. The estimation strategy involves two steps. The first step is to use the Maximum likelihood estimation technique to estimate parameters describing the structure of the stochastic production frontier. The subsequent step is to decompose the maximum likelihood residual terms to derive efficiency for each producer, conditional on the estimated parameters of the stochastic production frontier. Depending on different distributional assumptions, a number of models have been developed to decompose the error terms into a random error and an inefficiency component, including the Half-Normal Model, the Normal-Exponential Model, the Truncated-Normal Model, and the Normal-Gamma Model (Kumbhakar and Lovell, 2000). SFA is one of the most commonly employed methods in efficiency study, resulting in a wealth of literature emerging.

Using the parametric method, one important issue is to choose a particular functional form to present the structure of the production technology. Popular forms in the literature include Cobb-Douglas, translog, and the Fourier flexible functional form. Each has certain advantages and disadvantages. The Cobb-Douglas form has been conventionally used in empirical frontier literature because of its simplicity and self-duality. However, the simplicity comes with two problems. The first problem is the inability to accommodate a multiple outputs production technology. The second problem is that the over-simplified structure of production technology may compound un-modelled complexity into the error terms, resulting in biased efficiency estimates.

The translog form, originated by Christensen, *et al.* (1971, 1973), is the most popular functional form with no restrictions on returns to scale or substitution possibilities. It has several virtues over the Cobb-Douglas form. First, it may accommodate multiple outputs without necessarily violating the curvature conditions. Secondly, it is flexible, providing a second-order approximation to any well-behaved underlying cost frontier at the mean of the data. The flexibility diminishes the possibility of mixing up input

allocative inefficiency with a misspecification of the underlying functional form. Thirdly, it bases much of the empirical estimation and decomposition of cost efficiency on a system of equations.

On the other hand, the translog form suffers from a serious multi-collinearity problem among the regressors. This is likely to lead to biased estimates of structure parameters in the model and therefore incorrect information on the two error components. It also suffers from the problem of degrees of freedom. Although these problems can be eliminated by estimating a system of equations and the use of panel data, it comes with more complex computation. On balance, the benefit of the flexibility is likely to be offset by the costs of the statistically insignificant parameter estimates (Kumbhakar and Lovell, 2000).

Fourier-flexible functional form is recently developed and has been frequently used in bank efficiency studies like Deyoung and Hasan (1998), Berger and Mester (1997) Berger and Mester (2003). Fourier-flexible functional form is more flexible than the translog form since it consists of a standard translog plus Fourier trigonometric terms. In addition to a local approximation of the data by the embedded translog form, the Fourier-flexible form provides global approximation to virtually any cost or profit function by adding trigonometric terms. It suffers from the same disadvantages as the translog form due to the inclusion of too many regressors.

3.2.2 The estimation of best-practice frontier: non-parametric methods

A non-parametric approach provides a piecewise linear frontier to envelop the observation points using mathematical programming. The most commonly used non-parametric approach is DEA since free disposal hull is a special case of DEA by excluding the points on the lines connecting the DEA vertices. DEA presumes that linear substitution between observed input combinations is possible on an isoquant. Free disposal hull has no such assumptions and considers the isoquant as a step function. Free disposal hull analysis measures firm efficiency based on its dominance relations to observed input-output bundles and involves a more restricted version of the mathematical programming problem than does DEA (Berger and Humphrey, 1997).

DEA is originally introduced by Charnes, Cooper and Rhodes (1978). DEA generalizes Farrell's (1957) single-input/single-output efficiency measures for decision-making units to the multiple-outputs/multiple-input measures. Since their innovative work, DEA studies have been extensive. It represents another camp of frontier estimation and is frequently used by researchers. Examples can be found in Ferrier and Lovell (1990), Drake and Hall (2003), Chen *et al.* (2005), and Drake *et al.* (2006).

DEA employs linear programming methods to estimate a nonparametric piece-wise surface over the data and measure the efficiency of decision-making units. In particular, DEA frontier is a piecewise linear combination of a set of these best-practice observations, forming a convex production possibility set. The convexity assumption ensures that given feasible input-output combinations, any weighted average of the input bundles can produce a similarly weighted average of the corresponding output bundles (Ray, 2004). The sole requirement is that each decision-making unit lies on or below the extreme frontier. Those units on the frontier are the best practice institutions, while the inefficiencies of other units below the frontier are measured by the distance from the best-practice frontier. Thus, efficiency measurement from DEA is a relative standard rather than an absolute standard (Berger and Humphrey, 1997).

A non-parametric method seems more applicable because it allows efficiency to vary over time and does not require prior assumptions on the distribution of inefficiency across observations. However, the DEA approach has been arguably less accepted by some economists because of its nonparametric feature. Without the estimation of a production, cost, or profit function from the data, the usual conclusions about the technology are hard to be derived. Moreover, DEA takes no account of market prices and therefore it focuses on technical efficiency rather than economic efficiency. In other word, it neglects allocative efficiency—the price effects on efficiency.

A more fundamental drawback of DEA is the non-statistical nature. The linear programming solution of DEA does not allow the existence of standard errors and therefore does not distinguish inefficiency from random shocks. Any deviation from

the frontier is treated as inefficiency and there is no provision for random shocks (Ray, 2004). If the random error in a single observation that is on the efficient frontier, efficiency of all other firms will be affected by comparing with a linear combination on the frontier. In reality, random errors are likely to exist due to a number of sources, resulting in inaccuracy of estimated efficiency. By ignoring the existence of potential errors, the effects of omitted errors may be composed into the efficiency estimates (Berger and Humphrey, 1997). This feature also leads to the inability to test hypothesis.

Addressing this drawback, efforts have been made to add a stochastic dimension to DEA, including chance-constrained programming to reduce the noise effect and bootstrapping to generate statistical inference (Grosskopf, 1996). Among several different lines of research underway, bootstrapping (Simar, 1992; Simar and Wilson, 2000) appears to be most promising and is becoming increasingly popular. It is combined with DEA to gain empirical distributions for the efficiency measures of individual firms (Ray, 2004).

DEA also suffers from a self-identifiers and near-self-identifiers problem. When imposing constraints like quality controls and environment variables on the model, some firms may be self-identified as 100% efficient simply because no other firms or linear combination of firms are comparable in so many dimensions. When there are a small number of observations relative to the number of inputs, outputs and other constraints, it is difficult for a large proportion of the observations to match in all dimensions (Bauer *et al.*, 1998).

The robustness of efficiency measure is arguable because of various approaches available to estimate efficiency. Literature is inconclusive regarding which is superior to others. Berger and Humphrey (1997) and Berger and Mester (1997) find little invariant in average estimated efficiency employing different estimation techniques. Parametric and non-parametric methods estimate similar average efficiency values but dissimilar ranking of financial institutions using estimated efficiency levels. Berger and Humphrey (1997) review 130 studies employing at least five main approaches, of which parametric method (60) and non-parametric method (69) are roughly equally adopted. On average, there is about 20% cost inefficiency and about

half of the industry's profits inefficiency in US banking. Studies employing a non-parametric method obtained lower average efficiency estimates and greater dispersion than the studies using a parametric method. For example, in the US studies, the average efficiency score estimated by non-parametric methods is 0.72, while this score estimated by parametric methods is 0.84. Baleombe *et al.* (2006) compare a wider range of frontier methodologies: Bayesian, classical SFA and DEA. They find point estimates of technical efficiency are different across different models but the rank of firm level technical efficiency is consistent.

Bauer *et al.* (1998) argue that it is unnecessary to identify the single best frontier approach to estimating efficiency in order to provide useful information to concerning parties. The estimated efficiencies from different approaches should be consistent over time and coincide with market competitive conditions in terms of efficiency levels, rankings, identified best and worst firms. They outline six consistency conditions and examine four frontier estimation methods using a panel data of US large banks. Their results show a high degree of consistency within parametric methods and within nonparametric methods, whereas parametric and nonparametric methods are not generally mutually consistent. Parametric methods appear to be more consistent with the competitive conditions in banking market and non-frontier performance measures such return on assets.

3.2.3 The definition of output and input variables

How to define input and output variables is another controversial issue, causing a long-standing debate in bank efficiency literature regarding methodology. Unlike manufacturing firms that produce physical goods, banks produce a wide range of products that are unidentifiable intermediation services. A few measures of bank outputs, such as assets, liabilities and revenues, have been employed in early efficiency research. The number of deposits and loans accounts has been suggested as bank output because financial services are provided to owners of these accounts directly. Alternatively, the dollars in each account have also been recommended as bank output since the dollar amount in each account is a substantial source of profits, which generates usable funds and services. More funds in accounts need more services to account owners (Goddard *et al.*, 2001).

A services flow to customers appears a better proxy of bank output by focusing on the basic nature of the production process rather than stock variables. However, this causes a problem: how to measure this services flow? In the literature, a production approach and an intermediation approach are two popular approaches, while a value-added approach and a user cost approach are two less commonly used ones. In defining bank inputs and outputs, the value-added approach classifies all balance sheet items into inputs or outputs, depending on whether their contribution of adding or reducing the value to a bank (Berger and Humphrey, 1992). A user cost approach takes product's net contribution as a criterion to differentiate input or output (Aly *et al.*, 1990 and Sathye, 2001).

The production approach addresses physical inputs, such as capital and labour, and treats banks as firms producing different deposits and loan accounts. Banks deal with transactions and documents for its customers who own these accounts. The number and type of transactions and documents are thought of as the best measure of bank output. The idea is great theoretically, but it is impracticable because such specific data are generally unavailable. In practice, the number of deposit and loan accounts is usually used as the measure of bank output rather than detailed data on transaction and documents. Ferrier and Lovell (1990), and Fried *et al.* (1993) are examples employing this approach to define bank output.

The intermediation approach, pioneered by Sealey and Lindley (1977), treats banks as financial intermediaries that channel funds between depositors and creditors. In the bank production process, the value of bank loan and investment is thought of as output, while labour, deposits and capital are treated as inputs. This approach is distinguished from the production approach by adding deposits to input, which result in consideration of both operating and interest costs. This approach has been more frequently applied in the empirical literature. Examples of this approach include Avkiran, (1999), Drake and Hall (2003), Casu and Molynuex (2003), Fries and Taci (2005).

Among these approaches, loans and other earning assets are widely accepted to be treated as outputs. The role of deposits has been controversial as deposits have both

input and output natures. Deposits could be considered as input because the interest expenses should be paid for it. Deposits could also be thought of as an output because deposits are associated with a certain amount of liquidity, safekeeping and payments services provided to depositors. Previous studies have shown that the treatment of deposits is sensitive to measure efficiency. Recently, a dual approach becomes prevailing that deposits are treated as an output, while interests paid on deposits are treated as an input.

None of these approaches is perfect, they are complementary instead. Each approach emphasizes one side role of financial institutions that process transactions and documents and channel funds between depositors and creditors. In fact, these alternative approaches to defining bank outputs give rise to a doubt on the robustness of the estimated efficiency levels, especially the on-going debate on the specification of output variables in the empirical literature. It is an important area to be addressed with caution when carrying out empirical research on bank efficiency.

3.2.4 The incorporation of environmental factors

Although assessing firm performance using efficiency estimates is an important part of efficiency studies, identifying factors that explain the variation in performance is of more research interests since information could shed lights on policy implications. Earlier studies find that producer performance could be influenced from three very different dimensions during the production process. The first dimension is the efficiency of internal management in the process of arranging production activities. The second dimension is the features of the external environment in which production activities are carried out. The third dimension is the impact of random noise, such as good and bad luck, which would be captured in a random error term in a regression-based approach to measure producer performance (Fried *et al.*, 2002). It is important to separate the effects of different factors when assessing firm performance. Efficiency is a superior performance measure over conventional financial ratios because efficiency study has the ability to distinguish one effect from the others. It provides an objective best-practice benchmark for evaluating the performance of firms. Meanwhile, it could differentiate the impact of various factors on firm performance by examining how and to what extent they influence firm efficiency.

Efficiency analysis commonly consists of two stages. The first stage concerns the estimation of a best-practice frontier against which to measure the efficiency of producers during the time period under consideration. The frontier may be constructed by a non-parametric method or estimated by a parametric method discussed in the previous sections. The main task of this stage is to obtain efficiency estimates of producers in employing inputs to produce outputs, under certain behavioral or/and distributional assumptions. In this stage, the robustness of the estimation is important, affecting not only the reliability of efficiency estimates but also the usefulness of the results from the second stage.

In the second stage explores the reasons for efficiency differences across producers by incorporating bank specific characteristics and exogenous environmental variables into the estimation. External environmental variables may include a rather wide range of macroeconomic and regulatory factors, such as private consumption expenditure, government expenditure, GDP, net export, discount window base rate, unemployment, current account balance, ownership, location characteristics, and government regulations. These variables are out of managerial control but they could influence producer performance although they are neither traditional inputs nor outputs. The objective of the second stage is to identify possible sources of inefficiencies by investigating the relationship between variation in bank efficiencies and variation in the exogenous environmental variables (Kumbhakar and Lovell, 2000).

Environmental variables have been taken into account in efficiency analysis in a variety of ways. Employing a parametric method, external factors are assumed to affect either the structure of the frontier through which conventional inputs are processed into outputs, or directly affect technical efficiency. Assuming that external environmental variables have a direct effect on the production structure, they are included in the frontier function as control variables. In other words, each producer is assumed to face a different production/cost frontier (Drake *et al.*, 2006). If external environmental variables affect efficiency directly, they can be incorporated into a second stage regression against estimated efficiencies to quantify their effects. In practice, it is a matter of judgment on whether an exogenous variable characterizing the production technology or determining productive efficiency.

In the context of employing SFA, Kumbhakar and Lovell (2000) provide a summary on how to incorporate exogenous environmental variables in three different ways. The first way assumes that a vector of exogenous variables z influences the structure of the production process (therefore the production frontier) by which inputs x are converted to outputs y . Vector z is generally beyond the control of management in the production process but describing the environment in which the production process takes place. In this case, vector z is included along with x as netput in a stochastic production frontier as shown in Equation (3.7).

$$\ln y_i = \ln f(x_i, z_i; \beta) + v_i - u_i \quad (3.7)$$

where β is a vector of parameters to be estimated.

This approach can be interpreted as a more accurate characterization of production possibilities and therefore more precise estimates of producer efficiencies. However, it provides no information on the sources of inefficiencies across producers and therefore it is of limited use for policy analysis.

The second way of incorporating environmental variables is to link the variation of estimated efficiency to the variation in exogenous variables using a two-step procedure. A stochastic frontier is first estimated by excluding the exogenous variables and then the estimated efficiencies are regressed against the exogenous variables in the second step. The rationale of this approach is that the vector of exogenous variables z is assumed to indirectly influence the output vector y by their direct effects on efficiency. The objective of the second stage regression is to explain the variation in estimated efficiencies. The elements in z are assumed to be correlated with estimated efficiencies u , or with $E(u_i|v_i - u_i)$. This approach provides detailed explanation for the differences in estimated efficiencies and could provide valuable policy recommendations.

However, this two-step procedure suffers from serious econometric problems. First of all, the variables in z must be assumed to be uncorrelated with the elements in x in the first stage. If this assumption does not hold, maximum likelihood estimates of a

stochastic frontier model are biased because of omitting relevant variables in z . As a result, this would induce biased estimates in the second-stage regression. Under this circumstance, the estimates from the second stage will be unreliable. Secondly, this two-step procedure makes two contradictory assumptions in each stage. In the first stage, the inefficiencies are assumed to be identically distributed, but in the second stage, predicted efficiencies are assumed to have a functional relationship with z . This is the so-called 'schizophrenic approach'.

The third way of incorporating environmental variables is one-step procedure. This approach assumes that exogenous variables influence efficiency, rather than the structure of production technology. A few valuable models have been developed within this one-step procedure camp. For example, Reifschneider and Stevenson (1991) develop a hybrid model, by combining a stochastic production frontier with a deterministic inefficiency relationship. Other proponents of this one-step approach include Huang and Liu (1994) and Battese and Coelli (1995). This one-step procedure attempts to overcome shortcomings of above-mentioned approaches. It provides an explanation for variation in efficiency and characterizes the production environment. In addition, incorporation of the exogenous variables in a single frontier estimation procedure avoids the problem of independence assumptions associated with the two-step procedure.

As a result, the one-step procedure has become popular in efficiency study and a model proposed by Battese and Coelli (1995), thereafter BC95 model, has been outstanding among others. In addition to the advantages of the one-step approach, BC95 model has been developed in a panel data context. It is particularly helpful in overcoming some statistical problem, for example, the multi-collinearity problem associated with the translog functional form for a cost function. BC95 model assumes the time-varying nature of efficiency by including a time trend variable in its inefficiency effect regression. It also includes a time trend variable in the frontier function to capture technical change at a constant rate.

3.3 Literature on bank efficiency

3.3.1 An overview of bank efficiency literature

A large volume of research has contributed to a rich and well established literature on bank efficiency. As summarized by Berger and Humphrey (1997), the purposes of efficiency research have fallen into three broad directions, which are not mutually exclusive. The first set of purposes has been to inform government policy maker by assessing the effects of various regulatory methods on efficiency at industrial level. Regulatory variables include deregulation, mergers and acquisitions, foreign entry, market structure, privatization, financial liberalization, and so on.. By analyzing the impact of related variables in detail, efficiency study could generate valuable information to guide policy makers to encourage, discourage or modify a specific policy.

The second set of purposes has been concerned with research methodologies in order to improve the quality and robustness of estimation. Issues cover, for example, frontier estimation method, outputs and inputs definition, functional form, the use of particular models, etc. Studies address one or more specific issues and attempt to reach some degree of conclusion based on a variety of mathematical and statistical testing and modelling techniques. This direction of research would result in more reliable efficiency estimates and thus more useful information supporting authorities to make appropriate policy decisions.

The final set of purposes has been to provide useful information for bankers to improve managerial performance of a specific bank or a bank group. By constructing a benchmarking frontier, banks on or near the efficient frontier may share some commonalities in management practices or bank specific characteristics. These banks are considered as “best practices”. Banks located far away from the efficient frontier are regarded as “worst practices”. By identifying similarities and dissimilarities across ‘best practice’ and ‘worst practice’, bankers will tend to adopt “best practices” and use “worst practices” as a practical guidance to avoid making wrong decisions. The end result would be improvement of efficiency at industrial level.

Economies of scale and economies of scope have been popular research areas in earlier literature. Technically, economies of scale refer to “the rate at which output changes as all factor quantities are varied” (Molyneux *et al.*, 1996, p 137). Economies of scale are concerned with whether costs per unit can be reduced by increasing output. A measure of economies of scale is the ratio of the proportionate change in output to a certain proportionate change in all inputs, expressed by using a production function or its dual cost function. The conventional notion of the U-shaped average cost curve indicates the existence of an optimal scale of production, at which point the production cost would be minimized. In particular, economies of scale mean that with an increase in output of a firm, its average costs of production fall. In contrast, diseconomies of scale mean that average cost increases as output increases. A special case—constant returns to scale, refers to the situation that average cost remains unchanged when output changes. In the banking industry, the purpose of economies of scale studies is to help financial institutions to explore potential cost savings (Molyneux *et al.*, 1996). It might be one reason for the prevalence of mergers and acquisitions of banks in most developed countries.

Economies of scope seek the possibility of lowering average cost by diversifying output over the same organization. In other words, it explores whether costs per unit can be lowered by producing two or more outputs jointly. It refers to “The ability of financial institutions to generate synergistic cost savings through joint use of inputs in producing multiple products”. In contrast, diseconomies of scope are present if “The costs of joint production of financial institution’s services are higher than they would be if they were produced independently” (Saunders, 1999, pp 293). The studies of scope economies may provide valuable guidance on developing potential cost savings for firms, especially for financial institutions with a distinguishing feature of multi-products. This promotes banks to widen product lines.

Both economies of scale and economies of scope focus on cost savings based on accounting information. Simple financial ratios have been analyzed to relate costs to outputs and identify possible sources of cost inefficiency. Earlier studies provide some evidence for economies of scale for both large and small banks (Goddard *et al.*, 2001). Subsequently, a cost function has been employed in the estimation of scale and scope economies in the banking industry. Estimated economies of scale and

economies of scope become more robust than using simple financial ratio that could be affected by a number of reasons or even be easily manipulated in accordance with management intention.

Possible sources of economies of scale and economies of scope include more efficient use of input, spreading fixed costs, information economies, risk reduction, and customer economics. Empirical studies show significant scale economies for medium-sized banks of \$100 million to \$5 billion in assets in the 1980s, while scale economies have increased substantially, existing for large banks of \$10 billion to \$25 billion in assets in the 1990s in the US. The difference may be the result of improvement in research methods as well as technology, and the relaxation of geographic restrictions on competition (Saunders, 1999). As to scope economies, empirical studies indicate small cost inefficiencies.

More recently, the so-called X-efficiency has attracted much more research attention. X-efficiency, first coined by Leibenstein (1966), focuses on the intrinsic nature of human organization. It argues that people and organizations normally do not work as hard and effectively as they could for various reasons. X-efficiency, also called frontier efficiency, is regardless of firm size (scale economies) and the product mix (scope economies). Within a data set, the best-practice frontier can be estimated and X-efficiency measures deviations in performance from that of "best-practice" firms located on the efficiency frontier, holding exogenous market factors constant. In particular, difference between the best-practice frontier and the practice of a particular financial institution is the observed X-inefficiency and financial institutions can be ranked accordingly.

X-inefficiency reflects the difference in managerial ability to control costs for any given scale or scope of production. X-inefficiency may be caused by overall objective determinants, including knowledge or capability of management, corporate governance problems, the difficulties of principal-agent relationships within organizations, application of technologies, and so on. It has been found that X-inefficiency account for a considerable proportion of total costs and it is a much more important potential source for poor performance than both scale and scope economies.

Bauer *et al.* (1998) find a strong empirical association between X-inefficiency and higher probabilities of failures.

In developed countries, the second part of efficiency research has been concerned with the impacts on performance of market structure and concentration, deregulation, and mergers and acquisitions. The impact of market concentration on the profitability of banks has been examined extensively by testing four hypotheses: the structure-conduct-performance hypothesis, the relative-market power hypothesis, X-efficiency versus structure hypothesis, and scale efficiency versus structure hypothesis (Kapopoulos and Siokis, 2005). It is argued that there is a positive profit-structure relationship. For, example, X-efficiency versus structure hypothesis argues that leading banks with superior efficiency will obtain a high market share and therefore more concentrated market (Evanoff and Fortier, 1988). Nevertheless, mixed results from empirical literature unable to reach such a conclusion.

Various forms of banking deregulation have been a popular tone in many developed countries, in an attempt to spur bank competition and improve efficiency. Empirical literature, however, is inconclusive on the expected positive association between efficiency and deregulation. After deregulation, bank efficiency has been improved in some countries but worsened in other countries. For example, studies find post-deregulation improvement in bank efficiency in Australia (Sturm and Williams, 2004) and in Spain (Kumbhakar and Lozano-Vivas, 2005). In contrary to this finding, Bauer *et al.* (1993) observe that the deregulation in early 1980s has litter effect on bank efficiency in the US. Berger and Humphrey (1997) attribute these distinct findings to the industry conditions prior deregulation and the deregulation measures being implemented.

Mergers and acquisitions are another popular practice in banking industry in developed countries for their widely claimed positive effect on cost efficiency. However, again, literature has no such consensus due to mixed empirical findings about the relationship between mergers and acquisitions and bank efficiency. Empirical efficiency studies have found improved profit efficiency but none for cost efficiency. However, the improvement in profit efficiency is mainly attributable to the properly shifting portfolio to generate higher revenues and to improve the quality of

bank outputs by increasing revenues more than costs (Berger *et al.*, 1999, Resti, 1998, Hughes *et al.*, 1999, Avkiran, 1999 and Berger and Mester, 2003).

Banking systems in developed countries have rather different natures from those of developing countries and transition economies, in terms of external economic environment, characteristics of banking systems, and specialty of particular bank operations and management. Therefore, their respective policy makers and bankers might face different situations and problems and expect different information from efficiency research to serve their purposes. Possible determinants of variation in estimated efficiencies may also be quite different in developed countries from those in developing and transition economies. Conclusions from efficiency studies carried out in developed countries might provide valuable information for developing and transition economies, but they should be consulted with caution. Since this study is conducted using data from Chinese banks, the review of empirical literature will focus on studies in developing countries and transition economies in the next section, which might provide more useful guidance for this research.

3.3.2 Bank efficiency in developing and transition economies

Banking systems in transition economies share much commonality. In a centrally-planned economy, banks acted as accounting agencies to keep records of the financial transactions and they were functionally segmented by economic sectors. Banks lacked management skills and credit analysis systems. The banking systems were commonly associated with prevalence of state-ownership, poor asset quality, poor oversight institutions, and weak legal frameworks. Earlier market-oriented reforms focused on creating a two-tier system and subsequent reform strategies followed quite different paths. Claessens (1998) identified two approaches, namely rehabilitation and new entry. Countries in Central Europe mostly followed the former by transforming and revitalizing the old state banking system, while most countries in the former Soviet Union took the second approach by creating a new banking system.

During the past two decades, banking reforms have been highlighted on the policy agenda in order to transform banking systems into market-based ones in line with the economic development in those transition economies. The reform is also provoked by

the recognition that a well-functioning banking system is important for economic growth and development. Consequently, governments have devoted considerable efforts on reforming their banking system. The primary purpose is to improve the efficiency of resource allocation and to strengthen the financial foundation to the economy as a whole. Despite reform strategies varying across countries, reform measures generally include lowering entry threshold for both private domestic and foreign banks, privatizing state-owned banks, enhancing the supervisory framework, liberalizing interest rates, removing credit controls, and reducing government intervention.

Although a voluminous literature on bank efficiency has been documented, the majority of studies have been undertaken in developed countries like the US and European countries. In last two decades, bank efficiency study in developing and transition economies has received much attention and there has been a rapid development of empirical research because bank reform has taken place in most of these countries. Different from those of developed countries, most studies have focused on the effect of deregulation and financial liberalization, foreign bank entry, ownership characteristics, and privatization.

Deregulation

Bank reform in developing and transition economies commonly start with financial deregulation based on two theoretical motivations. Microeconomic theory suggests that any constraints, like regulations in resources allocation, increase the costs of production and induce inefficient resource allocation because of the lack of competition. Deregulation aims at creating a competitive and flexible environment and banks have more freedom over their operations. The unleashed competitive pressure forces banks to be more efficient by altering their input and output mix, upgrading technologies, and basing their operational decisions on market principles. Thus deregulation is expected to increase competition and improve performance.

Similar to the case in developed countries, this postulated positive effect of deregulation on bank efficiency has yet to be proved since the empirical evidence is mixed. Using a Malmquist TFP index, Isik and Hassan (2003b) show that the performance of all types of Turkish banks improved significantly after the

implementation of financial liberalization during 1980-1990. Similar findings are reported in Shyu (1998) for Taiwanese banks, Gilbert and Wilson (1998) for Korean banks, Leightner and Lovell (1998) for Thai banks, and Chen *et al.* (2005) for Chinese banks. In contrast, Katib and Mathews (2000) and Okuda *et al.* (2002) observe increased bank operational costs and negative technological progress after financial liberalization in Malaysia. Kumbhakar and Sarkar (2003) find little evidence in favour of liberalization in Indian banks during 1985-1996. Other studies (Isik and Hassan, 2003b; Ataullah *et al.*, 2004) find deregulation has different impact on the performance of banks of different types and sizes. Lying in between, Hao *et al.* (2001) find little or no significant effect of deregulation on bank efficiency and argue that the possible existence of positive association between deregulation and bank productivity in Korea may not be sustainable in the long term,

Ownership issue

The importance of ownership has been highlighted in bank reform in transition and developing countries. Primary concerns are optimal ownership and management structure that better reconciles management interests to that of owners (Spong *et al.*, 1995). State-ownership has been supported by the notion that governments can act in the best interest of social wealth and therefore state-ownership is economically efficient. By controlling the banking systems, governments are assumed to behave benevolently and finances preferred economic projects or industrial sectors in order to pursue greater social returns in excess of financial returns (Megginson, 2005). However, in reality, state-owned banks do not function as expected, resulting in much more inefficiency than privately-owned banks. Levine (2004) argues that government maximizes its own welfare rather than social welfare, regardless of risk taking and poor allocation of assets in bank operation.

Literature has been extensive on the relationship between industrial ownership and performance, especially for countries where state-owned banks dominate the banking system. Empirical research has generally shown a negative association between bank efficiency and state ownership. Political-driven lending has been a major source of inefficiency. Although state ownership in commercial banks has a few advantages, the negative economic outcomes outweigh its claimed benefits. On the other hand, private ownership is expected to promote efficiency gains by better tackling the

agent-principal problem and encouraging shareholders to exercise due diligence and monitor management performance. The most likely solution is the repeal of state ownership from bank and therefore privatization of state-owned banks is an obvious policy implication.

Privatization

Amongst interlinked and interactive banking reform measures, privatization of state banks is the linchpin of the success of bank reform since state banks are usually the dominant players in the banking system,. Over the last two decades, bank privatization has been prioritized on the policy agenda, involving more than 250 commercial banks in 59 countries in developed, developing, and transition economies (Megginson, 2005). This prevalence has been even more drastic in transition economies in Eastern-Central Europe, East Asia and Latin American. Privatization has brought dramatic changes in ownership of the banking systems from government control to private control and from domestic control to foreign control across the transition economies, and elsewhere (Berger *et al.* 2005).

Literature on privatization generally suggests that privatized banks should outperform similar state-owned banks in terms of profitability and efficiency. Privatization aims at changing ownership structure (therefore the corporate governance structure), in the hope of improving bank efficiency and the long-term viability. To achieve successful privatization, efforts should be made on resolving the corporate governance problems associated with public and private ownership. Corporate governance issue in banks is more complicated than in other firms because banks are more opaque and highly regulated (Levine, 2004). Sound governance mechanisms could better tackle principal-agent problems and therefore improve efficiency. Fundamental changes in the ownership structure will evoke management incentives to perform better, while new shareholders will better monitor the management, especially with respect to risk-taking.

Empirical studies have discovered clear performance improvements after privatization in developing countries and transition economies as most studies report a positive effect of privatization (Megginson and Metter, 2002; Gilbert and Wilson, 1998; and Boubakri *et al.*, 2005). Two studies particularly examine the effects of the

static, selection and dynamic governance changes on bank performance. Berger *et al* (2005) find that state-owned banks have poor long-term performance in Argentina. Dramatic improvements in performance have been observed after radical governance changes through bank privatization. Using a similar approach, Williams and Nguyen (2005) examine bank performance of five countries in South-East Asia in relation to privatization. They find bank privatization strategy is associated with superior profit efficiency and strong productivity over time relative to other types of bank governance. Disharmonic result has been reported in Croatia where Kraft *et al.* (2002) and Kraft *et al.* (2006) observe no performance improvement after privatization. The different results perhaps because the specialty of the unusual process of bank privatization. In Croatia, most banks were founded by real sector enterprises in the former Yugoslavia and the banking system was passively and indirectly privatized as a by-product of the real sector's privatization.

Politics have played a decisive role in the nature, timing, and eventual success or failure of bank privatization by affecting the privatization approach that influences the future behaviour of the privatized banks. With political considerations, benefits of privatization could be diminished by preferential policies, such as continuation of ownership, restricting competition, and prohibition of foreign banks participation. In emerging and developing countries and most transition economies, partial privatization of state banks is common practice. Governments divest some shares but retain substantial shares in the privatized banks. The purpose is to eliminate and smooth the economic shock of the transition process by continuing government intervention in bank lending policies. La Porta *et al.* (2002) survey government ownership of banks for 92 countries around the world. They find that government ownership in the banking industry is large and pervasive at a mean of 41.6% in 1995, even after bank privatization had been completed in many countries.

The rationale is that state influence is necessary to channel funds to sectors and groups with low financial but high social returns since the private sector is unlikely to best balance social and economic goals (Huibers, 2005). However, policy literature concludes that partial privatization is unlikely to improve bank performance. Government retaining too much bank equity makes it difficult to improve corporate governance. Continued significant government ownership stands in the way of

establishing market-oriented governance and decision-making systems in privatized banks, which encumbers operational efficiency improvements (Verbrugge *et al.*, 2000). Multiple objectives of government are more likely to limit the speed and depth of the fundamental reform necessary to improve the performance of the banking system.

Empirical research provides evidence supporting policy arguments and suggests government to reduce its influence over privatized banks. In the Czech Republic and Poland, Clarke *et al.* (2003) observe no improvement in bank performance after privatization when government still retained a substantial stake whereas the performance did improve after the government surrendered control. Clarke *et al.* (2005) conclude that bank privatization improves bank performance and raises competition. Gains from privatization are further improved, in the situations of no government control over privatized banks, foreign strategic investors' involvement, foreign bank participation, unrestricted competitive environment. Their results are in sympathy with conditions set for successful bank privatization by Megginson (2005).

Moreover, political lessons from Mexican and Argentinean experiences suggest government to exercise less dictation over the specific features of privatization. Strategies making privatization more politically palatable could invite the risk of banking crisis, while restricting competition to increase revenue has been proved short sighted (Clarke *et al.*, 2005). In South-East Asia, foreigners' participation has been strictly regulated in domestic financial markets. Following the serious financial crisis in 1997, most South-East Asian countries have deregulated. Banking markets have been open to foreigners, in the hope of strengthening competition, fostering efficiency, importing international best practice and advanced technology (Williams and Nguyen, 2005).

To an extreme, partial privatization could result in disastrous consequences for banks, taxpayers, and governments, instead of the expected benefits from privatization. After costly repeated re-capitalizations of state banks, most successful privatizations have ended up with governments handing over control to private owners. Some transition economies benefit from privatization after selling banks to foreign strategic investors during the middle and late 1990s (Megginson, 2005). Based on the above discussion,

one conclusion is that for bank privatization to be successful, complete divestments of government ownership are called for as partial privatization is unlikely to improve bank performance in the long run.

Methods of privatising state banks

Methods most commonly used to privatize state banks include attracting foreign strategic investors to participate in domestic bank ownership and making initial public offering for state banks. Participating ownership in domestic banks provides an entry method for foreign banks and financial institutions alternative to open their own branches. Bonin *et al.* (2005a, 2005b) highlight the importance of attracting a strategic foreign owner in privatization. Policy literature suggests that privatization with a controlling foreign ownership would improve the financial performance of the bank. This is because foreign owners bring in advanced modern banking techniques and upgrade technology. Foreign acquisitions of domestic bank normally lead to bank taking strategies, such as cost reduction, more cautious in risk-taking, and using more prudential and sophisticated operation techniques. In addition, foreign investors are normally international institutions, investment fund or worldwide international banks with a high profile, which facilitates privatized banks to attract better clients, hire more highly skilled labour and access cheaper sources of funding (Bonin *et al.*, 2005a). Consequently, foreign ownership participation in domestic banks is expected to raise bank efficiency, productivity, and technology levels, especially in developing and transition countries where initial levels are lower relative to developed nations.

Foreign ownership involvement in domestic banks has been pervasive in the process of bank privatization, which has motivated great research interests to investigate their impact on bank performance. Empirical literature in transition economies and developing countries generally reports improved performance, providing evidence for the privatization strategy of selling large state-owned banks to strategic foreign investors after recapitalization and cleaning the balance sheets (Boubakri *et al.*, 2005; Hao *et al.*, 2001; Fries and Taci, 2005; Grigorian and Manole, 2002; and Bonin *et al.*, 2005b). For instance, Bonin *et al.* (2005a) investigated the effects of strategic foreign ownership on banking efficiency in eleven transition countries. They found that privatization by itself is not sufficient to increase bank efficiency while banks with a foreign strategic owner have been found to be more cost-efficient than other banks.

Hungary is a successful example of inviting foreign financial institutions. The centralized mono-banking system has been replaced by a two-tier banking system in 1987 as in most other transition economies. By 1998, a privately owned banking system has been established, successfully solved the burden of bad debts, massive under-capitalization, and high concentration. Hasan and Marton (2003) investigate how a stronger banking system has been successfully constructed in such a short period of time. They attribute the success to early reorganization initiatives, flexible approaches to privatization, and liberal policies towards foreign bank involvement with domestic institutions. Both cost and profit efficiencies have been steadily improved during the sample period from 1993 to 1997. Banks with foreign involvement are found to be more efficient than their domestic counterparts. The Hungarian case provides strong evidence that skilled and experienced foreign banking institutions have increased competition in banking market and have a positive influence on the domestic banking system.

There are a few exceptional studies that find no or negative impacts of foreign ownership in domestic banks. In Pakistan, Patti and Hardy (2005) find improvement in efficiency immediately after privatization but the improvement is unsustainable in the subsequent period for most privatized banks. Yildirim and Philippatos (2002) report improved cost efficiency but lowered profit efficiency for banks with a majority foreign stake. Kim and Lee (2004) provide opposite evidence that higher levels of foreign ownership did not lead to cost reduction and actually produced less profits in Korea. One possible explanation is that these banks address asset quality by taking higher loan provisions which reduce profit in the short run with a long-term view of viability.

An IPO is another popular option to privatize state banks in recognizing the importance of market discipline. A lack of market discipline weakens the control over management and worsens the agent-principal problem by facilitating the agent pursuing its own interests which might conflict with those of owners (Altunbas *et al.*, 2001; Williams and Nguyen, 2005). However, IPO strategy is considered to be a less effective method than selling state shares to strategic investors (Clarke *et al.*, 2005). Private sales generally lead to a concentrated ownership structure and controlling

owners have incentive to monitor bank managers to spur better performance. In contrast, IPO usually leads to a dispersed ownership among individual owners and a weakened incentive to monitor management efforts. Hence, IPO is often associated with higher agency costs and poorer performance. This hypothesis has been confirmed by Boubakri *et al.* (2005) in which banks privatized through share issued privatization is less efficient.

Clarke *et al.* (2005, pp1925) suggest a general guide for successful bank privatization, that is

“...not to sell banks to risk-loving owners, or to provide government subsidies or bail outs, but to put better safeguards against expropriation in place, protect lenders’ property rights better, and improve access to creditor information.”

Based on policy literature and empirical findings, Megginson (2005) has outlined a set of detailed conditions and suggestions for bank privatization to be successful and the privatized banking system to be viable. The first essential condition is to privatize state banks in full rather than partial privatization in which government remains a controlling stake in privatized banks. In the case of government retaining partial ownership, it should act only as a passive investor, to prevent from continuing policy lending on some political or central-planning basis.

The second essential condition is concerned with how to tackle existing non-performing loans and control its new growth. Effective methods of coping with bad loans need to be launched before or/and during the privatization. This problem becomes more serious when uncollectible outstanding non-performing loans are mainly allocated to state-owned enterprises. It is therefore important to ensure that further loans can only be extended to these SOEs on the commercially arm-length basis after privatization.

The third essential condition is development of a functioning bank regulatory and supervisory system and an advanced financial reporting system. The bank regulatory and supervisory body should be sufficiently independent from the government in

order to ensure the effectiveness of examination, supervision and monitoring of commercial banks. In order to protect investors' interests, financial reporting systems should be designed to ensure transparency with regard to asset quality, profitability, risk profile, and the like.

The fourth essential condition is concerned with deposit insurance schemes for privatized banks that probably lead to moral hazard problems. Although insurance schemes are necessary to be in place to protect depositors, it is desired to avoid setting up 100% deposit insurance schemes after privatization. Finally, foreign strategic ownership is desirable in the process of state bank privatization, in an attempt to attract capital, expertise, technology and financial legitimacy.

Foreign bank entry

As part of banking reform, foreign banks are commonly invited by opening up policies. They bring in competition to the domestic banking system but also create threat to domestic banks. As to whether foreign-owned banks outperform domestic-owned banks, Berger *et al.* (2000) propose two alternative hypotheses: a home field advantage hypothesis and a global advantage hypothesis. The home field advantage hypothesis argues that domestic institutions are generally more efficient than foreign owned institutions. The advantage could arise from organizational diseconomies to operate and monitor an institution from a distance, the lack of understanding of local conditions, limited access to soft qualitative information. Moreover, a variety of barriers against foreign institutions to be more efficient, including language, culture, currency, regulatory and supervisory structures, and country-specific market features (Berger *et al.*, 2005).

The alternative global advantage hypothesis argues that foreign institutions can be more efficient for a number of reasons (Berger *et al.*, 2005; Berger and Mester, 2003; Buch, 2003; Weill, 2003). The first reason is that foreign shareholders may contribute their superior managerial skills, high quality human capital, best-practice policies and procedures, and sophisticated investment and risk management skills. Foreign banks with their state-of-art technology and international experience are expected to be more efficient than, or at least as efficient as, domestic banks especially in developing and transition countries. Secondly, foreign banks, generally being part of a large

banking organization, face the same scale economies and diseconomies as domestic banks. Thirdly, foreign banks always serve profitable multinational customers. Fourthly, foreign banks have better access to capital markets, superior ability to diversify risks, and the ability to offer some services to multinational clients not easily provided by domestically-owned banks. Fifthly, foreign-owned institutions from developed nations have access to superior information technologies for collecting and assessing 'hard' quantitative information, which is especially true in developing countries. Finally, foreign-owned banks may benefit from better control from private shareholders since these banks are mostly privately-owned, resulting in more incentive for managers to operate more efficiently.

Given opposite arguments outlined in two hypotheses, it is unsurprised that empirical literature has no agreement on whether foreign banks outperform domestic banks or the other way around. Claessens *et al.* (2001) carry out a comprehensive study on the effect of foreign bank entry on domestic banking using data covering 80 countries for the 1988-1995 period. They find a tendency that the home field advantage hypothesis holds in developed countries, while the global advantage hypothesis holds in developing countries. This finding is consistent with other studies. In developed countries, evidence supporting the home field advantage hypothesis can be found in Berger *et al.* (2000), DeYong and Nolle (1996), Sathye's (2001), Chang *et al.* (1998), Peek *et al.* (1999), and Mahajan *et al.* (1996).

In developing and transition economies, the empirical results are less conclusive. The limited form of global advantage hypothesis is supported by Weill (2003), Bonin *et al.* (2005b), Kraft *et al.* (2006), Leightner and Lovell (1998) and Jemric and Vujcic (2002). In contrast, Rao (2005) and Yao (2007) find alternative home field advantage hypothesis holds in United Arab Emirates and China, respectively. Other studies find mixed results regarding different type of banks and efficiency concepts used. For example, foreign banks are more efficient than other domestic banks but inferior to state banks in India for the sample period 1992-1998 (Shanmugam and Das, 2004), while foreign banks are more cost efficient but less profit efficient in Poland during 1997-2000 (Nikiel and Opiela, 2002).

3.3.3 Bank efficiency in China and the contribution of the present study

Despite the literature on bank efficiency in transition and developing countries has expanded rapidly, there are only a handful bank efficiency studies in China. The main reason for this deficit is the lack of data on the Chinese banking system to carry out meaningful analysis. These studies have generally reported improved efficiency over the sample period under consideration and the second part of these studies has exclusively focused on ownership issue. Joint-stock commercial banks are consistently found to outperform state-owned banks, regardless of using SFA (Yao *et al.*, 2007; Fu and Heffernan, 2007; and Berger *et al.*, 2007) or DEA (Hu *et al.*, 2006 and Wang *et al.*, 2005). One exceptional study is Chen *et al.* (2005) who show that state-owned commercial banks are the most efficient banks in China.

To our knowledge, this is the first and most comprehensive efficiency study for the period employing different efficiency concepts and methodologies. This study contributes to the established literature on bank privatization, foreign ownership participation, and financial restructuring with respect to developing countries and transition economies using data of the Chinese banks. This study attempts to provide useful information for policy makers regarding the ongoing banking reform in China by examining the effects of various reform measures on bank performance. It develops a more comprehensive distance function model by incorporating the advantages of existing models (distance function model), procedures (one-step procedures) and methods (Berger *et al.* 2005 method). It is one of the few empirical attempts investigating input price measurement by comparing the use of market input prices and bank specific input prices. Although limited, it helps bankers to understand their position in the market by benchmarking to industrial best-practice as well as international banking giants.

Particularly, this study distinguishes itself from existing efficiency studies on the Chinese banking industry in following aspects. First, it is the first study that examines the effects of institutional changes in banks on bank performance. Berger *et al.* (2005) highlight the importance of analyzing static, selection, and dynamic governance changes effects on bank performance in the same model. This study particularly attempts to quantify the static, selection and dynamic governance effects on bank

efficiency. Existing studies focus on static effects of different governance structure and none of them examines the selection and dynamic effects of governance changes.

