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World Financial Crisis and the Rise of Chinese Commercial Banks

By

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Abstract

The current financial crisis hit the banking giants of the world really hard. It is striking to note that some of the large Chinese commercial banks have emerged to be the biggest winners as a result of the crisis thanks to reforms over the last 10 years. The most significant reform before the crisis was ownership diversification, aiming to improve corporate governance and efficiency. Within one year from October 2005, three of the four biggest state-owned banks (SOBs) were listed on the stock exchanges. This paper will study whether this reform has really improved bank efficiency. Adopting the DEA (data envelopment analysis) approach, this paper examines whether IPO (initial public offering) is effective in enhancing bank performance. Using data of 14 listed banks during 1999-07, the results show that on average, bank efficiency increased by almost 10% after listing. Despite joint equity banks (JEBs) still perform better than SOBs, the latter manage to catch up and reduce the efficiency gap with the former during the past few years. This in part explains why the Chinese banking system has been less affected by the current world financial crisis than their western counterparts, leading to an important conclusion that SOB reforms in China over the last 10 years have produced remarkable results.

JEL Classifications: G21, C67, E58

Keywords: Financial crisis, Chinese state-owned banks (SOBs), DEA, technical efficiency, IPO

Outline

Non-technical Summary

The current financial crisis hit some world banking giants really hard. For example, share prices of Citigroup and the Royal Bank of Scotland tumbled by more than 95% from 2007 to January 2009. It is striking to note that China's largest commercial banks emerged to become the biggest winners as a result of the crisis thanks to reforms over the last 10 years. In 2008, three listed Chinese state-owned banks (SOBs), Industry and Commercial Bank of China (ICBC), Bank of China (BOC) and China Construction Bank (CCB) had replaced their American and European counterparts to be the world's three largest commercial banks in market value and profitability after they were listed on the stock exchanges only two years earlier.

This dramatic development triggered our research curiosity as to why the Chinese commercial banks managed to avoid destruction by the world financial crisis and whether their efficiency had indeed been enhanced after a series of reforms. The most significant effort before the crisis was ownership diversification, aiming to improve corporate governance and performance. Within one year from October 2005, three of the four SOBs were listed on the stock exchanges successfully. To address this issue, this paper adopts the DEA (data envelopment analysis) approach to examine whether IPO (initial public offering) is effective in enhancing bank performance.

Employing data of 14 listed banks during 1999-07, DEA results using different estimation techniques with alternative assumptions provide potent evidence that banking efficiency in China has been improved after stock listing. Information related to these listed banks is more readily available to investors and thus subjecting them to increased pressure of public scrutiny. The average efficiency of the sample banks was improved by 10% over the data period measured by the CRS (constant return to scale) super-efficiency approach. IPO not only improves efficiency by imposing a hard-budget constraint on bank operations as after listing the state will not be obliged to bail out failing banks, but also helps banks to realize their scale economy through raising capital from investors. Despite joint equity banks (JEBs) still perform better than SOBs, the latter manage to catch up and reduce the efficiency gap with the former during the past few years. This in part explains why the Chinese banking system has been less affected by the current world financial crisis.

In retrospect, the bank reform in China from 1998 to 2006 provided a sound capital and institutional basis for the listed banks to withstand the most severe financial crisis in the world since the 1930s. The systematic meltdown of the western banks was the most important factor responsible for the crisis. In contrast, the relative strength of the Chinese banks was a great hope for the Chinese and the world economy during the crisis.

1 Introduction

The world financial crisis reduced some world banking giants, such as Citigroup and Royal Banks of Scotland to ashes as their share prices tumbled by more than 95% from 2007 to January 2009. In the meantime, China's three large state-owned commercial banks replaced the American and European giants to become the three largest commercial banks in the world in market capitalisation by early 2009 after they were listed on the Hong Kong and Shanghai stock exchanges only two years earlier (Table 1, for detailed information, see Appendix III).

Table 1 Market capitalization of selected world largest banks 2005-09 ($ billion)

Banks	Dec-05	Dec-07	Dec-08	Mar-09
BOC	n.a.	229.7	110.3	129.6
ICBC	n.a.	371.8	173.0	192.5
CCB	n.a.	315.1	131.0	147.7
RBS	31.2	99.6	11.9	5.8
HSBC	177.1	195.0	112.3	94.7
Citigroup	265.8	147.1	38.9	13.9
BOA	156.9	183.1	70.6	43.7

Notes: BOC = Bank of China, ICBC = Industry and Commercial Bank of China, CCB = China Construction Bank, RBS = Royal Bank of Scotland, HSBC = Shanghai and Hong Kong Bank, BOA = Bank of America. All the values are measured in US dollars using official foreign exchange rates at each of the time periods.

Sources: http://finance.yahoo.com; http://www.google.co.uk/.

This dramatic development triggered our research curiosity as to why the Chinese commercial banks managed to avoid destruction by the world financial crisis and emerged to become the biggest winners in the world banking system as a result of the crisis.

The answer to this question comes from China's banking reforms that were conducted from 1998 in preparation for China to join the WTO (World Trade Organisation) and the post-WTO years (from 2001) to face competition of foreign banks entering into China. Along with China's comprehensive economic reform from 1978, the Chinese banking system has experienced tremendous structural transformations and fundamental changes. The banking system in China has evolved from a monopolistic state agent to one with more than a hundred commercial banks, urban cooperatives and financial institutions coexisting in the market.

In the past, banks served as government policy lending agencies, providing funds to state-owned enterprises (SOEs) and taking deposits from private and public savers. This was especially the case for the state-owned banks (SOBs). Encumbered with non-performing loans (NPLs), their profitability, productivity and asset quality remained quite low even after a series of banking reforms. Recently, the reform has focused on ownership diversification as reformers believe that tightened corporate governance, better budget control and privatization are ultimate ways to improve efficiency.

Foreign acquisition and stock listing are two major strategies for privatization without completely losing state control. Starting from 1999, the government has injected funds or stripped-off non-performing loans (NPLs) which together totalled RMB 2.62 trillion from the SOBs, enabling them to qualify for stock listing and become attractive to investors. In October 2005, China Construction Bank (CCB) was listed on the Hong Kong Stock Exchange (HKSE) successfully and it was followed by the Bank of China (BOC) and Industrial and Commercial Bank of China (ICBC) in 2006. The initial public offering (IPO) of ICBC on both of the Shanghai Stock Exchange (SSE) and HKSE was the largest IPO in the history of global capital market to that date.

The market reacted highly positive to these IPOs, in particular from the second half of 2006. Within 18 months, the SSE Composite Stock Index rose by nearly 300% to 6,124 in October 2007. The share prices of these SOBs rose by almost 100%. On 23 July 2007, ICBC's A share price reached RMB 5.75, making it the world's biggest bank by market value of over $251 billion, overtaking the US's Citigroup. Although bank share prices plummeted along with the collapse of the overall stock market in 2008, the annual reports of banks still disclosed encouraging results. For example, ICBC's profits increased by more than 60% in 2007 and maintained at 57% in the first half of 2008 despite tough market condition caused by the US credit crunch. This leads to an important research question whether IPO can improve bank efficiency. Thanks to their risk-averse nature, the Chinese listed SOBs turned out to be the least affected by the current world financial crisis among all the other big banks in the

world, outperforming their counterparts in the US and other major industrialized countries.

To compare bank efficiency before and after their IPOs, this paper employs the data envelopment analysis (DEA) and the super-efficiency model. According to our best knowledge, the effect of IPO on bank efficiency has not been well studied in the literatures because most banks have been listed on the stock exchanges for a rather short period of time. Apart from the effect of IPO, this paper will also answer a few other research questions. For example, how efficient are the Chinese listed banks currently? Have the SOBs become more efficient after a series of state supports? How is the scale efficiency of the Chinese SOBs? What are the key determinants of bank efficiency in China? What are the implications of the current world financial crisis on the Chinese SOBs?

The rest of the paper is organized as follows. Section 2 discusses the process of bank reform and evaluates the performance of the Chinese banking system. Section 3 reviews the literature on bank efficiency studies. Section 4 describes the research methodologies. Section 5 discusses the data and presents modelling results. Section 6 concludes and discusses policy implications.