Secondly, the study collects data for 11 years up to 2005, which is a unique period with far-reaching changes in the banking industry brought about by gradually deepened and broadened reforms towards a market-oriented banking system. Since 1995, the first year of our sample, all banks are legally considered as commercial banks under the Commercial Banks Law except for three state-owned policy banks. The examination of the cost efficiency and profit efficiency for our sample period becomes meaningful since the assumptions of cost minimization and profit maximization are more appropriate.

Thirdly, this study employs different efficiency measures of technical efficiency, cost efficiency, profit efficiency, as well as a variety of financial ratios to comprehensively assess the soundness and performance of Chinese commercial banks. It draws a more complete picture for the Chinese banking system by providing valuable information from different perspectives..

Finally, it addresses a number of important and controversial issues in the literature regarding research methodology. It is among a few studies examining following issues:

- 1) Models: employing Cobb-Douglas production function and developing a more comprehensive model based on recently developed distance function approach in estimating technical efficiency (Chapter 5 and 6);
- 2) Definitions of input and outputs: earning assets-based model versus income-based model in estimating technical efficiency (Chapter 6);
- 3) Functional forms: translog versus Fourier flexible functional form (Chapter 7);
- 4) Input price measurements: market average input prices versus bank specific input prices in estimating cost and alternative profit efficiency (Chapter 7).

A recent trend of efficiency study in transition and developing countries has been a cross-country analysis. For instance, Fries and Taci (2005) examined cost efficiency for 289 banks in 15 eastern European countries using a one-step SFA, while

Grigorian and Manole (2002) employ DEA to investigate 17 eastern European countries for the period 1995-1998. Other cross-country studies include Williams and Nguyen (2005), Weill (2003), Bonin *et al.* (2005a, b), Atallah, *et al.* (2004), and Yildirim and Philippatos (2002). While these studies provide comprehensive information on banking reform across some transition and developing countries, criticism arises from the estimation of a cross-border best practice frontier. These studies have to make a strong assumption that fundamental cross-country differences can be controlled for. As argued in Kraft *et al.* (2006), differences in regulatory and economic environments across countries and especially developing and transition countries are very strong and it is doubtful to control these variations.

A single country study can avoid an econometric problem of controlling for these across-nation differences and better account for the country's specialties. In this regard, single country efficiency study has prospered. Examples include Kraft and Tirtiroglu (1998), Matousek and Taci (2002), Jemric and Vujcic, (2002), Hasan and Marton (2003), Nikiel and Opiela (2002), Kraft *et al.* (2006), Gilbert and Wilson (1998), Leightner and Lovell (1998), and Hao *et al.* (2001). A single country study is considered to better address the ongoing banking reforms in China. Thus, this study pays attention exclusively to the Chinese banking system, given the increasingly importance of the Chinese economy and the prominent specialties of its banking industry.

Chapter 4 Data and current state of the Chinese banking system

4.0 Preamble

Literature review, together with information on Chinese banking system introduced in Chapter 2 has established a research background and methodology framework for this study. Before undertaking any further econometric analysis, this chapter focuses on a financial ratio analysis in order to grasp a basic understanding of the Chinese banking system. Employing an analytical framework for macro-prudential analysis, this chapter assesses the current state of the Chinese banking system in terms of profitability, capital adequacy, asset quality and liquidity. In fact, more than two decades of gradual reform necessitates an assessment of the performance, the current state, and the stability of the Chinese banking system.

The rest of this chapter is organized as follows. Section 4.1 describes data sources and the sample construction. Section 4.2 conducts an assessment for Chinese banking system from four dimensions: profitability, capital adequacy, the asset quality and the current condition of non-performing loans, and the liquidity risk. Section 4.3 concludes.

4.1 Data and sample

Data are collected mainly from BankScope which provides data for a huge number of banks in many countries of the world in the forms of balance sheets, income statements, various ratios, and ownership information. This database is updated monthly and the latest issue of the BankScope database used in this study is March 2007. Other critical supplementary data sources and information include Almanac of China's Finance and Banking (1986-2005) published by the China's central bank, China Statistical Yearbook (1991-2006) published by China Statistical Publishing House, IMF's international Financial Statistics, a wide range of press release, and statistics from the websites of PBC, CBRC, National Bureau of Statistics, and individual banks.

Considering the evolutionary process of the Chinese banking industry and the organizational structure of banks, Chinese commercial banks are classified into four

mutually exclusive and collectively exhaustive groups: state-owned commercial banks (SOCBs), joint-stock commercial banks (JSCBs), city commercial banks (CCBs), and foreign banks (FBs). Four SOCBs include BOC, ICBC, CCBC and ABC. By 2005, there were thirteen JSCBs. Eleven JSCBs are included, namely Bank of Communications, China Everbright Bank, China Merchants Bank, Minsheng Banking Corporation, China CITIC Bank, Guangdong Development Bank, Hua Xia Bank, Industrial Bank, Shanghai Pudong Development Bank, Shenzhen Development Bank, and China Evergrowing Bank. China Zheshang Bank and Bohai Bank are excluded since they were established in June 2004 and in December 2005, respectively. The final group of domestic banks is CCBs. Data on CCBs are much less complete. By the end of 2005, there were 112 CCBs. Due to the lack of data and the fact that most CCBs were established during 1997-1998 or even later, our dataset only consists of a small number of CCBs in the first half sample period and about 20 CCBs during the second half of the sample period.

Regarding this classification of commercial banks, one might argue that the separation of SOCBs from JSCBs is meaningless because the key shareholders of JSCBs are local governments and the state-owned or state-controlled enterprises. The only difference is whether the sole or major owners are the central government or local governments. However, although all JSCBs are subject to government influence, the degree of intervention is much less in JSCBs than in SOCBs. The latter take more responsibility for promoting macroeconomic stability and maintaining economic growth. Moreover, the remuneration system of JSCBs is more flexible as it is determined at provincial or city levels, whereas that of SOCBs tends to be more rigid by being set in line with other central government officials. In addition, the personnel management of JSCBs is also different from that of those SOCBs. Therefore, JSCBs are more competitive, profit-oriented, and performance-conscious.

One might also argue that all CCBs have been constructed in the form of joint-stock banks with local enterprises and finance bureaux as major shareholders. The separation between CCBs and JSCBs in this study is based on two reasons. The first reason is that all JSCBs are allowed to operate nation-wide, whereas CCBs are restricted to operate within their municipalities' localities. The second reason is that JSCBs operate on a commercially profit-oriented basis since they are subject to less

government intervention. CCBs are originally converted from urban credit cooperatives and they are subject to local government intervention. The managerial and operational skills are generally poorer than JSCBs. CCBs have carried on all their previous operations and it takes time to direct their management styles toward a higher level for fully commercial based banks and to improve their operational skills.

As to foreign banks, there were 254 foreign bank operating institutions by 2005. Foreign banks are not separated from joint venture banks because China treats a bank as a foreign bank if the share of one single foreign owner exceeds 20%. Data on foreign banks are not publicly available and the final dataset only include less than ten foreign banks. Including such a small number of foreign banks may not significantly impact on our analysis for two reasons. First, the total assets of foreign banks only accounts for less than 2% of the banking assets. Second, the business scope and operations of foreign banks are highly restricted to a small number of geographical locations, meaning that they do not operate on a level playing field with domestic banks. Although the coverage is small, the inclusion of foreign banks and joint-venture banks may provide comparative and complementary information for our analysis.

It should be appreciated that the quality of data in China is questionable and the analysis should take into account this limitation. In order to eliminate the effect of data quality on the reliability of research findings, data from BankScope have been carefully edited, complied with, and cross-checked for consistency with data from the above-mentioned sources. Following Bonin *et al.* (2005a), bank observations have been chosen against three criteria. First, when more than one set of financial statement are available, the consolidated statements are chosen. Second, the sample used in Chapter 4 includes both commercial banks and state-owned policy banks in order to draw more complete picture for the current state of the Chinese banking system. The sample used in efficiency estimation in Chapter 5, Chapter 6 and Chapter 7 consists of commercial banks only as this study focuses on the performance of commercial banks and the impact of institutional changes on bank performance. Finally, in Chapter the sample only include banks for which data are available at least for five years during 1995-2005, helping to separate bank inefficiencies from random noise in the error terms.

The final dataset includes 35 commercial banks with 310 observations. Due to the missing observations for a number of years and banks, the sample is unbalanced and its distribution is shown in Table 4.1. The observations range from 17 to 34 per year and spread relatively evenly over the sample period except for the first two years during which there are only 17 and 18 observations. The sample covers all major commercial banks in China, accounting for more than 80% of the country's total banking assets. The sample period is characterised by fundamental and drastic financial liberalization, reform, and opening up in the Chinese banking industry.

Table 4.1 Overall structure of dataset (number of observations)

Year	SOCBs	JSCBs	CCBs	FBs	Total
1995	4	10	1	2	17
1996	4	11	1	2	18
1997	4	11	3	4	22
1998	4	11	5	5	25
1999	4	11	9	6	30
2000	4	11	14	4	33
2001	4	11	13	5	33
2002	4	11	14	5	34
2003	4	11	14	5	34
2004	4	11	14	5	34
2005	4	9	12	5	30
Total	44	118	100	48	310

Notes: SOCB = state-owned commercial bank, JSCB = joint-stock commercial bank, CCB = city commercial banks, FB = foreign bank.

4.2 The current state of the Chinese banking system

An analytical framework for macro-prudential analysis is adopted to assess the current state of the Chinese banking system. The analytical framework has been developed after the worldwide banking crises in the 1980s and 1990s. It has been advocated by IMF and the European Systems of Central Bank for improving the safeguards against instability of the global financial system. The macro-prudential analysis framework consists of three main steps. The first step is to assess the current state of a financial sector through backward looking at banks' past performance. The second step is to identify the type and size of actual and/or potential sources of risk to which banks are exposed by analyzing the main drivers of bank profitability and

solvency. The third step is to examine the resilience of banks to possible risks by assessing the impact of identified risks on the stability of the banking system (Mörttinen, *et al.*, 2005). This study limits itself at the first step and will not go further into the other steps, since the main purpose is to provide a preliminary assessment of the current condition of the Chinese banking system. It merely borrows the framework of the financial soundness indicators to conduct a financial ratio analysis in a structured and informative way.

In order to probe how the banking system has performed under the past economic and financial market conditions, a wide range of financial ratios are analyzed, covering the main development in income statements, balance sheet conditions, capital adequacy, and asset quality. IMF has finalized these ratios into a core set and an encouraged set of indicators in the *Compilation Guide on Financial Soundness Indicators* (2004). The core set indicators include key ratios of earnings and profitability, capital adequacy, asset quality, liquidity and sensitivity to market risks (Mörttinen, *et al.*, 2005).

The assessment is essentially ratio analysis rather than the estimation of regression models to obtain reliable inferences. Ratio analysis is widely applied to financial institutions because of its clarity and simplicity. Its potential limitation is that it assumes that all other factors are held constant when considering a particular ratio. To overcome this limitation, the macro-prudential analysis framework employs a wide range of indicators to evaluate banks from different dimensions. A variety of financial information from bank balance sheets and income statements are grouped into indicators of profitability, capital adequacy, asset quality, and liquidity. Data and ratios analyzed are raw data without any adjustment and deflation as usually done in regression models. The aim is to make a backward-looking trend analysis of bank performance over the past ten years. The comprehensiveness and intensiveness of information thereof enable us to probe policy implications and make policy recommendations.

In addition to the trend analysis, financial ratios are also compared with those of seven selected internationally renowned commercial banks, namely JP Morgan Chase Bank, BNP Paribas, Bank of America, Barclays Bank, HSBC, Royal Bank of

Scotland, and Citigroup. These banks are selected as benchmark because not only are they leading banks in the world but also most of them are active foreign investors in the process of the opening up of the Chinese banking market. The comparability across Chinese banks and these international banks is questionable. There exist significant differences in terms of macroeconomic conditions, managerial skills, management style, market structure, culture, and the like. However, the aim of Chinese bank reform is to create a sound banking system and to transform domestic banks (specifically SOCBs) into internationally competitive banks. Benchmarking to the best performing international banks helps the Chinese banks to identify their weaknesses in order to improve their international competitiveness. In fact, for monitoring the ongoing bank reform, the government has already set out ten requirements for good corporate governance and seven performance indicators since 2004. These measures have been benchmarked to the top 100 largest banks globally, focusing on risk management and improving corporate governance.

4.2.1 Profitability

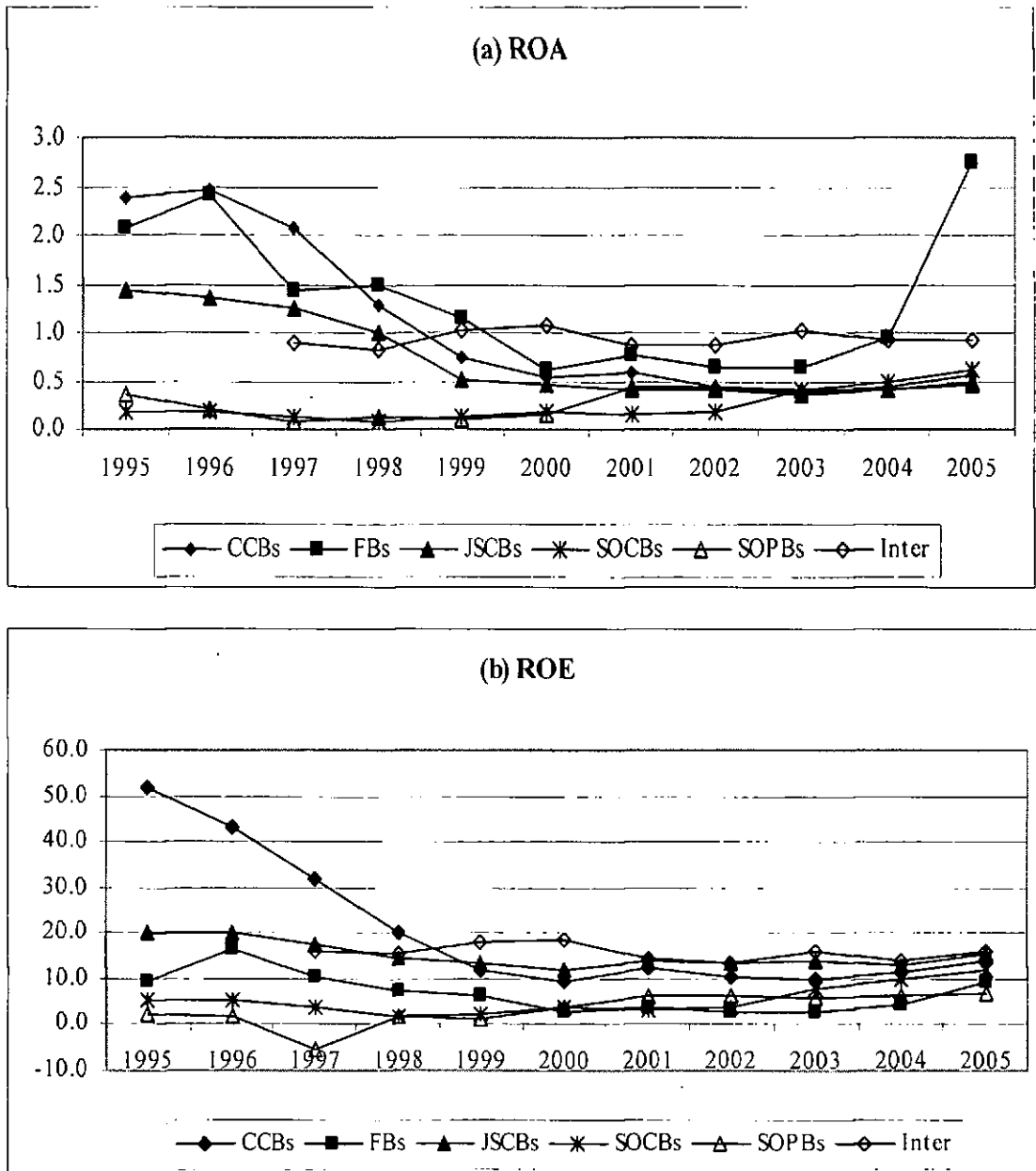
Bank profitability is evaluated by two frequently used performance measures of ROA and ROE. In addition, the ratio of interest margin to gross income and the ratio of costs to income are also analyzed to identify factors contributing to good/bad performance in an attempt to discover the strengths and weaknesses of banks' operation.

ROA (ROE) is defined as the ratio of net income to average total assets (equity). ROE needs to be interpreted in connection with capital adequacy as it is affected by both profitability and capital adequacy. A high ROE could result from high profitability and/or low capitalization, or *vice versa*. Net income in ROA and ROE calculation is net income after extraordinary items and taxes, while the denominators take the average of the beginning and end-period positions of asset and that of equity, respectively.

Figure 4.1 (a) and (b) plot the average ROA and ROE for different types of banks in China and seven selected international banks. The ROA of Chinese banks has declined steadily during the first half of the sample period and kept relatively stable

over the second half of the sample. Except for CCBs' ROE fell sharply in the first five years, other banks' ROE has remained stable for the entire period. On average, Chinese banks are less profitable compared with selected international banks. The average ROA and ROE of Chinese banks are 0.59% and 11% while those of international banks are 0.94 % and 16%, respectively.

Figure 4.1 ROA and ROE of different types of banks



Source: BankScope

Notes: ROA = return on assets, ROE = return on equity, CCB = city commercial bank, FB = foreign bank, JSCB = joint-stock commercial bank, SOCB = state-owned commercial bank, SOPB = state-owned policy bank, Inter = seven selected international banks.

Figure 4.1 shows that all banks suffered a systematic shock with different extent in 1997, reflecting the downside effects of the Asian financial crisis on the Chinese banking system. A subsequent decline lasted until 1999 when the Chinese government implemented the first round of SOCBs bailout in the forms of recapitalization and NPLs off-loading. FBs are the best performers measured by average ROA of 1.36% but much worse measured by average ROE of 6.87%. This is perhaps because foreign banks have small size of total assets but a relatively more adequate equity-capital base, compared with their domestic counterparties.

CCBs are more profitable than SOCBs but less profitable than FBs in terms of ROA. They are the second best bank group in terms of ROE in the sample. CCBs have experienced a dramatic decline in both ROA and ROE during the first half of sample period. The main reason is considered to be a sample bias. As shown in Table 4.1, only a few CCBs are included in the sample for the first five years. They have been established and have operated in well developed economic regions of China, such as Shanghai, Beijing, Tianjin, Shenzhen and Xiamen. Moreover, their management is generally superior to that of other CCBs. Evidently, the average ROA and ROE have dropped sharply when more CCBs are included during the second half of the sample period.

SOCBs have performed poorly throughout the whole sample period despite of an improvement in ROA and ROE after 2002. The overall performance of SOPBs is very similar to SOCBs, causing a particular concern. In principle, SOPBs are supposed to conduct policy lending activities to economically less profitable but socially beneficial industries and projects in support of the overall economic development. They do not operate on a profit-oriented commercial basis and therefore they are expected to underperform SOCBs who operate on commercial basis and have been freed from policy lending activities since 1994. This similarity in the performance among SOCBs and SOPBs has two implications. First, SOPBs have been concerned about profitability in extending policy loans which to some extent is in contradiction with their policy lending role. Figure 4.1 shows SOPBs' ROE has been increasing over the sample period. Second, SOCBs have been less concerned about profitability in their operations than they should be as commercial banks. It

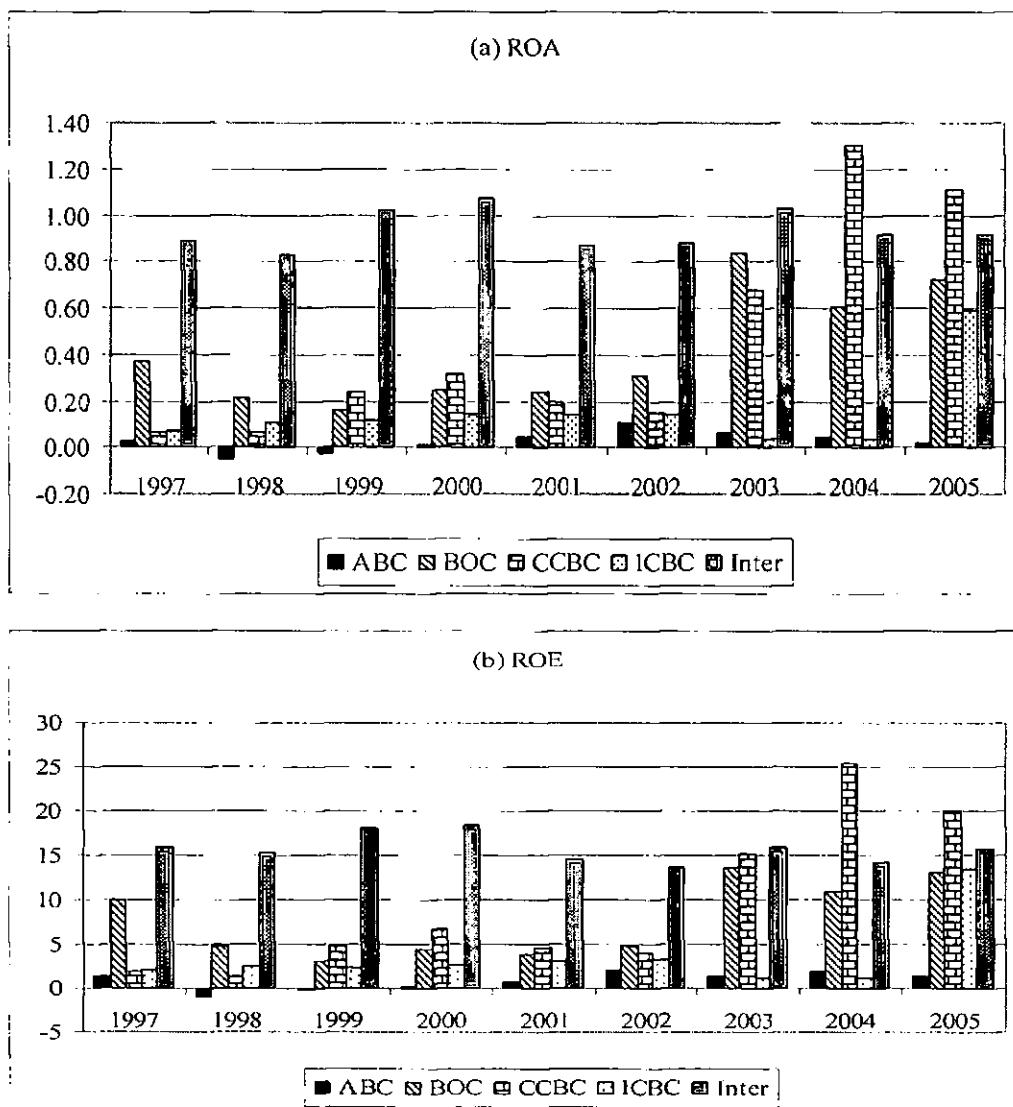
might be evident that SOCBs still have been playing a role in policy lending activity, consistent with the discussion of SOPBs in Chapter 2.

On average, JSCBs have higher ROA and ROE than other domestic banks and they even compete with international banks in terms of ROE for the most of sample period. Majority of JSCBs were established during the late 1980s and early 1990s as profit-oriented commercial banks. They are generally believed to have better management and some advantages over SOCBs, such as a more flexible remuneration system, more profit-orientation, and less government intervention. However, Figure 4.1 also reveals that JSCBs' ROA has been declining during the same period when other domestic banks' ROA have been stable or slightly improved. This trend opens a question as to whether their better performance has been the results of superior management and modern banking practices or simply the results of taking the advantages of new establishment with no historical burden as the SOCBs. In fact, key management officials of JSCBs are mainly transferred from SOCBs, resulting in more or less similar management philosophy, style, and operational skills. There is a danger that JSCBs could be a copy of SOCBs except for fewer NPLs burdens. For JSCB to be internationally viable in the long-term JSCBs' bankers should ensure their superiority in management and modern banking practices.

Given a high priority in banking reform and a dominant role in the Chinese banking system, it is worthwhile to have a close look at their performance in comparison with the performance of the selected international banks. In fact, the four SOCBs are at pivot of the Chinese banking system and at the forefront of bank reform. They are among the 40 largest banks in the world in terms of total assets, whereas their performance is much lagged behind the world's largest banks despite a significant improvement in recent years. Figure 4.2 shows the ROA and ROE for each of the SOCBs and average the ROA and ROE of the international banks. The performance of three restructured SOCBs (CCBC, BOC and ICBC) significantly caught up with that of the international banks over the past three years. Their ROA and ROE increased slowly before 2003 but rose sharply after 2003, suggesting a significant impact of drastic SOCBs reform starting from 2003. CCBC made the most impressive improvement, outperforming the international banks after 2004. Its ROA and ROE increased about six times, reaching 25.4%. BOC and ICBC experienced a similar

catching up process, achieving a significant increase in ROA and ROE from 2003. By 2007, except for ABC, the SOCBs were as profitable as the international banking giants.

Figure 4.2 ROA and ROE of SOCBs and international banks



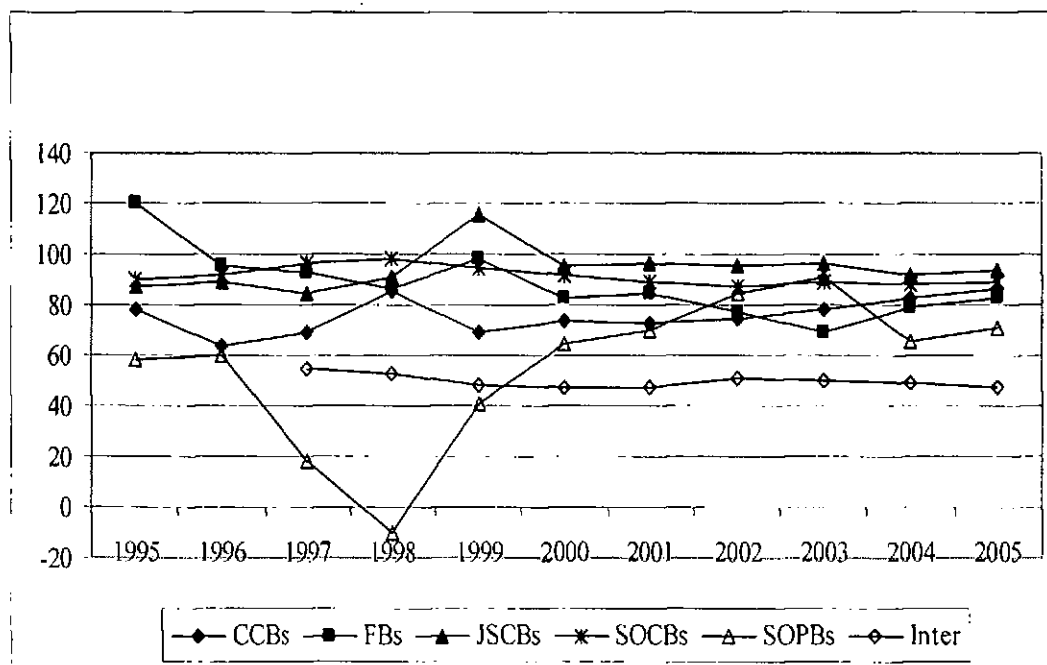
Source: BankScope

Notes: ROA = returns on assets, ROE = returns on equity, SOCB = state-owned commercial bank, ABC = Agricultural Bank of China, BOC = Bank of China, CCBC = China Construction Bank Corporation, ICBC = Industrial and Commercial Bank of China, Inter = International Banks.

The ratio of interest margin (interest received less interest paid) to gross income measures the relative share of net interest earnings in gross incomes, which indicates the sources of bank profit. Figure 4.3 shows the average of this ratio for different types of banks in China and international banks. Chinese banks have been

overwhelmingly and persistently dependant on interest incomes that accounts for about 90% of their gross incomes. In a sharp contrast, interest incomes in international banks only account for about 40% of their gross income. Among different types of bank, JSCBs have the highest dependency on interest incomes at about 94%, surpassing SOCBs. It is evident that JSCBs have concentrated on traditional lending activities with less involvement in more profitable modern banking activities to generate fees and commission incomes. The results suggest that JSCBs have developed in a similar fashion with SOCBs that they both have excessively dependent on traditional lending activities. There has been a lack in moving towards the advanced and diversified banking practices, suggesting a fundamental weakness of the Chinese banking sector.

Figure 4.3 Interest margin to gross income of different type of banks



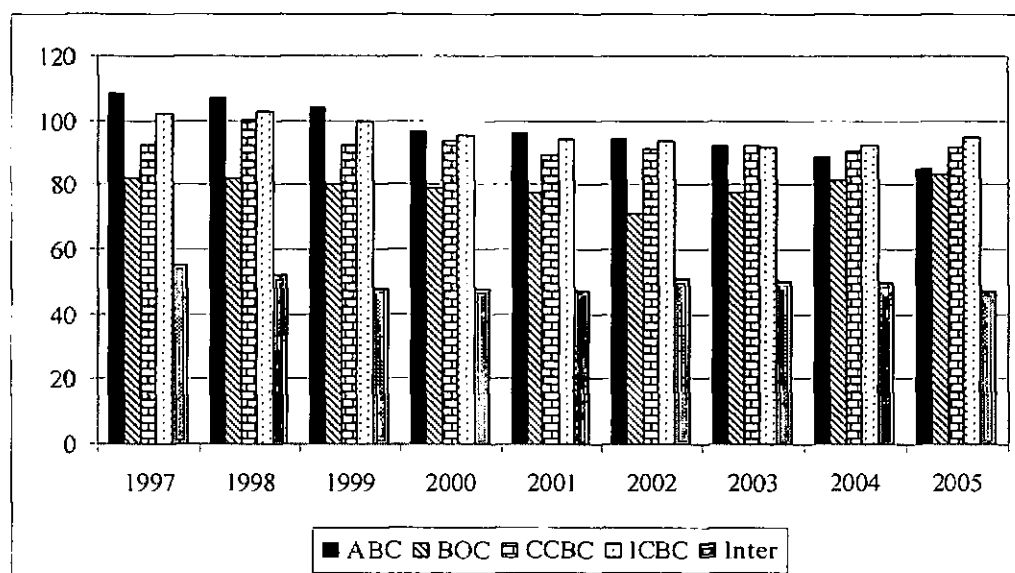
Source: Authors' calculation based on data from BankScope.

Notes: CCB = city commercial bank, FB = foreign bank, JSCB = joint-stock commercial bank, SOCB = state-owned commercial bank, SOPB = state-owned policy bank, Inter = international bank.

Figure 4.4 shows the ratio of interest incomes to gross income for individual SOCBs and the selected international banks group. Again, the ratios were as high as at 90%. It appears that Chinese banks were unaware of the benefits of diversifying income

sources away from interest incomes after almost three decades of reform. It is considered as a weakness of the banking system because higher dependence on interests makes banks' profitability more sensitive to assets quality. It is an area of great potential for future development and needs to be addressed.

Figure 4.4 Interest margin to gross income of SOCBs and international banks

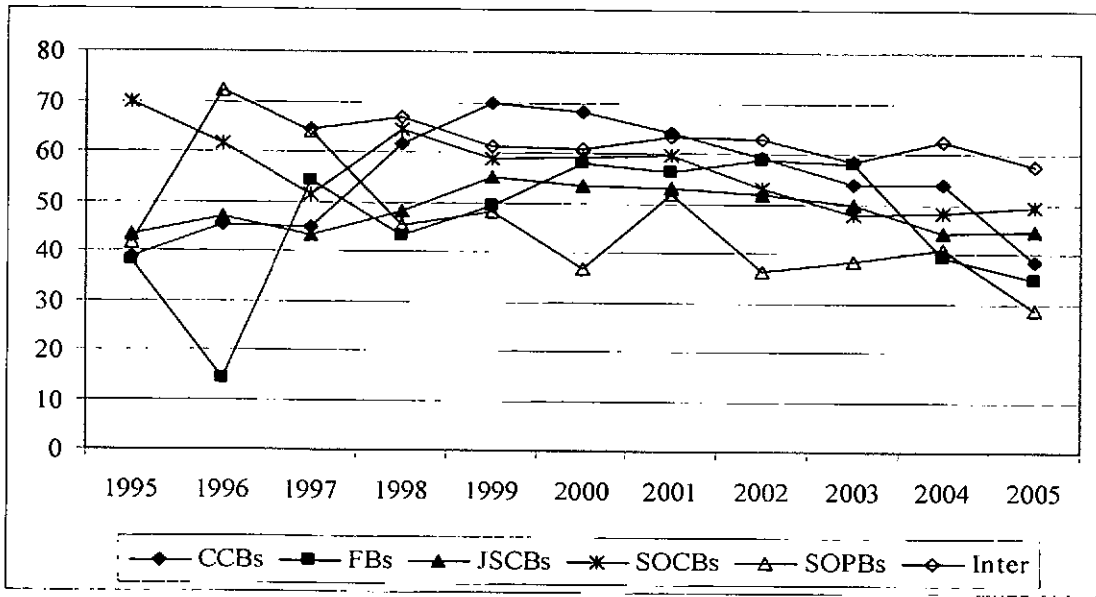


Source: Authors' calculation.

Notes: SOCB = state-owned commercial bank, ABC = Agricultural Bank of China, BOC = Bank of China, CCBC = China Construction Bank Corporation, ICBC = Industrial and Commercial Bank of China, Inter = International Bank.

Cost-to-income ratio is defined as the ratio of operating non-interest expenses to gross income, measuring the proportion of gross operating income absorbed by overhead expenses. It is a simple financial proxy for cost efficiency, widely used by banking system analysts. A lower value indicates greater efficiency. As shown in Figure 4.5, operating expenses consume a substantial portion of net operating income. The cost to income ratio declined over time for all types of banks, suggesting that all the banks were concentrated on cost savings to improve performance. Chinese banks performed much better in cost control than their international counterparts. In other words, they were more cost efficient. This is considered as the strength of the Chinese banking system.

Figure 4.5 Cost to income of different type of banks

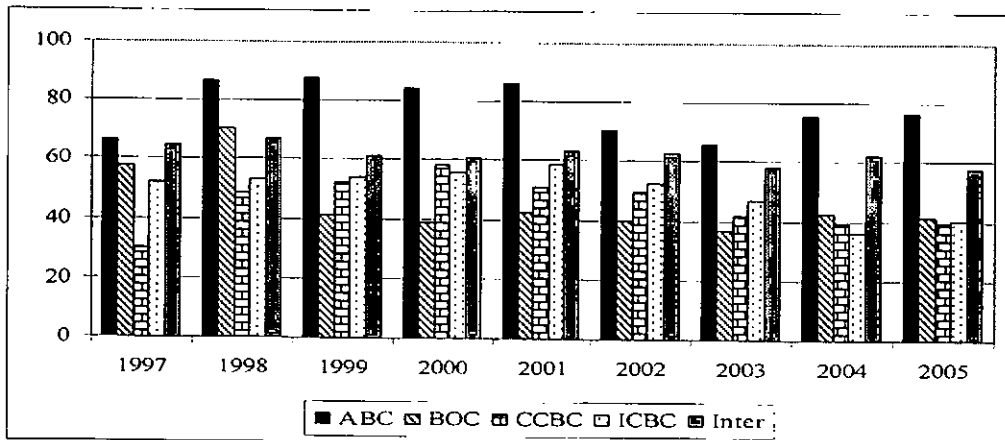


Source: BankScope.

Notes: CCB = city commercial bank, FB = foreign bank, JSCB = joint-stock commercial bank, SOCB = state-owned commercial bank, SOPB = state-owned policy bank, Inter = international bank.

Looking at the cost to income ratio of individual SOCBs shown in Figure 4.6, SOCBs, except ABC, achieved higher cost efficiency than the international banks. SOCBs made considerable efforts to reduce operating expenses by closing down unprofitable branches and cutting jobs. As a result, cost to income ratio was reduced by about 20% over the sample period.

Figure 4.6 Cost to income of SOCBs and international banks



Source: BankScope.

Notes: SOCB = state-owned commercial bank, ABC = Agricultural Bank of China, BOC = Bank of China, CCBC = China Construction Bank Corporation, ICBC = Industrial and Commercial Bank of China, Inter = International Bank.

When taking into account of increased loan loss provisions (LLP) for most Chinese banks during the period, cost savings were more significant since LLP constituted part of total expenses and consumed gross income. LLP are net new allowances against bad or impaired loans during an accounting period. On average, the ratio of LLP to gross income of domestic bank increased to 17% by 2005 from nearly zero in 1995 as a result of tightened regulations.

4.2.2 Capital adequacy

Banking is a highly leveraged industry that equity capital only accounts for 8% of total assets with the rest 92% being financed by depositors and other creditors. Such a small portion of equity capital plays a fundamental role in the banking business and it is vital to the survival and growth of banks in the long run. Bank capital functions as a source of funds, a cushion to absorb unexpected operating losses, and the final safeguard of bank solvency. When losses exceed bank capital in the extreme, banks will be insolvent and face closure. It is important for banks to have adequate capital. Capital adequacy ratio (CAR) measures the capacity of the financial sector to absorb losses and indicate bank solvency. CAR is regulated in most countries for the purposes of maintaining a sound banking system and protecting depositors.

IMF has introduced four capital adequacy indicators in the macro-prudential analysis framework, including regulatory capital to risk-weighted assets, regulatory Tier 1 capital (core capital) to risk-weighted assets, non-performing loans (net of specific provisions) to capital ratio, and equity to total assets ratio (E/A ratio). Tier 1 capital is common in all countries and it is the most important capital because of the greatest ability to absorb losses. It is related to bank profitability and competitiveness and has become an informative basis for interest parties to judge a bank's capital adequacy. The Basel Capital Accord sets minimum capital requirements for banks as 8% for regulatory capital and 4% for core capital. Generally, the higher the ratio, the safer is the bank, although over capitalization might imply economic inefficiency, waste, and opportunity cost for both shareholders and society.

In China, Regulation Governing Capital Adequacy of Commercial Banks has come into effect since 1 March 2004. Commercial banks were given a transition period up to 1 January 2007 to meet the minimum capital adequacy requirements by taking on a feasible phase-in plan. The disclosure of CAR is not an official requirement for banks before 2004. Although authorities have internally monitored banks' capital adequacy in accordance with the Basel Capital Accord since 1998, data on CAR are publicly unavailable for every bank. Therefore, the analysis is based on odd information gathered from various sources, including major annual reports, press releases, China Banking Regulatory Commission announcements, and *Almanac of China's Finance and Banking (1986-2005)*. Table 4.2 reports the CAR for the major banks in China and the average CAR of international banks.

Table 4.2 Capital adequacy ratio of Chinese banks

Year	2001	2002	2003	2004	2005
Chinese banks:					
ABC		1.44			
BOC	8.30	8.15	7.69	10.04	10.42
CCBC	6.88	6.91	6.51	11.29	13.57
ICBC		5.54	5.52		9.89
JSCBs			3.36	6.59	8.10
International banks	12.15	12.05	12.17	11.60	11.83

Sources: the Banker, *Almanac of China's Finance and Banking*.

Notes: ABC = Agricultural Bank of China, BOC = Bank of China, CCBC = China Construction Bank Corporation, ICBC = Industrial and Commercial Bank of China, JSCB = joint-stock commercial bank.

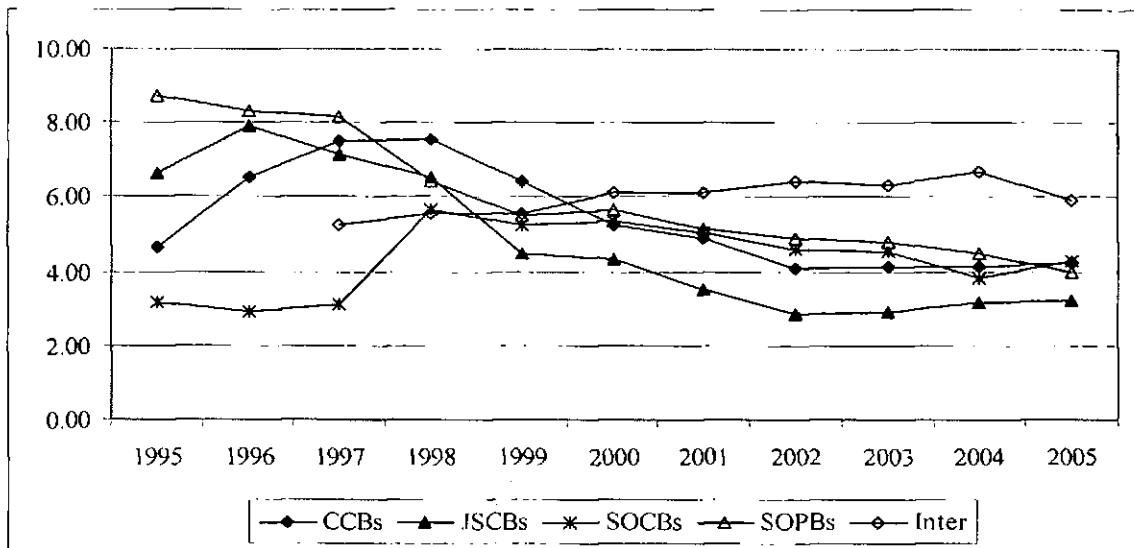
Low capitalization has been one of the major plights haunting the Chinese banking system. The capital adequacy for most Chinese banks has been much less than international standards set by the Basel Capital Accord. In order to increase banks' capital adequacy, the government has made every possible effort since 1998, including two rounds of capitalization and two rounds of NPLs off-loading. After a capital injection of RMB 270 billion in 1998, the CARs of SOCBs reached 8%. Nevertheless, SOCBs' CAR dropped below 8% except for BOC, although Tier 1 capital ratios of SOCBs were still above the international standard of 4% in 2002. Under the challenges from WTO accession, the government initiated the second round of capitalization and NPLs offloading for selected SOCBs to increase their

capital base and assets quality. As shown in Table 4.2, the CAR was well above the international requirement of 8% by the end of 2005, although still lower than the average international banks' CAR by about 3 to 4 percentage points.

In the absence of complete data on regulatory CARs, this analysis has to be compromised by concentrating on the E/A ratio that reflects the proportion of total assets financed by equity capital. The total assets are not risk weighted and equity only includes capital and reserves, taken from bank balance sheets directly. While equity to total assets ratio is less risk-sensitive than regulatory CARs, the changes in E/A ratio reveal shifts in bank balance sheet structure and shifts in bank risk taking. Figure 4.7 plots the E/A ratio for the major peer groups of Chinese banks and selected international banks.

The capital base of Chinese banks has declined over the sample period measured by the proportion of their total assets. Equity accounts for 5% or less of total assets, whilst that of selected international banks is above 6%, suggesting a slightly more vulnerable banking system in China. The E/A ratio of JSCBs dropped substantially during the first four years from the most capital adequate banks to the least ones. One reason is the rapid expansion of loans from 48% of total assets in 1995 to 60% in 2005, much faster than the equity growth. The E/A ratio of CCBs and SOPBs have moved in a similar pattern as that of JSCBs, declining first then becoming relatively stable. The movement of SOCBs' E/A ratio exhibits different patterns from other banks because of the significant effect of government subsidiaries. The E/A ratio of SOCBs was the lowest at 3% in the first two years and dramatically doubled as a direct consequence of the first round SOCBs bailout in 1998. Nevertheless, it then declined slowly in the next two years and then sharply until 2004. Again, due to the second round of SOCBs bailout, their E/A ratio slightly increased in 2005.

Figure 4.7 Equity to total assets ratio of different type of banks



Source: BankScope.

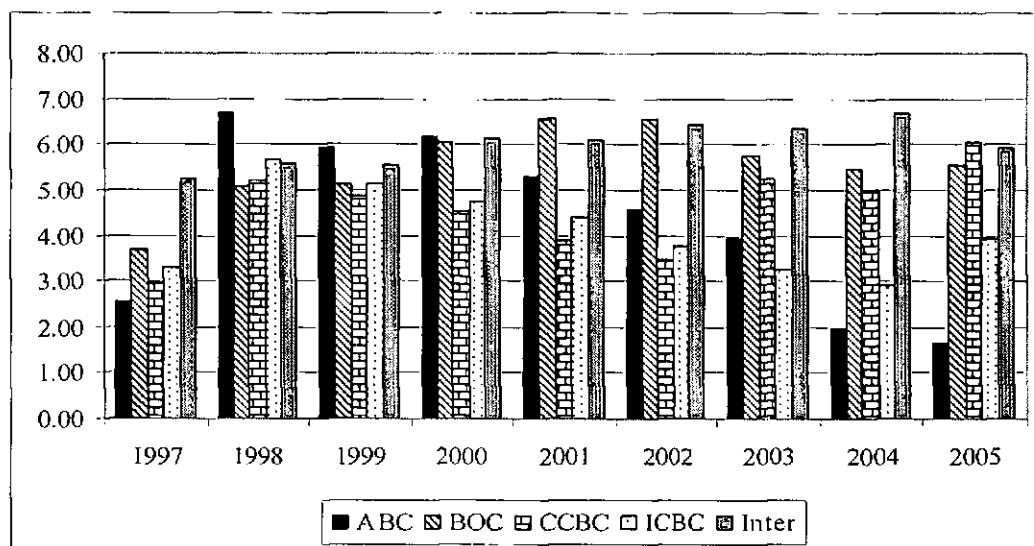
Notes: CCB = city commercial bank, JSCB = joint-stock commercial bank, SOCB = state-owned commercial bank, SOPB = state-owned policy bank, Inter = international bank.

Over the sample period, the overall E/A ratio of Chinese banking system has been declining, which may be explained as follows. First, rapid credit expansion has been driven by a rising demand for financing the fast growing economy. From 1996 to 2005, the total loans made by SOCBs and JSCBs increased by 157%. Second, domestic banks have been unable to raise external capital to keep up with the pace of credit expansion. The capital market in China remains underdeveloped and the market relatively is thin. Only six JSCBs have raised funds from the capital market through stock exchange listing by 2005. Until 2006 the government started to restructure SOCBs and let three SOCBs be listed in the stock markets. Third, banks have been unable to increase capital internally because of low profitability. Although JSCBs are profitable, they have extended out loans much faster than the increases in equity. SOCBs' low capitalization was the result of low profitability and rapid expansion of loans with low quality. The result suggests that the surge of foreign direct investment in the banking system and the IPOs of domestic banks were insufficient to significantly improve the capital base of the banking system at least by 2005.

When looking at SOCBs individually in Figure 4.8, the impact of government subsidies become apparent. The E/A ratio improved significantly in 1998 after the first round of SOCBs bailout, while the ratio kept falling gradually for all SOCBs

except for BOC until 2002. In late 2003, the government recapitalised three SOCBs as part of more radical SOCBs reforms. As a result SOCBs' E/A ratio improved significantly reaching a level of the international benchmark except for ABC.

Figure 4.8 Equity to total asset ratio of SOCBs and international banks



Source: BankScope.

Notes: SOCB = state-owned commercial bank, ABC = Agricultural Bank of China, BOC = Bank of China, CCBC = China Construction Bank Corporation, ICBC = Industrial and Commercial Bank of China, Inter = International Bank.

4.2.3 Asset quality and the non-performing loans

The quality of banks' loan portfolio is of fundamental importance to profitability, which, in turn, is the premise of banks' long term viability. Asset quality is particularly essential for a banking system where bank incomes are mainly supported by interest incomes as it is in China. Although a few financial ratios can be used to reflect assets quality, this study concentrates on the NPL ratio (the ratio of NPLs to Gross Loans) and loan loss reserves (LLR) to gross loans ratio.

NPL ratio is a backward-looking measure of assets quality based on historic information of bank loan portfolio. A higher ratio indicates lower asset quality. NPL is an important problem in the Chinese banking system as a vast amount of NPLs was accumulated in the SOCBs over the last two decades. Detailed NPL information has been unavailable until the People's Bank of China urged banks to disclose their NPL

ratios and balance sheets in accordance with the newly adopted internationally-accepted five-category loan classification system in 2000. Since 2002, all banks were officially required to disclose NPL figures in their annual reports. In 1998, the government first disclosed that the NPL ratio of SOCBs was less than 30%. However, our estimate was about 42% in 1999 as shown in Table 4.3, accounting for 40% of China's GDP for the year. The estimates in Table 4.3 are consistent with those by some international agencies, such as Standard & Poor's and Moody's, that the NPL ratio of Chinese banks was 35-50%.

In essence, NPLs of Chinese banks are different from those of banks in other countries. Rather than losses from managerial and operational failure, much of NPLs of Chinese SOCBs was a number of factors in the process of economic transition in the country. Such factors include government intervention to support loss-making SOEs, excessive credit expansion to finance the overheated economy during the economic bubble in the early 1990s, the lack of commercial banking experiences in a market-oriented environment, a weak supervisory and regulatory system, and the under-developed legal and accounting framework. These NPLs are the costs of the transition from a planned economy to a market one for maintaining social stability and sustaining high economic growth.

Before further analysis, it is worth looking at how to identify NPLs in China. A Chinese-style four-category loan classification system had been used until it was officially replaced by an internationally-accepted five-category loan classification system. Under the four-category loan classification system, loans are categorized as *Pass*, *Past-due*, *Idle* and *Bad*, of which the last three categories are identified as NPLs. Under the five-category loan classification system, bank loans are classified in accordance with their inherent risks as *Pass*, *Special-mention*, *Substandard*, *Doubtful* and *Loss*, of which the last three categories are identified as NPLs. The four-category loan classification system tends to underestimate NPLs relative to the five-category loan classification system since the former provides leeway to retain NPLs unexposed. According to PBC's internal studies, the five-category system increases NPL ratio by about 14% compared with the four-category loan classification system. Based on an experiment in Guangdong, the five-category loan classification system has been applied to all commercial banks since 2002.

SOCBs were the main producers of massive NPLs in the Chinese banking system. Table 4.3 summarizes the statistics of SOCBs for the period 1999-2005, based on our estimation and officially released information. In 1999, the total amount of NPLs in SOCBs reached RMB3.3 trillion and the NPL ratio was 43% under the four-category loan classification system, accounting for 40% of the country's GDP in that year. This figure would be higher if NPLs had been identified under the five-category loan classification system. After the first round of NPL divestment by RMB 1.4 trillion in 1999, the total amount of NPLs rebounded to RMB 2.3 trillion and the NPL ratio was 31% in 2001 under the newly adopted five-category loan classification system. After 2001, NPLs declined steadily. By 2005, the NPL ratio and total NPLs were down to 10.49% and RMB 1 trillion respectively, reflecting a significant achievement of government efforts to revitalise the SOCBs. The share of NPLs in SOCBs to GDP fell dramatically from 42% in 1999 to 6% in 2005, because of increasing GDP and decreasing NPLs.

Table 4.3 NPLs of SOCBs

	Four-category			Share of	Five-category		
	Ratio %	Balance RMB billion	Share of GDP %		Ratio %	Balance RMB billion	Share of GDP %
1999	42.83	3,345	40.76				
2000	29.18	1,952	21.82				
2001	25.37	1,877	19.29	31.02	2,286	23.49	
2002				26.10	2,208	20.99	
2003				19.74	1,964	16.75	
2004				15.57	1,575	11.54	
2005				10.49	1,073	5.88	

Sources: CBRC, Almanac of China's Finance and Banking, China Statistical Year book and author's calculation and estimation.

Note: NPL = non-performing loan, SOCB = state-owned commercial bank.

Due to the incompleteness of data, Table 4.4 shows the NPL ratios of major Chinese commercial banks for the period 2001-2005. Apart from ABC, all domestic banks have dramatically reduced their NPLs in both year-end balance and the ratio to total loans. The NPL ratio of three restructured SOCBs and CCBs have declined significantly from more than 20% in 2001 to 5% and 8% in 2005, respectively. JSBCs

had the lowest NPL ratio among all domestic banks. Their average NPL ratio declined from 13% in 2001 to 4% in 2005, indicating better asset quality control and risk management practice over SOCBs and CCBs. Despite substantial improvement, the NPL ratio of the Chinese commercial banks was still well above the average NPL ratio of about 2% achieved by the selected international banks. It implies that continuous efforts are required by the Chinese banks to fundamentally resolve their NPL problem.

Table 4.4 NPL ratios of Chinese banks (%)

Year	2001	2002	2003	2004	2005
ABC			30.1		26.2
BOC	27.5	22.5	16.3	5.1	4.9
CCBC	19.4	15.2	9.1	3.9	3.8
ICBC	29.8	25.4	21.2	19.0	4.7
JSCBs	12.9	9.5	7.6	4.9	4.2
CCBs	24.0	17.7	14.9	11.7	7.7

Sources: Almanac of China's Finance and Banking (2000-2005), The Banker.

Notes: ABC = Agricultural Bank of China, BOC = Bank of China, CCBC = China Construction Bank Corporation, ICBC = Industrial and Commercial Bank of China, JSCB = joint-stock commercial bank, CCB = city commercial bank.

The remarkable decline in the NPL ratio and year-end NPLs was largely due to the massive disposal of bad assets. The government first off-loaded NPLs by RMB 1.4 trillion to four state asset management companies at book value in 1999, which was followed by the second round of NPLs divestment in 2003 and 2005 totalling RMB 1.18 trillion. These divestments reduced absolute value of NPLs in SOCBs, significantly improving their asset quality. Moreover, the decline in NPLs was also attributable to the favourable economic environment and the rapid expansion of the credit market. Total loans extended by SOCBs increased one-third from RMB 6.4 trillion in 1999 to RMB 10 trillion in 2005. The expansion helped reduce the NPLs ratio at least in short run irrespective of the quality of new loans. Furthermore, the significant improvement in NPL condition was also the result of the ongoing bank reform aiming to enhance internal control, risk management, decision making mechanism of credit expansion, disclosure requirements, and quality control for new loans.

However, when looking at the overall NPL situation in China, a different story emerges as summarized in Table 4.5. It shows that although the NPL ratio and the total amount of NPLs decreased substantially, the problem was not resolved for the economy as a whole. Two rounds of NPL divestments transferred a total amount of RMB2.58 trillion NPLs from SOCBs and RMB 64 billion from Bank of Communication to asset management companies.

Table 4.5 Analysis of NPLs in Chinese banks (RBM billion)

	2000	2001	2002	2003	2004	2005
NPLs condition in AMCs						
NPLs received in 1999	1412	1412	1412	1412	1412	1412
Debt equity swaps		319	319	319	319	319
Accumulated Disposal		125	315	509	675	840
(Cash Recovered)		26	67	99	137	177
Outstanding NPLs from 1999	1412	968	778	583	418	253
New removal from Banks					542	705
NPLs balance in AMCs	1412	968	778	583	960	958
NPLs in banks	1952	2286	2208	2441	1718	1313
Total NPLs	3364	3255	2986	3024	2677	2271
Share of total NPLs to GDP %	37.60	33.44	28.39	25.79	19.61	12.46

Sources: CBRC, Almanac of China's Finance and Banking, China Statistical Yearbook, and author's estimates

Notes: (1) NPLs for 2000 are under four-category loan classification system and the rest are all under the newly adopted five-category loan classification system. (2) NPL = Non-performing loan, AMC = Assets management company.

The last two rows in Table 4.5 show the total amount of NPLs that include NPLs in both asset management companies and banks and the share of NPLs to GDP for each corresponding year. The absolute total amount of NPLs in the country had declined by one-third from a total of RMB 3,364 billion in 2000 to RMB 2,271 billion in 2005. As GDP increased from RMB 8.2 trillion in 1999 to RMB18.2 trillion in 2005, the NPL/GDP ratio declined to 12% in 2005.

Taking a closer look at the asset management companies' operation in resolving these transferred NPLs, the problem became more apparent. With respect to RMB 1412 billion NPLs received in 1999, the asset management companies arranged debt-for-equity swap by about RMB 400 billion, of which RMB 319 billion were ultimately

approved by the State Council in 2003. The conversion could end up with worthless rights if there were no fundamental improvement in the performance of these debtors (mainly loss-making SOEs). Thus, the debt-for-equity resolution is not the end of the game since the ultimate result is uncertain. For the rest NPLs of RMB 1,100 billion, only about 20% were recovered as cash. The cash recovery ratio for the remaining NPLs would be lower than 20% since NPLs with relatively better quality had been disposed of already.

Asset management companies had financed those purchased NPLs by the central bank lending and the issue of special bonds guaranteed by the Ministry of Finance. Asset management companies themselves had no sources to repay principal, which would possibly become bad debts again but changed hands from SOCBs to asset management companies. Moreover, the costs on these central bank lending and special bonds were substantial. By assuming the average cost of 2.25% (recent one-year prevailing deposit rate), the total costs for 6 years would be about RMB 191 billion by 2005. The accumulated recovered cash from the disposal of NPLs was RMB 177 billion, which was insufficient to cover the costs of funds to finance purchased NPLs. In addition, there were also initial capital investments of RMB 40 billion to asset management companies when they were established in 1999.

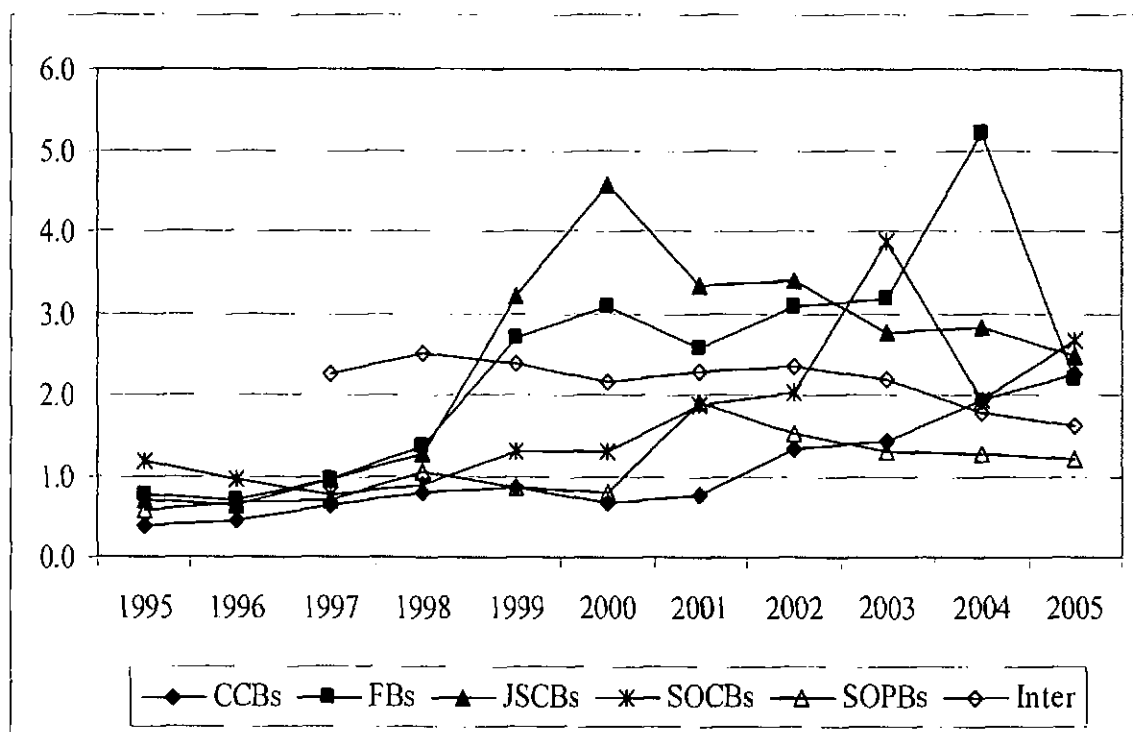
The real effect of the NPLs transfer to asset management companies was to beautify bank balance sheets in order to attract foreign strategic investors and to reduce the possibility of banking crisis. Our analysis implies that the transfer of RMB 1.4 trillion NPLs to asset management companies would possibly end up with the same amount of losses for the economy as a whole, when taking into account the potential losses arising from the debt-for-equity swap. Thus we conclude that the NPL condition of the Chinese financial sector as a whole has not been improved and the NPLs problem remains unresolved. This fosters potential threat to the country's economy as the state probably would pay for the total losses.

The second indicator of bank assets quality is the ratio of LLR to gross loans that measures how much banks provide for unanticipated losses from loan defaults. LLR is used as a cushion against possible future loan defaults before using other types of equity capital. Adequate LLR is a primary indicator of bank financial strength. This

provisioning ratio provides information on bank assets quality by focusing on the ability of the banking system to prepare for possible losses arising from loans. Higher provisioning ratio indicates that a bank provides more for losses on loans and therefore the banks become more immune from unexpected loan defaults. Changes in assets quality can be captured from the changes in provisions. Provisions normally decrease when asset quality is improved with better economic conditions (Mörttinen, 2005). Increased provisions reflect deteriorating assets quality, which in turn corrodes bank performance.

Figure 4.9 shows the average ratio of LLR to gross loans for banks in China and selected international banks. The ratio of Chinese banks has increased steadily, suggesting the improved financial strength of the banking system. During the first four years, only less than 1% of gross loans were secured by LLR for all banks (including foreign banks) in China. Since 1998, in line with more prudential regulatory and supervisory requirements, JSCBs and foreign banks surpassed the average LLR to gross loan ratio of international banks in the rest of the sample period, suggesting the relative stronger ability in absorbing unexpected loan losses. SOCBs improved their performance slowly at the beginning of the sample period. From 2003, their LLP position was significantly improved thanks to the joint-stock reforms. CCBs also exhibited a healthy upward trend in LLR to gross loans ratio. By 2005, all major commercial banks in Chinese had a higher LLR to gross loans ratio than the selected international banks.

Figure 4.9 LLR to gross loans ratio of different type of banks

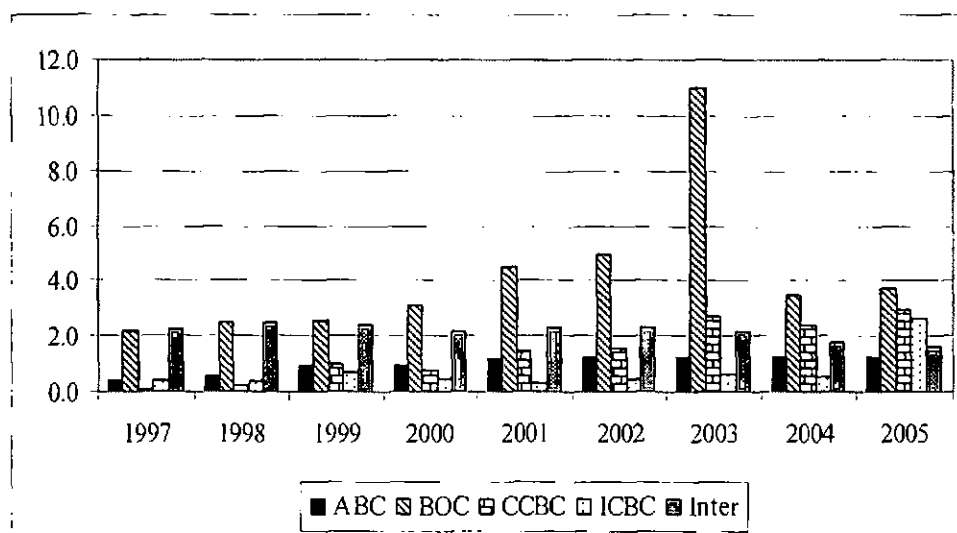


Source: BankScope.

Notes: LLR = loan loss reserve, CCB = city commercial bank, FB = foreign bank, JSCB = joint-stock commercial bank, SOCB = state-owned commercial bank, SOPB = state-owned policy bank. Inter = international bank.

Figure 4.10 depicts the loan loss reserve position for the SOCBs in comparison with the average of selected international banks. Bank of China had a higher ratio of LLR to gross loans than other domestic banks and international banks throughout the sample period. China Construction Bank Corporation was the second best bank whose ratio of LLR to gross loans increased from 1999 and surpassed the international banks after 2003. The LLR to gross loan ratio of ICBC was the lowest among the SOCBs until 2004, but surpassed that of ABC and the international banks in 2005. Although not significant, LLR to gross loan ratio of ABC has improved steadily over the sample period. Thus, considering the ratio of LLR to gross loans along, the Chinese banks appear sound by benchmarking to the international average level.

Figure 4.10 LLR to gross loans ratio of SOCBs and international banks



Source: BankScope.

Notes: SOCB = state-owned commercial bank, ABC = Agricultural Bank of China, BOC = Bank of China, CCBC = China Construction Bank Corporation, ICBC = Industrial and Commercial Bank of China, Inter = International Bank.

NPL ratio and LLR to gross loan ratio measure asset quality from different aspects. In order to draw a more complete picture of bank assets quality when evaluating the bank financial strengths, two indicators should be interpreted jointly. NPL is the most likely source of charge-off loans, while NPL provisioning coverage ratio implies the adequacy of a bank's LLR to cover possible future loan losses. In particular, NPL coverage ratio is defined as the ratio of LLR to NPLs, which is shown in Table 4.6.

Table 4.6 Bank NPL Coverage Ratio in China

Year	2001	2002	2003	2004	2005
ABC			4.19		4.85
BOC	16.3	22.1	67.2	68.2	75.9
CCBC	7.73	10.1	29.9	62.1	78.4
ICBC	1.01	1.69	2.88	2.95	56.2
JSCBs	25.8	35.7	36.5	57.5	58.9
CCBs	3.2	7.51	9.52	16.5	29.2

Source: Almanac of China's Finance and Banking, The Banker, and authors' calculation.

Notes: NPL coverage ratio = loan loss reserve to NPL ratio, NPL = non-performing loan, ABC = Agricultural Bank of China, BOC = Bank of China, CCBC = China Construction Bank Corporation, ICBC = Industrial and Commercial Bank of China, JSCB = joint-stock commercial bank, CCB = city commercial bank.

NPL coverage ratio increased rapidly for all Chinese banks except for ABC over the past five years as a result of a decreased NPL ratio and an increased LLR to gross loan ratio. By 2005, most domestic banks provided loan loss reserve covering more than half of the outstanding NPLs except for CCBs which covered only one-third of NPLs. However, the NPL coverage ratio of seven benchmarking international banks was much higher than that of Chinese banks, ranging from 150% to 300%. Although international banks had lower LLR to gross loan ratio, they had much lower NPL ratios than the Chinese banks. The majority of Chinese domestic banks were under-provisioned against their higher level of NPLs, whereas international banks provided sufficient LLR by as much as three times of their NPLs.

On average, JSCBs were the financially safest domestic banks in providing provisions for outstanding NPLs, implying their better asset quality control and more prudential operational practices. Bank of China was the best amongst the SOCBs with the highest average coverage ratio of 50%, while ICBC and CCBC caught up in loan loss provision after the latest reform. Meanwhile, the NPL coverage ratio of CCBs also improved by 10 times by 2005, thanks to the overall tightening regulatory and supervisory framework and more prudential practice in the Chinese banking system.

4.2.4 Liquidity

Liquidity represents the extent to which bank funds are available to meet the most important cash demand for deposit withdrawals, loans, and profitable investment opportunities. The banking system is a highly geared industry, and it is important for banks to maintain a prudent level of liquid assets. Serious problems in banking liquidity could cause financial losses, bankruptcy of an individual bank, and bank run. It could even trigger a financial crisis for a country or a larger region in the extreme. Therefore, at the industrial level, banking liquidity has been closely monitored by authorities.

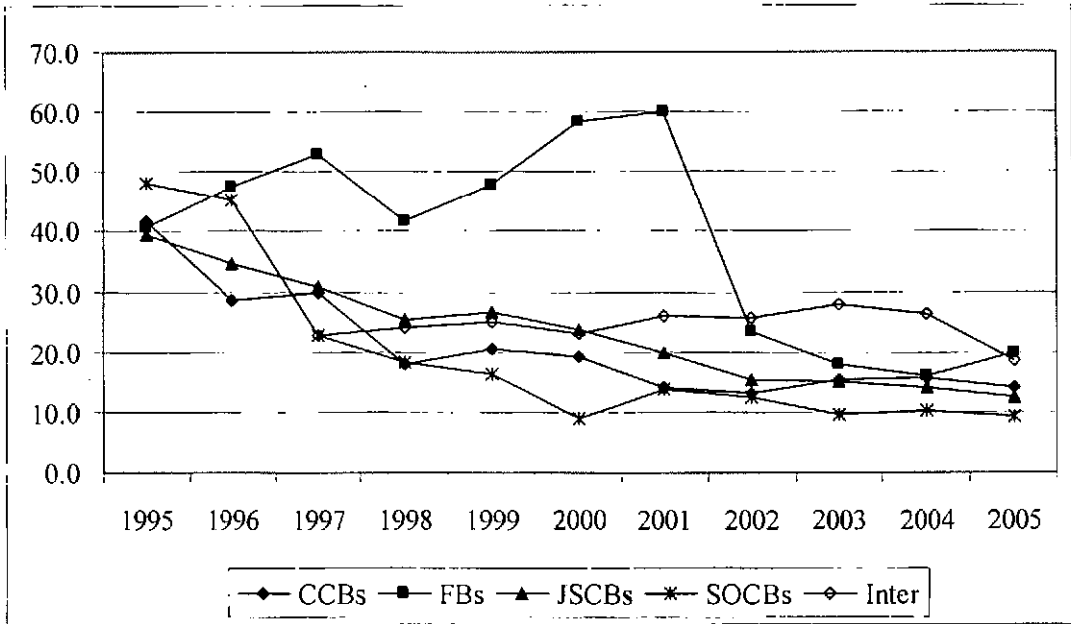
There exists a trade off between asset liquidity and profitability because highly liquid assets are normally associated with lower profitability. It is necessary to maintain certain level of liquid assets to meet cash demand in daily operations, while excessive liquid assets have adverse impact on bank profitability. Lower level of liquid assets to

total assets may result in the risk of being unable to meet cash demand that could be either deposit withdrawals or more profitable investment opportunities. Financial losses might occur when banks have to liquidate assets or raise more expensive funds to meet cash demand in case of depositors' withdrawals to avoid adverse publicity and reputation. Therefore, at the individual bank level, liquidity management is also important for smoothing its daily operations.

It is difficult to measure and assess liquidity due to the involvement of subjective judgement when identifying liquid assets. There is no exact benchmark specifying the extent to which assets held as liquid assets is considered as adequate. IMF suggests two indicators for measuring and assessing bank liquidity—the ratio of liquid assets to total assets (liquid asset ratio) and the ratio of liquid assets to short-term liabilities. Liquid assets are those that can be readily converted into cash without significant loss under normal business condition.

Liquid asset ratio indicates the proportion of liquid assets held by banks for meeting expected and/or unexpected demand for cash. The higher the ratio, the lower the liquidity risk a bank faces. Figure 4.11 plots the liquid assets ratios for major Chinese bank groups and the average ratio for selected international banks. The share of liquid assets in bank total assets declined over the sample period for all domestic banks, in contrast to the relatively stable level of international banks. Domestic banks hold less liquid assets than those selected international banks and the gap widened during the second half of the sample period. On average, domestic banks held about 20% of their total assets in the form of liquid assets, of which JSCBs had higher liquidity than SOCB and CCBs. As to foreign banks, about half of total assets were liquid assets until 2002 but their liquid assets level dropped to the same level as domestic banks by 2005.

Figure 4.11 Liquid assets to total assets ratio of different type of banks

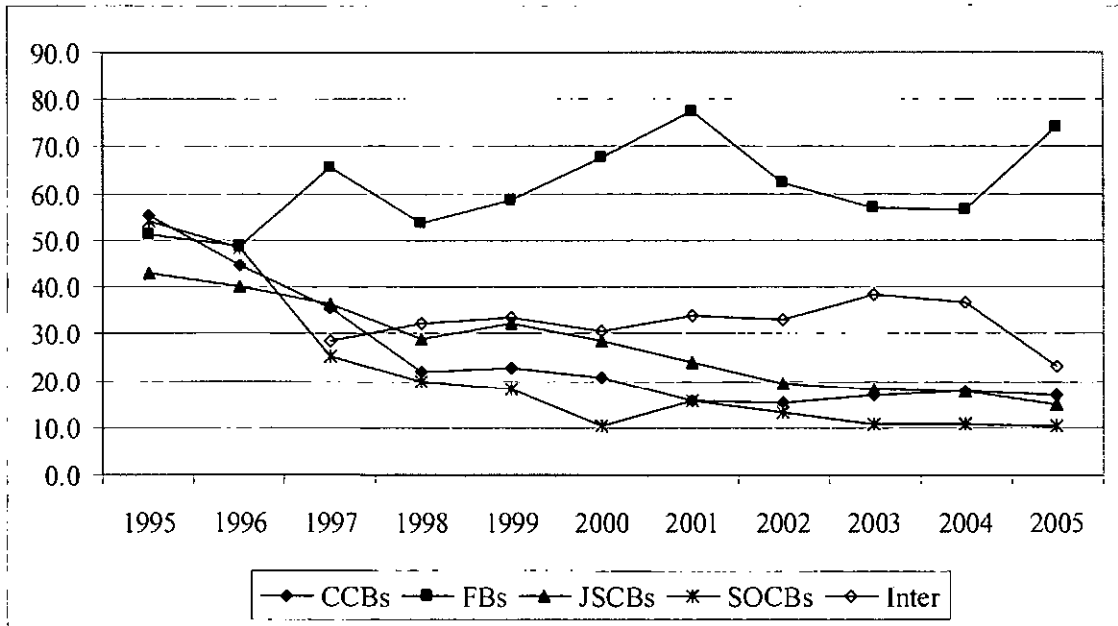


Source: BankScope.

Notes: CCB = city commercial bank, FB = foreign bank, JSCB = joint-stock commercial bank, SOCB = state-owned commercial bank, Inter = international bank.

The ratio of liquid assets to short-term liabilities captures the liquidity mismatch of assets and liabilities. It reflects a bank’s ability to meet short-term liabilities without liquidity problems. The trends of the liquid asset to short-term liabilities ratios as shown in Figure 4.12 were very similar to the trends of liquid assets ratios as shown in Figure 4.11. The ratios of domestic banks were lower than the average ratios of the international banks. The level of liquid assets as a proportion of short-term liabilities declined. At the end of 2005, the average liquid assets to short-term liabilities ratio of the Chinese banks was 14%, lower than the average level of the international banks by about 10%. Again, JSCBs had a higher ratio than other domestic banks.

Figure 4.12 Liquid assets to short-term liabilities ratio bank types



Source: BankScope.

Notes: CCB = city commercial bank, FB = foreign bank, JSCB = joint-stock commercial bank, SOCB = state-owned commercial bank, Inter = international bank.

In short, two liquidity indicators consistently suggest declining liquidity and increasing liquidity risks for the Chinese banks. However, it is unclear whether this trend was an unfavourable sign or not. On the one hand, it could be a negative indication that banks became more vulnerable because of increased liquidity risk. The decline in the proportion of liquid assets in total assets and in short-term liabilities reflected a weakening position in liquidity, which was an unfavourable signal for a sound banking system. On the other hand, it could be a positive indication that banks became more experienced in liquidity management by taking account of the real market condition in China. Reduction in liquid assets could improve bank profitability by lending to profitable projects. China has its own speciality that domestic depositors have rather higher level of trust on state-owned banks. Bank run is highly unlikely even the SOCBs are technically insolvent. Thus, it is possible for Chinese banks to operate at a lower liquidity level without facing liquidity problems. Moreover, liquidity management techniques also help banks better balance the trade-off between liquidity and profitability.

4.3 Chapter summary

This chapter has assessed the performance and current financial condition of the Chinese banking system by analyzing financial ratios under a macro-prudential analysis framework. To snapshot the banking system from different dimensions, a variety of financial ratios are grouped into four main categories—profitability, capitalization, assets quality, and liquidity. To identify the relative strengths and weaknesses of different types of Chinese banks, the analysis is conducted for different groups of domestic banks in comparison with seven selected international banks.

Prior to 2003, bank reform in China had been a gradual process of preparation and adjustment by touching the stones to cross the river. The reform objective was to transform the banking system to a market oriented one through commercializing SOCBs. By 2002, the main achievements were the establishment of a multi-layered banking system with a strengthened legal, regulatory and supervisory framework. Not in line with the considerable reform efforts made by the government, very little improvement in financial term was made from four dimensions reviewed during this period. A number of factors hindered the pace of reform including the persistence of the government intervention, the lack of managerial and operational experiences, and weak corporate governance in banks. In essence, the Chinese authorities had only tackled the superficial problems but not the deep-rooted causes of real problems in the banking system.

After 2003, the government has speeded up the banking reform process by radically restructuring the SOCBs. Significant improvements have been subsequently observed in terms of profitability, capital adequacy and assets quality. SOCBs performance has improved remarkably following financial restructuring and joint-stock reorganization. CCBC has even become one of the most profitable banks in the world in terms of ROE. The issue of the low capitalization has also been well addressed to strengthen the capital adequacy and solvency of the Chinese banking system. By 2005, a total of 53 Chinese banks were reported to have a capital adequacy ratio of more than 8%, minimum requirement of international standards. The most impressive progress was made in the resolution of NPLs problem with significant decreases in both NPL ratio

and the absolute amount of NPLs. Assets quality of SOCBs improved significantly as a result.

As to different bank groups, JSCBs have outperformed other bank groups throughout the sample period, with higher profitability, better capitalization, better assets quality, and liquidity. CCBs have also made considerable progress in every dimension, in line with the pace of bank reform. The preferential reform measures implemented by the government have effectively made a turnaround for SOCBs of which most have become profitable enterprises with a sound and healthy capital structure and a good corporate governance mechanism (although not fully functioning) by 2005.

One particular concern of this study is the sustainability of these achievements. Recent improvements are largely attributable to the two rounds of NPLs divestments and capitalization initiated by the government. The sustainable soundness of the banking system relies on banks' better performance upon which banks could be viable in an internationally competitive financial market. The government has done what it can to help these banks to raise capital adequacy, divest the historical NPLs, and be listed on the stock markets, leaving the rest to the banks. To become an internationally viable and financially sound commercial bank, it is vital to have advanced management skills, functioning corporate governance, better risk management and control, after the one-off government bailout.

Compared with the selected international banks, the Chinese banking system is still at a vulnerable condition despite of recent improvements. Most Chinese commercial banks are still less profitable and their income is highly dependent on lending activities. The Chinese authorities have encouraged domestic banks to attract capital from both domestic and international capital markets by being listed on the stock exchanges but the banking system as a whole does not have enough capitalization. There is a significant capital gap for banks, such as ABC, CCBs, and RCCs and UCCs, to meet the capital adequacy requirement. It is uncertain whether the domestic capital markets and foreign investors have the capacity and the willingness to provide capital for all these banks.

Assets quality of Chinese banks is still poor compared with the international banks although it has been remarkable improved recently. At the end of 2006, CBRC announced that the NPL ratio was down to 7%, which was still far higher than the international level of 1-2%. In terms of NPL coverage ratio, only a few banks reached the lower bound of international level recently. If taking into account of NPLs in the AMCs, the situation is even worse. The transfer of NPLs to AMCs has cleaned up the SOCBs' balance sheets, which only effectively postpone but not relieve the threats of the NPLs problems for the economy as whole. Given the inability of asset management companies to repay borrowings and bond issues for purchasing NPLs, the government should pay sufficient attention and make an effective stepped plan to tackle this potential threat in the future financial reform to avoid unexpected adverse shocks to the economy.

The financial ratio analysis cannot form a conclusion as to whether bank reform has been successful and whether SOCBs could be internationally commercially viable in the long run. Since major reform measures have been undertaken from the late 2003, the time period is too short to give such a conclusion. What conclusion could be made is that the banking reform and SOCBs are on the way to success in a right direction. It calls for continuous efforts on bank reform. Further development should depend more on banks' own ability to enhance capital adequacy and control asset quality, which comes from efficient operations. Therefore future reforms need to be directed to improve bank efficiency which is the only promise for long run viability of the Chinese banks.

Chapter 5 Economic rationale of bank reform in China

5.0 Preamble

The Chinese government has launched a gradual approach to reform the banking system for almost three decades. As a result, the Chinese banking system has become an increasingly competitive market. It is imperative to distinguish well-performing banks from poor ones through comparative benchmarking analyses. Commonly employed performance measure of ROA and ROE are generally regarded as lacking comparability and reliability, especially in the transition and developing countries. For this reason, a more sophisticated performance measure—frontier efficiency has been widely used to evaluate performance.

The main objective of bank reform is to improve bank performance in order to better support economic development. Concrete reform measures have been initiated and implemented taking into account the condition and specialty of the Chinese banking system with reference to the experiences of the banking reform in other transition economies and developing countries. Among these reform measures, the ownership reform and hardening budgetary constraints are two major strategies.

Employing a one-step SFA, this chapter answers the first set of research questions of this study. It attempts to rationalize the economic foundations of banking reform strategies in China by testing whether bank reform has been grounded on the agency theory and/or the budgetary constraints theory. Two main purposes of this chapter are: (1) to rationalize the economic foundations of bank reform; and (2) to examine the impact of WTO accession on the performance of Chinese major commercial banks. Performance is measured by technical efficiency, estimated by the single-output Cobb-Douglas production models. The following two chapters examine bank performance and the effects of the bank reform on performance in terms of technical efficiency (Chapter 6), cost efficiency and profit efficiency (Chapter 7).

The remainder of this chapter is organized as follows. Section 5.1 briefly reviews the efficiency literature on the relationship between performance and the agency theory and budgetary constraints theory. Section 5.2 outlines methodology of the one-step

SFA and specifies empirical models. Section 5.3 discusses empirical results and findings. Section 5.4 draws conclusions.

5.1 Literature review

The relationship between performance and ownership and corporate governance has been well documented in bank efficiency literature under the principal-agent theory and the soft-budget constraint theory. The agency theory has been developed in the 1970s. When there is a separation between owners and management, owners (principal) delegate the responsibility and related authorities of daily management and even strategic management to senior managers (the agent). There is a danger that the agent may not act on the best interests of the owners (shareholders), for example, they may not work as efficiently as they could. They may also pursue their own interest at the expense of that of shareholders. Thus the principal has to exercise due care on the running of business and monitor the management. They need to assess the management performance exceptionally and periodically through mechanisms such as external auditing and board of directors. The principal also need to ensure these governance mechanisms in place and well functioning.

However, the corroboration of agents' behaviours and the evaluation of actual performance could be difficult or costly. This is because the information asymmetry problem that the agents involve daily operations and possess more information than the principal. The central dilemma of the principal-agent theory is how to ensure the agent (the manager or employee) to act in the best interests of the principal (the shareholder or employer), given the agent has more information on the business over the principal and different, maybe conflicting, interests from the principal. The cause of principal-agent problems is the separation between ownership and control. Firms with different ownership types have different corporate governance mechanisms to solve the agent-principal problems, resulting in variations in performance (Williams and Nguyen, 2005). In particular, the agency problem is considered as a source of inefficiencies (Button and Weyman-Jones, 1992).

The budgetary constraints theory was first introduced by Kornai in 1979. A soft budget constraint indicates that firms could obtain capital infusion from government

or similar sources to surmount the financial distress without facing bankruptcy. The strongest argument for the existence of a soft budget constraint is that the costs of bailout would be cheaper than the costs of firm failure when taking account of social or/and political costs. In contrast, a hard budget constraint implies that a firm has no access to government financial subsidies. The determination of a firm's continuation or bankruptcy should be purely based on market disciplines and considerations on performance, re-allocating capital to more productive firms in the best interests of shareholders as well as the economy as a whole. Literature has generally suggested that the adverse effects of a soft budget constraint outweigh its benefits and a soft budget constraint appears to be one source of inefficiency of a firm. Therefore, the theory suggests that the state should abandon the role of being the last resort for state-owned banks.

Typically, state-owned banks are faced with a soft-budget constraint largely capitalized by state funds. In transition economies, governments are under various pressures during the transformation of the economy from centrally planned to a market oriented one. Government bailout appears necessary to the financial sector for maintaining employment and social stability. The expected bailouts inevitably lead to a moral hazard problem. For example, in China, state-owned banks had been entirely capitalized using state funds until the recent joint-stock reform in 2003. In the past, whenever the state banks ran into difficulty as they always did, the state had to help them out of the trouble. State-bank managers had a good understanding that the state would be the ultimate resort of help and would bail them out if things went wrong. They were not concerned with profitability and might act thoughtlessly when making economic decisions, resulting in losses and inefficiency. They lent relentlessly to whatever clients they considered to be trustworthy, resulting in mounting NPLs that could never be recovered.

There are a number of reasons suggesting that state-owned banks are less efficient than other types of banks, which have been well explored by some political and economics theories. The first argument is that state-ownership is less efficient by design based on political theories. The state ownership in banks facilitates governments to provide funds to financially inefficient but politically desirable projects (La Porta *et al.*, 2002). It is common practice that state-owned banks act as

government agents to fulfil national development plans with much less concerns on profitability and efficiency. Under the control of state ownership, state banks finance SOEs to pursue non-economic goals of maintaining social stability and patronage employment as well as economic growth goals by supporting infrastructure investments and exports. These goals are in conflict with the commercial goal of profit maximization and the latter commonly gives way to other goals, resulting in poor performance. Moreover, government acts as both the owner and the regulator who might also have somewhat conflicting interests (Megginson, 2005).

The second argument for low efficiency in state banks is a severe free-rider problem among owners (Huibers, 2005). In theory, all citizens are the co-owners of state-owned banks. The government is their representative to appoint managers to run state banks on the best interest of the owners. In reality, these owners have no ability to effectively influence the management and therefore have no incentive to monitor the operations of these banks. They have to be free-riders, leaving the government the only agent to effectively influence the management of the state-owned banks. However, government essentially uses state banks as a mechanism to help accomplish their multiple, often conflicting, goals. As discussed in the last paragraph, this would lead to inefficiency.

The third argument for low efficiency of state banks is the agency problem associated with state-ownership. The incentives for state bank managers to efficiently allocate resources might differ to those under other ownership arrangements (Laeven, 1999). On the one hand, state bank managers have no incentive and pressure to improve efficiency and therefore are less diligent in maximizing revenues and minimizing costs. They are more likely to pursue “a quiet life” or their own interests at the expense of owner interests. On the other hand, there exists a collective action problem in state-owned banks, resulting in the lack of means for punishing managers when they act in the best interest of sub-part’s performance (Megginson, 2005). In fact, managers of state banks are rarely punished individually for poor performance, whereas the managers will be replaced by shareholders or a hostile takeover for poor performance in a private bank. In the absence of proper capability to monitor the activity of management and appropriate methods of disciplining managers in state-owned banks, agency problems become serious.

The final argument for low efficiency of state banks is soft budget constraint faced by state-owned banks. State-owned banks are normally large banks in size and play a crucial role in the economy. The fear of too-big-to-fail or too-important-to-fail permits the survival of inefficient state banks. The government is unlikely to make or let poorly performing state-owned banks become bankrupt by subsidizing insolvent state-owned banks in pursuit of its multiple objectives. Managers of poorly performing state-owned banks develop a dependency on the government for funding when their banks go into financial difficulties. In contrast, managers of private banks do not have such a dependency and their clear understanding is that banks facing finance distress may be bankrupt. Therefore, managers of state banks are under weak capital markets discipline and less threat of financial distress than those of private banks.

Empirical research finds a negative association between bank efficiency and state ownership with a few exceptions. La Porta *et al.* (2002) find that financial performance of publicly owned banks is inferior to that of private banks using a dataset of large banks in 92 countries. Hao *et al.* (2001) report a negative association between bank cost efficiency and the share of government ownership in Korean banks. In transition economies, state-owned banks are found to be significantly less efficient than their private counterparts (Bonin *et al.*, 2005b; Matousek and Taci, 2002; and Fries and Taci, 2005). Nevertheless, Spong *et al.* (1995) argue that no single organizational structure appears to be a guarantee of efficiency. Little evidence from Altunbas *et al.* (2001) suggests superior efficiency of privately owned banks, while Isik and Hassan (2003a) and Shanmugam and Das (2004) find state banks outperform other types of banks in Turkey and India, respectively.

In short, the agent-principal problem and the soft budgetary constraint problem simultaneously become prominent in state-owned banks. The role of SOCBs and the role of government are ambiguously defined as they have multiple (and often conflicting) objectives to achieve. It is hard for the agent (managers) to clarify what the principal (government) exactly expects from them. The solution is to provide appropriate incentives so that agents are more likely to act in the best interest of the principal by better solving the agent-principal problem. Ownership reform therefore

is the most common strategy in banking reform by turning the state-owned banks into joint-stock enterprises. Multi-ownership in state banks will enhance the corporate governance and the exit of state-ownership will harden budgetary constraints.