2. Development of the Chinese Banking System

2.1 Chinese Banking System Reform

In 1949, the establishment of the People's Bank of China (PBOC) represented the beginning of China's contemporary banking system. For almost 30 years, the Chinese financial system was totally dominated by one single bank, the People's Bank of China (PBOC), which played a dual role of policy lending and commercial operation. Since economic reforms in 1978, the banking sector has experienced fundamental structural changes. The reform process could be divided into four stages.

The initial banking reform period of 1979-1985 saw the establishment of a two-tiered banking system, in which the commercial operation of PBOC was replaced by four

specialized banks, namely, the Agricultural Bank of China (ABC), the CCB, the ICBC, and the BOC. These specialized banks were the lending mechanism of the government, through which financial support was provided to SOEs. In order to fulfil the regional production and construction plans, the banks progressively accumulated huge amount of NPLs due to poor performance of SOEs. Moreover, these four specialized banks retained a monopoly power over specific sectors, contradicting the nation's original goal of marketisation. As a result, restrictions on bank operation were removed in 1985.

The second stage of bank reform during 1985-96 was characterized by further market reform and the establishment of three national policy banks. The policy banks were established in 1994 to take away policy lending activities of the aforementioned state-owned commercial banks, leaving the latter to focus on commercial lending activities only. Thereafter, the former four specialized banks were officially renamed as commercial banks which were expected to be operated based on profitability rather than driven by policy needs. In addition, the Central Bank Law and the Commercial Bank Law were passed in 1995 and 1996 respectively, representing the government's determination to further strengthen the authority of PBOC as the central regulatory bank and provide a legal framework for commercial bank operation. This period also saw the development of smaller JEBs, such as Bank of Communications (BOCOM), Shenzhen Development Bank (SDB) and China Merchants Bank (CMB). As these banks had greater independence from the central or local governments, their operations were more flexible, and the competition within the whole banking industry therefore intensified.

The third stage of bank reform lasted for almost 5 years until China's accession to the WTO in 2001. Major events during this period included the reorganization of PBOC, restructuring of some urban cooperatives into city commercial banks, the establishment of four Asset Management Companies (AMCs) and the first round of NPL disposal. In order to compensate the "Big Four" for more than two decades of policy lending and restore their financial health, the four AMCs were established to take over their NPLs. In 1999, 1.4 trillion RMB NPLs from the "Big Four" were disposed, which was almost equivalent to 20% of China's GDP in the same year.

The final step of the banking reform began after China's entry into the WTO. The NPLs of the "Big Four" were further stripped off (Table 2) and foreign acquisition and participation was encouraged. By the end of 2005, the NPLs to Total Loans of the three biggest state banks had been reduced from 33.3% in 1999 to 5.9% (Table 3). With a healthier balance sheet, Chinese SOBs began to be listed on the stock market. On October 20, 2005, the CCB was listed on HKSE, raising approximately $8 billion. This was followed by the BOC and the ICBC in 2006. The IPO of ICBC raised $21.9 billion and set a new world record, surpassing the $18.4 billion record set by Japan's NTT Mobile Communications Network Inc. in 1998 (Mitchell, 2006). This period also saw the listing of several joint-equity banks. By the end of 2006, the aggregated weighting of the banking sector was about half of the overall SSE Composite Index and they jointly exerted strong impact over the whole financial market (Yao et al., 2008).[1]

Table 2 NPLs Disposal of the "Big Four"

Year	Amount of NPL Unloading or Capital Injection	Assistance Mechanism
1999	RMB 1.4 trillion of the NPLs from the "Big Four"	NPLs transferred to AMCs
	$45 billion to BOC and CCB	Granted by state council to increase capital
2003	RMB 56.9 billion NPLs of CCB	NPLs write-off
	RMB 140.0 billion NPLs of BOC	NPLs write-off
2004	RMB 128.9 billion NPLs of CCB	NPLs transferred to AMCs
	RMB 149.8 billion NPLs of BOC	NPLs transferred to AMCs
2005	RMB 705.0 billion NPLs of ICBC	NPLs transferred to AMCs

Notes: NPLs = non-performing loans; AMC = state asset management company. CCB = China Construction Bank, BOC = Bank of China; ICBC = Industry and Commercial Bank of China. Big Four = CCB, BOC, ICBC and Agricultural Bank of China.
Source: Yao, et al. (2008).