In China, the government has assumed the responsibility for removing much of the NPLs from SOCBs to generate a fresh capital structure similar to that of a true commercial bank so that they can compete with the incoming foreign entrants on a level playing field. The most recent one-off bailout implies the abolishment of the soft budget constraint that the state will never have to bail them out in the future. These restructured SOCBs have successfully attracted foreign strategic investors as well as sufficient capital from the stock markets. In the future, these banks will have to be entirely responsible for their own profits and losses without political or administrative interference. Their competitiveness will depend on the ability to earn profits and pay dividends to shareholders. By turning SOCBs into joint-stock companies, the incentive structure has changed and the state banks now face a hardened budget constraint. Banks have to rely more and more on raising capital from various shareholders, rendering them to be responsible for shareholders' interests rather than state (or local) government interests.

In order to empirically rationalize the theoretical motivations of bank reform in China, two specific hypotheses are tested with regard to the agency theory or/and budgetary constraints theory. First, it hypothesizes that joint-stock banks are expected to outperform state banks, ascertaining the economic rationale of the joint-stock ownership reform to be the agency theory. Second, it hypothesizes that banks subject to a harder budget constraint are more efficient than banks subject to a softer budget. These two hypotheses will be tested using a stochastic frontier approach which provides statistical inference with certain reliability and accuracy.

5.2 Methodology

5.2.1 SFA and a one-step estimation procedure

Parametric method and nonparametric method are two main frontier methodologies to determine the relative efficiency by identifying best practice institutions. There is no

consensus on which method is superior over another since each of them possesses certain advantages and disadvantages. Non-parametric method does not specify a functional form for the frontier and thus it is free from the possibility of mis-specification of functional form for the underlying production relationship. Using a linear programming technique, the best-practice frontier is formed as the piecewise linear combinations. However, a principal shortfall of non-parametric is that the linear programming solution does produce any error term. Any deviation from the frontier is considered as inefficiency and no random shocks are allowed. In addition, a non-parametric approach cannot be used for hypothesis testing.

The parametric method has been criticized for using a predetermined frontier functional form which may be mis-specified and for the pre-assumed distributional assumptions with respect to the random error terms and inefficiencies. However, a parametric method has its virtues. First of all, a major advantage is the allowance for the random errors. Deviations of actual performance from best practice are represented by composite errors that are theoretically decomposed into inefficiencies and random shocks. It is argued that the separation of random errors and inefficiencies leads to more accurate estimated technical efficiency. Secondly, despite distributional assumption on inefficiencies induces the suspicion of the estimated efficiency level, SFA always rank the firm efficiency in the same order as the orders of their cost function residuals. Thirdly, parametric methods appear to be more consistent with the competitive conditions in banking market and more consistent with non-frontier measures of bank performance such as return on assets Bauer *et al* (1998).

This study employs a parametric method—SFA, Fries and Taci (2005) provide particular argument for the adoption of SFA in bank efficiency study in transition economies because problems of measurement errors and uncertain economic environments are more likely to prevail. SFA is one of the popular and widely applied methods of investigating efficiency in the literature. For instance, SFA has been used to study bank efficiency in the US by Ferrier and Lovell (1990), Bauer *et al.* (1993), Kwan and Eisenbeis (1996), DeYoung and Hasan (1998), and Clark and Siems (2002). Hasan and Marton (2003) use a translog functional form to investigate bank efficiency in Hungary while Shanmugam and Das (2004) have studied bank

efficiency in India. Very recently, a few studies employ SFA to investigate bank efficiency in China, including Fu and Heffernan (2007), Yao *et al.* (2007), and Berger *et al.* (2007).

SFA is developed by Aigner, Lovell, and Schmidt (1977) and Meeusen and van den Broeck (1977) independently. SFA specifies a functional form for the cost, profit or production function, which allows inefficiencies to be included in the error term. The composite error term consists of random error (v_i) and inefficiency (u_i), which are separated by two distributional assumptions. The first assumption is that the inefficiencies (u_i) are independent and identically distributed as exponential or asymmetric half-normal distribution, based on the logic that inefficiencies only increase costs above frontier levels. The second assumption is that random errors (v_i) are independent and identically distributed with mean zero and constant variance (σ_v^2), based on the fact that random fluctuations can either increase or reduce costs. The estimated inefficiencies of any firm is taken as the conditional mean or mode of the distribution of the efficiency term, μ , given the observations of the composed error term, ε (Bauer *et al.*, 1993). Later studies argue that alternative distributions for inefficiencies, such as truncated-normal distribution, may be more appropriate than the half-normal and exponential distributions.

Efficiency studies have commonly adopted a two-step estimation procedure. The first step is to specify a stochastic production function and estimate the technical inefficiencies for individual firms, assuming these inefficiencies are distributed identically. The second step is to regress the predicted inefficiencies against a set of firms' specific characteristics and environmental variables (z_i), such as managerial experience, ownership, location, and the like. The purpose of the second step is to identify possible determinants of the differences in predicted inefficiency across firms.

However, this two-step procedure has serious econometric problems, due to its contradictory assumptions on the independence of the inefficiencies in the two estimation stages (Battese and Coelli 1995; Kumbhakar and Lovell, 2000). Using the two-step procedure, the elements of z_i must be assumed to be uncorrelated with the

elements of input vector (x_i) in order to assure that Maximum Likelihood (ML) estimates of the first stage stochastic frontier model are unbiased. Moreover, the predicted inefficiencies are assumed to be identically and independently distributed in the first stage, but they assumed to have a functional relationship with z_i in the second stage. This contradiction between two steps makes the two-step procedure so-called 'schizophrenic approach'.

The awareness of this problem has stimulated the development of a one-step procedure, in which the potential relationship between z -variables and technical efficiency is imposed in a single procedure to estimate the production technology and the possible determinants of inefficiency simultaneously. A number of studies, such as Kumbhakar *et al.* (1991), Reifschneider and Stevenson (1991), Huang and Liu (1994), and Battese and Coelli (1995) have contributed to this development by proposing slightly variant models to overcome problems arising from the two-step procedure. Wang and Schmidt (2002) provide further theoretical insights into reasons why the two-step procedure is biased and provide extensive Monte Carlo evidence showing the severity of the bias. They find biased estimates at both steps and the magnitude of the bias is substantial. They strongly recommend one-step models as long as the research interest is in the effects of firm characteristics on efficiency levels.

Among these developments, this study adopts a one-step approach suggested by Battese and Coelli (1995), thereafter BC95 model. It assumes that non-negative technical inefficiency is a function of firm-specific variables and time. The distributional assumption is that the inefficiency effects are independently distributed as truncations of normal distributions with constant variance, but with means that are a linear function of observable variables. The BC95 model shown in Equation (5.1) allows the estimation of both technical change in the stochastic frontier and time-varying technical inefficiencies.

$$\ln y_{it} = \beta_0 + \beta_1 t + \beta x_{it} + (v_{it} - u_{it}), \quad i=1, \dots, N; t=1, \dots, T, \quad (5.1)$$

where y_{it} denotes the production at the t -th time period ($t=1,2,\dots,T$) for the i -th firm ($i=1,1,\dots,N$); x_{it} is a $1 \times k$ vector of inputs and other explanatory variables associated with the i -th firm at the t -th time period; β is a $k \times 1$ vector of unknown parameters to be estimated; v_{it} is a random variable assumed to be *iid* with mean zero and a constant variance, $N(0, \sigma_v^2)$, independently distributed of the u_{it} ; u_{it} is a non-negative random variable, associated with technical inefficiency of production, which are assumed to be independently distributed as truncations at zero of the normal distribution with mean, $z_{it}\delta$ and variance σ^2 , $N(z_{it}\delta, \sigma_u^2)$.

Equation (5.1) specifies a stochastic frontier production function based on the original production values. The technical inefficiency effects (u_{it}) are specified as a function of a set of explanatory variables (z_{it}) and an unknown vector of coefficients (δ). Some input variables in the stochastic frontier may be included in the inefficiency model as explanatory variables, provided the inefficiency effects are stochastic.

The technical inefficiency effects (u_{it}) model is shown in Equation (5.2)

$$u_{it} = \delta_0 + \delta_1 t + \delta z_{it} + \varepsilon_{it} \quad (5.2)$$

where z_{it} is a $1 \times m$ vector of explanatory variables associated with technical inefficiency of production over time; δ is an $m \times 1$ vector of unknown coefficients to be estimated; ε_{it} is a random variable defined by the truncation of the normal distribution with zero mean and variance σ^2 , $N(0, \sigma_v^2)$.

Finally, the technical efficiency of the production for the i -th firm at the t -th time is defined by Equation (5.3).

$$TE_{it} = \exp(-u_{it}) = \exp(-z_{it}\delta - \varepsilon_{it}) \quad (5.3)$$

The BC95 model is flexible by allowing the estimation of both technical change in the stochastic frontier and time-varying technical inefficiencies in the technical inefficiency effects. The time trend variable t included in Equation (5.1) accounts for Hicksian neutral technical progress at a constant rate, while in Equation (5.2) capturing temporal changes in inefficiency at a constant rate against the shifting frontier with respect to time. Therefore, productivity changes are decomposed into the shift in the frontier and the movement towards or away from the theoretically predicted production frontier. Greater efficiency can be gained through either technological innovations or improvement of efficiency in general caused by learning-by-doing effects or dissemination of the best-practice.

The BC95 model is a generalized model by encompassing other efficiency estimation models as special cases. By setting all elements of the δ -vector to be zero that the technical inefficiency effects are unrelated to the z -variables, the case represents the original specification of Argner, Lovell and Schmidt (1977) with the half-normal distributional assumption. If the first z -variable has value of 1 and the coefficients of all other z -variables are 0, then the model becomes the case in Stevenson (1980) and Battese and Coelli (1988, 1992). Moreover, the BC95 model can be applied to different production technology representations, such as distance function, cost function, profit function, and production function, using different functional forms, such as Cobb-Douglas, translog, and Fourier flexible form.

More importantly, the model is applicable in practice to estimate efficiency because the parameters of the stochastic frontier and the model for the technical inefficiency effects can be estimated simultaneously using the method of maximum likelihood. Tim Coelli (1996) has developed a computer program—Frontier 4.1c that contains the Battese and Coelli (1995) specification, making the estimation easier. With these virtues, the BC95 model has been applied more frequently in recent efficiency study, like Williams and Nguyen (2005), Kraft *et al.* (2006), and Fries and Taci (2005).

5.2.2 Defining outputs and inputs variables

Choosing proper proxies for bank inputs and outputs is one of the important issues in bank efficiency study. There is no agreement on this controversial issue regarding the

most appropriate indicators of inputs and outputs. The selection of approach to measuring inputs and outputs depends on both the objective of the study and the availability of data. This study adopts the most commonly employed intermediation approach (Sealey and Lindley, 1977), as its main concern is the bank efficiency at industrial level and the impacts of reform on bank efficiency. The intermediation approach treats banks as using labour, physical capital and fund to produce earning assets. Service flows are treated as output measured by the dollar value of the various types of earning assets. Deposits are considered as inputs in the production of earning asset output, along with capital, materials, and labour inputs. This approach takes interest expenses into account, which is useful not only for examining bank efficiency but also for frontier analysis.

The intermediation approach appears more appropriate for studying the economic differentiation of banks by controlling the overall costs of banks, in contrast to the production approach which is more appropriate for studying the cost efficiency of banks by addressing the operational costs (Ferrier and Lovell, 1990). The production approach is more suitable to assess efficiency at branch level. The role of a particular branch focuses on processing transaction and document since branch managers generally could not impose much influence on the funding and investment decision making process (Berger and Humphrey, 1997).

In the banking industry, it is crucial to take into account the multiple-output nature of production when defining outputs. This study defines outputs as the book value of the profit before tax, and the book value of loans using data from bank annual financial reports. Both profit and loans are frequently employed as proxies for outputs in bank efficiency literature. Technical efficiency of individual banks is estimated by defining bank output as pre-tax profit and loans respectively in two different specifications—profit model and loan model. The value of loans includes short-term, medium and long-term, and other loans, having deducted LLRs.

Bank inputs are defined as fixed assets, deposits, equity and labour in both profit model and loan model. Fixed assets (physical capital) reflect the bank ability to provide service to its customers, which is expected to have a positive effect on output. The value of fixed assets has been net of depreciation. Deposit is a sensitive variable

and its treatment distinguishes between the production approach and the intermediation approach. The value of deposit includes short-term customer deposits and long term deposits. The more the deposit attracted, the more the profits could be earned by extending loans or investments. A positive effect of deposit on performance is expected. Equity is a proxy for capital input along with physical capital input of fixed assets. It includes share or/and own capital, as well as retained profits. Labour cost is included, which generally accounts for a large proportion of operational expenses. Following common practices in the literature, when direct labour costs are unavailable overhead is used as an approximation of labour capital input.

5.2.3 Empirical model specification

This chapter specifically applies the one-step SFA production frontier model proposed by Battese and Coelli (1995). Traditional Cobb-Douglas functional form is employed as the presentation of the production technology to estimate bank technical efficiency. It has been criticized because of its inability to accommodate multiple-outputs. However, it has the virtue of self-duality, simplicity, and the economic interpretability of the coefficients on output, input and control variables. The estimated coefficients for the frontier model using a translog or Fourier flexible functional form commonly provide no economic meanings because of the collinearity problem in the presence of second order and interaction variables, and trigonometric terms. The main purpose of this chapter is to verify the economic rationale of the reforming strategies and the impact of WTO accession on bank performance. The precision of efficiency estimates will be addressed in the next two chapters by using more comprehensive models. Information from a Cobb-Douglas production functional form is considered to be sufficient for the research purpose of this chapter.

Apart from input and output variables defined in the last section, a dummy variable is included in the frontier estimation for testing the effect of WTO accession on bank efficiency. It is assumed that WTO accession influences bank efficiency via its influence on the structure of the production technology in Chinese banking, rather than a direct effect on the productive efficiency. The dummy has a value of 0 until WTO accession in 2001 and 1 since 2002. This variable is expected to have a

positive sign, that bank performance is expected to be improved under the incoming threats as well as the opportunity for Chinese banks.

In the technical inefficiency effect model, two variables are particular included to statistically ascertain the economic rationale of ongoing bank reform in China. An ownership dummy and a capitalization ratio are employed for testing two hypotheses with respect to the agency theory and the budgetary constraint theory, respectively. The ownership variable takes the value of 1 for joint-stock commercial banks and 0 for state-owned commercial banks. A negative sign is expected, since joint-stock banks are generally believed to have better governance structure to cope with the agent-principle problem and therefore have lower inefficiency level than state banks. In other words, joint-stock banks are expected to be more efficient than state banks.

A capital risk indicator, E/A ratio, reflects the extent to which banks are subject to a hard budget. Banks with a high E/A ratio are better capitalized and face less risk-taking, and hence subject to a softer budget constraint. In deriving an equity to total assets ratio, equity is defined as in Chapter 4. Total assets include loans, fixed assets and other assets, which equals total liabilities plus equity where total liabilities include deposits, borrowing from other institutions, and other funds. As total assets include loans, a bank is subject to higher risk with a lower E/A ratio, since for a given amount of equity, the bank is exposed to more liabilities. If a bank is a joint-stock company, part of its equity will be share capital. A lower E/A ratio may theoretically mean that the bank is less capitalized and subject to a harder budget constraint. The bank takes more risk in order to increase loans to its clients.

If a bank is capitalized and supported by the state, equity consists of state capital. When the government is involved in changing the E/A ratio, different banks will be subject to different budget constraints and the E/A ratios need to be interpreted with caution. Governments have resources and incentives to bail out failing banks especially in post-socialism nations, giving rise to a soft budget constraint for state banks. Usually, the state will support the state-owned banks with capital injection and increase E/A ratio, *ceteris paribus*. When a bank expects to obtain economic assistance in financial difficulties, it is said to face a soft budget constraint. A soft budget constraint causes a moral hazard problem, resulting in low efficiency by

inefficient operations and careless expansions of credits and investments. As a result, the E/A ratio is expected to have a positive sign, that is, by facing a soft budget constraint, well capitalized state banks have a higher E/A ratio but lower efficiency, and *vice versa*.

The empirical specification of the profit model is shown in Equations (5.4) and (5.5), where a time trend is included in both the frontier model and the technical inefficiency effects model.

$$\ln(\text{profit}_{it}) = \beta_0 + \beta_1 t + \beta_2 \ln(\text{Fixedasset}_{it}) + \beta_3 \ln(\text{Deposit}_{it}) + \beta_4 \ln(\text{Equity}_{it}) + \beta_5 \ln(\text{Overhead}) + \beta_6 \text{WTO} + v_{it} - u_{it} \quad (5.4)$$

$$|U_{it}| = \delta_0 + \delta_1 t + \delta_2 \text{Ownership} + \delta_3 E/A + \varepsilon_{it} \quad (5.5)$$

where subscripts i and t respectively denote banks and time; \ln denotes natural logarithm; v_{it} , u_{it} , ε_{it} are the same as defined in Equations (5.1) and (5.2); β s are parameters to be estimated.

The empirical specification of a loan model is identical to this profit model with the same structure and explanatory variables, except for the dependent variable being replaced by total loans.

5.2.4 Data

The data sources and the reliability have been discussed in Chapter 4. The sample used in this chapter includes only joint-stock commercial banks and state-owned commercial banks over the period 1995-2005, which is different from that in the next two chapters due to differences in research purposes. Apart from four state-owned banks and 11 joint-stock banks, even small commercial banks are included, namely Kincheng Banking Corporation, Kwangtung Provincial Bank (The), National Commercial Bank Ltd., Sin Hua Bank Limited, Yien Yieh Commercial Bank Ltd., China & South Sea Bank Ltd., and (The) China State Bank Ltd. They are classified as state-owned banks since they are ultimately owned by one of the state banks or state council. The exclusion of city commercial banks and the inclusion of seven state-

owned banks' subsidiaries are for distinguishing the effects of soft budget constraints faced by state banks. Of the total 22 banks, two have data for 1996-2004, one for 1996-2005, seven for 1995-2000, and the rest for 1995-2005. This forms an unbalanced panel data set with 204 observations sufficient to construct a stochastic frontier. The summary statistics of variables are reported in Table 5.1 and data have been deflated to 1995 price level using the CPI to control for the effect of inflation.

Table 5.1 Summary statistics of variables

	Profit	Loans	Fixed Assets	Deposits	Equity	Overheads	E/A ratio	Total Assets
SOCBs	9.26	856.67	26.85	1335.99	67.32	16.14	7.33	1504
JSCBs	1.86	112.07	2.68	165.36	7.47	2.22	4.65	200

Sources: Bankscope

Notes: (1) SOCB = state-owned commercial bank, JSCB = joint-stock commercial bank, E/A ratio = equity to total assets ratio; (2) Data shown by ownership in RMB billion except for E/A ratio.

5.3 Results

5.3.1 The profit model

Using a modification of the computer program, Frontier 4.1C (Coelli, 1996), Maximum-likelihood estimates of parameters from the profit model are obtained and reported in Table 5.2 with their *t*-statistics. In Table 5.2, panel A shows the estimates of the production frontier function, panel B shows those of the technical inefficiency model, panel C and D contain the information on the overall explanatory power and fitness of the model to the data.

The signs of the estimated coefficients for the stochastic frontier are as expected. All coefficients are statistically significant at the 1-10% critical level. The negative coefficient on time trend indicates that output decreases by 7% per year. In other words, the best-practice frontier has been downward moving over the 11-year period. The estimated coefficients on fixed-asset, deposit, equity, and labour are their elasticities with respect to bank outputs because the estimated production model is in a log-linear form. The elasticity of fixed-asset is relatively small at 0.08 but significant. Deposit and equity have a positive impact on output with roughly equal

importance for the production. Their respective elasticities are 0.46 and 0.42, indicating that a 1% increase in deposit or equity would result in about 0.4% increase in profit before tax, holding all others constant. Labour has an expected negative impact on outputs at 1% statistically significant level. A 1% rise labor input would lead to a 0.2% drop in profit. The coefficient on WTO dummy is positive and highly significant, highlighting the influence of WTO accession on the Chinese banking system. Facing more competition pressure from incoming foreign banks, the banking system as a whole has actively responded by upgrading production technology so that bank performance has been improved.

Table 5.2 Results of the production frontier and inefficiency effect function
Dependent variable: ln (profit before tax)

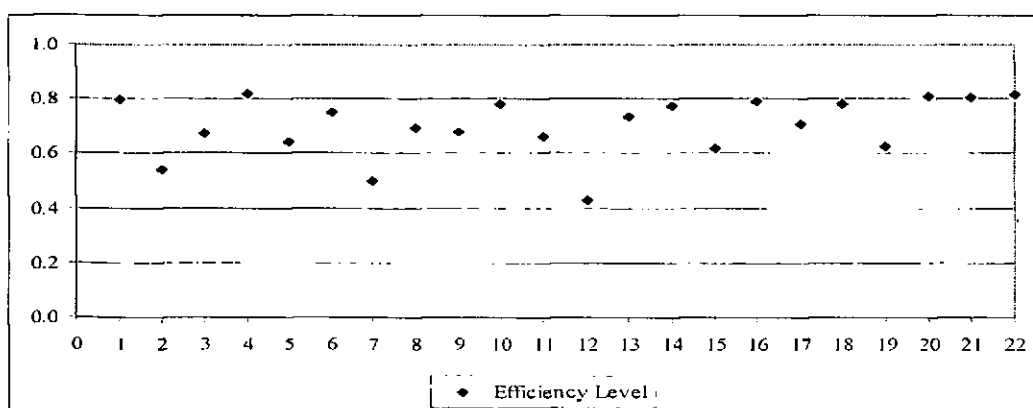
Variables	ML estimates	T-Value
A. Production Frontier		
Time (β_1)	-0.07***	-4.41
Fixed-asset (β_2)	0.08*	1.73
Deposit (β_3)	0.46***	4.48
Equity (β_4)	0.42***	7.85
Labor (β_5)	-0.21**	-2.40
WTO entry (β_6)	0.66***	4.85
B. Inefficiency Effect Model		
Time (δ_1)	0.14**	2.65
Ownership(δ_2)	-1.76**	-2.66
Equity/Asset Ratio(δ_3)	0.20*	1.40
C. Variance parameters		
Sigma-squared	4.98**	2.9
Gamma	0.99***	236
D. Diagnosis and other information		
LR test	148	
Ln (likelihood)	-123	
Number of observations	204	
Number of years	11	
Number of cross-sections	22	
Average technical efficiency	0.69	

Notes: (1) All the variables are in natural logarithms; (2) Negative sign in the inefficiency function indicates that the variable has a positive effect on production efficiency and *vice versa*; (3) *, **, *** indicate significance level at 10%, 5% and 1% respectively.

Estimated variance parameters and LR test suggest that the one-step SFA model has been well estimated. The variance ratio—gamma ($\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$) is 0.99, indicating that half of the error terms is attributable to the inefficiency element u_{it} and it is stochastic. The presence of the one-sided error component is also justified by the highly significant LR test shown in Table 5.2 panel D. These statistics demonstrate the significance of inefficiency effects and the inadequacy of a classical regression model of the production function to represent the data of Chinese banks.

The average technical efficiency over the sample period is estimated to be 69%, indicating that the Chinese banking industry produces 31% less than they would at a maximum possible level. The average estimated technical efficiencies for 22 individual banks are plotted in Figure 5.1. The most efficient bank is a shareholding bank—China Merchants Bank with average technical efficiency of 82%, whilst the most inefficient bank is a state-owned bank—ABC with a technical efficiency of 43%. Wide efficiency gaps across banks indicate that there is substantial potential for improving efficiency in the Chinese banking industry. Most banks are distributed closer to the best-practice banks with a few outliers that drive down technical efficiency from the best of 82% to the average level of 69%.

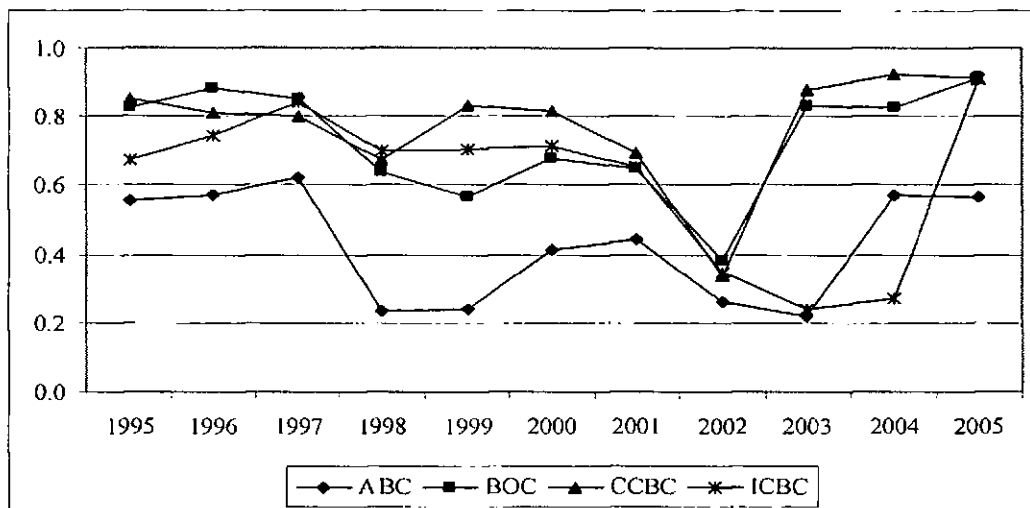
Figure 5.1 Technical efficiency of Chinese banks for 1995-2005 (profit model)



Note: The numbers of 1 to 22 on the X-axis represent individual banks, corresponding with Bank of Communications, China Everbright Bank, China Evergroving Bank, China Merchants Bank, Minsheng Bank, CITIC Bank, Guangdong Development Bank, Hua Xia Bank, Industrial Bank, Shanghai Pudong Development Bank, Shenzhen Development Bank, Agricultural Bank of China, Bank of China, China Construction Bank Corporation, Industrial and Commercial Bank of China, Kincheng Banking Corporation, Kwangtung Provincial Bank (The), National Commercial Bank Ltd, Sin Hua Bank Limited, Yien Yieh Commercial Bank Ltd, China & South Sea Bank Ltd. (The), China State Bank Ltd.

As the bedrock of the Chinese banking system, the big four SOCBs are at the forefront of the ongoing banking reform. Figure 5.2 plots average estimated technical efficiencies of individual SOCBs. From the figure, two systemic downside shocks are observed in 1998 and 2002. The first shock happened in 1998 when the Asian Financial Crisis hit China hard. The downside shock was stabilized quickly by the first round of government bailout during 1998-1999. However, this round of government bailout addressed only the superficial problems of low capitalization and mounting NPLs but not the fundamental causes of these problems. Without a fundamental reform, bank performance worsened during 2000-2001.

Figure 5.2 Average technical efficiency of SOCBs (profit model)



Notes: SOCB = state-owned commercial bank, ABC = Agricultural Bank of China, BOC = Bank of China, CCBC = China Construction Bank Corporation, ICBC = Industrial and Commercial Bank of China.

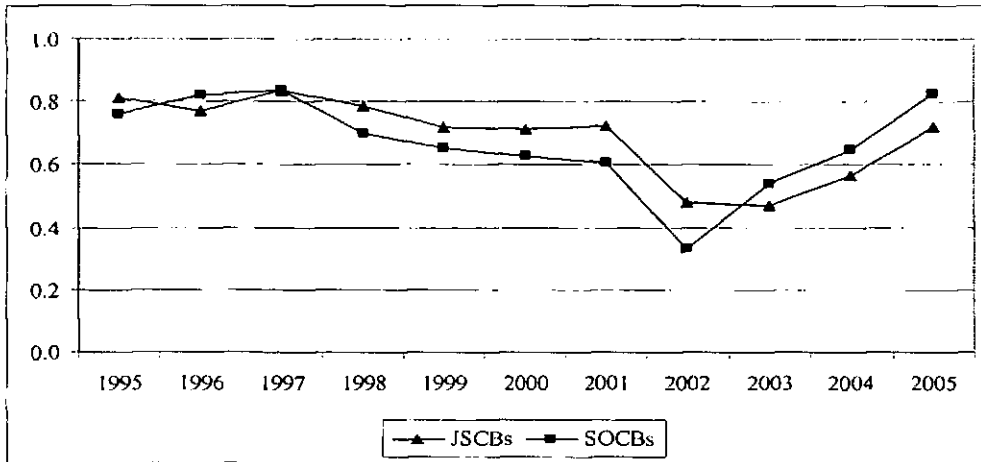
The second shock occurred in 2002 due to the Chinese WTO entry in 2001. In the estimation, a dummy is included in the frontier model to account for the WTO impact. The coefficient is positive and highly significant, suggesting a rapid technological upgrading and therefore an upward moving frontier. When upward movement of the best practice frontier is faster than performance improvement of individual banks, the measured relative bank efficiency becomes low. The adverse trend has been corrected shortly by the second round of government bailout and the subsequent radical SOCBs reform started in 2003. Three reformed SOCBs reached the highest level of technical efficiency at 91% for the sample period in 2005.

The technical efficiency of SOCBs has moved in a similar pattern over the sample period. All SOCBs have achieved efficiency gains for two years from 1995 to 1997 except for CCB. After the systemic shock in 1998, CCB first enjoyed a significant efficiency gain in 1999 but followed by a sharp decline in 2000 and 2001. The efficiency level of ICBC remained unchanged and that of ABC and BOC increased. Following the second systematic shock in 2002, BOC and CCB picked up efficiency growth in 2003 and sustained a steady increase thereafter, while ICBC experienced a further efficiency loss in 2003 and increased dramatically in 2005, consistent with the recent radical SOCBs reform. ABC is the least efficient bank with more drastic fluctuations in performance. Although it is yet to be reformed, ABC has improved its performance in the last two years of the sample period.

Results from the technical inefficiency effect model are of particular interest. Ownership characteristic of banks is measured by a dummy variable taking a value of 0 for SOCBs and a value of 1 for JSCBs. As reported in Table 5.2 panel B, ownership has a significant impact on technical inefficiency with an estimated coefficient of -1.76. The negative sign indicates that JSCBs are more efficient than SOCBs, demonstrating that ownership structure is an important variable in explaining the variations of bank inefficiency. The average technical efficiency of SOCBs and JSCBs is depicted in Figure 5.3, showing the impact of ownership characteristic on bank efficiency. JSCBs are found to have outperformed state-owned banks until 2002. SOCBs surpassed JSCBs since 2003 when the government started the ownership reform of SOCBs by joint-stock restructuring.

The results provide strong evidence supporting our first hypothesis so that the Chinese banking reform can be partially rationalized on the economics ground of the agency theory. Shareholding ownership structure is found to better solve the agent-principal problem since joint-stock banks significantly outperform state-owned banks and the performance of former SOCBs has been improved after joint-stock restructuring. The results also show the expected positive effects of reforms on bank performance. Because of rapid improvement in performance in SOCBs during the last three years, the average efficiency of JSCBs is 69%, just slightly higher than that of SOCBs by two percentage points

Figure 5.3 Technical efficiency of JSCBs and SOCBs (profit model)



Notes: JSCB = joint-stock commercial bank, SOCB = state-owned commercial bank.

JSCBs and SOCBs exhibit similar technical efficiency movements as shown in Figure 5.3. The average efficiency slightly increased from 1995 and reached a peak in 1997. After the Asian Financial Crisis, the efficiency level declined for two years and was stabilized by 2001. The decline reflects both the external as well as internal shocks. External shocks were largely triggered by the Asian Financial Crisis, but the internal shocks reflected the government efforts to improve bank efficiency during the post-crisis period. Our results suggest that the tightening policy in the aftermath of the Asian Financial Crisis had paid a high dividend. In 2002, all banks suffered significant efficiency losses caused by the WTO entry in 2001. However, these efficiency losses are considered to be caused by the upward moving best-practice frontier. Thereafter, the average technical efficiency of both state and non-state banks increased rapidly over the last three years of the data period because of the deepened and widened banking reform.

The E/A ratio is employed to test the second hypothesis that banks subject to a harder budget constraint are more efficient than those subject to a softer budget. The E/A ratio is found to have a negative relationship with efficiency, that is, well-capitalized banks are less efficient, providing strong evidence supporting the hypothesis. Regression results suggest that banks which are subject to a hard budget, and hence less capitalized, tend to take more risk and become more efficient than those which are subject to a softer budget constraint and hence more capitalized. If banks are

subject to a soft budget constraint, such as the state-owned banks, their capital assets are mainly raised from state funds and they tend to be well capitalized. However, a soft budget constraint causes moral hazard problems and leads to inefficiency. But if banks are subject to a hard budget, they have to raise capital from shareholders. These banks will tend to be less capitalized, and hence have to take more risk to make profits. Our results ascertain that the Chinese banking reform has been partially grounded on the budgetary constraint theory. The government has taken concrete measures to harden the budgetary constraints for SOCBs by diversifying their capital structure, listing them on the stock market, and implicitly indicating no more bailout in the future.

5.3.2 The loan model

A slightly different picture emerges from the loan model as shown in Table 5.3. The variance ratio—gamma ($\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$) is 0.11, indicating only a small part of the error terms attributable to the inefficiency element of u_{it} . However, LR test has justified the presence of the one-sided error component. In general, the estimated parameters of the production frontier and the coefficients on output and input variables suggest that the loan model has also been well estimated.

The signs of the estimated coefficients are consistent with those of the profit model except for coefficients on time trend variable and labour. The coefficient on the time trend variable is 0.01, implying an upward moving production frontier. The output level tends to increase by 1% per year over the data period although not significant. The elasticity of fixed-asset is 0.02, which is even smaller and less significant than in the profit model. Deposits are found to have much stronger impact on efficiency than in the profit model, consistent with the fact that deposits have more direct influence on loans than on profits. The elasticity of deposit is as high as at 0.8, that is, a 1% increase in deposit would result in a 0.8% increase in loans, *ceteris paribus*. The significant importance of deposits also helps explain the positive sign on labour. In China, deposits are mainly collected from a labour intensive branch network. Extensive coverage of the branch network is important for attracting more deposits but requiring more manpower. The increase in labour cost by 1% would lead to a

0.14% increase in loans, holding other factors unchanged. The elasticity of equity becomes 0.08, which is significant but much smaller than in the profit model, indicating that equity has more direct impact on profit than on loans.

Table 5-3: Results of the production frontier and Inefficiency Functions
Dependent variable: ln (loans net of loan loss reserve)

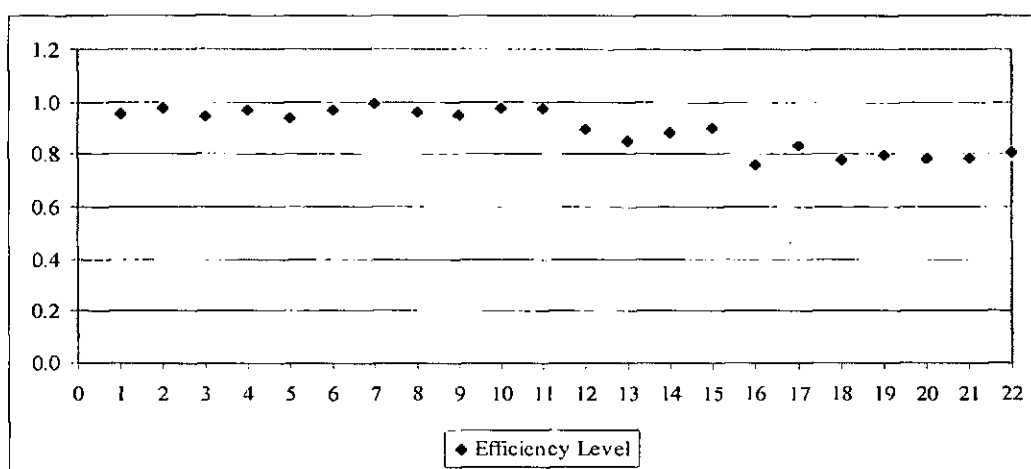
Variables	ML estimates	T-Value
A. Production Frontier		
Time (β_1)	0.01	1.17
Fixed-asset (β_2)	0.02	0.96
Deposit (β_3)	0.80***	19.21
Equity (β_4)	0.08**	2.82
Labor (β_5)	0.14***	4.87
WTO entry (β_6)	0.13***	3.12
B. Inefficiency Effect Model		
Time (δ_1)	0.05***	9.03
Ownership(δ_2)	-0.15***	-4.50
Equity/Asset Ratio(δ_3)	0.05***	7.06
C. Variance parameters		
Sigma-squared	0.02***	10.5
Gamma	0.11***	9.75
D. Diagnosis and other information		
LR test	68	
Ln (likelihood)	129	
Number of observations	204	
Number of years	11	
Number of cross-sections	22	
Average technical efficiency	0.89	

Notes: (1) All the variables are in natural logarithms; (2) Negative sign in the inefficiency function indicates that the variable has a positive effect on production efficiency and *vice versa*; (3) *, **, *** indicate significance level at 10%, 5% and 1% respectively.

The coefficient on WTO dummy is positive and significant, consistently showing a positive impact of WTO entry on bank performance. However, its impact is much less than in the profit model as the value of the estimated coefficient in the loan model is 0.13, compared to 0.66 in the profit model. These results suggest that Chinese banks have focused more on improving profitability after the WTO accession.

The average estimated technical efficiency in the loan model is 89%, higher than that of the profit model by 20 percentage points. Figure 5.4 plots the average technical efficiency for 22 individual commercial banks. Guangdong Development Bank turns out as the most efficient bank, followed by Shanghai Pudong Development Bank and Shenzhen Development Bank. The most inefficient banks are those small state-owned banks' subsidiaries. Banks are substantially indifferent in performance when output is measured by loans and most banks locate near the best-practice frontier. The spread between best- and worst-performed banks is much smaller than in the profit model.

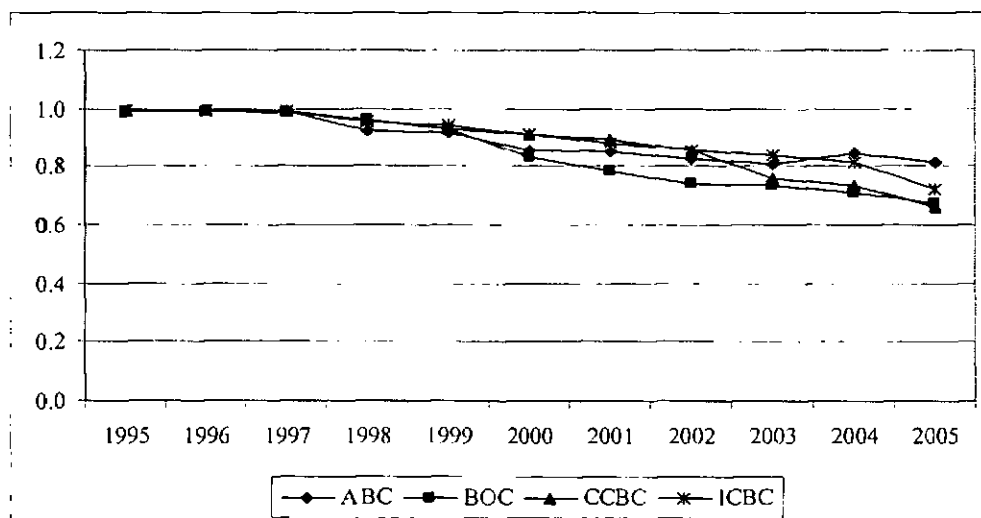
Figure 5.4 Average technical efficiency of Chinese banks (loan) for 1995-2005



Note: The numbers on the X-axis represent the same banks as in Figure 5.1.

The estimated technical efficiency of individual SOCBs is shown in Figure 5.5. The levels of SOCBs' technical efficiency have moved similarly with a gradually faster declining trend. In terms of extending loans, their performance has been stable over the first three years and started a downward slump throughout the rest of the sample period since the Asian Financial Crisis in 1997. Surprisingly, BOC is the least efficient bank with an average technical efficiency of 85%, whereas ABC turns out as the most efficient bank with a higher efficiency of 90%. This is in contrast with the results of the profit model as well as the general expectation.

Figure 5.5 Average technical efficiency of SOCBs (loan model)



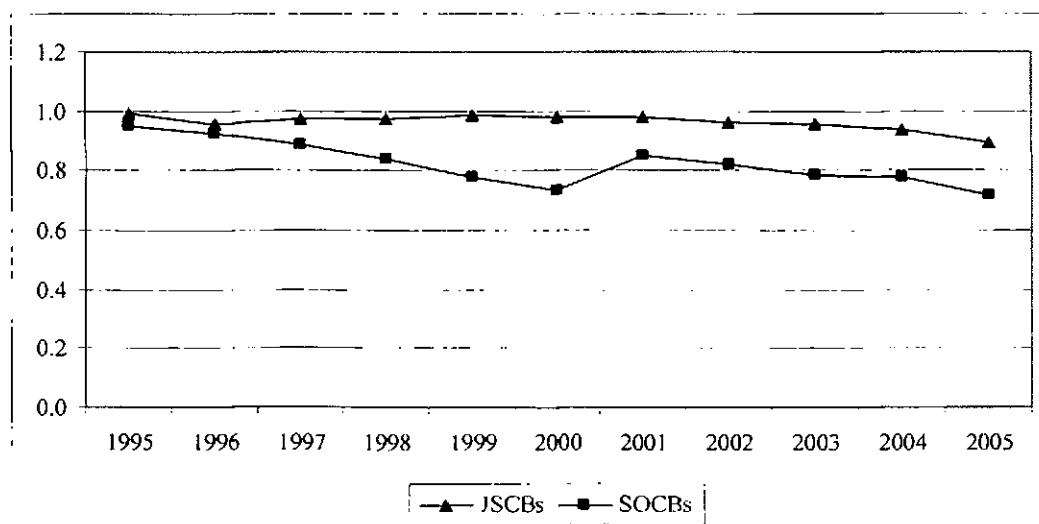
Notes: SOCB = state-owned commercial bank, ABC = Agricultural Bank of China, BOC = Bank of China, CCBC = China Construction Bank Corporation, ICBC = Industrial and Commercial Bank of China.

These puzzling results from the loan model and the inconsistency between the profit and loan models give rise to a question of the underlying reasoning. Is this caused by the inability of the estimation technique or the deficiency in defining the output variable? The answer tends to be the latter when looking at the estimated efficiency in conjunction with bank assets quality. The level of NPLs in SOCBs loan portfolio helps explain most of the unexpected results. The undesirable output of NPLs has inflated efficiency level when it is included in total loans as the output. BOC has the lowest average NPL ratio while ABC contains more than 30% of NPLs in its loan portfolio, resulting in better performance of ABC over BOC in the loan model. It also helps explain why the estimated efficiency in the loan model is much higher than that of the profit model, that is, a high proportion of NPLs in loan portfolio has been counted as output in the loan model but generating no profits. Moreover, the declining trend of the efficiency in the loan model is also attributable to the NPLs problem. Since 1998, the authorities have started to address the NPL problem in the banking system and have made considerable efforts on reduce NPLs. By taking away NPLs from SOCBs, efficiency has declined in the loan model but increased in the profit model because of improved assets quality. The effects of NPLs on efficiency estimation will be readdressed in more detail in the next chapter.

The results from the technical inefficiency effects model, shown in Table 5.3 panel B, are of particular interest since they are in connection with testing two theoretical hypotheses. The results are consistent with those of the profit model, which provide strong evidence supporting both hypotheses under testing and therefore prove the economic rationale of bank reform, supported by the agency theory and the budgetary constraints theory. To conserve space and avoid repetition, the discussion here will be brief.

The estimated coefficient on the time trend is positive and significant, indicating that technical efficiency decreases by 5% per year. The elasticity of E/A ratio is 0.05 and statistically significant, indicating a positive impact on inefficiencies. Ownership is found to have a negative impact on inefficiency. Its coefficient is statistically significant, suggesting a better performance of shareholding banks. The estimated technical efficiency is depicted by ownership characteristic in Figure 5.6 for the period 1995-2005. JSCBs are more efficient than SOCBs throughout the whole sample period. On average, JSCBs outperform SOCBs by 14 %. The efficiency level of JSCBs has been relatively stable, whereas that of SOCBs has been decreasing.

Figure 5.6 Technical efficiency of JSCBs and SOCBs (loan model)



Notes: JSCB = joint-stock commercial bank, SOCB = state-owned commercial bank.

5.4 Chapter summary

This chapter examines the underlying economic rationale of bank reform in China. The data provide adequate information for constructing a stochastic production frontier model. The empirical results support both hypotheses that joint-stock banks are more efficient than state-owned banks and banks facing a hard budget constraint outperform banks subject to a soft budget constraint. The results provide evidence for ownership reform and change in budgetary constraints that could lead to more competition and greater efficiency gains. Therefore, it is rationalized that the economic foundations for bank reform have been the agency theory and the budgetary constraint theory.

Moreover, this chapter also examines the impact of WTO entry on the performance of the banking industry. Under the incoming threats from foreign banks, Chinese authorities as well as banks have positively responded by deepening and widening the ongoing bank reform. WTO entry has been found to have significant positive impact on bank performance by affecting production technology employed by the banking industry. Moreover, the impact of WTO entry is much stronger on improving profitability than on lending activities.

The average estimated technical efficiency is 69% in the profit model and 89% in the loan model. Joint-stock banks are found to outperform state-banks by two percentage points in profitability and 14 percentage points in loans. The observed small difference in profitability is due to the recent radical SOCBs reform. Three recently reformed SOCBs have made significant improvement in profitability during the last three years of the sample period, effectively driving up the average profitability of SOCBs and narrowing the performance gap between state-owned banks and joint-stock banks. Being the dominant force in the Chinese banking system, SOCBs still operate at a low efficiency level after many years of reforms. After more radical reforms started in 2003, the profitability of SOCBs improved dramatically. This partially justifies the effectiveness of reform by changing the ownership structure and subjecting SOCBs to a hard budget.

NPL is an undesirable output of the banking production process and it is an important factor in bank efficiency study. We have not paid much attention to the problem of NPLs. However, in this regard, an important methodological issue has come into view when comparing the results of the profit and loan models. When NPLs ratio is high, the estimated efficiency is sensitive to the definition of outputs. This issue will be further addressed in the next chapter.

Chapter 6 Technical efficiency of Chinese banks

6.0 Preamble

Having investigated the economic rationality of bank reform, the thesis turns to the more precise assessment of bank performance and differentiates the effects of reform measures on bank efficiency. Employing the same one-step SFA as in the previous chapter, this chapter focuses on estimating technical efficiency using a recently developed distance function approach.

Using technical efficiency as performance measure, this chapter investigates the impact of various institutional changes on bank performance. The main purposes are threefold. The first purpose is to develop a stochastic frontier model by incorporating important bank specific variables and overcoming the potential drawbacks of other commonly used techniques to estimate efficiency. The second purpose is to provide reliable and up-to-date performance measurements for commercial banks China. The final purpose is to differentiate the effects of institutional changes on bank technical efficiency by jointly analyzing the static, selection, dynamic effects of governance changes.

The rest of this chapter is organized as follows. Section 6.1 describes the stochastic distance function approach and its application to bank efficiency study. Section 6.2 defines output and input variables, specifies empirical models, and describes data. Section 6.3 analyses the empirical results. Section 6.4 draws conclusions and policy implications.

6.1 An output distance function approach

The distance function approach is a recently developed technique in efficiency analysis. Its application is not as popular as the traditional cost function and profit function approaches. However, with the growing recognition of the potential advantages over traditional approaches, the distance function approach has attracted increasing attention in the field of productivity and efficiency in different industries. For example, Cuesta and Orea (2002) employ a stochastic output distance function to

examine the temporal variation of technical efficiency for Spanish savings banks. Coelli and Perelman (1999, 2000) apply this approach to European railways to assess their technical efficiency. Morrison *et al.* (2000) use it to investigate the impact of regulatory reform on efficiency in New Zealand farming. Other applications of the distance function approach include English *et al.* (1993), Grosskopf *et al.* (1995), Morrison *et al.* (2004), Berg and Lin (2006), and Drake and Simper (2003).

The distance function approach is chosen to estimate technical efficiency because of its prominent advantages (Cuesta and Orea, 2002; Coelli and Perelman, 2000; Fare *et al.*, 1993; and Grosskopf *et al.*, 1995). First, the distance function is capable of representing a multiple outputs and multiple inputs production technology. This advantage facilitates efficiency study for industries characterised by multiple-outputs. The multiple-output nature of production technology has traditionally been dealt with in two ways: (1) aggregating the multiple outputs into a single index of output and then applying a single-output modelling technique; (2) applying a dual cost function or/and profit function approach. Comparing the distance function approach with a single-output model, Coelli and Perelman (2000) find substantial differences in parameter estimates of the production technology and efficiency rankings, in favour of the distance function approach for a multiple outputs setting.

Secondly, the distance function approach requires less information compared to a dual approach like the cost function or profit function approaches. The distance function approach requires no price information while accommodating the multiple-inputs and multiple-outputs production technology. Under some circumstances, price information may not be available. Even available, price information may not be exogenous as required by a cost or profit function approach. In this regard, the distance function approach is advantageous over a cost or profit function approach because it avoids the problem of unavailable price information and reducing the chance of using unsuitable price information.

Thirdly, the distance function approach needs no behavioural assumptions. For highly regulated industries like railway and banking, certain assumptions of cost-minimization or/and profit-maximization may be inappropriate. Thus, the dual cost and/or profit function approach becomes inapplicable. However, the distance function

approach could serve as an applicable alternative while accounting for the multi-output nature in those industries.

Finally, the output distance function is dual to the revenue function, which allows the shadow prices to be indirectly derived from the distance function using Shephard's Lemma. These can then be used to calculate marginal rates of transformation of Morishima elasticities of substitution among outputs. Examples of such applications include Fare *et al.* (1993) and Grosskopf *et al.* (1995).

A distance function that represents the production technology can be defined in terms of radial input conservation or output expansion. With multiple outputs and inputs, this representation becomes a multidimensional problem, in contrast to typical empirical representation of the technology with one output and multiple inputs. This multidimensional technological relationship can be represented by the technology set, which is a list of the technologically feasible combinations of inputs and outputs. If the vector of M inputs is denoted by $x = (x_1, x_2, \dots, x_M)$ and the vector of N outputs is denoted by $y = (y_1, y_2, \dots, y_N)$, then the technology set can be defined by Equation (6.1).

$$T = \{(x, y) : x \in \mathfrak{R}_+^M, y \in \mathfrak{R}_+^N, \text{ } x \text{ can produce } y\} \quad (6.1)$$

For each input vector x , let $P(x)$ be the set of feasible output vectors y that are obtainable from the input vector x :

$$P(x) = \{y \in \mathfrak{R}_+^N : x \text{ can produce } y\} \quad (6.2)$$

where the technology is assumed to satisfy the standard axioms, such as convexity, weak disposability, listed in Fare and Primont (1995).

Shephard proved the duality between the input distance function and the cost function in 1953 and lately introduced the duality between the output distance function and the revenue function in 1970. Based on a common definition of production technology that transforms inputs into outputs, the output distance function is defined in terms of the output set $P(x)$ as in Equation (6.3).

$$D_o(x, y) = \min.\{\theta > 0 : (y/\theta) \in P(x)\}. \quad (6.3)$$

where θ is the scalar ‘distance’ by which the output vector can be deflated; in other words, the output distance function measures the maximum possible proportional increase in the observed output vector given that the expanded vector must still be an element of the original output set.

The output distance function, if well-defined, will always satisfy the properties of $D_o(y, x)$ as summarized in Lovell *et al.* (1994). These properties include monotonicity, non-decreasing in output and non-increasing in input, convexity in y , and homogeneity of degree 1 in output. The value of $D_o(y, x)$ will be less or equal to one if the output vector, y , is an element of the feasible production set of $P(x)$. If y is located on the surface of the production possibility set, the distance function $D_o(y, x)$ equals one, suggesting the firm is best-practice performer. If y is interior of the frontier, the value of the distance function falls short of 1, indicating the deviation of the firm from best-practice production.

A translog functional form rather than the commonly employed Cobb-Douglas form is selected in this study to represent the distance function. The translog functional form is flexible and allows the homogeneity of degree 1 in output. Specifically, the output distance function with M outputs, K inputs, for I firms is given by Equation (6.4).

$$\begin{aligned} \ln D_{oi} = & \alpha_0 + \sum_{m=1}^M \alpha_m \ln y_{mi} + \frac{1}{2} \sum_{m=1}^M \sum_{n=1}^M \alpha_{mn} \ln y_{mi} \ln y_{ni} + \sum_{k=1}^K \beta_k \ln x_{ki} \\ & + \frac{1}{2} \sum_{k=1}^K \sum_{l=1}^K \beta_{kl} \ln x_{ki} \ln x_{li} + \sum_{k=1}^K \sum_{m=1}^M \gamma_{km} \ln x_{ki} \ln y_{mi} \quad i=1,2,\dots,N \end{aligned} \quad (6.4)$$

where “o” indicates an output-oriented distance function and i denotes the i -th firm in the sample.

Output distance function must theoretically satisfy regularity restrictions of homogeneity and symmetry. Restriction on homogeneity of degree one in outputs is defined by Equation (6.5).

$$\sum_{m=1}^M \alpha_m = 1, \quad \text{and} \quad \sum_{n=1}^M \alpha_{mn} = 0 \quad (m=1,2,\dots,M), \quad \text{and} \quad \sum_{m=1}^M \gamma_{km} = 0 \quad (k=1,2,\dots,K) \quad (6.5)$$

and restriction on symmetry is shown by Equation (6.6)

$$\alpha_{mn} = \alpha_{nm} \quad (m,n=1,2,\dots,M) \quad \text{and} \quad \beta_{kl} = \beta_{lk} \quad (k,l=1,2,\dots,K) \quad (6.6)$$

Following Lovell *et al.* (1994), the homogeneity constraint is imposed by normalizing the output distance function by one of the outputs. The homogeneity property implies that $D_o(x, \omega y) = \omega D_o(x, y)$ for any $\omega > 0$, which can be satisfied by output normalization using an arbitrary output in empirical practices. If the M th output is chosen for normalization and ω is set at $1/y_M$, then $D_o(x, y/y_M) = D_o(x, y)/y_M$. In particular, Equation (6.4) becomes

$$\begin{aligned} \ln D_{oi} / y_{Mi} &= \alpha_0 + \sum_{m=1}^{M-1} \alpha_m \ln y_{mi}^* + \frac{1}{2} \sum_{n=1}^{M-1} \sum_{m=1}^{M-1} \alpha_{mn} \ln y_{mi}^* \ln y_{ni}^* + \sum_{k=1}^K \beta_k \ln x_{ki} \\ &\quad + \frac{1}{2} \sum_{k=1}^K \sum_{l=1}^K \beta_{kl} \ln x_{ki} \ln x_{li} + \sum_{k=1}^K \sum_{m=1}^{M-1} \gamma_{km} \ln x_{ki} \ln y_{mi}^* \quad i=1,2,\dots,N \end{aligned} \quad (6.7)$$

where $y_{mi}^* = y_{mi} / y_{Mi}$, $y_{ni}^* = y_{ni} / y_{Mi}$.

Rearranging Equation (6.7) into Equation (6.7a)

$$\begin{aligned} -\ln y_{Mi} &= \alpha_0 + \sum_{m=1}^{M-1} \alpha_m \ln y_{mi}^* + \frac{1}{2} \sum_{n=1}^{M-1} \sum_{m=1}^{M-1} \alpha_{mn} \ln y_{mi}^* \ln y_{ni}^* + \sum_{k=1}^K \beta_k \ln x_{ki} \\ &\quad + \frac{1}{2} \sum_{k=1}^K \sum_{l=1}^K \beta_{kl} \ln x_{ki} \ln x_{li} + \sum_{k=1}^K \sum_{m=1}^{M-1} \gamma_{km} \ln x_{ki} \ln y_{mi}^* - \ln D_{oi} \quad i=1,2,\dots,N \end{aligned} \quad (6.7a)$$

where the summation sign over m implies summing only the $M-1$ outputs not used for normalization. If $M=1$, this function is reduced to the standard one-output translog form model.

Standard stochastic frontier models encompass both a symmetric (noise) random error term v_i and an asymmetric (inefficiency) error term u_i , in which u_i are dependent on environmental factors. The key to incorporate a distance function within a stochastic production frontier context is to reinterpret the distance, $-\ln(D_{oi})$, as a traditional

disturbance term in stochastic model. It reflects the difference between the observed data points and those points predicted by the estimated production technology. By interpreting the distance $\ln(D_{0i})$ in equation (6.7a) as a composed error term with a noise (v_i) and technical inefficiency (u_i), the distance function in equation (6.7a) becomes

$$\begin{aligned}
 -\ln y_{Mi} &= \alpha_0 + \sum_{m=1}^{M-1} \alpha_m \ln y_{mi}^* + \frac{1}{2} \sum_{m=1}^{M-1} \sum_{n=1}^{M-1} \alpha_{mn} \ln y_{mi}^* \ln y_{ni}^* + \sum_{k=1}^K \beta_k \ln x_{ki} \\
 &+ \frac{1}{2} \sum_{k=1}^K \sum_{l=1}^K \beta_{kl} \ln x_{ki} \ln x_{li} + \sum_{k=1}^K \sum_{m=1}^{M-1} \gamma_{km} \ln x_{ki} \ln y_{mi}^* + v_i - u_i \quad i=1,2,\dots,N \quad (6.7b)
 \end{aligned}$$

For the purpose of empirical estimation, the left hand side of the Equation (6.7b) is transformed to be $\ln y_i$ rather than $-\ln y_i$ and it becomes a standard SFA model in Equation (6.8).

$$\begin{aligned}
 \ln y_{Mi} &= \alpha_0 + \sum_{m=1}^{M-1} \alpha_m \ln y_{mi}^* + \frac{1}{2} \sum_{m=1}^{M-1} \sum_{n=1}^{M-1} \alpha_{mn} \ln y_{mi}^* \ln y_{ni}^* + \sum_{k=1}^K \beta_k \ln x_{ki} \\
 &+ \frac{1}{2} \sum_{k=1}^K \sum_{l=1}^K \beta_{kl} \ln x_{ki} \ln x_{li} + \sum_{k=1}^K \sum_{m=1}^{M-1} \gamma_{km} \ln x_{ki} \ln y_{mi}^* + v_i - u_i \quad i=1,2,\dots,N \quad (6.8)
 \end{aligned}$$

As noted in Coelli and Perelman (2000) and applied in Morrison *et al.* (2000), this transformation reverses the signs of the estimated coefficients for a normal distance function. However, the interpretation of estimates becomes more comparable to those of standard production function models. For example, after the transformation, the expected sign of the logarithmic derivative or elasticity $\partial \ln y_i / \partial \ln x_k$ to be positive for a marginal product, rather than negative as would be the case if Equation (6.8) were defined in terms of $-\ln y_i$. Likewise, the corresponding elasticities of the output variables (y_m^*) are negative, consistent with their interpretation as the slope of the production possibility frontier.

One might have been aware of the possibility of simultaneous equation bias because of the appearance of both inputs and outputs in the distance functions as regressors.

Particularly, in an output distance function, the inputs should be treated as exogenous and the output will be endogenous. However, the normalization results in the output ratios appear in the model rather than output variables. Coelli and Perelman (1996) argue that these output ratios may be assumed to be exogenous since the output distance function is defined for radial expansion of all outputs, given the input levels.

Equation (6.8) represents a stochastic translog output-oriented distance function and its generalized versions incorporating into BC95 model are:

$$\ln y_{Mit} = TL(x_{it}, y_i / y_{Mit}, \alpha, \beta, \gamma) + v_{it} - u_{it} \quad (6.9)$$

$$u_{it} = \sum_n \delta_n z_{nit} + \mu_{it} \quad (6.10)$$

$$TE_{it} = \exp(-u_{it}) = \exp(-z_{it}\delta - \varepsilon_{it}) \quad (6.11)$$

where the model is re-parameterised by $\sigma^2 \equiv \sigma_v^2 + \sigma_u^2$ and $\gamma \equiv \frac{\sigma_u^2}{\sigma_v^2 + \sigma_u^2}$ (Battese and Corra, 1977).

The orientation of the efficiency measure is selected dependant on the arguments about the endogeneity and exogeneity of the input and output sets (Coelli and Perelman, 1999). This study chooses the output distance function based on the following considerations. First of all, this study focuses on the effects of various institutional changes in banks on bank efficiency. Institutional changes will generally involve changes in the governance structure in order to improve bank performance. This can possibly be achieved by cutting cost, whereas costs are more like to increase, at least in the short run, in the process of institutional changes. Therefore, it is reasonable to assume that banks are more likely to improve performance by focusing on output augmentation rather than costs contraction. Secondly, having experienced economic development with high speed, the Chinese economy is still marked on the round of an uprising period. Given the favourable macroeconomic conditions and the scarcity of capital, it is also reasonable to assume that bank production is driven by outputs. Finally, Berger *et al.* (1993) find that the majority of inefficiency arises from deficient revenues rather than excessive costs.

Morrison *et al.* (2000) innovatively embed the distance function approach into a SFA framework. They argue that such a model is a somewhat complex but general and rich representation of production technology to estimate efficiency and its possible determinants. On the one hand, the model is stochastic with a composite error term in contrast with a typical econometric approach and a nonparametric or a deterministic econometric frontier approach. The former fits a function to the data assuming a normal error distribution and the latter lacks statistical inference. On the other hand, the model is based on a distance function approach that has a few advantages over a dual cost/profit function approach in dealing with multi-outputs and multi-inputs production technologies as discussed earlier.

Borrowing the idea from Morrison *et al.* (2000), this study has enriched an empirical model to provide comprehensive information on efficiency and to differentiate the impact of various reform strategies. Based on the work of Morrison *et al.* (2000), this model applies the output distance function in a flexible translog functional form to a one-step stochastic frontier model—the BC95 model. In addition, the method proposed by Berger *et al.* (2005) has been incorporated into the technical inefficiency effects model of the BC95 model to jointly examine static, selection and dynamic effects of governance changes on bank efficiency. This comprehensive model inherits all statistical and practical virtues of the distance function approach, one-step stochastic BC95 model and Berger *et al.* (2005) method. Moreover, the technical inefficiency effect model also simultaneously examines the effects of bank risk taking characteristics and macroeconomic conditions. Such a comprehensive model is empirically applicable because of the econometric package—FRONTIER (Version 4.1c) developed by Tim Coelli.

6.2 Empirical specifications and variable definitions

This study specifies three different combinations of inputs and outputs (shown in Table 6.1) since efficiency estimates are sensitive to the empirical specification of inputs and outputs. Different specifications are also for addressing the issue arising in the last chapter regarding how to define output in the presence of high level NPLs and their effects cannot be properly accounted for. Model 1 is an income-based specification of inputs and outputs which specifies two inputs—non-interest expense

and total interest expense, and two outputs—net interest income and non-interest income. This model has been employed by Sturm and Williams (2004) and Park and Weber (2006).

Table 6.1 Empirical model specifications

Model	Outputs	Inputs	Time
1	Net interest income (y_1)	Total interest expense (x_1)	t
	Non-interest income(y_2)	Non-interest expense (x_2)	
2	Total loans(y_3)	Total interest expense (x_1)	t
	Total deposits(y_4)	Labor and physical capital (x_3)	
	Non-interest income (y_2)		
3	Total loans(y_3)	Physical capital (x_4)	t
	Total deposits(y_4)	Labour (x_5)	
	Other earning assets(y_5)	Total interest expense (x_1)	

Model 2 and Model 3 are earning asset-based models, in which outputs are defined using balance sheet information on earning assets. It has long been argued that the efficiency estimates are sensitive to the treatment of deposits. Regarding this controversial issue, a dual approach has been proposed and widely employed, which treats the stock value of deposits as an output while treating the costs of deposits as an input (Berger and Humphrey, 1991; Bauer *et al.*, 1993; Humphrey and Pulley, 1997; Chen *et al.*, 2005; Cavallo and Rossi, 2001). Following this approach, In Model 2 and Model 3, total deposit is defined as an output to measure the service flows provided to customers and interest paid on deposit is defined as an input.

Specifically, Model 2 specifies two inputs and three outputs. Two inputs include labour and physical capital, and total interest expense, while three outputs are total loans, total deposits and non-interest income. Non-interest income or fee-related income is defined as an additional output for capturing the effect of increasingly important diversification of bank activities, such as fee income and off-balance-sheet activities, rather than traditional bank lending activities. The same model has been applied in Rogers (1998) and Park and Weber (2006). Model 3 specifies three inputs

and three outputs. Three inputs include physical capital, labour and total interest expense. Three outputs include total loans, total deposit, and other earning assets.

Variables are defined using the intermediation approach (Sealey and Lindley, 1977). However, input variables specified in Model 2 and Model 3 slightly violate the standard intermediation approach because of the rather incomplete data on personnel expenses and the number of employees. In Model 2, total operating expenses are used as a proxy for both the labour and physical capital inputs. In Model 3, overhead is used as a proxy for labour input, while fixed assets serves as physical capital input. The use of these approximations as input variables is the best solution based on the theoretical ground and the data availability for Chinese banks. This practice has recently become popular in bank efficiency study in developing nations. Examples include Patti and Hardy (2005), Fries and Taci (2005), Chen *et al.* (2005).

The translog output distance function specified and estimated in this chapter is given by Equation (6.12)

$$\begin{aligned} \ln y_{Mi} = & \alpha_0 + \sum_{m=1}^{M-1} \alpha_m \ln y_{ni}^* + \frac{1}{2} \sum_{m=1}^{M-1} \sum_{n=1}^{M-1} \alpha_{mn} \ln y_{ni}^* \ln y_{ni}^* + \sum_{k=1}^K \beta_k \ln x_{ki} + \frac{1}{2} \sum_{k=1}^K \sum_{l=1}^K \beta_{kl} \ln x_{li} \ln x_{ki} \\ & + \sum_{k=1}^K \sum_{m=1}^{M-1} \gamma_{km} \ln x_{ki} \ln y_{ni}^* + \sum_{m=1}^{M-1} \alpha_{mi} t \ln y_{ni}^* + \sum_{k=1}^K \beta_{ki} t \ln x_{ki} + t + v_i - u_i \\ & i=1,2,\dots,N \end{aligned} \quad (6.12)$$

where y^* are outputs normalized by either total loans or net-interest income; x are inputs and t is a time trend.

A summary of descriptive statistics of all variables in the stochastic distance frontier model, and other useful financial ratios are presented in Table 6.2. For variables used in the technical inefficiency effect model, risk taking indicators are reported in Table 6.2. Governance effect indicators representing various institutional changes will be summarized in Table 6.3. Four risk taking indicators include the capital leverage ratio for capital risk, LLR to total loans ratio for credit risk, interbank borrowing to total deposits ratio for market risk, and the total loans to total deposits ratio for liquidity risk. Data are taken from banks' annual financial statements.

Table 6.2 Mean values of sample banks by governance type (1995-2005)

	CCBs_ ALL	CCBs_ NO	FBs_ ALL	JSCBs ALL	JSCBs NO	SOCBs All	SOCBs NO	Listed banks	Selection foreign	Selection listing
<i>Outputs and Inputs and other financial figures</i>										
Loans*	19	11	1	115	113	1,676	1,501	322	494	757
Other earning assets*	17	9	1	77	73	1,007	656	208	325	495
Deposits*	30	16	1	147	149	2,231	1,795	438	673	1,030
Net interest income	575	306	51	3,163	2,616	42,473	36,853	9,770	12,809	19,658
Other operating income	376	217	35	1,570	1,502	18,662	9,200	4,385	6,391	9,697
Fixed assets	469	402	31	2,684	2,677	52,024	49,064	10,466	14,493	22,396
Overhead	387	222	16	2,219	2,035	30,694	32,415	6,692	8,758	13,413
Interest expense	781	432	71	3,719	4,191	106,420	56,744	11,569	32,283	49,724
Non-interest expense	414	239	21	2,374	2,160	35,034	36,830	7,339	9,906	15,192
ROA	1.65	1.78	12.27	1.36	0.94	0.57	0.29	1.29	1.20	1.07
Cost efficiency	1.14	1.11	0.91	1.20	1.16	1.13	1.48	1.24	1.19	1.12
Total assets*	39	22	2	200	200	2,886	2,335	555	874	1,336
<i>Risk taking indicators</i>										
Capital risk	4.90	5.14	31.93	4.65	3.79	4.35	4.08	4.66	4.78	4.57
Credit risk	1.29	1.26	2.33	2.24	1.24	1.53	0.91	2.31	1.99	2.06
Market risk	87.94	80.87	268.53	38.76	37.88	52.57	40.00	27.12	57.51	39.11
Liquidity risk	70.32	72.48	131.94	79.74	76.96	81.42	97.20	80.61	76.79	77.97

Source: BankScope and authors' calculation.

Notes: (1) ROA = return on assets; LLR = loan loss reserve; Cost efficiency = overhead over total assets. CCB = city commercial bank, FB = foreign bank, JSCB = joint-stock commercial bank, SOCB = state-owned bank, NO = no changes, ALL = all banks in the group, Selection foreign = selected for foreign acquisition, Selection listing = selected for listing on stock exchanges. (2) All monetary variables have been deflated to 1995 price level. (3) * Loans, other earning assets, deposits, and total assets are presented in billion RMB, other variables are presented in million except for ratios.

These data provide a preliminary preview for different types of banks. Foreign banks are shown to have very different characteristics from domestic banks. They are the most profitable and cost efficient banks indicated by ROA of 12.27% and a simple cost efficiency measure of overhead to total assets ratio of 0.91%. Their risk taking indicators are the highest among banks, suggesting relatively low capital risk and credit risk, but high market risk and liquidity risk. Data on SOCBs suggest that they are the least profitable but more cost efficient than the average of all JSCBs. This is consistent with most of the static research literature on state ownership in developing nations that always find unfavourable effects. CCBs turn out as the most profitable and cost efficient domestic banks at slightly high ROA and simple cost efficiency ratio of overhead to total assets.

The data also provide information on the effect of the institutional changes. In terms of profitability, all types of banks experiencing no institutional changes (therefore no governance changes) during the sample period are less profitable than their corresponding entire groups, except for CCBs. The possible reason is that better performing banks have been picked up for institutional changes, or that banks have improved performance after institutional changes, or both. In terms of financial cost efficiency ratio, CCBs and JSCBs without governance changes are more cost efficient than their respective group average. This suggests that governance changes generally involve excessive costs at least in the short run but the downside effects have been fully offset by the improved profitability.

The effects of institutional changes in SOCBs are more favourable with significant improvement in profitability without suffering excessive costs as other types of bank. The group average ROA is 0.57, which is double of the ROA of SOCBs experiencing no governance changes. The governance changes have contracted costs since SOCBs without changes have higher overhead to total assets ratio than SOCBs experienced changes. The data have provided preliminary evidence for the positive effects of changing corporate governance as result of institutional changes in banks.

Following existing literature, a number of specific procedures have been applied to data wherever necessary prior to the estimation. First, all monetary variables with a negative or zero value have been added to a constant, where the constant equals the

absolute of their respective minimum values plus one. The purpose is to avoid taking natural logarithm on the negative or zero value. Secondly, all monetary variables are expressed in million Renminbi and they have been deflated by their corresponding year CPI to 1995 price level in order to control the inflation effects. Thirdly, all input and output variables has been mean-corrected, that is, all data are normalized by their geometric sample mean. Thus, the first order coefficients can be interpreted as distance elasticities with respect to other outputs and the inputs, evaluated at the sample means. Finally, the homogeneity constraint has been imposed by normalizing all outputs using net interest income in Model 1 and using total loans in Model 2 and Model 3. The choice of normalizing output variable is arbitrary and causes no difference in estimation results. This ensures the homogeneity of degree one in outputs for all models. The moralization also has the benefits of reducing the problem of heteroscedasticity and multicollinearity.

The technical inefficiency effects model examines the impact on bank performance of risk taking characteristics and various institutional changes in banks in a certain macroeconomic environment. In particular, these independent variables are proxy for management practice, business environment, operational experience, foreign involvement, and ownership structure of individual banks. Among other factors, risk management practice and corporate governance structure are two most important aspects to improve for Chinese banks to be profitable and viable in the long run. They are simultaneously examined in a one-step SFA model—BC95 model. It is assumed that that difference in risk taking and institutional changes influence banks' efficiency level rather than the production technology structure. The empirical specification of the technical inefficiency effects model is given by Equation 6.13.

$$u_{it} = \delta_0 + \sum_{a=1}^{10} \delta_a CG_{it} + \sum_{b=1}^{14} \delta_b Risk_{it} + \delta_{15} GDP + \delta_{16} t + \varepsilon_{it} \quad (6.13)$$

where t is a time trend variable; CG_{it} is a vector of governance changes indicators representing various institutional changes in banks; $Risk_{it}$ is a vector of risk taking indicators; GDP is GDP growth rate representing the macroeconomic condition.

Risk taking characteristics are represented by a set of financial ratios—the capital leverage ratio for capital risk, LLR to total loans ratio for credit risk, interbank borrowing to total deposits ratio for market risk, and total loans to total deposits ratio for liquidity risk. These characteristics do not necessarily be causations of inefficiency or efficiency, but they might be more popular in efficient or inefficient banks' operations (Mester, 1996). The equity capital ratio reflects managerial risk preferences in solving the maximization problem. LLR to total loans ratio measures how much banks provide for unanticipated losses because of loan defaults. It reflects banks' financial strength since LLR is used as a cushion against possible loan defaults. The ratio of interbank borrowing to total deposits measures the extent to which a bank depends on wholesale funding rather than retail operations. GDP growth is included as a proxy for general macroeconomic environment in which banks operate. A time trend variable is for capturing common effects on efficiency, i.e. technology change, policy change, and regulatory mechanism change.

A set of governance changes indicators has been defined and employed to estimate and differentiate the effects of various institutional changes on bank performance in China. Following Berger *et al.* (2005), different types of bank ownership are considered as forms of governance. Changes in governance include any kinds of institutional changes, such as restructuring, foreign acquisition and going public. The aim is to investigate whether institutional changes improve performance, and if any, to ascertain which changes have such positive impact. The static governance indicators are used to depict the different effects on performance of having certain types of governance structure over the long term. Selection effect indicators are used to discover whether better or poorly performed banks are selected for governance changes. Dynamic governance indicators explore the short-run and long-run effects of governance changes on performance. The present study specifies 11 governance indicators (defined as dummy variables in Table 6.3), including five static effect indicators, two selection effect indicators, two short-run dynamic effect indicators and two long-run dynamic effect indicators.

Table 6.3 Definition of governance effect indicators

Governance Indicators	Definition	No. of banks	Total assets	
<i>Static Effect Indicators</i>				
			%	%
CCBs—No Change	Dummy indicating a city commercial bank that underwent no changes in governance over the entire sample period. It equals 1 for such banks and 0 for all other banks for all periods. This variable is excluded from the regression as the base case when all the other static and selection governance indicators are included.	9 (14)	64	34
JSCBs—No Change	Dummy indicating a joint-stock commercial bank that underwent no changes in governance over the entire sample period. It equals 1 for such banks and 0 for all other banks for all periods.	2 (11)	18	18
SOCBs—No Change	Dummy indicating a state-owned commercial bank that underwent no changes in governance over the entire sample period. It equals 1 for such banks and 0 for all other banks for all periods.	1 (4)	25	20
FBs—No Change	Dummy indicating a foreign-owned commercial bank that underwent no changes in governance over the entire sample period. It equals 1 for such banks and 0 for all other banks for all periods.	6 (6)		
Listed Banks	Dummy indicating whether a bank is listed or not. It equals 1 for listed banks and 0 for all other banks for all periods.	7(35)	20	27

Selection Effect Indicators

Selected for Foreign Acquisition	Dummy indicating a bank that underwent at least one foreign acquisition over the entire sample period. It equals 1 for such banks and 0 for all other banks for all periods.	14 (35)	40	77
Selected for Going Public	Dummy indicating a bank that underwent IPO since 1995 up to 2006 other than 2005 due to two significant SOCB IPOs took place in 2006. It equals 1 for such banks and 0 for all other banks for all periods.	9 (35)	26	75

Dynamic Effect Indicators--ST

Underwent Foreign Acquisition	Dummy indicating the year following a bank's foreign acquisition. It equals 1 starting in the year of acquisition for such banks and 0 prior to the bank's acquisition and for all other banks for all periods.			
Underwent Going Public	Dummy indicating the year following a bank's IPO. It equals 1 starting in the year of IPO for such banks and 0 prior to the bank's IPO and for all other banks for all periods.			

Dynamic Effect Indicators--LT

Underwent Foreign Acquisition	The number of years since foreign acquisition. It starts with 1 since the year of acquisition for such banks and 0 prior to the bank's acquisition and for all other banks for all periods.			
Underwent Going Public	The number of years since a bank's IPO. It starts with 1 since the year of IPO for such banks and 0 prior to the bank's IPO and for all other banks for all period.			

Note: Figures in parentheses are the total number of respective types of banks or total banks in the sample.

Five static effect indicators are *CCBs—No Change*, *JSCBs—No Change*, *SOCBs—No Change*, *FBs—No Change*, and *Listed Bank*. The former four indicators represent banks that underwent no changes in governance over the sample period, corresponding to city commercial banks, joint stock commercial banks, state-owned commercial banks and foreign banks. For all periods, these variables equal 1 for banks with no governance change and 0 for all other banks. The last static indicator shows if banks are listed in stock exchanges. It equals 1 for listed banks and 0 for all other banks for all periods.

Following the literature (Berger *et al*, 2005; Williams and Nguyen, 2005), the first static indicator, *CCBs—no change*, is excluded in the estimation as the base case for the purpose of performance comparison. One caveat needs to be born in mind that the results for CCBs are not representative of the average of CCBs in China but the upfront of better performing CCBs. The sample only includes about 15 CCBs out of 112 CCBs for those whose data are available for at least five years. To some extent, the length of the periods for which data are publicly available is indicative of banks' better management and data quality. Therefore, these banks are expected to outperform the rest of CCBs. Moreover, some of CCBs included in the sample locate in more economically developed cities, such as Bank of Shanghai and Bank of Beijing, and in fact these CCBs might even outperform some JSCBs. Another piece of evidence for their better performance is the fact that 6 CCBs have been acquired by international strategic investors, of which 5 have been included in our sample. As later confirm, these investors have cherry-picked better performing banks for acquisition. However, as a control group, the sample bias would not affect our analysis since our main concern is the relative efficiency level of each type of banks rather than focusing on CCBs only.

As shown in Table 6.3, in terms of the number of banks, 64% of CCBs, 18% of JSCBs and 25% of SOCBs remain unchanged in governance. In terms of total assets, the percentage of total assets owned by banks without governance change is, 34% for CCBs, 18% for JSCBs and 20% for SOCBs. In sum, 41% of domestic banks (12 out of total 29 banks) have experienced no governance changes, only accounting for 20% of the total banking assets. In other words, 59% of domestic banks controlling 80% of the total banking assets have experienced governance changes. The most active banks

in governance changes are JSCBs of which 82%, in terms of both the number of banks and total assets, have undergone governance changes during the sample period. These striking figures suggest that institutional changes (therefore governance changes) in Chinese banking system are prevail and significant. As to the listing status of Chinese banks, only 7 banks out of 35 banks are listed on stock exchanges, possessing only 27% of the total banking assets.

The selection effect indicators, *Selected for Foreign Acquisition* and *Selected for Going Public*, represent banks that have been selected for foreign acquisition or IPO during the sample period. The purpose of selection indicators is to capture the performance effects associated with being selected by foreign investors or for IPO. Variables equal 1 for all periods for such a bank and 0 for all other banks for all periods. Some banks experienced both foreign acquisition and going public changes. In these cases, both changes are accounted separately. *Selected for Foreign Acquisition* indicator is employed to account for possible factors underpinning foreign investors' acquisition decision, such as performance, size, market share, and nationwide network. There has been a surge of foreign investment in domestic banks and banks' IPOs up to 2006. A number of various foreign institutions have acquired stake or have been negotiating to acquire stake in domestic banks, covering all types of domestic commercial banks. As shown in Table 6-3, 14 out of 35 banks have been selected by foreign strategic investors, of which 5 are CCBs, 6 are JSCBs and 3 are SOCBs. These 14 banks possess 77% of the total banking assets.

Selected for Going Public indicator is to scrutinise the performance of banks being selected for going public. IPO of banks is another important banking reform strategy undertaken by Chinese government. Although only 9 domestic banks have been selected for IPO, they control 75% of the total banking assets. When looking at static indicator of *Listed Bank* and selection effect indicator of *Selected for IPO* shown in Table 6-3, two more banks are included for accounting the selection effect and listed banks' share of total banking assets has increased from 27% for *Listed Bank* indicator to 75% for *Selected for IPO* indicator. The reason is that *Listed Bank* accounts for the listing status up to the end of 2005, while *Selected for Going Public* up to the end of 2006 in order for considering the effect of two large SOCBs' IPOs—Bank of China and Industrial and Commercial Banks of China.

Dynamic effect indicators attempt to examine the effects of governance changes by comparing bank performance before the changes with their subsequent performance after the changes. Two short-term dynamic effect indicators, *Underwent Foreign Acquisition-ST* and *Underwent Going Public-ST*, measure the timing following the governance changes in order to capture short-term effects of governance change on bank performance. The dummy equals 0 prior to the governance change and 1 starting in the year following the change. Two long-term dynamic effect indicators, *Underwent Foreign Acquisition-LT* and *Underwent Going Public-LT*, measure the number of years following a governance change. Long-term dynamic variables equal 0 prior to the governance change for all banks and start with 1 in the year of the change. Existing literature suggest deleting the observations in the year and the year following governance change to help mitigate transition effects, whereas it is impractical for the present study given a large proportion of governance changes took place within the last two years of the sample period.

It is important to distinguish the long-term effects from the short-term effects since transition costs incurred during the governance changes may last more than one year. Moreover, banks may return back to prior behaviour after a governance change rather than on the track of the predicted ways. Results from dynamic effect indicators might have policy implications. For instance, a change from a short-term favourable effect to an adverse long-term effect may suggest that governance changes do not persist in functioning as expected and observed in short term for a longer period of time. Thus, actions could be taken to investigate the reasons and amend the policy when necessary.

6.3 Empirical results

6.3.1 Results of the stochastic frontier model and bank performance

Variations of the frontier model have been estimated in order to gauge the sensitivity of different outputs and inputs combinations. Estimated average levels of technical efficiency are generally consistent with each other as shown in Table 6.4. Since the sign of the dependent variable in the output distance function has been transformed

into positive prior to estimation, the signs of the coefficient estimates have been reversed which become consistent with the estimates from the standard output distance function. Most input and output variables are highly significant at 1% level. Elasticities in all three models have the expected signs, that is, elasticities for output variables are positive and those for input variables are negative. Thus, the monotonicity of distance function has been fulfilled in addition to the homogeneity constraint imposed prior to the estimation. Furthermore, the second-order output and cross-outputs have the correct signs, suggesting that the transformation curve has a concave shape. Because the models have been estimated in a translog functional form, these estimated elasticities do not have direct economic interpretation.

The overall fitness of models is judged by Maximum likelihood estimates for the parameters. Gamma ($\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$) are more than 0.82 for all models at 1% significance level. Results of LR test of one-sided error are greater than 160 for all three models, highlighting the existence of the one-sided error within the error terms. These estimated parameters demonstrate that inefficiency is the main source of the deviation and a classical regression model of production function is inadequate to represent the data. The positive coefficient on the time trend in the production frontier function indicates that the production frontier moved upward. In balance, the regression results suggest that the models are well estimated with good fitness of the output distance function presenting the bank production technology in China.

One of the virtues of distance functions is that it allows the computation of scale elasticities. Following Fare and Primont (1995) and Coelli and Perelman (1999), the scale elasticity is given by Equation (6.14)

$$EE_u = - \sum_{k=1}^M \partial \ln D_0(y_u, x_u) / \partial \ln x_k \quad (6.14)$$

Table 6.4 Estimated parameters of stochastic output distance function

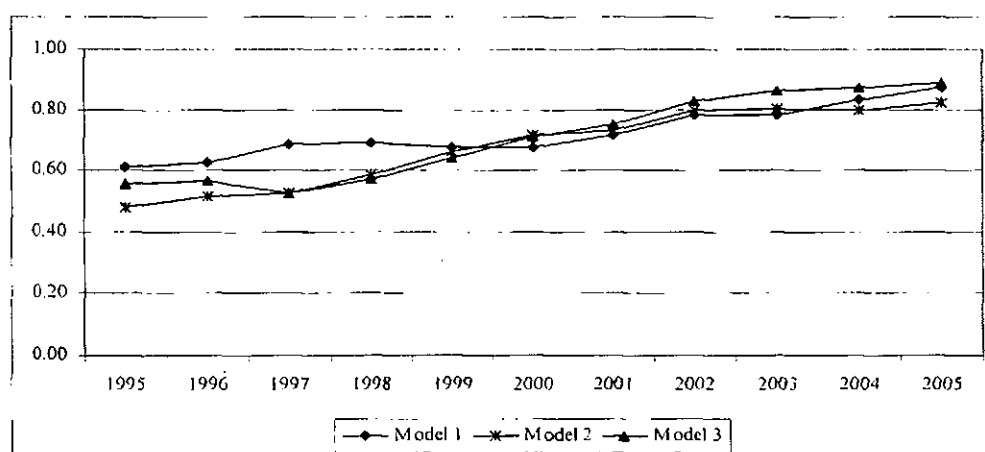
	Model 1	Model 2	Model 3
Net interest income $y1$			
Non-interest income $y2$	0.462 (9.12)***	0.198 (3.47)***	
Total loans $y3$			
Total deposits $y4$		0.859 (5.23)***	0.256 (1.55)*
Other earning assets $y5$			0.298 (1.95)**
Total interest expense $x1$	-0.442 (-5.6)***	-0.415 (-4.7)***	-0.578 (-7.9)***
Non-interest expense $x2$	-0.314 (-3.7)***		
Labour and physical capital $x3$		-0.404 (-4.5)***	
Physical capital $x4$			-0.191 (-2.2)**
Labour $x5$			-0.047 (-3.1)**
T	0.003 (0.13)	0.012 (1.12)	0.024 (1.05)
γ	0.888 (29.6)***	0.860 (27.9)***	0.818 (22.1)***
LR test	194	166	161
Mean Technical Efficiency	73.43	69.98	73.18
$y2*y2$	-0.141 (-7.5)***	-0.139 (-6.1)***	
$y2*x1$	0.068 (1.82)**	0.017 (0.39)	
$y2*x2$	-0.062 (-1.6)*		
$y2*x3$		-0.049 (-1.2)	
$y2*t$	0.003 (0.33)	-0.008 (-0.8)	
$y4*y4$		-0.110 (-2.5)**	-0.222 (-2.7)**
$y4*y2$		0.275 (3.83)***	
$y4*x1$		0.110 (2.35)**	-0.016 (-0.4)
$y4*x3$		0.075 (1.41)*	
$y4*x4$			0.008 (0.08)
$y4*x5$			0.077 (0.66)
$y4*t$		0.046 (2.55)**	-0.019 (-0.8)
$y5*y5$			-0.141 (-2.2)**
$y5*y4$			0.377 (3.56)***
$y5*x1$			0.095 (2.02)**
$y5*x4$			0.136 (1.98)**
$y5*x5$			-0.301 (-4.2)***
$y5*t$			0.026 (1.22)
$x1*x1$	0.144 (0.71)	0.053 (1.79)*	-0.023 (-0.8)
$x1*x2$	0.002 (-0.04)		
$x1*t$	-0.019 (-1.8)*	-0.004 (-0.3)	-0.025 (-2.3)**
$x2*x2$	0.019 (0.81)		
$x2*t$	0.030 (265)**		
$x3*x3$		0.050 (1.91)**	
$x3*x1$		-0.090 (-1.7)*	
$x3*t$		0.013 (1.01)	
$x4*x4$			0.058 (1.49)*
$x4*x1$			0.063 (1.16)
$x4*x5$			-0.180 (-2.5)**
$x4*t$			-0.002 (-0.4)
$x5*x5$			0.097 (2.21)**
$x5*x1$			-0.013 (-0.2)
$x5*t$			0.043 (2.33)**

Notes: Figures in parenthesis are t-values. '***' signifies significance at 1%, '**' at 5% and '*' at 10% levels.

The negative sign of the sum of the first-order input coefficients in the output distance function is an indicator of returns to scale in the production process. A value greater than one indicates the presence of increasing returns to scale at the mean, while a value less than one suggests decreasing returns to scale. This indicator takes the values of 0.75, 0.81 and 0.81 in Model 1, Model 2 and Model 3 respectively, consistently suggesting decreasing returns to scale at the mean in the Chinese banking industry.

As shown in Figure 6.1, bank performance has been steadily improved over the sample period. The average estimated technical efficiency is about 70% in all three models, indicating the Chinese banking industry produces less than they would at the maximum possible level by 30%. The efficiency level falls into the reasonable range reported in the efficiency literature. The most efficient bank is China Merchants Bank in Model 1, Bank of Communications in Model 2 and Bank of China in Model 3, with the estimated technical efficiency of 93%, 89% and 93%, respectively. Although different models identify different most efficient banks, the rank order of these banks is relatively stable. China Merchants Bank is ranked at the seventh in Model 2 and the fourth in Model 3, while Bank of Communications is the second best in Model 1 and Model 3.