[1] See appendix I for all the listing Chinese commercial banks until the end of 2007.

Table 3 NPLs/total loans ratios of state-owned banks (%): 1999-2008

Banks	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
ICBC	39.5	34.4	29.8	25.7	21.2	19.0	4.5	3.8	2.7	2.29
BOC	37.4	27.2	27.5	22.5	16.3	5.1	9.6	4.0	3.1	2.65
CCB	23.0	15.7	19.4	15.2	9.1	3.9	3.5	3.3	2.6	2.21

Notes: See notes to Table 2.
Source: Yao et al. (2008), for 1999-2005; Bankscope for 2006-08.

2.2 Current Performance of the Chinese Banking Sector

After a series of state supports, the amount of NPLs of the SOBs decreased significantly in recent years. By December 2008, the NPLs/total loans ratio of the SOBs was reduced to 2.81% (Table 4; Yao et al., 2004). The same ratio of JEBs also decreased sharply to 1.51%, indicating that all Chinese commercial banks had improved their risk management and credit control abilities.

Table 4 NPLs in Major Chinese Commercial Banks (billion yuan and %)

Years	2003	2004	2005	2006	2007	2008
All Banks	17.8%	13.21%	8.61%	7.09%	6.17%	2.45%
	2,440	1,718	1,313	1,255	12,684	5682
State-owned	20.1%	15.6%	10.49%	9.22%	8.05%	2.81%
Banks	1,853	1,575	1,073	1,054	11,149	4208
Joint-equity	8.1%	5.0%	4.22%	2.81%	2.15%	1.51%
Banks	197	143	147	117	860	737

Notes: NPL = non-performing loans. Figures in % measure the share of NPL in total loans. The values are absolute values of NPLs.
Sources: CBRC 2008 2Q- 2003; Bankscope 2003 and author's calculations.

In addition, the profitability of the major Chinese commercial banks had also improved. Although they rely heavily on interest incomes, the ratios of return on equity (ROE) and return on asset (ROA) of SOBs had risen almost three times from 2002 to 2006, reaching 10.7% and 0.6% respectively (Bankscope, 2002-06).

With a cleaned balance sheet and enhanced income generating ability, stocks of the banking sector became attractive when they were listed on the stock exchanges. During the bullish run of the Chinese stock market from 2006 to 2007, the market growth was distinguished by a rapid rise in the price of bank stocks, especially after the double listing of ICBC. On 23 July 2007, ICBC's A share price reached RMB5.75,

making it surpass the US's Citigroup to become the world's biggest bank by market value of over $251 billion (Yao et al. 2008b). Nevertheless, prices of banking stocks also plummeted because of the collapse of the Chinese stock market and the following world financial turmoil in 2008. Compared with those fragile Wall Street giants making huge losses due to the US credit crunch, performance of the Chinese banks was encouraging. For example, the net profit of BOC went up by 31% in 2007 even when it suffered tremendous losses in its US sub-prime related investment while ICBC managed to realize 65% rise in its net profit (Leow, 2008). Under the pressure of increased globalisation, banks not only need to expand their income generating operations in future, but more importantly, their risk resistance ability needs to be further strengthened.

3. Literature of Bank Efficiency

3.1 Scale and Scope Economies

The basic concept of "efficiency" could be explained as the ratio of output (goods and services) to input resources under certain conditions. In the banking environment, most of the earlier studies were focused on scale and scope economies (Yao et al, 2007). Economy of scale relates to firm size, and can be realized when the average costs decline as output rises while scope economy deals with efficiencies from joint production. Empirical studies of scale economy generally agreed that average cost could be minimized by medium-sized banks with asset ranging between $100 million and $300 million (Berger et al. 1993; Ferrier and Lovell, 1990; Berger and Humphrey 1991; Altunbas and Molyneux, 1996). However, this range could be increased substantially to between $2 billion and $10 billion if only bigger US banks were included in the model (Hunter et al., 1990; Noulas et al., 1990; Hunter, 1995). This could be best illustrated by the merger and acquisition between some huge UK commercial banks, like the Royal Banks of Scotland and the National Westminster Bank, and the Bank of Scotland with Halifax. For the scope economy, despite it was believed that joint production could cut off repeated investments, and hence increase bank efficiency; results of prior literatures were ambiguous (Gilligan et al., 1984; Lawrence and Shay, 1986; Mester, 1987; Edirisuriya and Brien, 2001).