Figure 6.1 Overall technical efficiency of Chinese banks

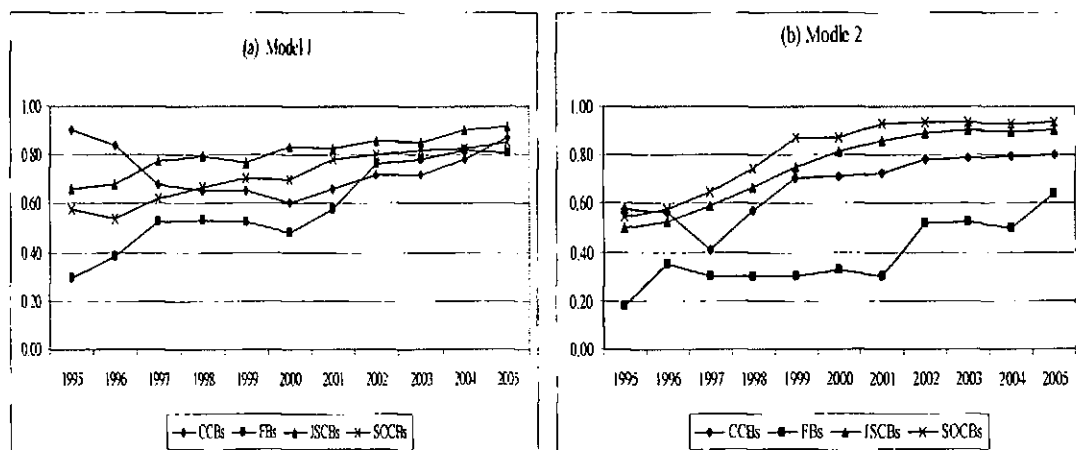


All three models have identified the most inefficient domestic bank as China Evergrowing Bank whose efficiency level is as low as at about 40%. Wide efficiency differentiations across banks indicate that there are substantial rooms for performance

improvement. Given similar results from earning assets-based Model 2 and Model 3, only Model 2 will be further analyzed along with income-based Model 1 unless otherwise stated.

The estimated technical efficiency for different bank groups is plotted in Figure 6.2 (a) for Model 1 and Figure 6.2 (b) for Model 2. The efficiency level of different groups tends to increase in both models but more convergent in Model 1 than in Model 2. Foreign banks are the most inefficient group in both models and they are more efficient in the income-based model than in the earning-assets based model. Our results support the home field advantage hypothesis of Berger *et al.* (2000), there is no clear cut as to whether foreign banks outperform or under-perform domestic banks in literature. On average, CCBs are the least technically efficient domestic banks except for the first two years. The possible explanation for this exception is that only a small number of better performed CCBs are included in the sample for early years.

Figure 6.2 Mean technical efficiency by bank types (1995-2005)



Notes: CCB = city commercial bank, FB = foreign bank, JSCB = joint-stock commercial bank, SOCB = state-owned commercial bank.

JSCBs and SOCBs have shown similar movements in technical efficiency in both models. JSCBs are the most efficient banks in Model 1, consistent with findings of most efficiency studies on Chinese banks as well as the expectation that JSCBs are reasonably expected to outperform other banks. JSCBs are subject to less intervention from local and central governments and have no historical financial burden as in SOCBs. In terms of profitability, despite of notable progresses, SOCBs still operate at

relatively low efficiency level compared with JSCBs, not in line with the considerable reform efforts made by the government. As in previous discussions on the reasons why state ownership is generally associated with low efficiency, government intervention persists on SOCBs' lending decision. State banks have to satisfy contradictory objectives even after many years of reform (Dobson and Kashyap, 2006). SOCBs need to finance SOEs and infrastructure investment to support the nation's overall economic development project. On the other hand, banks are formally required to transform themselves into commercially viable corporate entities to pursue profitability and efficiency of their operations. The contradiction provides rooms for the moral hazard problem that result in poor performance. Our results suggest that government influence is still substantial and is a main source of its low efficiency.

SOCBs have turned out as the most efficient banks in Model 2. This finding is same as that in Chen *et al.* (2005). However, it is inconsistent with majority of efficiency literature in developing countries and transition economies where state ownership has been generally found to be associated with lower level of efficiency. JSCBs are more efficient in income generation while SOCBs are more efficient in earning assets growth. The average efficiency scores of JSCBs and SOCBs are 81% and 72% in Model 1, and 75% and 81% in Model 2. Different results from two different models for a same bank group reflect the difference in banks' operation and management. JSCBs tend to be more cautious in extending loans and investing activities and to be more profit-oriented in their operations, while SOCBs tend to focus on earning assets growth with less attention to their quality and profitability.

Perceived differences in efficiency estimates from two models have shed important lights on research methodology regarding empirical model specification. Model 1 focuses on the efficiency on income generation (profitability), while Model 2 devotes more attention to the efficiency of earning assets growth (loans growth and deposit collection). Two models measure the efficiency of banks' operations from different angles. Efficiency estimates should be interpreted with caution, especially for Chinese banking industry where the percentage of non-performing assets is much higher than the internationally acceptable level of 1-2%. Although the growth of earning assets is important, they are intermediary outputs to be used subsequently for

generating income. High efficiency in earning assets expansion does not necessarily result in high efficiency in income generation. Efficiency estimates from the earning assets-based model could be inflated by high level of NPLs being included in the total loans as the output. Since NPLs generate no income but extra costs, the efficiency estimated by income-based model will be low.

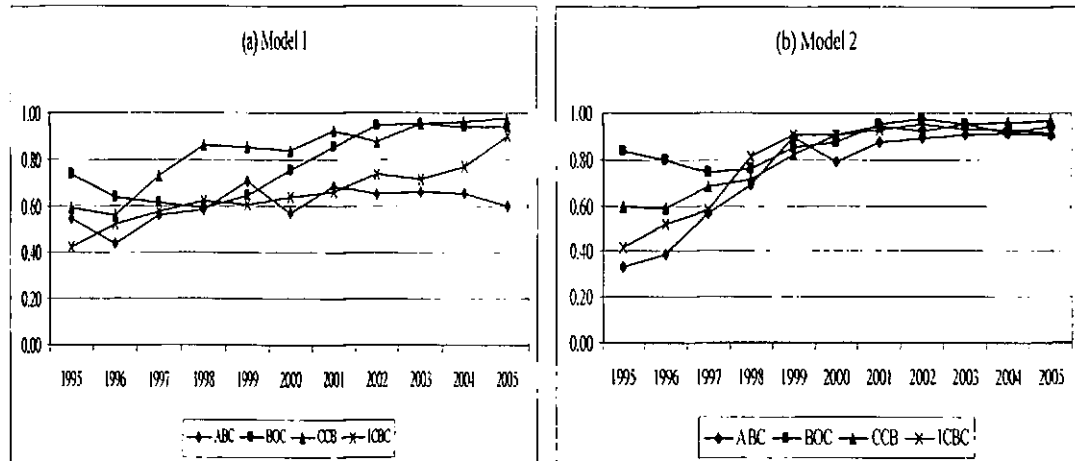
The efficiency curves are flatter in Figure 6.2 (a) than in Figure 6.2 (b) until 2001, indicating that banks have focused on earning assets growth rather than the profitability and recoverability of these earning assets. Thereafter, the curves become relatively steeper in Figure 6.2 (a) compared with those in Figure 6.2 (b), suggesting that banks have become more profitability conscious instead of pursuing rapid growing of earning assets. During the second half of the sample period, unchanged efficiency in earning assets growing is associated with increased efficiency in income generation. The suggestion is that assets quality has been improved, consistent with the progresses being made in solving NPL problems. Our results demonstrate a real improvement in bank efficiency for the banking system as a whole.

SOCBs are the bedrock of the Chinese banking system and it is imperative to examine their performance in more detail. The average technical efficiency of individual SOCBs is plotted in Figure 6.3 (a) for Model 1 and Figure 6.3 (b) for Model 2. The performance of SOCBs has been improved with similar pattern in both income-based model and the earning-based model. Wider dispersion in performance observed in Model 1 implies greater differences among SOCBs in the ability to generate income. In Model 2, the performance of individual SOCBs was very different during the first three years, while becoming almost identical for the rest of the sample period.

Specifically, on average, BOC and CCBC have out-performed ICBC and ABC in both models. Figures show that BOC was hit more seriously than other SOCBs by systematic shock of Asian Financial Crisis in 1997 perhaps because it was involved more deeply in international businesses. The technical efficiency of ABC has increased slightly in the income-based Model 1, but much faster in the earning assets-based Model 2. ABC has been identified as the least efficient bank and its average efficiency is lower than other SOCB by about 20% in Model 1. However, it has been

almost as efficient as other SOCBs in Model 2. The result shows that higher efficiency in earning assets growth does not necessarily lead to high efficiency in generating income.

Figure 6.3 Mean technical efficiency of SOCBs



Notes: SOCB = state-owned commercial bank, ABC = Agricultural Bank of China, BOC = Bank of China, CCB = China Construction Bank Corporation, ICBC = Industrial and Commercial Bank of China.

Based on above argument, one methodological conclusion could be made that the income-based model is superior to the earning assets-based models in measuring bank performance as far as our sample banks are concerned, while the latter provides additional useful information. In the presence of high level of NPLs, if its effects on efficiency cannot be effectively controlled because of the insufficient data, income-based model is recommended to provide more reliable efficiency estimate while earning assets-based model could be used as complement.

Literature on the relationship between bank size and efficiency is not conclusive and the evidence is mixed. Positive relationship has been reported in Leightner and Lovell (1998) for Thailand, Kraft *et al.* (2006) for Croatia, Yildirim (2002) for Turkey and Berger and Humphrey (1997) for US. However, Leightner and Lovell (1998) find medium-sized banks are the most efficient banks in Malaysia, while Girardone, *et al.* (2004) find no clear relationship between assets size and bank efficiency in Italia.

In order to investigate the relationship between bank efficiency and banks size, banks are classified into four groups based on their size measured by total assets. The

criteria used to group banks are the same as Chen *et al.* (2005). Group 1 consists of banks whose total assets are greater than 1 trillion RMB (about 125 billion USD), including four SOCBs and Bank of communication. Group 2 contains banks whose total assets are less than 1 trillion RMB but greater than 100 billion RMB (\$ 12.5 billion to \$125 billion), consisting of all JSCBs except for China Evergrowing bank and Bank of Communications and two CCBs—Bank of Beijing and Bank of Shanghai. Group 3 includes CCBs mainly whose total assets lie between 10 billion and 100 billion RMB (\$ 1.25 billion to 12.5 billion). Banks in group 4 are foreign banks with total assets less than 10 billion RMB (\$ 1.25 billion).

The estimated mean technical efficiencies for differently sized banks from different models are presented in Table 6.5. In general, large and medium-sized banks in Group 1 and Group 2 outperform smaller banks in Group 3 and Group 4. Model 1 and Model 2 yield different best performing bank group. Medium-sized banks are more efficient than large banks in income-based model, while large banks outperform medium-sized banks by in earning assets-based model. In other words, large banks enjoy economies of scale in earning assets generation and deposits collection, while medium-sized banks are superior in controlling costs and generating income. Given the superiority of the income-based model, the results are consistent with literature that medium-sized banks are generally more efficient than large banks. Excessive costs on administration, overstaffing, remote controls for larger banks outweigh the gains from economies of scale claimed for them.

Table 6.5 Mean technical efficiency by bank size (1995-2005)

	Group 1	Group 2	Group 3	Group 4
Model 1	0.76	0.85	0.65	0.60
Model 2	0.83	0.78	0.69	0.41
Model 3	0.86	0.78	0.71	0.52

Group 1: total assets >1 trillion RMB; Group 2: 100 billion RMB<total assets<1 trillion RMB; Group 3: 10 billion RMB<total assets<100 billion RMB; Group 4: total assets<10 billion RMB.

6.3.2 Results of the technical inefficiency effects model

The results of the technical inefficiency effects model (shown in Table 6.6) explore the relationship between bank performance and institutional changes and banks' risk-taking characteristics. Information from these relationships is more relevant to policy makers by differentiating effects of different forms of governance structure and its changes. In Table 6.6, the exogenous variables are presented and will be discussed in the order of (1) four static effect indicator, *FBs--No Change*, *JSCBs--No Change*, *SOCBs--No Change*, and *Listed Banks*; (2) two selection effect indicators, *Selected for Foreign Acquisition* and *Selected for IPO*; (3) four dynamic effect indicators, *Underwent Foreign Acquisition* and *Underwent IPO*, of which two for capturing short-term effects and two for long-term effects; (4) four risk taking indicators, *Equity Leverage Ratio*, *LLR to Total Loans Ratio*, *Interbank Borrowing to Total Deposits ratio*, *Total Loans to total Deposits ratio*; (5) a time trend t and GDP . The first static indicator, *CCBs--No Change*, is omitted for comparison purpose. The control group is city commercial banks with no governance changes, which is not the group of entire CCBs. The negative coefficient on the time trend in the inefficiency function reveals that the inefficiencies of production tended to decrease by 5% per year. The negative sign of the coefficient on GDP growth suggests that favourable macroeconomic condition of an economy has a positive impact on bank performance.

Table 6.6 Estimated parameters of technical efficiency effects model

	Model 1		Model 2		Model 3	
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Governance Effect Indicators						
<i>Static Effect Indicators</i>						
FBs--No Change (δ_1)	0.156	0.895	-0.043	-0.341	-0.254	-1.357
JSCBs--No Change (δ_2)	-0.665***	-4.494	-0.495***	-4.433	-0.392**	-2.637
SOCBs--No Change (δ_3)	-0.256	-1.087	-0.576**	-2.853	-0.472**	-1.873
Listed Banks (δ_4)	-0.743***	-3.946	0.026	0.249	0.330**	2.253
<i>Selection Effect Indicators</i>						
Selected for Foreign Acquisition (δ_5)	-0.431***	-4.097	-0.207**	-3.290	-0.221**	-2.570
Selected for IPO (δ_6)	0.099	0.494	-0.406***	-3.639	-0.715***	-4.953
<i>Dynamic Effect Indicators</i>						
Underwent Foreign Acquisition—ST (δ_7)	-0.351	-1.078	0.242*	1.733	0.090	0.433
Underwent IPO—ST (δ_8)	-0.707*	-1.557	-0.792***	-3.493	-0.445	-0.200
Underwent Foreign Acquisition—LT (δ_9)	-0.079	-1.03	-0.220***	-7.674	-0.156***	-3.769
Underwent IPO—LT (δ_{10})	0.064	0.523	-0.039	-0.314	0.003	0.005
Risk Taking Indicators						
Capital Risk (δ_{11})	-0.287***	-3.859	0.004	0.068	0.083	1.192
Credit Risk (δ_{12})	-0.050*	-1.347	-0.023	-0.910	-0.061*	-1.652
Market Risk (δ_{13})	0.088**	2.167	0.173***	5.838	0.237***	4.668
Liquidity Risk (δ_{14})	0.099	1.246	0.596***	4.329	0.099	0.684
T (δ_{15})	-0.096***	-5.364	-0.124***	-6.532	-0.106***	-4.771
GDP (δ_{16})	-0.219	-0.587	-0.077	-0.321	-0.058**	-1.859

Notes: (1) *CCBs--no Change* is omitted as base case; (2) *, **, *** indicate significance level at 10%, 5% and 1% respectively; (3) Negative sign of the estimated coefficient indicates that the particular variable has a positive effect on production efficiency and *vice versa*.

The estimated coefficients on static effect indicators measure the long-term performance effects of maintaining a constant ownership structure by comparing with the control group—city commercial banks that underwent no governance changes over the whole sample period. Coefficients on *FBs--No Change* (δ_1) from three empirical model specifications are insignificant with mixed signs, suggesting that the performance of foreign banks is not significantly different from that of the control group. Coefficients on *JSCBs--No Change* (δ_2) are negative and highly significant at 5% or higher level in all models, indicating that JSCBs are significantly more efficient CCBs by 66 % in income-based model and by more than 40% in earning assets-based models. Regression results on *SOCBs--No Change* (δ_3) from Model 1 show that the performance of SOCBs with no governance change are not significant different from the performance of the control group in terms of profitability. However, SOCBs are more efficient than the control group in terms of earning asset growing at the significance level of 5% in Model 2 and Model 3. SOCBs are less efficient than JSCBs, suggested by relatively less significant estimated coefficients.

The coefficient on *Listed Banks* (δ_4) is significant and negative in Model 1, suggesting listed banks are on average significantly more efficient in income generation than CCBs with no governance changes by 74 %. In contrary to this result, they are less efficient in producing earning assets perceived in Model 2 and Model 3. Looking at results of three models together, it is indicative that listed banks operate more prudentially in investment and credit expansion relative to other banks. Better performance is the expected consequence of better controlled asset quality and superior management in listed banks.

Moving on to the selection effects indicators, coefficients of the selection effect indicators, *Selected for Foreign Acquisition* (δ_5) and *Selected for IPO* (δ_6), quantify the differences in performance before banks being selected for foreign acquisition or going public. Coefficients on *Selected for Foreign Acquisition* (δ_5) are negative and significant at 1% or 5% levels in all three models. Foreign investors have carefully cherry-picked domestic banks that on average outperformed the control group by 43% in income-based Model 1 and by 20% in earning assets-based Model 2 and

Model 3. The magnitude of estimated coefficients demonstrates that foreign investors emphasise more on the efficiency of income generation than the efficiency of earning assets production. These results provide strong evidence for the presence of selection effects that foreign investors have chosen better performed domestic banks to acquire.

Coefficients on *Selected for IPO* (δ_6) indicate that banks selected for going public are not significantly more efficient than the control group in income-based Model 1, suggesting no selection effects in IPO in terms of profitability. When eliminating the effects of two most recent IPOs of BOC and ICBC in 2006, the regression results show a significant selection effect for going public in the same model, highlighting the effects of recent SOCBs reform. In earning assets-based Model 2 and Model 3, banks being chosen for IPO are significantly more efficient than the control group since coefficients on *Selected for IPO* (δ_6) are negative and statistically significant at 1% level. The explanation for these results is that IPO has been recently used by Chinese government as a strategy of SOCBs reform rather than choosing banks on the pure financial considerations. The technical efficiency of SOCBs is low in generating income but relative high in earning assets growing, which has influenced the estimated coefficients on selection effect indicators.

The exploration of the dynamic effects of governance changes on bank performance could provide more fruitful information on banking reform in China. Coefficient on dynamic effects indicators measures the difference in performance before and after governance changes. *Underwent Foreign Acquisition-ST* (δ_7) and *Underwent IPO-ST* (δ_8) account for short-term effects and *Underwent Foreign Acquisition-LT* (δ_9) and *Underwent IPO-LT* (δ_{10}) account for the effects realizable in a longer time period.

Estimated coefficients on *Underwent Foreign Acquisition-ST* (δ_7) have mixed signs and insignificant. A negative coefficient in Model 1 suggests a possible short-term efficiency gain in income generation following the foreign acquisition. In contrast, coefficients are positive in earning assets-based Model 2 and Model 3, suggesting efficiency losses in production of earning assets after foreign acquisition. The

explanation for this lowered performance could be the results of more prudential practice in lending and investing activities compared with previous careless ones. However, foreign acquisition has found to have more favourable effects on performance in a longer term, suggested by the negative coefficients on *Underwent Foreign Acquisition-LT* (δ_9) in all three models. Both Model 2 and Model 3 suggest that insignificant short-term efficiency losses have been turned into efficiency gains in the long-term, while Model 1 has yet shown such an improvement in performance. Thus, a conclusion is that the strategy of foreign acquisition has a positive effect on the banking performance but it is realized in a longer term. This finding is consistent with Hasan and Marton (2003) that find banks with higher foreign bank ownership involvement were associated with improved efficiency.

The impact of the strategy of IPO has been found to be different from that of foreign acquisition. A short-term positive effect on performance has been found as the coefficients on *Underwent IPO-ST* (δ_8) are negative in all three models and significant in Model 1 and Model 2. However, these efficiency gains tend to fade in the long-term as the coefficients on *Underwent IPO-LT* (δ_{10}) become positive in all three models although not significant. In other words, improvement in performance is not sustainable in the long run.

There are a number of possible explanations for this unexpected result. The first explanation is that as time goes by, the increase in extra costs outweighs the efficiency gains from being listed. Such costs may include agency costs, costs on complying with regulations of the stock markets, and costs on more extensive disclosure and reporting requirements. The second explanation is that the short-term efficiency gains are the result of beautifying effects of measures taken in order for attracting investors before and shortly after the IPO. Over a longer period, the true performance surfaces since beautifying effects cannot last for long without fundamental improvement in their operations and management. The final explanation is that banks have performed better after going public with new professional behaviours because of better corporate governance and market discipline in place. However, as time elapses, it is likely that banks behave as their previous inefficient routine since no clear evidence has been found to suggest that SOCB have changed

behaviours and have become market oriented in their management and operations (Podpiera, 2006).

The findings from these governance effect indicators, especially four dynamic effects indicators, have shed important lights on policy implications regarding banking reform in China. Attracting foreign strategic investor is one major strategy taken by the government in the process of SOCBs privatization. Our empirical results have shown the long term positive effect on bank performance after short-term losses, providing strong evidence for this strategy. IPO is the other important privatization strategy implemented by government in banking reform. Domestic banks, especially SOCBs, have been encouraged to be listed on stock exchange. Through IPO, banks could raise much-needed capital in domestic and international markets. Meanwhile, IPO could impose market pressure on banks to improve performance. Our empirical results show that IPO itself cannot result in better performance. Without fundamental changes in management and operations, without effectively functioning corporate governance in place, any gains are temporary. One suggestion is that the reasons for the negative long-term effects of IPO should be followed up. If necessary, steps should be taken to assist in the future implementation of the IPO strategy or amend it.

The coefficients on risk taking indicators show the relationship between risk taking preference of banks and performance. Capital risk (δ_{11}) is found to be positively associated with performance in Model 1, while the opposite is true in Model 2 and Model 3. Credit risk (δ_{12}) is negatively associated with performance for all three model. A higher the LLR to total loan ratio indicates a low credit risk, which in turn brings a better performance. Both market risk (δ_{13}) and liquidity risk (δ_{14}) are found to be negatively associated with banks' technical efficiency and most are statistically significant for all three models. Banks are less efficient if they depend more on borrowings from the wholesale market than collecting deposits from the retail market. They also tend to be less efficient when facing more liquidity risks.

The coefficients on-the time trend variable in the technical inefficiency effects model are negative and significant for all three empirical specifications. That implies bank efficiency has bank improved by about 10% per year. GDP growth is also found to

have a positive impact on banks efficiency in all three empirical models although not all coefficients are statistically significant. Hence, a favourable macroeconomic condition of an economy has a positive impact on bank performance.

6.4 Chapter summary

This chapter examined the technical efficiency of the main Chinese commercial banks over the period 1995-2005. This period featured with drastic and intensive bank reforms, including significant institutional changes in all types of commercial banks. The relationship between bank performance and institutional changes is examined. The primal approach is the estimation of a stochastic distance function which requires no behavioural assumptions imposed on producers.

This chapter makes two contributions to the research methodology. The first contribution is the development of an empirical model to estimate technical efficiency based on a distance function, the one-step stochastic frontier model and the method of Berger *et al.* (2005). The model is constructed by incorporating advantages and avoiding disadvantages of those existing approaches and methods. The second contribution is the examination of different specifications of the income-based model and the earning assets-based model. Various models combining different output and input variables depict different aspects of bank efficiency. The income-based model is proved to be superior to the earning assets-based model, at least for our dataset from China. The choice of empirical model is important when studying bank efficiency, especially in developing countries and transition economies where assets quality is generally low. Our suggestion is that both models should be used to analyze banks efficiency. Different estimates from alternative models could yield more valuable information and draw a more complete picture on bank performance.

The estimated average efficiency is moderate at 70%, implying that there exists significant room for efficiency improvement. Joint-stock commercial banks are found to be the most efficient group, while foreign banks are the least efficient (static effects). Notwithstanding considerable reforming efforts made by the government, the performance of SOCBs is still poor (static effect), requiring a continuous in-depth reform.

The underlying reason for low efficiency of SOCBs is likely to be the persistence of the government intervention in lending decision, albeit explicitly. It is uncertain whether this implicit intervention could be reversed in the near future. The 11th Five-Year Plan approved by the National People's Congress in 2006 addresses the growing rural-urban and regional inequality and projects to balance the urban and rural development through urbanization. There are more needs for employment to absorb surplus labour force from rural-urban migration. The role of SOCBs is uncertain and they are more likely to be expected to assist in the achievement of the overall goals and to provide necessary finance. In this regard, their economic objectives of profitability and efficiency might give way to the overall national development goal. The implication is that government influence might remain and the reform of transforming SOCBs to truly commercial banks might take longer.

Strong cherry-picking effects have been found for the foreign acquisition strategy, that is, foreign investors have selected well performed banks for acquisition. The foreign acquisition strategy is found to have positive impact on bank performance in the long run after suffering from short term efficiency losses. Institutional changes in the form of foreign equity participation in domestic banks have forced banks to become more efficient. Our results have provided economic justification for the strategy of foreign acquisition.

As for the going public strategy (i.e., IPO), it is also found to have a selection effect. The selection effect, however, is not as strong as that of the foreign acquisition strategy. Going public, or IPO, was used by the government as an important reform method to fundamentally transform the SOCBs. Although the intention of IPO is similar to that of foreign acquisition, the latter differs from the former in that foreign investors only select the best domestic banks for strategic investment, irrespective of whether the domestic banks are listed or not. The selection effects in IPO were diluted by two SOCBs' IPOs in 2006. Our empirical results show that banks realized efficiency gains in the short run but such gains appear to fade in the long run. While the effects are insignificant, the deteriorating trend is worrisome. The government should follow up this adverse trend and correct it by taking steps to make

fundamental changes in management and operations in order to build up good corporate governance for the listed SOCBs.

Chapter 7 Cost and profit efficiency of Chinese banks

7.0 Preamble

Employing the same one-step SFA BC95 model, this chapter assesses the performance of Chinese banks using the concepts of cost efficiency and profit efficiency. Behavioural assumptions are that producers are cost minimisers or profit maximisers, or both. As producers may behave differently, there are deviations of actual performance from the best practice. The deviations are called ‘inefficiencies’ which are usually represented by the composite errors in a particular cost or profit function in empirical analysis.

A dual approach that estimates a cost or profit function rather a production function is commonly employed in empirical efficiency study on industries producing multiple outputs. When behavioural assumptions of cost minimization or profit maximization are appropriate, a cost or profit function is used as the representation of the structure of a multi-outputs production technology. Against the estimated cost and/or profit frontier, cost or profit efficiency can be derived (Kumbhakar and Lovell, 2000).

These economic efficiency concepts are based on economic foundations since these measures account for not only the use of technology in the production process but also the production optimization for the given market prices and competition condition (Berger and Mester, 1997). The assumptions of cost minimization and profit maximization are considered to be appropriate during our sample period 1995-2005 because all banks are legally defined as commercial banks under the Law of the People’s Republic of China on Commercial Banks since 1995. The main objective of commercial banks is clearly defined as profit maximization, which apparently requires cost minimization at the same time.

The purposes of this chapter are threefold. First, it addresses a methodological issue by investigating the effects on efficiency estimates of choosing a particular functional form for the cost or profit function. Secondly, it investigates the difference in the use of market average input prices or banks’ specific input prices by comparing their impacts on estimated efficiency. Finally, this paper provides more precise

performance assessment for Chinese commercial banks in terms of cost and profit efficiency.

This chapter is set out as follows. Section 7.1 reviews the literature on bank cost efficiency and profit efficiency, including methodological issues in the estimation of the stochastic cost and profit frontiers. Section 7.2 describes methodology, including the definition of outputs and input price and the specification of empirical models. Section 7.3 discusses estimation results and Section 7.4 draws conclusions.

7.1 Brief literature review on cost and profit efficiency study

Cost efficiency is an aggregate measure of performance since its changes indicate relative progress that a bank has made with its specific characteristics within the general economic environment. There are three principal reasons for the investigation of bank cost efficiency (Fries and Taci, 2005). First, the improvement in cost efficiency may be the consequence of the changes in incentives and constraints in banking, structural and institutional reforms, and the more efficient provision of public services by the state. Second, the improvement in cost efficiency of a banking system could contribute directly to the overall economic development through reducing the usage of resources in the operation of payments systems and the intermediation of savings into investments. Third, the improvement in cost efficiency could contribute indirectly to other aspects of bank performance and to the overall economic development as a whole. For instance, more productive loans made by banks in a more cost efficient manner could promote performance of other sectors.

Cost efficiency is defined as the ratio of minimum feasible cost to actual cost observed, which is bounded between zero and unity. It measures how close a bank's costs to the costs of a best practice bank for producing the same bundle of outputs using the same bundle of inputs under the same conditions, adjusted for random errors. Cost efficiency can be obtained by estimating a cost function, in which the dependent variable is the total cost and explanatory variables include input prices, output quantities, and any fixed inputs and outputs. The disturbance term is assumed to have two components: v_{it} , representing measurement error and other uncontrollable

factors, and u_{it} representing cost inefficiency. The frontier approach asserts that managerial or controllable inefficiencies (u_{it}) increase costs above the frontier (the best-practice levels), which are themselves subject to random fluctuations (v_{it}). Estimated cost inefficiencies can be further decomposed into input-oriented technical efficiency and input allocative efficiency. The former is caused by excessive utilization of input quantities and the latter is due to relative higher prices of inputs (Kumbhakar and Lovell, 2000; Berger and Mester, 1997).

A generalized form of a cost function is given in Equation (7.1)

$$\ln C_{it} = f(w_{it}, y_{it}, z_{it}, v_{it}) + \ln u_{it} + \ln \varepsilon_{it} \quad (7.1)$$

where \ln denotes natural logarithm; C_{it} measures the i -th bank's total costs for the period t ; $f(\cdot)$ represents a functional form; w is a vector of input prices; y is a vector of output quantities; z is the quantities of any fixed netputs; u_{it} is an inefficiency factor measuring possible increased costs beyond the best-practice level; and ε_{it} is random errors.

Profit efficiency can be derived by estimating a profit function based on the duality theory. A standard profit function assumes that both input prices and output prices are exogenous to banks. That is, banks are price-takers in both input and output markets. The profit maximization can only be achieved through altering the combination of controllable input and output quantities (Berger and Mester, 1997; Kumbhakar and Lovell, 2000). Competitive market argument could ensure the exogeneity of input and output prices, whereas perfect competition for banks sometimes is questionable.

In response to the circumstances where the assumptions underlying a standard profit function are not satisfied, an alternative profit efficiency measure has been developed by assuming that banks can exercise a degree of market power in setting output prices. The alternative profit function approach is regarded to be advantageous in studying efficiency in the banking industry over a standard profit function approach (Berger and Mester, 1997 and DeYoung and Hasan, 1998). First, it enables the estimation of

profit efficiency when the prices of certain outputs, such as transaction services and fee-based transactions, are unavailable or hard to be measured reliably. Secondly, the variation in output quantities is likely to be more variable across banks than the variation in output prices. Thirdly, the unmeasured differences in the quality of services provided by banks could be better controlled in the alternative profit function. The extra costs spent on improving output quality are offset against extra corresponding revenue in the alternative profit function, while these costs are accounted as inefficiencies in a cost function. Finally, alternative profit efficiency better control for the heterogeneity in bank size by including output quantities rather than output prices. Alternative profit efficiency reflects the bank's ability to generate profits at the same output levels for different-sized banks. This approach could reduce possible scale bias in profit efficiency estimation when optimal output levels cannot be reached by small banks.

A logged form alternative profit efficiency function is given in Equation (7.2).

$$\ln(\pi_{it} + \theta) = f(w_{it}, y_{it}, z_{it}, v_{it}) + \ln u_{it} - \ln \varepsilon_{it} \quad (7.2)$$

where π_{it} measures the i th bank's profit for the period t ; θ is a constant added to every firm's profit to avoid taking logarithm on a negative or zero value. All other variables are the same as in the cost function in Equation (7.1) except for the disturbance term that is $(v_{it} + u_{it})$ in a cost function due to the fact that managerial inefficiency increases the total costs above the best practical level, while it becomes $(v_{it} - u_{it})$ in a profit function because managerial inefficiency reduces profits below the best practice level.

Similar to cost efficiency, profit efficiency is defined as the ratio of actual profit to predicted maximum profit. It measures how close a bank's profit to the profit of a best practiced bank for producing the same bundle of outputs using the same bundle of inputs with given input and output prices, adjusted for random errors. For many banks, profit maximization is an ultimate goal. Hence, profit efficiency is considered more suitable to evaluate the overall performance since it simultaneously addresses efficiency in cost savings and efficiency in revenue generation (Berger and Mester, 1997; Kumbhakar and Lovell, 2000). Moreover, the shortfall in profits from maximal

levels is caused by deficient revenues rather than excessive costs, since output efficiencies are generally found to be lower than input efficiencies (Berger *et al.*, 1993; Akhavein *et al.*, 1997).

A one-step BC95 model for estimating a cost function is shown as Equation (7.3).

$$\ln C_{it} = f_{it}(w, y, z, v) + u_{it} + \varepsilon_{it} \quad (7.3)$$

where the u_{it} are assumed to be independently distributed as truncations of the $N(m_{it}, \sigma_{it}^2)$ distribution and $m_{it} = z_{it}\delta$ where z_{it} is a $p \times 1$ vector of variables which may influence the efficiency of a bank and δ is a $1 \times p$ vector of parameters to be estimated.

The essence of SFA is the pre-specification of production, cost or profit function in an appropriate functional form. While the Cobb-Douglas and translog forms are commonly employed in the literature, more recent studies have increasingly employed a Fourier Flexible functional form, for example, Altunbas *et al.* (2000), Rao, (2005), DeYoung and Hasan, (1998), and Mitchell and Onvural, (1996). Fourier flexible functions are first introduced by Gallant (1981). It adds non-parametric Fourier series to a translog function that only represents a second-order Taylor series and local approximation for an arbitrary function. Variables are transformed into trigonometric terms of the $0, 2\pi$ (radians interval), providing a global approximation and therefore a better fit of a broader range of curves. Fourier functional forms are stable because they contain a translog specification which centres on the sample average, while they are flexible due to the Fourier trigonometric terms which consider observations far away from the average. The flexible Fourier form represents a semi-non-parametric approach to the problem of using the data to infer inter-relationship among the variables when the true functional form of the relationships is unknown.

More recently, researchers have been in favour of the global approximation of the Fourier flexible functional forms rather than the local approximation of a translog form in bank efficiency study because of its smaller approximation errors and the resultant more precise estimates of efficiency measure (Kraft *et al.*, 2006; McAllister and McManus, 1993; Girardone, *et al.*, 2004; Huang and Wang, 2004; Elbadawi *et al.*,

1983 and Chalfant and Gallant, 1985). However, other studies, such as Berger and Mester (1997), find the difference between the translog form and Fourier Flexible form are negligible. The literature has a consensus regarding which functional form is better over others and this is one of the objectives of this chapter to examine the effects of employing different function forms on efficiency estimation.

Two methodological issues have recently arisen in bank efficiency study. The first issue is whether to estimate an industry 'best practice' frontier or to estimate separate frontiers for different ownership categories. The former is a commonly used approach based on the argument that all firms in the marketplace face the same external macroeconomic environment and they are subject to similar market conditions regardless of ownership types. Estimated efficiency scores are comparable since they are derived against the same industry 'best practice' frontier. The latter approach argues that different types of firms may adopt different production technology and therefore using pooled industry frontier could confound inefficiencies and the effects of technology choice (Mester, 1993). This more rigorous approach limits cross-firm comparison to the same ownership type and fails to compare the efficiencies of different types of firms. Thus, it is of limited usefulness when concerning bank liberalization and privatization (Altunbas *et al.*, 2001). The research interest of this study is to differentiate the impacts of bank reform measures (mainly ownership change) on performance at the industry level. Thus, a single frontier approach appears more appropriate which enables the comparison of efficiencies among banks with different ownership types and helps identify better performing ownership.

The second issue is the input price misspecification first noticed by Mountain and Thomas (1999). The cost function approach assumes some substitutability between inputs through a choice of technologies. It thus implicitly assumes that banks face imperfect factor markets, such as labour and capital markets, where input prices vary among banks. Factor prices are usually calculated by dividing total cost attributable to a factor by the number of units utilized. Mountain and Thomas (1999) observe that labour prices obtained in such a way is out of the reasonable range and they attribute a wide variety of labour prices to labour heterogeneity. They argue that financial capital price might also be mis-specified. They suggest mis-specified input price variables should be dropped in a cross-sectional study, while in a panel analysis input

prices should be properly specified. This is another issue addressed by the present study by examining the effects of using different price specifications on the cost and profit efficiency estimation.

7.2 Variable definitions and empirical model specifications

7.2.1 Variable definitions

The same as in chapter 6, input and output variables are defined using a modified intermediation approach (Sealey and Lindley, 1977), which treats interest costs on deposit as an input along with capital and labour inputs, and treats total deposits as an output. The cost function and alternative profit function contain identically defined input and output variables. They have three outputs—total loans, other earning assets and deposits; two variable inputs—cost of fund and cost of labour; and one fixed netput—equity. To capture the Hicksian neutral technical progress on efficiency, linear and quadratic trend terms as well as its interaction terms are included in the cost and alternative profit models. Table 7.1 provides a summary statistics for input prices and outputs used in the cost and profit frontier models. The definitions of outputs, inputs prices are given in the notes to Table 7.1.

The price of funds is defined in a normal way as the ratio of total interest expenses to total interest bearing funds. Theoretically, the price of labour and the price of physical capital should be measured separately in the estimation of cost and profit efficiency models. Because data on the number of employees and personnel expenses for Chinese banks in the sample are unavailable, this study uses available data to construct one best price approximation for labour and physical capital together—the ratio of non-interest expenses to total assets. It is a common approach to define labour and physical capital prices in bank efficiency literature, especially for researchers investigating bank efficiency in transition and developing countries using BankScope as a major data source. The approach is first used by Hasan and Marton (2003) and followed by Fries and Taci (2005), Patti and hardy (2005), Bonin *et al.* (2005a, b).

Following Mester (1996), equity capital is included in the model to control for the difference in risk preferences, which are expected to improve the accuracy of bank efficiency estimates. Berger and Mester (1997) support the inclusion of equity in the cost function. They argue that equity acts as a cushion to absorb losses and so the level of equity affects bank insolvency risk. Bank insolvency risk, in turn, affects the bank costs because an insolvent bank needs to have a risk premium on the funds. The inclusion of equity in a cost function is particularly important in transition economies since the insolvency risk of banks is high due to high level NPLs. Moreover, equity needs to be considered in cost efficiency estimation since it is more costly as an alternative to deposits and interbank borrowing in financing loans.

Both cost and profit functions assume that banks face exogenously determined input prices in competitive factor markets so that the behavioural assumptions of costs minimization and profit maximization become reasonable (Fare and Primont, 1995). However, in most cost and profit efficiency studies, input prices are calculated by dividing total factor expenses by the total units of factors employed, resulting in bank specific inputs prices. For instance, the price of funds is the ratio of interests paid on deposits and interbank borrowings to the total borrowed funds. By implicitly assuming imperfect factor markets, conventional endogenously computed input prices could be mis-specified, which could result in biased efficiency estimates (Mountain and Thomas, 1999).

Only a few studies have attempted to construct exogenously determined market prices to estimate cost and/or profit efficiency in the awareness of the potential problem of endogenously calculated input prices. Such studies include Patti and Hardy (2005), Berger and Mester (2003), DeYoung and Hasan (1998), Bos and Kool (2006) and Koetter (2005). Among these studies, only Bos and Kool (2006) and Koetter (2005) investigate the impact of different input price measurements on cost and profit efficiency. They find that the issue of input price measurement matters and they suggest the use of properly defined market input prices.

Table 7.1 Mean sample descriptive statistics and variable definitions

	by governance indicators in RMB million in 1995 prices									
	CCB_all	CCB_no	FB_all	JSCB_all	JSCB_no	SOCB_all	SOCB_no	Listed	For_sel	List_sel
<i>Outputs and Inputs and other financial figures</i>										
Total costs (C)	1,479	1,185	253	6,911	6,863	151,156	96,086	20,806	45,728	70,150
Profit (π)	461	348	164	1,863	1,711	16,972	6,575	5,049	6,166	9,443
Total loans (y_1)	19,106	14,770	1,752	114,949	112,553	1,675,942	1,500,546	322,294	493,743	756,860
Other earning assets (y_2)	17,352	12,685	1,500	77,283	72,679	1,007,263	656,118	208,258	324,532	494,679
Total deposits (y_3)	30,427	22,732	2,109	147,254	148,634	2,230,996	1,795,032	437,873	672,955	1,030,032
Equity (z_1)	1,776	1,339	562	7,472	6,600	126,041	90,083	23,772	38,650	59,015
Total assets (z_2)	38,851	29,702	3,361	199,740	200,000	2,885,792	2,335,387	555,494	873,774	1,336,357
Price of labour and physical capital (w_1)	0.02	0.02	0.12	0.02	0.01	0.02	0.02	0.02	0.02	0.02
Price of fund (w_2)	0.03	0.02	0.04	0.03	0.03	0.05	0.03	0.03	0.03	0.03
Market price of labour and physical capital (w_1')	0.02	0.02	0.12	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Market price of funds (w_2')	0.03	0.02	0.03	0.04	0.04	0.04	0.04	0.04	0.03	0.04
<i>Risk Taking Indicators</i>										
Capital risk	4.90	5.14	31.93	4.65	3.79	4.35	4.08	4.66	4.78	4.57
Credit risk	1.29	1.26	2.33	2.24	1.24	1.53	0.91	2.31	1.99	2.06
Market risk	87.94	80.87	268.53	38.76	37.88	52.57	40.00	27.12	57.51	39.11
Liquidity risk	70.32	72.48	131.94	79.74	76.96	81.42	97.20	80.61	76.79	77.97

Source: BankScope and authors' calculation.

Notes: (1) CCB = city commercial bank, FB = foreign bank, JSCB = joint-stock commercial bank, SOCB = state-owned commercial bank. NO = no changes, Selection foreign = selected for foreign acquisition, Selection listing = selected for listing.

(2) Variable definitions:

Total costs (C): interest costs, and non-interest expenses that include costs of labour, physical capital, and loan loss provisions.

Profit (π): profit before tax with a constant added to. The constant equals the absolute of minimum profit before tax plus one in order to avoid taking natural logarithm on a negative value.

Total loans (Y_1): gross loans including short-term loans, medium and long-term loans, impaired loans, and loan loss reserves.

Other earning assets (Y_2): sum of deposits with central bank and banks, short-term and long-term investments.

Total deposits (Y_3): sum of short-term customer deposits and long-term deposits.

Equity (Z_1): banks' equity capital including capital reserve, capital surplus, paid in capital and retained profits.

Price of labour and physical capital (W_1): the ratio of bank specific non-interest expenses to bank total assets. Non-interest expenses include overhead, other operating expense and loan loss provision. Because the loan loss provisions are not reported separately from overhead in the earlier periods, they are included in the later period to ensure consistency.

Price of fund (W_2): the ratio of total interest expenses to total interest bearing funds. Interest expenses include interests paid on deposits and interbank borrowings, while total interest bearing funds include deposits, short-term funding and other funds.

Market price of labour and physical capital (W_1): the un-weighted average of labour and physical capital prices of other banks for each type of banks excluding the bank own price.

Market price of funds (W_2): the un-weighted average of fund prices of other banks in the market excluding the bank own price.

Specifying market average input prices is considered to be advantageous over conventional bank specific prices in efficiency study (Berger and Mester, 2003). Market average input prices are derived from other banks' data in the market excluding the data of the bank under concern. Therefore, they are more exogenous to the bank than those prices derived from the bank's own data. Market prices are the average prices the bank may face rather than the actual prices paid by the bank. Moreover, using market average prices as a benchmark, inappropriate input prices taken by banks are treated as inefficiencies rather than being treated as random errors resulting from good or bad business conditions. Furthermore, market average prices could average out some measurement errors of individual banks.

This study addresses this issue and investigates the impact of different input price measurements by specifying two sets of inputs prices—conventional bank specific prices and market prices. The purposes are twofold. First, it attempts to investigate the effects of different price specifications on efficiency estimation. The second purpose is to obtain more reliable efficiency estimates by properly specifying input prices. This helps ensure the reliability and quality of further analysis on the effects of institutional changes on bank performance. In theory, market prices are expected to result in better estimation since both cost and alternative profit function assume that banks face exogenous input prices prevalent in competitive markets, rather than bank specific input prices.

When approximating exogenous market input prices, a main issue is to define factor markets. Existing studies adopt different criteria to define factor markets. One common way of defining market is by regional location as DeYoung and Hasan (1998) and Berger and Mester (2003) where Metropolitan Statistical Areas and non-MSA counties are defined as markets for the US banks. In addition to geographical regions, Bos and Kool (2006) consider the degree of urbanization of the region. Koetter (2005) takes account of bank types to define markets by assuming large banks in Germany competing in one federal input market. Patti and Hardy (2005) assume one single market in Pakistan and simply compute the weighted average of prices of other banks as exogenous market input prices, where the weights are market shares of relevant inputs and outputs.

This study takes into account both the theoretical rationale and the realities of the Chinese banking industry when defining factor markets. One single national fund market is assumed based on the fact that interest rate structure in China is set by the central bank. Fund prices are mainly determined by central bank's interest rate policy and commercial banks have been strictly restricted in setting interest rates paid on deposits and borrowed funds. Moreover, geographical segments of financial markets with divergent interest rates and asset prices are not commonly reported in China. Therefore, one single market for funds is a reasonable assumption. By assuming one single fund market, the market average price of fund is computed as the un-weighted average price of other banks excluding the bank own price.

As to labour and physical capital factors, the market is defined by bank types—SOCBs, JSCBs, CCBs and FBs. Regional divisions are considered to be inappropriate for Chinese banks. Only a small number of banks operate in one particular market, unlike in the US and other developed countries where a large number of similar banks operate in one market. The management of four state-owned banks and most national wide joint-stock commercial banks are centralized, which also make the regional division impossible. Following a bureaucratic structure, the same bank operates in a similar way in setting wages and acquiring physical assets across different regions. City commercial banks are local banks located in particular cities. They are subject to similar regulations set by central banks and CBRC. Their managerial operations are broadly in a similar fashion, although differences exist among CCBs that locate in different areas such as east coastal and inland areas. Defining markets by bank types, market average prices of labour and physical capital is constructed as the un-weighted average prices of other banks excluding the bank own price for each bank type.

7.2.2 Empirical model specifications

In cost and profit efficiency studies, the most popular functional form is the translog form. Though recent studies have shown an increasing trend using Fourier flexible functional form, empirical evidence has been inconclusive regarding which functional form is better than the other. This study specifies cost and alternative profit models in both translog and Fourier flexible functional forms for two purposes. First it attempts to identify better presentation for the production technology employed in the Chinese

banking industry by comparing results from translog and Fourier Flexible specifications. Another purpose is to obtain more accurate efficiency estimates, which in turn, enhance the reliability of findings.

Translog specification

The specification for the cost function in translog form is shown in Equation (7.4)

$$\begin{aligned}
 \ln(TC / w_2 z_2) = & \alpha + \sum_{i=1}^3 \beta_i \ln(Y_i / z_2) + \sum_{k=1}^3 \psi_k \ln(W_k / w_2) + \sum_{r=1}^3 \phi_r \ln(Z_r / z_2) + \tau_1 T \\
 & + \frac{1}{2} \sum_{i=1}^3 \sum_{j=1}^3 \beta_{ij} \ln(Y_i / z_2) \ln(Y_j / z_2) + \frac{1}{2} \sum_{k=1}^3 \sum_{m=1}^3 \psi_{km} \ln(W_k / w_2) \ln(W_m / w_2) \\
 & + \frac{1}{2} \sum_{r=1}^3 \sum_{s=1}^3 \phi_{rs} \ln(Z_r / z_2) \ln(Z_s / z_2) + \frac{1}{2} \tau_{11} T^2 \\
 & + \sum_{i=1}^3 \sum_{k=1}^3 \varpi_{ik} \ln(Y_i / z_2) \ln(W_k / w_2) + \sum_{i=1}^3 \sum_{r=1}^3 \kappa_{ir} \ln(Y_i / z_2) \ln(Z_r / z_2) \\
 & + \sum_{k=1}^3 \sum_{r=1}^3 \sigma_{kr} \ln(W_k / w_2) \ln(Z_r / z_2) + \sum_{i=1}^3 \eta_i \ln(Y_i / z_2) T \\
 & + \sum_{k=1}^3 \eta_k \ln(W_k / w_2) T + \sum_{r=1}^3 \eta_r \ln(Z_r / z_2) T + \ln \varepsilon + \ln \mu \quad (7.4)
 \end{aligned}$$

where $\ln TC$ is the natural logarithm of a bank's total costs in a given year; $\ln Y_i$ is the natural logarithm of bank outputs quantities; $\ln W_k$ is the natural logarithm of input prices; $\ln Z_r$ is the natural logarithm of fixed netput quantities; T is a time trend variable; ε_i is a identical and independently distributed random variable which is independent of the μ_i ; μ_i is a non-negative random variable that is assumed to account for inefficiencies. $\alpha, \beta, \psi, \phi, \tau, \varpi, \kappa, \sigma,$ and η are unknown coefficients to be estimated.

According to the duality theorem, a cost function requires standard restrictions of linear homogeneity in input prices, which can be imposed by normalizing the total costs and input prices by one arbitrarily chosen input price. This study chooses the price of fund as a normalization variable to divide total costs, profits, and labour and physical capital price. Thus,

$$\sum_{k=1}^2 \psi_k = 1; \quad \sum_{k=1}^2 \psi_{km} = 0 \text{ for all } m; \quad \sum_{k=1}^2 \varpi_{kr} = 0 \text{ for all } j. \quad (7.5)$$

Moreover, the second-order parameters must be symmetric and so

$$\beta_{ij} = \beta_{ji} \text{ for all } i, j; \quad \psi_{km} = \psi_{mk} \text{ for all } m, k. \quad (7.6)$$

Fourier flexible specification

A Fourier flexible model extends the standard translog model by adding Fourier terms. Restrictions in Equation (7.5) and Equation (7.6) with respect to the translog model in Equation (7.4) need to be held for the translog portion of the Fourier flexible model. The specification of the cost function in Fourier flexible functional form is shown in Equation (7.7):

$$\begin{aligned} \ln(TC / w_2 z_2) = & \alpha + \sum_{i=1}^3 \beta_i \ln(Y_i / z_2) + \sum_{k=1}^2 \psi_k \ln(W_k / w_2) + \sum_{r=1}^3 \phi_r \ln(Z_r / z_2) + \tau_1 T \\ & + \frac{1}{2} \sum_{i=1}^3 \sum_{j=1}^3 \beta_{ij} \ln(Y_i / z_2) \ln(Y_j / z_2) + \frac{1}{2} \sum_{k=1}^2 \sum_{m=1}^2 \psi_{km} \ln(W_k / w_2) \ln(W_m / w_2) \\ & + \frac{1}{2} \sum_{r=1}^3 \sum_{s=1}^3 \phi_{rs} \ln(Z_r / z_2) \ln(Z_s / z_2) + \frac{1}{2} \tau_{11} T^2 \\ & + \sum_{i=1}^3 \sum_{k=1}^2 \varpi_{ik} \ln(Y_i / z_2) \ln(W_k / w_2) + \sum_{i=1}^3 \sum_{r=1}^3 \kappa_{ir} \ln(Y_i / z_2) \ln(Z_r / z_2) \\ & + \sum_{k=1}^2 \sum_{r=1}^3 \sigma_{kr} \ln(W_k / w_2) \ln(Z_r / z_2) + \sum_{i=1}^3 \eta_i \ln(Y_i / z_2) T \end{aligned}$$

$$\begin{aligned}
& + \sum_{k=1} \eta_k \ln(W_k / w_2)T + \sum_{r=1} \eta_r \ln(Z_r / z_2)T \\
& + \sum_{n=1}^3 \sum_{p=1}^3 \sum_{q=1}^3 a_{npq} \cos(x_n + x_p + x_q) + b_{npq} \sin(x_n + x_p + x_q) \\
& + \sum_{n=1}^3 \sum_{p=1}^3 a_{np} \cos(x_n + x_p) + b_{np} \sin(x_n + x_p) \\
& + \sum_{n=1}^3 a_n \cos(x_n) + b_n \sin(x_n) + \ln \varepsilon + \ln \mu \tag{7.7}
\end{aligned}$$

where $\ln TC$, $\ln Y_i$, $\ln W_k$, $\ln Z_r$, T , ε_i , and μ_i are same as defined in Equation (7.3); X_n are adjusted values of the log of outputs so that they fall within the interval $[0.1 \times 2\pi, 0.9 \times 2\pi]$ ¹; $\alpha, \beta, \psi, \phi, \tau, \varpi, \kappa, \sigma, \eta, a$, and b are coefficients to be estimated.

Following the literature (Berger and Mester, 1997; Altunbas *et al.*, 2000; Girardone *et al.* 2004 and Williams and Nguyen, 2005), Fourier terms are applied for output variables only, leaving the effects of input prices to be determined by the translog terms alone. This practice not only limits the number of Fourier terms in the model, but also facilitates the imposition of the usual homogeneity restriction on input prices.

Total costs, profits, output variables and netput variables are normalized by total assets for adjusting scale biases between institutions and controlling heteroskedasticity. This normalization also leads to an economically meaningful dependent variable of ROA for the alternative profit model. Although equity can also

¹ $\ln(Y_i / z_2)$ are rescaled so that each x_n term falls into the interval of $[0, 2\pi]$. Following Berger and Mester (1997), both end of the interval $[0, 2\pi]$ are cut off by 10% so that x_n to span an interval of $[0.1 \times 2\pi, 0.9 \times 2\pi]$ for reducing approximation problems near these endpoints. According to Berger and Mester (1997), the rescaling formula is $0.2 - \mu_i \times a_i + \mu_i \times \ln(Y_i / z_2)$ where $[a, b]$ is the range of $\ln(Y_i / z_2)$ over the entire 11-year time interval, and $\mu_i = (0.9 \times 2\pi - 0.1 \times 2\pi) / (b_i - a_i)$.

be used as the normalization variable, Patti and hardy (2005) suggest that the normalization by total assets is more appropriate when there are changes in capital requirements and provisioning regulations and when there are capital injections into the state-owned banks.

By assuming that banks face exogenously determined output quantities and input prices so that they maximize profits through altering output prices and input quantities, this study estimates alternative profit efficiency for the Chinese banks. The specifications of the alternative profit model are identical to the cost models shown in Equation (7.4) and Equation (7.7) except for some minor changes. The dependant variable, total cost, is replaced by profit and the inefficiency term becomes $-u$ rather than $+u$ in the cost function. Although the restriction of linear homogeneity in input prices is unnecessary for alternative profit function, it is imposed for keeping the functional forms equivalent (Berger and Mester, 2003 and Patti and hardy, 2005).

The inefficiency effects model of a one-step SFA BC95 model is used for investigating the effects of institutional changes on bank cost efficiency and profit efficiency. It is shown in Equation (7.8), which is identical to Equation (6.13) in Chapter 6. The definitions for variables in Equation (7.8) are also the same as those used in Chapter 6 where they have been discussed in detail. For the sake of brevity, it is skipped but readers are referred to Chapter 6.3 and Table 6.3 for detail.

$$u_{it} = \delta_0 + \sum_{a=1}^{10} \delta_a CG_{it} + \sum_{b=1}^{14} \delta_b Risk_{it} + \delta_{15} GDP + \delta_{16} t + \varepsilon_{it} \quad (7.8)$$

where t is a time trend variable; CG_{it} is a vector of governance indicators representing various institutional changes; $Risk_{it}$ is a vector of risk taking indicators; GDP is the GDP growth rate, representing macroeconomic condition.

7.3 Empirical results

7.3.1 The choice of functional form and proxies for input prices

Estimated parameters and average efficiency from the cost function and profit function in both translog and Fourier-flexible forms are reported in Table 7.2 (full

results are reported in Appendix 1-1 and 1-2). Individual estimated parameters are difficult to interpret because of the collinearity resulting from the presence of second order and interaction variables in translog specifications and additional trigonometric terms in Fourier-flexible specifications. In efficiency analysis, the coefficients of individual variables are of less importance since the main focuses are error terms from which to derive cost and profit inefficiencies. Following conventional practices, individual coefficients are not discussed and the overall explanatory power of the models is judged by utilizing the re-parameterization of Battese and Corra (1977) in the process of maximum likelihood estimation. They replace σ_u^2 and σ_v^2 with $\sigma^2 \equiv \sigma_v^2 + \sigma_u^2$ and $\gamma \equiv \sigma_u^2 / \sigma_v^2 + \sigma_u^2$. Specifically, σ^2 is the sum of squared standard deviations of random errors and squared standard deviations of inefficiencies. γ is the ratio of the standard deviation attributable to inefficiency to the sum of standard deviations of random noise and inefficiencies, indicating the proportion of inefficiency within the total composite error term.

In Table 7.2, the estimated parameters for translog (shown in columns 1 and 3) and Fourier flexible functional forms (shown in columns 2 and 4) are reported in pairs for cost and alternative profit frontiers using different input prices. On average, both translog and Fourier flexible functional forms provide fair presentation of the technology structure of the bank production process in China. In general, there is no significant difference between two functional forms in terms of likelihood estimates and the significance of coefficients within each model specification. The values of γ , log likelihood function, and LR tests for one-sided errors are reasonably high and all statistically different from zero. The finding is consistent with Rao (2005) and Kraft (2006) that compare translog SFA model and Fourier flexible SFA model for choosing a better functional form.

Table 7.2 Estimated parameters of cost frontier and profit frontier

	Bank specific input prices		Market average input prices	
	Translog (1)	Fourier-flexible (2)	Translog (3)	Fourier-flexible (4)
Panel A: Cost function				
Total loans (y_1)	0.41*(1.48)	0.45*(1.68)	1.06 (0.65)	2.19** (2.22)
Other earning assets (y_2)	0.56**(2.30)	0.58**(2.47)	0.61 (0.39)	1.78** (1.90)
Total deposits (y_3)	0.09(0.52)	0.06(0.32)	3.78*** (3.70)	1.04* (1.39)
Labour and physical capital price(w_1 or w_1')	0.46*** (6.79)	0.44*** (6.65)	1.81** (2.55)	-1.57** (-2.21)
Equity (z_1)	-0.02(-0.92)	0.006(0.07)	-0.48 (-1.28)	1.94*** (4.14)
Time trend (t)	-0.01(-0.12)	-0.01(-0.76)	-0.05 (-0.44)	0.52*** (4.00)
Gamma (γ)	0.69***	0.77***	0.97***	0.99***
Sigma-squared (σ^2)	0.003***	0.004***	0.23***	0.21***
Log likelihood function	560	574	41	80
LR test of one-sided error	217	215	247	210
Mean cost efficiency	0.94	0.94	0.54	0.75
Panel B: Alternative profit function				
Total loans (y_1)	2.01 (1.29)	3.02*** (3.98)	-0.36 (-0.39)	1.84 (1.13)
Other earning asset (y_2)	0.90 (0.60)	2.41** (3.05)	-3.72*** (-4.31)	-2.07* (-1.55)
Total deposits (y_3)	2.19** (2.72)	2.19** (3.24)	3.14*** (3.49)	2.36** (2.89)
Labour and physical capital price(w_1 or w_1')	0.18 (0.66)	0.64** (2.82)	-0.63 (-0.81)	-0.98 (-1.13)
Equity (z_1)	1.90*** (3.91)	1.21** (2.61)	3.64*** (6.49)	3.92*** (5.54)
Time trend (t)	-0.62***(-3.90)	-0.56***(-6.20)	-0.07 (-0.36)	-0.04 (-0.25)
Gamma (γ)	0.99***	0.99***	0.76***	0.86***
Sigma-squared (σ^2)	0.74***	0.69***	0.41***	0.56***
Log likelihood function	123	91	168	152
LR test of one-sided error	191	231	133	140
Mean profit efficiency	0.62	0.61	0.71	0.75

Notes: (1) Figures in parenthesis are t-values. '***' signifies significance at 1%, '**' at 5% and '*' at 10% levels. (2) Full results are shown in Appendix 1-1 and 1-2.

The estimated efficiency levels are not fundamentally different between the translog form and the Fourier flexible form, indicating that the choice functional form does not affect efficiency measures significantly. However, with a closer look at the estimated parameters, Fourier flexible specifications have resulted in somewhat improvement. This is especially true for the cost function estimation using market average input prices where Fourier flexible form provides better estimation over the translog form. Consequently, Fourier flexible functional form is finally chosen by this study to present production technology.

In addition to the choice of an appropriate functional form, it also examines the differences between the market average input prices and bank specific input prices. Estimated parameters are reported in Table 7.2 under the headings of bank specific input prices and market average input prices. Columns (1) and (2) in Panel A of Table 7.2 shows regression results using bank specific input prices. Although most parameters are statistically high, the critical parameter—the size of the standard deviation-squared of composite error terms is rather small. These results raise some doubt on the explanatory power of the model and thus the precision of the inefficiency estimates that are supposed to be derived from these composite errors.

When using market average input prices, regression results from cost frontiers improve significantly and fall into a reasonable range. Most estimated parameters of the first order variables shown in Columns (3) and (4) in Panel A of Table 7.2 as well as the second order and interaction variables (not shown) are statistically significant. γ is 0.97 and 0.99 for the translog and Fourier-flexible specifications respectively, indicating a large part of residuals attributable to inefficiencies. This is further justified by the significant LR tests for one-sided errors.

Estimated parameters of alternative profit frontiers are reported in Panel B of Table 7.2 and results are in favor of the use of market average input prices. Although the impact of using different input prices is much less compared with results from cost frontiers, the explanatory power of the model is improved. Log likelihood values increased from 231 and 91 to 168 and 152 for the translog and Fourier-flexible specifications, respectively. γ is significantly different from zero for all profit

frontiers, indicating that the proportion of profit inefficiencies to total errors is significant no matter how input prices are specified. The magnitudes of γ and σ are larger for models using bank specific input prices than using market average input prices, indicating that different input prices affect the distribution of inefficiency estimates as in Koetter (2004). The use of market average input prices also affects the level of profit inefficiency. The use of bank specific input prices overstates profit inefficiencies by about 10%, a downward bias for those banks whose labour and physical capital prices above the market average. Koetter (2005) and Bos and Kool (2006) find similar effects for cost efficiency but not for profit efficiency. They argue that profit efficiency is more likely to be driven by sub-optimal output choices. Our explanation is that in China tight regulation on interest rates gives limited room to individual banks for setting output prices, which in turn limits the driving force of sub-optimal output choices for individual banks. Therefore, the impact of market prices on profit efficiency becomes relatively prominent in China.

On balance, our results show that the exogeneity/endogeneity of input prices matters in efficiency estimation. It provides evidence for the use of market average input prices, which would lead to more precise efficiency estimates. The different inputs prices are found to influence not only the estimated inefficiency levels (observed in profit efficiency) but also the distribution of estimated inefficiencies (observed in both cost and profit efficiency), consistent with findings in Bos and Kool (2006). Similar to Koetter (2005), cost efficiency is found to be more sensitive to the use of different input prices than profit efficiency. This is because changes in input prices are expected to have more direct influence on costs than on profits (Bos and Kool, 2006). Based on the above arguments and empirical evidence, our finalized cost and alternative profit model is in a Fourier flexible functional form using market average input prices. The following discussions will be based on the results from these models unless otherwise stated.

7.3.2 Overall cost and profit efficiency

Table 7.3 provides statistics of cost and profit efficiency estimates in terms of both efficiency level and rank order. Rank order is created based on the cost (profit) efficiency levels for each year using the formula $(order_{it} - 1)/(n_t - 1)$, where $order_{it}$ is

the place in the ascending order of the i th bank in the n th period and n_i is the number of banks in the country in the period (Berger *et al.*, 2007 and Williams and Nguyen, 2005). The lowest rank of 0 $[(1-1)/(n_{i-1})]$ presents the worst performance of a particular bank, while the highest rank of 1 $[(n_i - 1)/(n_i - 1)]$ indicates the best performing bank.

Table 7.3 Statistics of estimated cost and profit efficiency

		CE order	CE level	PE order	PE level
N	Valid	35	35	35	35
	Missing	0	0	0	0
Mean		.4688	.7474	.5259	.7501
Median		.5181	.7873	.5683	.7990
Mode		.03(a)	.37(a)	.02(a)	.27(a)
Std. Deviation		.22998	.15050	.22800	.14938
Skewness		-.144	-.986	-.236	-1.556
Std. Error of Skewness		.398	.398	.398	.398
Minimum		.03	.37	.02	.27
Maximum		.98	.96	.96	.92

Notes: (1) (a) indicates multiple modes exist and the smallest value is shown.

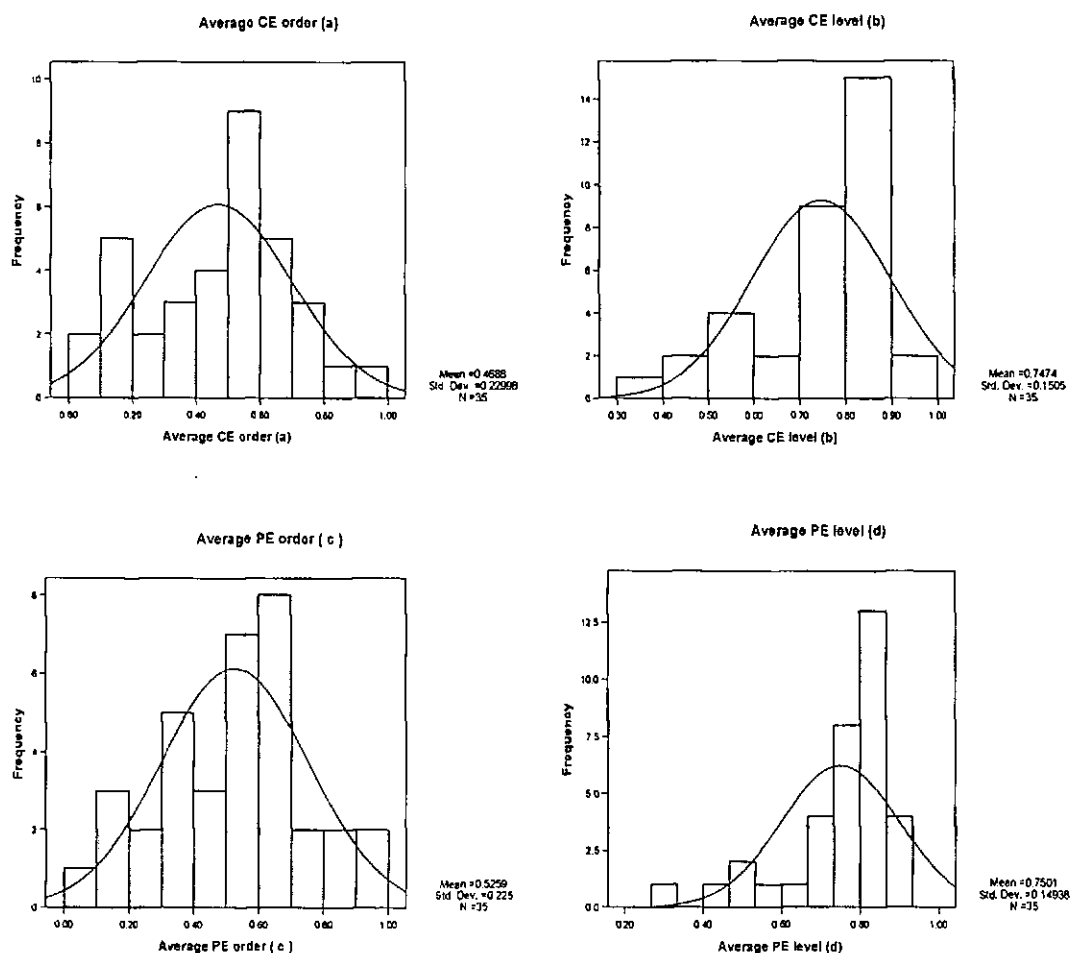
(2) CE = cost efficiency, PE = profit efficiency.

The mean cost efficiency is in the order of 75% and the dispersion is about 60% from the least performing bank of 37% to the best of 96%. The distribution of cost efficiency level and rank order is found to be negatively skewed (left-skewed) as suggested by SFA efficiency literature where a larger proportion of banks operate fairly close to the 'best practice' frontier. The skewness is more clearly shown in Figure 7.1 (a) and (b).

The average profit efficiency is also about 75%. Profit efficiency estimates distribute left-skewed but with wider dispersion of 65% than cost efficiency. This suggests that more banks are located close to the best practice while the gap between the best and the worst performing banks increases due to a more volatile nature of earnings than costs. Both rank order of cost efficiency and profit efficiency have lower means,

higher standard deviations, less skewness and wider dispersion, relative to profit efficiency.

Figure 7.1 Distribution of cost and profit efficiency level and rank order



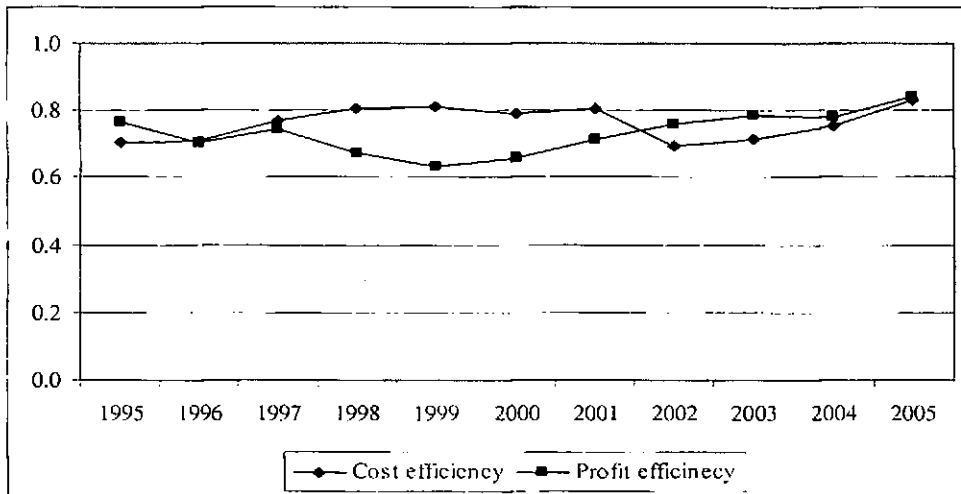
Notes: CE = cost efficiency, PE = profit efficiency.

Although rank order has recently been used in the literature, efficiency level is preferred over rank order for two reasons. First, the cost (profit) efficiency level of a bank is computed by comparing actual costs (profits) with the best-practice minimum costs (maximum profit) to produce the same bundle of outputs. The efficiency essentially reflects the distance from the actual bank performance to the best frontier in a more interpretable sense, while efficiency rank lacks interpretability. Second, it is argued that efficiency rank is more comparable over time in cross-country studies (Berger *et al.*, 2004). This study focuses on bank performance in a single country—China. It concerns the magnitude by which efficiency is improved as a result of past

reforms or can be improved in the future. In addition, the employed one-step procedure is used to derive estimated inefficiencies rather than rank order against a set of variables.

The estimated cost efficiency and profit efficiency are plotted in Figure 7.2. The banking system enjoyed gains in cost efficiency during the first four years and then remained stable for the following three years. A major driver of this improvement is considered to be the declining interest rates manipulated by the central bank. For instance, interest on one-year deposits dropped from 10.98% in 1995 to only 2.25% in 2001. Banks have also become concerned with cutting operational costs, especially SOCBs that have implemented effective costs saving projects by cutting off branches and labour redundancies.

Figure 7.2 Mean cost efficiency and profit efficiency (1995-2005)



In 2002, a sudden drop wiped out all previous gains, as a result of tightened regulatory requirements and prudential accounting practices. At the beginning of 2001, loan loss provisions were required to reflect the quality of assets quality. Loan loss provision could be up to 100% compared with the previous requirement of 1%, resulting in a substantial increase in costs. After 2003, cost efficiency increased steadily for the rest of the sample period and reached a peak at 83% by 2005. This recovery is considered to be the positive effects of deepened and broadened bank reform from 2003 onward.

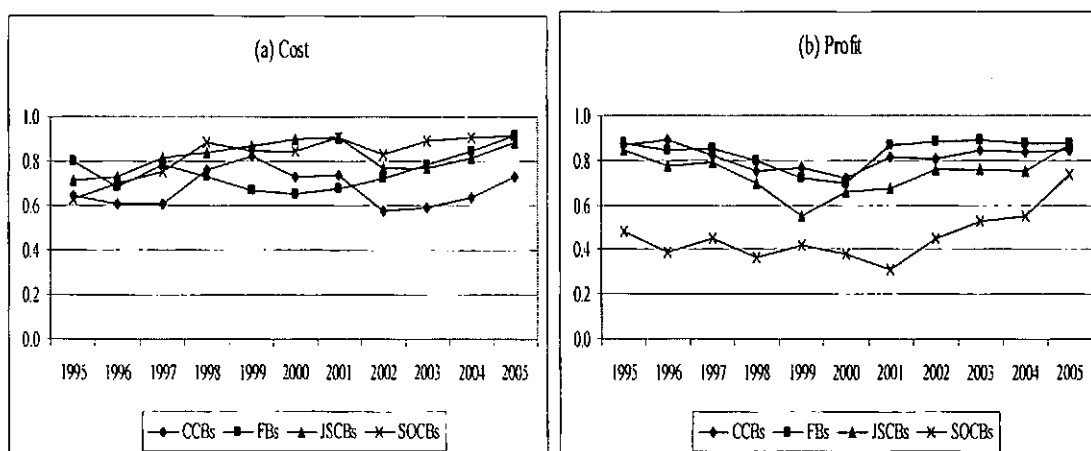
The movement of profit efficiency can be broken into two periods. The first five-year was a decreasing period in which profit efficiency decreased from 76% in 1995 to 63% in 1999. In contrast to increasing cost efficiency, banks appeared to control costs better but failed to generate sufficient profits. The reason for this decline is the worsened asset quality. Massive non-performing loans were accumulated during this period, reaching RMB3.3 trillion in 1999, accounting for 43% of the total loans and 40% of GDP in that year. It could be argued that decreasing profit efficiency is the result of interest rates cutting. However, lower interest rates did not appear to have any effect on profitability because the interest rate spread between loans and deposits was relatively stable, or even increased. For instance, the interest rate spread between six-month loans and deposits increased from 2.52% in 1996 (9.72% - 7.2%) to 3.42% (5.58% - 2.16%) in 1999. The rest six-years were an increasing period in which profit efficiency increased steadily, reaching the highest level 84%, in line with comprehensive bank reform. Among other factors, the most significant factor is the two rounds of NPLs divestments, which had an immediate and direct positive impact on profit efficiency.

Profit efficiency and cost efficiency appear to move in opposite direction until 2003. The high level of NPLs and the later divestments could explain this opposite movement. In the presence of high level NPLs, cost efficiency is inflated by including NPLs in total loans as outputs. Meanwhile, profit efficiency is deflated because no profit could be generated from these NPLs. The divestment of NPLs from the banking system reduced the output level by deducting NPLs, while the profitability increased because of improved asset quality. Therefore, during 1999-2002, cost efficiency declined but profit efficiency increased. After 2003, cost efficiency and profit efficiency moved in parallel along a healthy upward trend.

Banks perform differently because different types of banks are associated with certain efficiency advantages and disadvantages relative to one another. Mean cost efficiency and profit efficiency by bank types are plotted in Figure 7.3, showing the movement

of performance for each type of banks². In term of cost efficiency shown in Figure 7.3 (a), SOCBs are the most efficient banks with average cost efficiency of 83%, and JSCBs are second to them with only one percentage lower in cost efficiency. CCBs are the most inefficient bank group with average cost efficiency at 68%. Foreign banks performed better than CCBs by seven percentage points but much worse than SOCBs and JSCBs. In terms of profit efficiency shown in Figure 7.3 (b), the results somehow appear opposite. The most efficient bank group is foreign banks. Their average profit efficiency is 83%, followed by CCBs at 81%. SOCBs turn out as the worst performer at 46%, while the average profit efficiency of JSCBs is moderate at 71%. When considering both cost efficiency and profit efficiency, JSCBs performed outstandingly over other types of banks in China.

Figure 7.3 Mean cost efficiency and profit efficiency by bank types (1995—2005)



Notes: CCB = city commercial bank, FB = foreign bank, JSCB = joint-stock commercial bank, SOCB = state-owned commercial bank.

The opposite effects of NPLs on cost efficiency and profit efficiency become apparent in the SOCBs. The majority of NPLs was due to the SOCBs, which helped explain the puzzling phenomenon that SOCBs were associated with the highest average cost efficiency at 83% but the lowest level of profit efficiency at 46%. On the other hand, the divestments of NPLs explained why the profit efficiency of SOCBs increased after 2001. In this regard, our results support the notion that profit

² Discussions here are based on estimated efficiency levels of different types of banks, while the statistical inference regarding each ownership type will be made with reference to regression results from the inefficiency effects model in next section.

efficiency as an overall performance measure is superior to other efficiency concepts (Berger and Mester, 1997 and Kumbhakar and Lovell, 2000). Profit efficiency measure takes into account the costs contracting and revenue augmenting effects of banks activities at the same time. It is considered to be more appropriate in China and other emerging and transitional economies where NPLs are normally high and their effects are hardly to be incorporated into the estimation of performance due to the lack of data on NPLs.

Mean cost efficiency and profit efficiency for banks of different sizes are presented in Table 7.4. Banks are classified into four groups using the same criteria as in Chapter 6. The relationship between size and performance is very different in terms of cost efficiency and profit efficiency. Large banks (Group 1) are the most cost efficient banks, whereas they are the least profitable banks, suggesting that large banks enjoyed the economies of scale on the costs side of their operations, but diseconomies of scale in generating revenues. Medium-sized banks also enjoyed the same economies of scale in production costs as large banks, while they performed much better than large banks in terms of profit efficiency. These banks emphasized on contracting costs as well as on raising revenues. Small banks in Group 3 and Group 4 are the least cost efficient banks, while they surprisingly turn out to be the most profit efficient banks. These banks tend to be more profit-oriented than large and medium-sized banks but they are less able to control costs. The main conclusion is that on average medium-sized banks (Group 2) are the most efficient banks in the Chinese banking industry as far as cost efficiency and profit efficiency are concerned.

Table 7.4 Mean cost and profit efficiency by bank size (1995-2005)

	Group 1	Group 2	Group 3	Group 4
Cost efficiency	0.84	0.84	0.65	0.71
Profit efficiency	0.50	0.73	0.81	0.87

Group 1: total assets >1 trillion RMB; Group 2: 100 billion RMB<total assets<1 trillion RMB; Group 3: 10 billion RMB<total assets<100 billion RMB; Group 4: total assets<10 billion RMB.

7.3.3 Results of the inefficiency effect model

The technical inefficiency model attempts to assess the impacts of institutional changes on bank cost and profit efficiency. Results of the inefficiency effects in Equation (7.8) are reported in Tale 7.5. Regarding different bank types, five static effect indicators, *CCBs--No Change*, *FBS--No Change*, *JSCBs--No Change*, *SOCBs--No Change*, and *Listed Banks*; are defined for investigating the effects on performance of maintaining a particular ownership over the long term. The inefficiency effect model also includes two selection effect indicators, *Selected for Foreign Acquisition* and *Selected for IPO*; and four dynamic effect indicators, *Underwent Foreign Acquisition* and *Underwent IPO*, along with a set of risk taking indicators and macroeconomic environmental indicators. The first indicator is excluded for comparison purpose.

Coefficients on *FBS—No Change* (δ_1) are negative and insignificant in the cost model, but positive and significant in the profit model, that is, foreign banks are not significantly more cost efficient but significantly less profit efficient than the control group *CCBs—no changes*. When looking at the magnitude and significance level of estimated coefficients, foreign banks appear slightly more efficient than JSCBs and far more efficient than SOCBs in the profit model, providing evidence for the global advantage hypothesis (Berger *et al.*, 2000). In the cost model, foreign banks perform indifferently from SOCBs with no governance changes but are significantly less efficient than JSCBs. Thus, foreign banks are more profitable but associated with excessive costs than domestic banks, implying that the cost side of their operations is an area for future efficiency improvement.

Table 7.5 Estimated parameters of the inefficiency effects models

	Cost model	Alternative profit model
<i>Static Effect Indicators</i>		
FBs—No Change (δ_1)	-0.06(-1.27)	1.42(1.96)**
JSCBs—No Change (δ_2)	-0.11(-2.06)**	1.44(3.54)***
SOCBs—No Change (δ_3)	-0.05(-1.06)	3.10(5.02)***
Listed Banks (δ_4)	-0.09(-1.87)**	-1.34(-2.88)**
<i>Selection Effect Indicators</i>		
Selected for Foreign Acquisition (δ_5)	-0.22(-4.02)***	0.85(2.91)**
Selected for IPO (δ_6)	-0.06(-1.15)	1.75(3.95)***
<i>Dynamic Effect Indicators</i>		
Underwent Foreign Acquisition—ST (δ_7)	-0.003(-0.06)	-1.45(-2.61)**
Underwent IPO—ST (δ_8)	0.03(0.64)	0.11(0.14)
Underwent Foreign Acquisition—LT (δ_9)	-2.16(-5.52)***	0.46(4.66)***
Underwent IPO—LT (δ_{10})	-0.01(-0.06)	-0.74(-5.33)***
<i>Risk taking and environmental indicators</i>		
Capital Risk (δ_{11})	-0.96(-2.86)**	-1.22(-3.60)***
Credit Risk (δ_{12})	-0.72(-3.27)**	0.15(1.10)
Market Risk (δ_{13})	-0.14(-1.35)*	0.19(1.50)*
Liquidity Risk (δ_{14})	0.01(0.04)	-0.35(-0.86)
T (δ_{15})	-0.06(-1.25)	-0.07(-1.46)*
GDP (δ_{16})	-0.62(-3.66)***	-0.51(-3.94)***

Notes: (1)FB=foreign bank, JSCB=joint-stock commercial bank, SOCB=state-owned commercial bank, IPO=initial public offering, CCBs--no change is omitted as base case; (2) *, **, *** indicate significance level at 10%, 5% and 1%, respectively; (3) Negative sign of the estimated coefficient indicates that the particular variable has a positive effect on cost or profit efficiency and *vice versa*.

Coefficients on *JSCBs--No Change* (δ_2) show that JSCBs are the most cost efficient banks as it is the only bank group that are more efficient than the control group at 5% significance level. In the profit model, although JSCBs are less efficient than the control group and slightly less efficient than FBs, they are far more efficient than SOCBs. Thus, joint-stock ownership is generally associated with better performance as expected. State-ownership is identified as the least efficient static governance structure by the sign and magnitude of estimated coefficients on *SOCBs--No Change* (δ_3). SOCBs without governance changes are the least profitable banks and their cost efficiency is also low.

The last static effect indicator—*Listed Banks* (δ_4) tracks the relationship between banks' listing status and their performance. Listed banks are found to be more efficient than non-listed banks in terms of both cost and profit efficiency at 5% significance level, consistent with the literature that publicly traded banks are found to outperform non-listed banks in cost efficiency and profit efficiency (Berger and Mester, 1997; Isik and Hassan, 2003a; and Girardone, *et al.*, 2004).

Two selection effect indicators—*Selected for Foreign Acquisition* (δ_5) and *Selected for IPO* (δ_6) examine the performance of banks before they are selected by foreign investors and selected for going public. Coefficients on *Selected for Foreign Acquisition* (δ_5) show a significant (1%) selection effect for foreign acquisition in the cost model, while these selected banks are significantly less efficient than those unselected in the profit model. Foreign investors tend to base their decisions more on a bank's cost efficiency rather than profitability. This appears to be a rational and strategic choice since foreign banks are less cost efficient but more profit efficient than domestic banks in China. By selecting banks this way, foreign banks could benefit through incorporating their cost disadvantages and profit advantages with the cost advantages and profit disadvantages of target banks.

The selection effects of the IPO strategy (δ_6) are much weaker because banks selected for IPO are not significantly cost efficient but profit inefficient. This implies

that the government may have used IPO as a reform instrument to transform SOCBs which are less profitable than the non-state owned banks.

Four dynamic effect indicators, of which two are for the short-term effects and two for the long-term effects, are designed to examine the performance changes after governance changes take place. The estimated negative coefficients on *Underwent Foreign Acquisition—ST* (δ_7) indicate that in the short run there is no significant improvement in cost efficiency but profit efficiency is improved dramatically. The coefficient on *Underwent Foreign Acquisition—LT* (δ_9) suggest that in the long run the short-term gains in cost efficiency are subsequently consolidated and foreign acquisition has a significant positive impact on cost efficiency. In contrast, short-term gains in profit efficiency fade and turn out as losses in the long run, suggesting that the foreign acquisition strategy has a long term negative impact on bank profit efficiency. The favourable short-term effect on profit efficiency is likely to be the NPLs divestment before foreign acquisition takes place. It may take a longer time to see a positive effect of foreign investors' participation on bank profitability by fundamentally improving assets quality and management, especially for SOCBs.

The coefficients on *Underwent IPO—ST* (δ_8) in cost and profit models are positive but statistically insignificantly different from zero, suggesting that IPO has very little short term impact on cost or profit efficiency. For a longer time, as suggested by the coefficients on *Underwent IPO—LT* (δ_{10}), the IPO strategy has a significant and positive impact on profit efficiency, implying that the positive effect of IPO on profitability can only be realised in the long run. Although insignificant, the short-term negative impact on cost efficiency is turned into a long-term positive impact. In an effort to privatise SOCBs, the Chinese government allowed three SOCBs (CCBC, BOC and ICBC) to be listed on the stock markets in 2005 and 2006. Our consistent results from the cost and profit models provide strong evidence supporting the IPO strategy with a long-term forward-looking view.

Four risk taking indicators are used to examine the relationship between bank efficiency and their risk taking behaviours to reflect managerial quality from different aspects. A general hypothesis regarding capital risk (δ_{11}) is that banks with sufficient

capital generally reflect higher management quality and better control in risk taking and thus higher level efficiency. This hypothesis has been supported in the literature that generally shows a positive association between the level of capital and efficiency (Rao, 2005; Spong *et al.*, 1995; and Berger and Mester, 1997). This study also provides strong evidence supporting this hypothesis in both the cost model and the profit model. The causality could go both ways (Berger and Mester, 1997). More profitable banks could contribute more to equity than less profitable ones. On the other hand, owners with less capital to loss may have less incentive to properly monitor bank operations, resulting in inefficiencies and therefore, less profitability.

Credit risk (δ_{12}) is found to be significantly and positively associated with cost efficiency but unrelated with profit efficiency. The coefficients on market risk (δ_{13}) are statistically different from zero at 10% significance level, while it is negative in the cost model and positive in the profit model. The suggestion is that banks using more wholesale purchased funds tend to be more cost efficient but less profit efficient. This finding is consistent with Berger and Mester (1997) who find banks dependant more on purchased fund tend to have higher cost efficiency but lower profit efficiency than other banks. Isik and Hassan (2003a) also find that banks with higher a proportion of purchased funds are associated with higher cost, technical, pure technical and scale efficiencies. Liquidity risk (δ_{14}) is found to be unrelated to cost or profit efficiency.

The coefficients on the time trend variable (δ_{15}) suggest that on average bank cost and profit efficiency improved over time at a rate of 6% and 7% respectively. Although performance catching up is insignificant measured by cost efficiency, it is significant at 10% level when measured by profit efficiency. GDP growth is used as a proxy for macroeconomic conditions. Favourable economic conditions are supposed to have a positive impact on the demand and supply of banking services, and are expected to improve bank efficiency. The estimated coefficients on GDP (δ_{16}) indicate that GDP per capita is significantly and positively associated with cost and profit efficiency, consistent with expectations as well as empirical findings as in Grigorian and Manole (2002).

7.4 Chapter summary

This chapter investigates a few methodological issues, which help improve the quality and robustness of frontier estimation and enhance the reliability of comprehensive analyses based on those efficiency estimates. Based on better addressed methodological issues, this chapter examines cost and profit efficiency of Chinese commercial banks for the period 1995-2005. It differentiates the impacts on efficiency of various institutional changes associated with comprehensive ongoing banking reforms in China. Main findings and conclusions are drawn below.

In estimating the cost and alternative profit frontier models, two methodological issues are investigated through the choice of functional form and the choice of input prices measurement. First, no fundamental difference is found between the standard translog and Fourier flexible functional forms. The Fourier flexible form is preferred because of its slightly better explanatory power. Second, due to the exogeneity of input prices in the cost and profit functions, this chapter examines the impacts of using different input prices proxies—bank specific input prices and market average input prices. The measurement of input prices appears to influence not only the level of estimated inefficiency but also the distribution of inefficiencies. Our conclusion is that market average input prices should be used in the estimation of the cost and profit models.

Mean cost efficiency and profit efficiency are about 75%, in line with the literature. It suggests that Chinese banks either utilize 25% more inputs or generate 25% less profits compared with the 'best practice' frontiers. Both cost efficiency and profit efficiency improved over the data period, but they tended to move in opposite directions for much of the sample period. The major explanation is the presence of the large NPLs in the banking system. NPLs inflate cost efficiency because they are included in total loans as an output, and depress profit efficiency because they bring in no profits but extra management costs. The opposite influences of NPLs on cost efficiency and profit efficiency become more prominent in SOCBs. In this regard, we support the notion that profit efficiency is superior to cost efficiency in measuring overall performance. However, we suggest the use of both as cost efficiency provides

more detailed complementary information by breaking down the aggregate measure of profit.

Using the method proposed by Berger *et al.* (2005), this chapter investigates the static, selection, and dynamic effects of governance changes simultaneously. JSCBs are identified as the most efficient banks when taking into account of both cost and profit efficiency. SOCBs are second to JSCBs in terms of cost efficiency but they are the least efficient in profit, with average profit efficiency lower than the industry average by 30 percentage points (static effects). The selection effects of foreign acquisition are unclear. However, their investment strategy is considered as rational by picking up more cost efficient banks for investment. Negative selection effects of IPO are found in terms of profit efficiency, consistent with the argument that the government may have used IPO as a reform instrument to fundamentally transform the SOCBs which are less profitable than other domestic banks.

In terms of cost efficiency, the foreign acquisition strategy is found to have a positive impact on performance in both the short and long terms. Foreign acquisition appears to lead to a win-win situation, that is, foreign investors expect to overcome their cost disadvantages while domestic banks may benefit from foreign banks' international best practice and technologies. However, the expected positive impact on domestic bank profitability remains to be seen as foreign acquisition appears to have an adverse impact on profit efficiency in the long-term dynamic indicator. It might take an even longer time to consolidate foreign banks' comparative advantage in profitability. IPO is proved to have improved performance in terms of both cost efficiency and profit efficiency. The empirical evidence justifies the IPO strategy, which is grounded on the economic argument that market disciplines could help improve bank performance by eliminating the negative effects of agency problems and soft budget constraints.

Chapter 8 Conclusions and policy implications

8.0 preamble

This study contributes to the well-established efficiency literature with respect to transition and developing countries by being the first study that comprehensively analyzes bank efficiency and differentiates the effects of various on-going bank reforms in China. The dataset consists of 310 annual observations for the period 1995-2005 on 35 commercial banks in China and the sample covers more than 90% of the country's total banking assets. By reviewing the literature on the Chinese banking system, this study provides rich evolutionary information on the history, regulation, and market environment of the Chinese banking industry. Using simple financial ratios, this study assesses the current state of the Chinese banking system and the relative strengths and weaknesses of the Chinese banks. Employing more sophisticated SFA, this study has also evaluated bank performance in terms of technical efficiency, cost efficiency and profit efficiency. These evaluations are the reflection of the banking reform in China over past 20 years and it is not the end story of this study. Since 2003, the Chinese government has speeded up banking reform and has partially privatized three of the state-owned banks through attracting foreign strategic investors and IPOs. In order to gain a better understanding of the ongoing bank reform, this study differentiates the effects on bank performance of various reform strategies. Based on the analysis and empirical results, this study discusses policy implications regarding on-going bank reform and provides policy recommendations to future reform in China.

The methodology employed is robust and sound, including financial ratio analysis and more sophisticated stochastic frontier analysis. Within SFA, this study has chosen estimation methods, models and procedures that are considered to be best suit to each research task. Although the main objective of this study is to examine the performance of banks in China and the effects of bank reform, this study has paid proper attention to a number of methodological issues in the literature in order to enhance the reliability of efficiency estimates and the usefulness of policy recommendations wherefrom. It has developed a more comprehensive empirical stochastic distance function model when estimating technical efficiency. Moreover,

this study uses market input prices rather than bank specific input prices when estimating cost efficiency and profit efficiency. It also employs different functional forms to obtain better estimates.

Drawing overall conclusions for this study, this chapter is organized as follows. Section 8.1 summarizes the current state of the Chinese banking system. Section 8.2 ascertains the economic rationale of bank reforms and assesses the performance of banks in China in terms of technical efficiency, cost efficiency, and profit efficiency. Section 8.3 summarizes different effects of institutional changes on bank performance. Section 8.4 addresses the contributions of this study to efficiency research methodology. Section 8.5 highlights policy implications and proposes policy recommendations for future banking reform in China.

8.1 The current state of the banking system

Under the macro-prudential analysis framework, financial ratio analysis is employed to assess the current state of the Chinese banking system in four dimensions—profitability, capitalization, assets quality, and liquidity. Having experienced major reforms over past a quarter of century, the Chinese banking system is moving towards a modern system. Improvements have been made in each dimension, especially after recent radical SOCBs reforms from 2003. Profitability has improved steadily in terms of ROA and more rapidly in terms of ROE. Most Chinese commercial banks have become more profitable, given their rather low previous profitability base. A few joint-stock commercial banks and restructured state-owned commercial banks have recently reached or surpassed the internationally well performing banking institutions in profitability. Bank of China and China Construction Bank, for example, have become as profitable as the internationally renowned banks after 2003 and the latter even became the most profitable bank worldwide in 2004 and 2005. Chinese banks are found to be more operationally cost efficient than international banks measured by a simple cost to income ratio.

Considerable reform efforts made by the government have effectively rectified the historically low capitalization problem in the Chinese banking system. By 2005, 53 banks including most major commercial banks have reached or exceeded the

minimum international capital adequacy requirement of 8%. Increased capital base in individual banks has consequently strengthened the overall solvency of the banking system. The most significant progress has been made in improving assets quality. There has been enormous reduction in both NPL ratio and the absolute value of outstanding NPLs. NPL ratio was lowered from about 42% in 1999 under the four-category loan classification system to about 5% in 2005 under the five-category loan classification system for most major Chinese commercial banks except for Agricultural Bank of China whose NPL ratio was 26%. The outstanding NPLs were cut down by more than two-thirds from RMB 3.3 trillion in 1999 to RMB 1 trillion in 2005. Increasing LLR to gross loan ratio also indicates improved financial strength of Chinese banks. In contrast, average liquid assets to total assets ratio of major Chinese commercial banks has declined over time from more than 40% in 1995 to less than 15% in 2005. Decreased liquid asset has a positive impact on profitability but a negative impact on the ability to meet short-term liabilities.

Despite of improvement and enhancement, the Chinese banking system is still in a poor and vulnerable condition when benchmarking to the peer group of 7 selected international banks. Compared with international banks, Chinese banks are generally associated with low profitability, low capitalization, poor asset quality, and less liquidity. The ROA of most Chinese banks are less than half of that of the international banks. The average capital adequacy ratio of Chinese banks has been increased to about 10%, which is still lower than international level of about 12%. The average E/A ratio has decreased over time to about 4% in 2005, lower than international level of 6%. Asset quality has been an area being significantly improved, while the progress is far insufficient for Chinese banks to catch up international banks. The NPL ratio of Chinese banks has been remarkably cut to 8.6% by 2005, which, however, is still four times or even more of that of international benchmarking banks.

As to different banks, foreign banks are on average the financially soundest bank group measured in all four dimensions, perhaps inherited from their parent banks. This group has limited influence on the overall state of the Chinese banking system due to its small size of total assets only accounting for 2% of the total banking assets. Small-sized CCBs generally outperform SOCBs but are inferior to JSCBs in all dimensions except for capitalization. SOCBs and SOPBs have been on the other

extreme on the spectrum being the least profitable banks with the worst asset quality and less liquidity but SOCBs have higher capital adequacy ratio over other domestic banks due to central government's generous subsidies. Poor state of SOCBs is due to complicated and interlinked multiple causes and most are incident to the state ownership. Following more radical reforms taking place since 2003, SOCBs have made significant improvements in term of profitability, asset quality and capital adequacy ratio.

Medium-sized JSCBs is the outstanding domestic bank group with better profitability, good assets quality and better liquidity. Five principal factors are considered to have driven JSCBs to excel. First, the joint-stock ownership facilitates JSCBs to construct good and functioning corporate governance. Secondly, except for the recent three IPOs of SOCBs, all listed banks have been JSCBs and they are subject to public scrutiny. Thirdly, JSCBs have been actively attracting foreign ownership and importing advanced western management, operational practice, and accounting standards. Fourthly, JSCBs are subject to less government intervention as well as protection, resulting in more commercial sense in their operations. Finally, JSCBs are under threat of closure since they are not 'too big to fail' as SOCBs. In balance, JSCBs' relative better performance is not simply because of diversified ownership, but also due to competitions and market scrutiny, more advanced managerial and operational skills, less government intervention, and the threat of possible closure.

8.2 Economic rationale of banking reforms and bank efficiency in China

Employing SFA, this study has examined the rationale of banking reforms in China and bank performance using more sophisticated measure of efficiency. The sample spans 11 years from 1995 to 2005 encompassing 35 large commercial banks. The sample period is characterised with remarkable reforms and incentives given by the authorities to the banks. Two hypotheses have been tested for examining whether bank reforms over past a quarter of century are theoretically grounded on the principal-agent theory and the budgetary constraint theory. The first hypothesis is that joint-stock banks are more efficient than state-owned banks, which ascertains whether joint-stock ownership could better solve the agency problem. The second hypothesis is that banks subject to a hard budget are more efficient than those facing a soft

budgett, examining whether soft budget constraints is a source of inefficiency. A single-output production function frontier in Cobb-Douglas form is estimated using a sub-sample that includes state-owned commercial banks and joint-stock commercial banks only. Empirical results provide sufficient evidence supporting these hypotheses. Hence, we conclude that the government has implemented the ongoing banking reform on the economic grounds of agency theory and soft budget constraint theory. Ownership reform and changing a soft budget to a hard one are expected to result in greater efficiency gains for the Chinese banks, especially the SOCBs.

Having ascertained the economic rationale of reform, bank performance is examined in term of technical efficiency, cost efficiency and profit efficiency. These measures are estimated based on careful consideration regarding estimation techniques, variables definitions, and model specifications. The sample includes 35 commercial banks, which are classed into four mutually exclusive groups, namely state-owned commercial banks, joint-stock commercial banks, city commercial banks and foreign banks. Technical efficiency is derived from a stochastic output-oriented distance function using three different specifications. The income-based model tends to be superior to the earning assets-based model but the latter could provide complementary information on efficiency of other aspects of bank operations. The estimated technical efficiency steadily improved from 61% in 1995 to 87% in 2005. Average technical efficiency is 73%, suggesting that the outputs of Chinese banks are below the maximum possible outputs by 27%. On average, JSCBs are the best performing bank group at an average technical efficiency level of 81%, while foreign banks are the least efficient bank group operating at 59% technical efficiency. CCBs and SOCBs perform at 74% and 72%, respectively.

Since the commercial bank law was enacted in 1995—the first year of our sample period, all banks were defined as commercial banks with the main goal of profit maximization except for state-owned policy banks. Therefore, behavioural assumptions of cost minimization and profit maximization are appropriate. Based on properly constructed market average input prices, a dual cost approach and alternative profit approach are employed to estimate cost efficiency and profit efficiency. Estimated cost efficiency and profit efficiency are both at 75%, suggesting Chinese commercial banks expend more costs by 25% but earn less profits by 25% compared

to the industry 'best practice'. Both cost efficiency and profit efficiency fluctuated over time between 60% and 80% during 1995-2004 ending up with an increase to 84% in 2005. In terms of cost efficiency, SOCBs and JSCBs are found to be the best performing bank groups operating at 83% and 82% efficiency levels, while CCBs are the least efficient bank group with 68% efficiency level. Foreign banks perform better than CCBs but worse than SOCBs and JSCBs. In terms of profit efficiency, foreign banks present the best practice with estimated profit efficiency level at 83%, while SOCBs are the worst performers at 46% efficiency level.

From rigorous and robust performance assessments, two particular findings are presented below. First of all, the average technical efficiency, cost efficiency and alternative profit efficiency are consistent with each other at about 75% and they improved over the sample period. These estimates fall into reasonable range of reported efficiency levels in the bank efficiency literature. For example, the average efficiency score is about 80% for the US banks (Berger and Humphrey, 1997). One conclusion could possibly be made that efficiency estimates at industrial level are stable and consistent, regardless of the efficiency concepts used. The dispersion of efficiency level across different bank types is found to be substantially wide for all efficiency measures, suggesting great potential for future improvement. The largest performance difference between the best and the worst performing banks is found in profit efficiency amounting 37%. It is found that more banks perform poorly and locate away from the theoretical profit frontier. The smallest performance gap lies on cost efficiency measurement by 15%, indicating that more banks operate closer to the cost frontier. The difference in technical efficiency between the most and the least efficient banks is moderate at 21%. The results imply a promising area for banks to improve performance.

The second finding is concerned with the relationship between size and efficiency. The existing literature has been inconclusive and our findings are different depending on different efficiency concepts under review. The medium-sized banks are found to benefit from size advantage in terms of technical efficiency and cost efficiency. They are the most efficient banks outperforming large banks and small banks, consistent with a commonly claimed flat U-shape average cost curve for the US banks in the literature. However, it is in contradiction to Chen *et al.* (2005) who find large and

small banks are the most technical efficient and medium sized banks are least technical efficient in China. The explanation is that Chen *et al.* (2005) employ an earning-assets based model in which high level of NPLs in larger Chinese banks has the inflationary effect on estimated technical efficiency. In terms of profit efficiency, the result is opposite as small banks appear to be most efficient and large banks the least efficient, supporting the findings in Bauer, Berger, and Humphrey (1993) that report increased inefficiency with large asset size.

8.3 The effects of institutional changes on bank efficiency

This study evaluates not only the performance of Chinese banks, but also the effects of different bank reform strategies on performance. This part of the study is of particular importance since it sheds important light on policy implications. The Chinese banking system experienced significant institutional changes in all types of commercial banks, especially during the last few years of data period. The method proposed by Berger *et al.* (2005) is employed to jointly explore the static, selection and dynamic governance effects on bank performance in a single model. Eleven governance effect indicators representing various institutional changes in different types of banks are defined, of which five are static effect indicators, two selection effect indicators and four dynamic effect indicators.

The first four static effect indicators are concerned with the effect of having a certain type of ownership structure over a long time. To draw more complete conclusions, the estimated coefficients need to be interpreted in conjunction with estimated average efficiency level. Static effect indicators focus more on governance structure, while the average efficiency reflects the efficiency level for an entire group. The performance of CCBs is mixed measured by different efficiency concepts. They are the most profit efficient domestic banks even surpassing JSCBs by 8%, whereas they are the worst cost controller with the lowest estimated cost efficiency of 68%. Foreign banks perform poorly in terms of technical efficiency and cost efficiency, but they perform best in profit efficiency among all the banking groups.

JSCBs are the best performing bank group in the Chinese banking industry, consistent with the result of the previous ratio analysis. They are the most technical efficient and

cost efficient banks. Although they are the third profitable bank group, profits earned are healthy due to better assets quality. As to SOCBs, notwithstanding considerable preferential reform efforts, they are the most inefficient domestic bank group. They perform outstandingly in terms of cost efficiency, presenting their relative strength and attractiveness to foreign strategic investors to take equity stake. SOCBs are currently undergoing more drastic institutional changes and their performance is expected to be improved in the near future.

The fifth static indicator suggests that listed banks are consistently and significantly more efficient than unlisted banks for all efficiency measures under study, in line with the general expectations that public scrutiny drives banks to excel. This result is also consistent with the empirical literature where publicly traded banks are found to be more efficient than unlisted banks.

Two selection effect indicators particularly examine whether better performing banking are selected for foreign acquisition or/and going public. Attracting foreign strategic investors and going public are two important partial privatization strategies initiated by the government during the most recent bank reform. Strong selection effects are found in foreign acquisition, as foreign investors appear to select domestic banks based on technical efficiency and cost efficiency rather than on profit efficiency. The investment decision is rational because foreign banks are found to be more profit efficient but cost and technical inefficient than the domestic banks. By targeting banks with better technical and cost efficiency, foreign banks attempt to combine their comparative profit advantage with domestic banks' comparative cost and technical advantages to achieve overall high efficiency. On the other hand, this strategy helps domestic banks obtain much needed capital, advanced technology and managerial skills to improve their profitability. The strategy of foreign ownership participation appears to have created a win-win situation for both parties.

No selection effect is found for the partial privatization strategy of going public in terms of technical and cost efficiency. In terms of profit efficiency, adverse selection effect is found as less profitable banks are selected for IPO. This result seems unreasonable but it is consistent with the fact that the Chinese government encouraged the least profitable SOCBs to be listed on the stock exchanges. Using IPO

as an important reform instrument to fundamentally transform the SOCBs, the government could raise more capital while hardening the budget constraint on SOCBs by subjecting to a free market competition. The bullish stock markets in Shanghai and Shenzhen from the second half of 2006 up to 2007 proved that the IPO strategy was unexpectedly successful, although a cautious note needs to be served to small investors that they need to be careful not to bear the entire cost of bank reform in China.

Dynamic effect indicators gauge short-term and long-term effects of institutional changes on bank performance. The empirical results are mixed when using different efficiency concepts. Foreign acquisition is found to have positive short-term effects on bank performance since all estimated coefficients are negative. The coefficients are statistically significant for profit efficiency but insignificant for technical efficiency and cost efficiency. Over the long run, the short-term cost efficiency gains appear to have consolidated into significant long-term positive effect while gains in technical efficiency remain insignificant. Significant short-term gains in profit efficiency caused by foreign acquisitions appear to have caused significant long-term losses. Short-term gains in profit efficiency are possibly the results of a cleaning up effect before implementing the privatization strategies. Banks are financially restructured by receiving substantial subsidies from the government just before the foreign acquisition, which have a direct positive impact on profitability. However, these effects are short-term and these banks appear to become less profitable in the longer term. The expected profit advantage from foreign ownership seems to take an even longer time to be realized since the scale of foreign ownership in domestic banks may be insufficient to turnaround these less profitable domestic banks into profitable ones in a short period. It would take more time to solve those deep-rooted problems such as dis-functioning corporate governance, poor assets quality, and immature managerial skills.

Likewise, IPO is found to have different impacts on different efficiency measures. IPO has resulted in significant gains in technical efficiency, while these gains have faded in a longer term. On the other hand, IPO has caused little losses in cost efficiency and profit efficiency in the short-term. These losses have been reversed

into fruitful long term gains and the effects on profit efficiency even become statistically significant.

To sum up, two major partial privatization strategies—foreign acquisition strategy and IPO strategy are currently being implemented by the Chinese government to reform its banking system. These strategies are underpinned by the agent-principal theory and soft budget constraints theory. This study provides strong empirical evidence supporting these strategies. Bank performance has improved, although some expected positive effects may take a long time to be realized. Thus, we conclude that banking reform in China has been in the right direction since foreign ownership reform and IPO are proved to be two effective and promising strategies.

8.4 Findings with respect to research methodology

This study comes up with some conclusions, contributing to the development of research methodology by paying particular attention to four main issues. Although these conclusions are based on the Chinese banks, they have more general applicability, at least in developing and transition economies where the banking system shares certain commonalities with China. First, a comprehensive stochastic distance function is developed to estimate technical efficiency by combining the advantages of existing approaches, models, methods and procedure in the literature. The model has three principal attributes. The first attribute is that the model is based on a recently developed stochastic distance function approach. This approach has the advantages of accommodating multiple-output production technology and requiring no price information and behavioural assumptions. It overcomes one limitation of the primal approach to estimate technical efficiency for industries with multiple-outputs production technology. For such an industry, a traditional dual approach has been widely used by estimating a cost function or/and a profit function. However, these dual approaches require price information and behavioural assumptions of cost minimization or profit maximization. Under some circumstances, price information may not be available or/and optimization assumptions may not be appropriate.

The second attribute of the newly developed empirical model is that it incorporates a method proposed by Berger *et al.* (2005) that simultaneously examine the static,

selection, and dynamic effects of governance changes on bank performance in one single model. It enables us to differentiate the effects of various institutional changes, providing valuable information for policy makers regarding the on-going banking reform in China. The final attribute of the newly developed empirical model is that the distance function approach and Berger *et al.* (2005) method have been estimated using a one-step procedure proposed by Battese and Coelli (1995). This one-step procedure overcomes serious statistical problem suffered by the commonly used two-step procedure caused by contradictory assumptions made in two separate steps. This comprehensive model has been applied to data of Chinese banks and it has been well estimated. Technical efficiency estimates fall within the reasonable range and consistent with cost and profit efficiency estimates. It can be concluded that the model is robust, providing richer information and reliable estimates of bank efficiency.

The second methodological issue addressed by this study is the sensitivity of efficiency estimates to different model specifications that combine different output and input variables. This study has estimated both the income-based model and the earning assets-based model. The former addresses the ability to generate income revenue based on data from income statements, while the latter focuses on earning assets growth by taking data from balance sheets. In other words, the earning assets-based model reflects the first phase of bank production process that attracts funds and then invests in loans or other earning assets, while the income-based model describes the second phase of bank production process that generates incomes from those loans and earning assets. Higher efficiency in earning assets growth does not necessarily result in higher efficiency in rising income. For banks with poor assets quality, estimated technical efficiency by the earning assets-based model has been much higher than that estimated by the income-based model. This finding has important methodological implications relating to the choice of models to investigate bank efficiency, especially in developing countries and emerging economies where assets quality of banks is generally low. We argue that the income-based model is superior to the earning assets-based model, at least for our dataset from China. However, we suggest the use of both models when analyzing banks efficiency, which would provide more valuable information and draw a more complete picture on bank performance.

The third methodological issue addressed by this study is the measurement of input prices, an area which has been generally neglected or mis-conducted by previous studies. Particular attention has been paid to the exogeneity of input prices and the different measurements of input prices are found to influence both the level and the distribution of estimated inefficiencies. Market average input prices are found to be more appropriate than bank specific input prices when estimating cost efficiency and profit efficiency. When defining cost and alternative profit function, banks are assumed to face competitive markets where input prices are exogenously determined. This is a pre-condition for the costs minimization and profit maximization to be reasonable. However, most cost and profit efficiency studies employ bank specific inputs prices by dividing total factor expenses by the total units of factors employed. This contradiction has been firstly noticed by Mountain and Thomas (1999). To knowledge, there are only a few studies investigating the measurement issue of input prices. The present study is considered to be the third one that specifies both market average input prices and bank specific input prices and compares their impacts on the level and distribution of estimated cost and profit efficiency.

The final methodological issue addressed by this study is concerned with the superiority between cost efficiency and profit efficiency as performance measures. Profit efficiency has been found to be superior to cost efficiency in measuring overall performance, consistent with the literature. This finding is especially important for efficiency study in banking systems where the level of NPLs is high, for example, in China. Estimated cost efficiency for Chinese banks is found to move in the opposite direction of profit efficiency except for the last four years of the study period when both of them increase. Paradoxically, SOCBs have the highest estimated cost efficiency but the lowest profit efficiency. The reason for these unusual results is that NPLs have been included as outputs. NPLs have an inflationary effect on cost efficiency while deflationary effect on profit efficiency because of losses from NPLs. Although profit efficiency is a superior aggregate performance measure to evaluate overall achievement, cost efficiency provides segmental and complementary information by breaking down the profit. Thus, we suggest the use of both cost efficiency and profit efficiency to assess bank performance.

8.5 Policy implications, remaining problems and possible solutions

The study has addressed the hot-red banking reform in China with a particular focus on policy concerns through empirically evaluating the effects of various institutional reforms on bank performance. Results from this comprehensive and in-depth analysis have shed important lights on policy implications and thereby induces policy recommendations for the future reform of the Chinese banking system.

The most recent reform strategy is partially privatizing SOCBs through attracting foreign investors and IPOs. Literature generally shows improvements in performance after privatization in developing countries and transition economies. Consistent with literature, this study has also found evidence that those privatization strategies tend to have positive impacts on bank efficiency. The privatization of the state banks appears to be a right move to modernize the Chinese banking system. Following the reform, a modern banking system has taken shape and SOCBs have been reconstructed into modern banking enterprises with sound financial good governance structure in place. Chinese banking reform has achieved notable progresses and the reform seems on track with a right direction, whereas this study cannot form a conclusion whether the reform has succeeded and achieved its ultimate goal. After more than 20 years' reform as well as recent series of re-capitalization, financial restructuring, and IPOs implemented to major commercial banks, it is still too early to make such a conclusion as remaining problems are still many and difficult. Much has been done, while much more need to be done for the ultimate success of the Chinese banking reform.

Next step reform should first consolidate the up-to-date achievements. Current proven reform policies should be reinforced to ensure their positive impacts could last in the long term. Banks need to be closely monitored and overseen whether they are operated and managed in line with the goals of the banking reform. CBRC has set out guidance for good corporate governance and detailed requirements for performance by benchmarking to the top 100 largest global banks. Authorities should ensure the enforcement of these measures. Any deviations should be followed up and adjust carefully ongoing reform measures where necessary. While consolidating up-to-date achievements, authorities should proceed with and deepen the banking reform by

implementing more effective measures to solve remaining and new emerging problems. These problems are tougher since easy ones have already been tackled, but they are fundamental to the success of the Chinese banking reform.

As the dominant of the Chinese banking system, SOCBs are still in the forefront of the future reform. Despite of significant progress, SOCBs are faced with a number of problems that hinder them to become modern banking enterprises and make future banking reform tougher. Constructing good corporate governance has been a hot topic in banking reform. The Chinese government has implemented a series of concrete measures to reform SOCBs and now three of them have good governance structure in place. Nevertheless, what is more important is that these corporate governance mechanisms are functioning and effective. To achieve this, a number of issues need to be properly addressed and dealt with from the deep-rooted causes.

The first issue is the persistence of government interventions in SOCBs' operations. After more than two decades of banking reform, it is evident that SOCBs still subject to government interventions, although less explicit than previous practice. In order to pursue multiple social objectives, such as supporting overall economic development, providing employment and maintaining social stability, government has incentive to direct banks lending to political preferred projects rather than profitable alternatives. SOCBs continue to finance (essentially provide fiscal subsidy) to underperforming SOEs to keep them in operation. This casts suspicion on whether SOCBs are able to behave as true commercial banks that are expected to use market principles to evaluate and manage their operational risks and to make lending decisions independent of political consideration and personal connections. It is uncertain whether, or if so, how soon the government would step away from SOCBs. It is therefore important that government should stop intervening SOCBs' operations and provide them a real commercial atmosphere to operate in.

The second issue is concerned with the partial privatization policy that the Chinese government has partially privatized state banks. Even after foreign acquisitions and IPOs, the state remains majority ownership in SOCBs. Policy literature and empirical studies in developing countries and transition economies both suggest full relinquishment of government ownership in state banks. Partial privatization has

shown to have no positive impacts on bank performance in the long-term. Majority government ownership could result in corporate governance dysfunction although it is well established. It also facilitates government intervention on banks' operation, especially lending decisions. The solution could be speeding up the pace of privatization, which would help release SOCBs from government interventions and provide environment and room for corporate governance to be functioning.

The third issue is the built-in connection between senior management of SOCBs and the governmental/political system. Senior management is appointed based more on political considerations rather than being selected according to their experience and track record in banking management. Senior managers also have ranks in the political system and most of them are transferred from government officials to manage the SOCBs on the behalf of the state. They could be promoted as higher-ranked officials in the political system if they improve SOCBs' overall performance, while the performance here has certain non-commercial ingredients, such as personal relationship with government officials. These senior managers might have incentive to keep good relationship with government. They could provide finance to industries or project preferred by government with no or few commercial considerations. This problem is much easier to deal with compared with previous two problems. Government could cut the tie by either selecting senior management from markets or stop granting bank management political ranks. The former is preferred since it opens to the possibility to select senior management from international market with desired experience and advanced managerial skills. The latter has the advantage of in-depth knowledge of the banking system and Chinese speciality but managers are disincentive because something will be taken away from their pockets.

The fourth issue is SOCBs have a preference to extend credits to inefficient SOEs rather than profitable non-state private firms. There is an invisible tight tie between SOCBs and SOEs, partially due to the third issue discussed above and partially due to their historical role to finance SOEs. Although the government started SOE reform earlier than banking reform, the reform has been partial and incomplete. Most SOEs are less profitable or even still making losses. Lending to these underperforming SOEs not only undermines SOCBs' profitability but also increases the risk of new NPLs in the future. More importantly, inefficient allocation of capital is detrimental

to the economy. This issue involves changing conventional behaviours in banking operations and it will take time. However, if above three issues could be properly addressed, that is, SOCBs free from government intervention, good corporate governance functioning, and the tie between SOCBs management and governments weakened, the process of changing behaviour would be much quicker.

The fifth issue is SOCBs are 'too big to fail' or 'too important to fail'. SOCBs are strategically important to the Chinese economy, making closure and bankruptcy costly and therefore highly unlikely even they have made significant losses and/or produced huge amount of NPLs. Essentially, SOCBs are faced with a soft budget constraint just the same as their main clients—SOEs. The soft-budget constrains always lead to moral hazard problem and it is fertile soil for inefficiency. The government is expected to bailout SOCBs when SOCBs are in financial distress as it always did in the past. Management have well understanding and therefore has less incentive to pursue better performance. It is not an easy question to answer as indeed even in advanced economies with well established banking system, government bailout is not unusual and the central banks act as the lender of last resort. However, in order to reduce the downside effect of a soft budget constraint, government should ensure effective mechanisms in place to restrict the implementation of government bailout.

The last issue is concerned with the SOCBs themselves. Chinese government has done much to reform the banking system—essentially SOCBs. Their overall performance has improved and their financial position has much strengthened. However, these achievements are largely attributable to direct government subsidies in the forms of capital injections and NPLs off-loading. In the future, banks need to stand on their own feet without government subsidies. The success of the banking reform in China depends on whether banks, especially SOCBs, can fundamentally improve their management and operational skills, and how they will deal with remaining problems as well as newly emerging problems. A concrete training plan would well solve the problem. Banks could recruit new staff with desired skills while providing training courses for existing staff to develop their skills.

Apart from above problems, SOCBs are also faced with problems that are common to all commercial banks in the Chinese banking system. The first problem is that Chinese banks have an operational weakness that they are overwhelmingly dependent on traditional lending activities instead of more profitable fee-based activities. More than 90% of gross income is raised from net interest revenue, compared to 50% of the selected international banks. The performance of the banks is rather sensitive to the performance of their clients. Lack of diversification in business activities undermines banks' operational independence when making lending decisions. This problem is particularly prominent in SOCBs where a larger proportion of loans have extended to underperforming SOEs. The diversification of income is a particular area for banks to make more efforts in order to be more profitable. Banks should explore and develop new businesses to diversify their product portfolio.

The second problem faced by Chinese banks is the underdeveloped accounting and auditing practice in terms of procedures, standards, and internal and external controls. Information infrastructure is underdeveloped and accounting and auditing profession are lack of enforcement power. Financial information could be easily manipulated and both managers and accountants carrying out such practice are hardly punished. When bank management has an incentive to distort financial information, it is technically achievable while avoiding breaking accounting rules or violating regulations. Under high pressures to cut down NPL ratios, SOCBs tend to extend more loans (conventionally to underperforming SOEs) or/and to hide problematic loans using the leeway in the classification of loans. The former would lead to potential new NPLs in the future while the latter does not solve the existing NPLs problem at all. Moreover, it is not unusual practice for SOCBs to extend new loans to underperforming SOEs who pay back the money to banks as the interest payments for their old loans. In so doing, NPLs are effectively hidden in short term while new loans are likely to become new NPLs. Without reliable financial information, reform measures that aim at solving particular problems might well depart from their original goals at the end. This issue has already been addressed and new accounting standard has been adopted since 2008.

The third problem faced by banks is the interest rates control. Being the price of fund, interest rates are mainly driven by market forces in a mature financial market. With

flexible interest rates, banks are able to adjust difference in associated risks when pricing loans. In China, interest rates are still set by the central bank while giving commercial banks very limited room in setting interest rates on loans but not on deposits. Limited flexibility in setting interest rates makes banks unable to adjust interest rates to reflect the risks. Without pricing loans in accordance with their associated risks, it is hardly to say that SOCBs could operate on a commercial basis. Moreover, Goodhart and Zeng (2006) argue that Chinese banks' interest rate margins are considered to be too low to generate proper return on capital and strengthen the capital adequacy ratio. The operational environment is not yet to be supportive for Chinese banks to become true commercial banks. This is another intractable problem as interest rates liberalization is linked to foreign exchange rate as well as capital control. There is no policy recommendation on interest rates liberalization as interest rates are beyond the scope of this study.

The fourth problem faced by banks is the lack of capital sources to improve their capital adequacy. The gap between capitals needed by Chinese banks to meet the minimum capital requirement of 8% and funds available domestically and internationally is huge. Government used to be the main capital provider for banks, especially for SOCBs, while recent reforms implicitly indicate such capital would no longer be available. It becomes banks' responsibility to raise capital, which is going to be a real problem as banks could hardly find way out. Banks are unable to raise sufficient fund internally given their generally low profitability. Meanwhile, capital market in China is still too thin and available foreign capitals are limited. Even foreign capitals available, the limit for maximum foreign shareholding of 25 % might prevent banks from raising capitals internationally. How Chinese banks will increase capital adequacy remains uncertain. Privatization could be a possible solution with increased the foreign shareholding limit.

The fifth problem faced by banks is to improve corporate governance structure and risk management. The corporate governance is the way how banks are run and operated. Historically Chinese banks (most of them are with majority of state-ownership) had no modern corporate governance in place. Even some banks now have good corporate governance structure; it is not fully functioning given their recent move toward modern banking enterprises. Moreover, Chinese banks generally

lack of experience and expertise in risk management. Chinese banks have traditionally extended loans without proper risk assessment exercise. It is argued that even with flexible interest rates in pricing loans, banks may not have the ability to accurately measure, assess and price those associated risks.

The final problem faced by banks is the NPLs problem. The Chinese government has made significant progress in solving the NPL problem in banking system and both NPL ratio and absolute amount of NPLs have dropped dramatically. The progress, however, is mainly attributable to the transfer of NPLs from banks to AMCs. Without the effective role of risk management exercise in lending decision as well as functioning corporate governance and internal controls in place, how banks could control NPLs from new loans is questionable. Moreover, the massive amount of NPLs has been transferred to AMCs that have made no essential progress on the disposal of the NPLs (see detailed discussion in Chapter 5). The end results from AMCs are estimated to be the same as the amount of NPLs transferred to them. Therefore, when looking at the financial sector as a whole, the threat of NPLs to the economy still remains, although not being faced by banks. Again NPLs issue is not discussed in detail and no constructive recommendation could be made (leaving for future research)

These interrelated problems faced by Chinese banks are not exhaustive. Without properly address the deep-rooted causes of these problems and fundamentally solve them in the near future, the chance of successful banking reform is very small. Any progresses would be in the short-term, just like any buildings without a firm foundation in place, all else would be built on moving and sinking land. The ultimate success of the reform not only depends on how the governments implement effective reform measures to solve those fundamental problems but also depends on how banks (especially SOCBs) respond to reform measures. There is no catholicon to remedy all problems in one go and the banking reform will take more time. It is arguably to say that the Chinese banking reform now is just about to crack the hardcore of the banking reform since remaining and potential problems are tough. Future research should pay more attention to these problematic areas on an on-going basis.

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Appendix

Appendix 1-1 Estimated parameters of second order and intersect terms for frontiers in translog functional form

	Bank specific input prices		Market average input prices	
	Cost function	Profit function	Cost function	Profit function
y1*y1	0.029(0.34)	-0.193(-0.53)	0.425(1.25)	-0.77**(-2.16)
y1*y2	0.175(1.28)	-0.358(-0.54)	-1.003**(-2.16)	-1.61**(-2.60)
y1*y3	-0.034(-0.4)	0.584(1.28)	-1.540**(-2.13)	0.76*(1.59)
y1*wl	-0.063*(-1.65)	-0.188(-1.29)	1.223**(2.55)	-0.96**(-2.16)
y1*zl	0.006(0.13)	-0.258***(-4.31)	0.656*(1.77)	-0.03(-0.30)
y1*t	-0.022**(-2.39)	0.498**(2.40)	-0.435*(-1.63)	0.93*** (3.58)
y2*y2	0.131*(1.89)	-0.685**(-1.83)	0.459*(1.70)	-1.80***(-4.81)
y2*y3	-0.009(-0.14)	0.665*(1.77)	-0.017(-0.21)	0.71*(1.65)
y2*wl	-0.031(-1.07)	-0.176*(-1.57)	-0.176(-0.46)	-0.62*(-1.56)
y2*zl	-0.027(-0.69)	-0.204***(-3.56)	0.925**(2.65)	-0.03(-0.34)
y2*t	-0.027***(-3.47)	0.369**(2.49)	0.562*(1.51)	0.26(1.02)
y3*y3	0.043**(2.31)	0.239**(2.59)	-0.232(-0.97)	0.58*** (3.86)
y3*wl	-0.036**(-1.96)	0.104(1.26)	0.214(1.00)	0.28*(1.33)
y3*zl	-0.027(-0.93)	-0.062**(-2.28)	-0.047(-0.67)	-0.07*(-1.64)
y3*t	0.003(0.46)	0.188(1.29)	0.439**(3.25)	0.33*(1.68)
wl*wl	0.082*** (13.8)	0.184*** (5.94)	0.485** (3.10)	-1.78** (-2.06)
wl*zl	-0.010(-0.97)	-0.035**(-2.17)	-0.181*(-1.54)	0.02(0.68)
wl*t	-0.001(-0.55)	-0.153**(-2.42)	0.144(1.14)	0.08(0.59)
zl*zl	0.001(0.16)	0.019*** (5.89)	-0.069**(-1.83)	0.40*** (5.58)
zl*t	0.000(0.03)	-0.001(-0.04)	0.057(0.64)	0.001(0.05)
t*t	-0.001**(-2.15)	0.162** (3.11)	-0.117**(-1.88)	0.001(0.20)

Notes: Figures in parenthesis are t-values. '***' signifies significance at 1%, '**' at 5% and '*' at 10% levels.

Appendix 1-2 Estimated parameters of second order, interseet and trigonometric terms for frontiers in Fourier-flexible functional form

	Bank specific input prices		Market average input prices	
	Cost function	Profit function	Cost function	Profit function
y1*y1	0.048(0.56)	0.266(1.08)	2.676*** (5.75)	-0.090(-0.18)
y1*y2	0.176(1.29)	0.936** (2.16)	0.047(0.14)	-0.416(-0.52)
y1*y3	-0.047(-0.52)	0.441* (1.31)	-0.860* (-1.69)	0.327(0.70)
y1*w1	-0.065* (-1.81)	0.018(0.11)	-0.256(-0.67)	-1.207** (-2.54)
y1* z1	0.017(0.37)	-0.266*** (-6.08)	0.401(1.14)	0.003(0.033)
y1* t	-0.019** (-2.12)	0.059(0.28)	-0.428* (-1.88)	1.120*** (3.81)
y2*y2	0.127* (1.85)	-0.030(-0.11)	0.754** (2.87)	-1.456*** (-3.54)
y2*y3	-0.017(-0.25)	0.422* (1.39)	0.183** (2.34)	0.471(1.21)
y2*w1	-0.041* (-1.40)	0.002(0.014)	0.201(0.68)	-0.733* (-1.73)
y2* z1	-0.008(-0.19)	-0.228** (-4.92)	-0.167(-0.61)	-0.022(-0.27)
y2* t	-0.023** (-2.92)	0.062(0.30)	0.496* (1.72)	0.350(1.23)
y3*y3	0.033(1.29)	0.362** (2.92)	-0.395** (-2.05)	0.477** (3.17)
y3*w1	-0.045** (-2.33)	0.125(1.27)	0.428** (2.27)	0.208(0.94)
y3* z1	-0.020(-0.67)	-0.067** (-2.68)	0.123** (2.15)	-0.076* (-1.76)
y3* t	0.005(0.83)	0.260* (1.47)	0.395** (2.55)	0.240(1.32)
w1*w1	0.080*** (12.74)	0.175*** (3.73)	0.648*** (3.99)	-0.192** (-2.39)
w1* z1	-0.014* (-1.32)	-0.048** (-2.57)	-0.235*** (-3.63)	0.018(0.58)
w1* t	-0.001(-0.37)	-0.121** (-1.95)	-0.072(-0.66)	0.034(0.22)
z1*z1	0.001(0.10)	0.015*** (5.66)	-0.011(-0.52)	0.407*** (5.30)
z1* t	0.001(0.50)	0.024(1.30)	-0.663*** (-4.32)	-0.002(-0.06)
t*t	-0.001* (-1.70)	0.167*** (3.61)	0.755*** (4.31)	0.001(0.11)

Appendix 1-2 Estimated parameters of second order, intersect and trigonometric terms for frontiers using Fourier-flexible functional form (continued)

	Bank specific input prices		Market average input prices	
	Cost function	Profit function	Cost function	Profit function
cos (x1)	-0.006*(-1.31)	0.019(0.70)	0.423***(4.09)	-0.070*(-1.87)
cos (x2)	-0.003(-0.73)	0.048*(1.63)	0.084***(4.03)	0.022(0.58)
cos (x3)	0.007*(1.60)	-0.015(-0.69)	-0.324***(-4.86)	-0.022(-0.59)
cos (x1+x1)	0.002(0.35)	0.004(0.18)	-0.192**(-2.37)	-0.039(-1.00)
cos (x1+x2)	-0.007*(-1.59)	0.031(1.07)	-0.038**(-2.03)	0.010(0.28)
cos (x1+x3)	-0.002(-0.55)	0.004(0.18)	0.151*** (6.24)	0.047(1.27)
cos (x2+x2)	0.007*(1.53)	0.035(1.16)	0.002(0.15)	0.019(0.50)
cos (x2+x3)	0.002(0.46)	0.070**(2.93)	-0.006**(-2.17)	0.077**(2.07)
cos (x3+x3)	0.002(0.42)	-0.013(-0.44)	0.008(0.58)	-0.024(-0.64)
cos (x1+x1+x1)	-0.005(-1.07)	0.044*(1.78)	-0.010(-0.83)	-0.000(-0.009)
cos (x2+x2+x2)	-0.004(-1.00)	0.005(0.25)	0.001(0.09)	0.054*(1.53)
cos (x3+x3+x3)	-0.000(-0.02)	-0.036*(-1.61)	0.060*** (5.42)	-0.017(-0.46)
sin (x1)	0.001(0.16)	0.014(0.74)	0.042*** (3.80)	0.006(0.16)
sin (x2)	-0.002(-0.48)	0.025(1.03)	0.025** (2.22)	0.006(0.16)
sin (x3)	0.002(0.45)	-0.012(-0.53)	-0.012(-0.99)	-0.064*(-1.72)
sin (x1+x1)	-0.001(-0.34)	0.080*** (3.59)	0.008(0.62)	0.052*(1.43)
sin (x1+x2)	0.001(0.26)	-0.025(-0.96)	-0.014(-1.00)	0.010(0.27)
sin (x1+x3)	0.003(0.81)	0.043** (1.99)	-0.007(-0.56)	-0.003(-0.08)
sin (x2+x2)	-0.002(-0.54)	-0.012(-0.59)	-0.018*(-1.60)	0.033(0.95)
sin (x2+x3)	0.001(0.25)	-0.013(-0.54)	-0.010(-0.97)	-0.054*(-1.48)
sin (x3+x3)	-0.004(-0.91)	0.028(0.99)	-0.019*(-1.60)	0.031(0.77)
sin (x1+x1+x1)	0.006(1.26)	-0.035(-0.98)	-0.003(-0.19)	-0.045(-1.18)
sin (x2+x2+x2)	-0.001(-0.26)	-0.047**(-1.82)	-0.03**(-2.43)	-0.043(-1.17)
sin (x3+x3+x3)	-0.005(-1.20)	0.008(0.30)	0.034*** (3.46)	0.000(0.005)

Notes: Figures in parenthesis are t-values. '***' signifies significance at 1%, '**' at 5% and '*' at 10% levels.