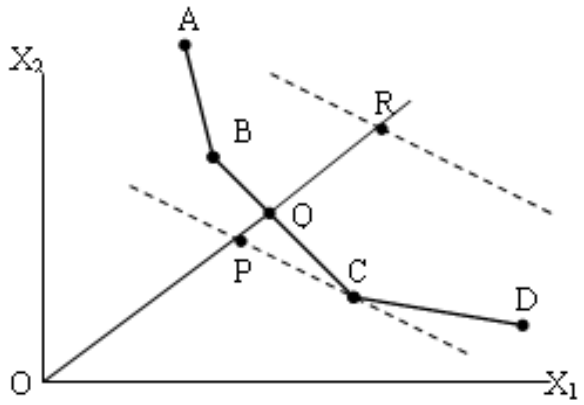
More recently, research has shifted to frontier efficiency studies. The concept of cost efficiency, first introduced by Leibenstein (1966), was not widely applied to the financial institutions until the late 1980s. Berger and Humphrey (1991) argued that instead of spending effort to realize some optimal level of scale and scope economies, banks could improve their cost efficiency more easily by simply reducing frontier inefficiencies. Later literatures supported their conclusion and confirmed that X-efficiency differences across banks were actually larger and dominated scale and scope economies, which accounted for about 20% of bank costs, while the other two diseconomies only took 5% of total costs (Berger and Humphrey, 1991; Hunter and Timme, 1986, 1991).

3.2 Concepts of X-Efficiency and Frontier Methods of Measurement

In the banking industry, the cost or input X-efficiency refers to the deviations from the cost frontier, where the banks output bundle is produced at the minimum cost for given input prices.[2] It can then be further divided into two components—technical efficiency (TE) and allocative efficiency (AE). The former one refers to the ability to achieve optimal utilization of all available resources either by producing maximum output for a given input mix or by using minimum inputs to produce a given output while the latter one refers to the ability to achieve the optimal combination of inputs and outputs facing fixed prices (Lovell, 1993; Yao et al. 2007). Figure 1 depicts the relationships among the overall efficiency, TE and AE.

[2] Unlike the manufacturing firms producing physical goods, how to measure banks output is always an issue. According to different approaches, many variables, like total loans, deposits, profit before tax, etc. can all be chosen as the output of the bank. This problem will be discussed in the following section.

Figure 1 Technical, Allocative and Overall Efficiency



Two inputs, X_1 and X_2 are used to produce a single output. The space above the piecewise linear curve ABCD and its vertical and horizontal extensions contains all feasible levels of input mix to secure a unit of output. The curve ABCD is the locus of technical efficient input levels because on that curve lowering one input level would require the raising of the other. The cost line is labelled PC, tangential to ABCD at C. Thus the point C has the combination of input levels which can deliver a unit of output at the lowest aggregate cost feasible. If unit R were to become technically efficient, it would operate at Q. OQ/OR is therefore the technical input efficiency. As the aggregate cost of the inputs at Q can be lowered at P, OP/OQ is the allocative efficiency of unit R. The overall efficiency of unit R is OP/OR and it can be deduced that under constant return to scale (CRS);

$$\frac{OP}{OQ}\frac{OQ}{OR}=\frac{OP}{OR} \qquad (1)$$

However, the above equation is only appropriate when the assumption holds, hence, technical efficiency is further decomposed into pure technical efficiency (PTE) and scale efficiency (SE). Under various return to scale (VRS), Haunter (2005) amended the cost efficiency equation into the following formula;

$$CE=AE*SE*TE \qquad (2)$$

That is, cost efficiency (CE) is a product of allocative efficiency (AE), SE and technical efficiency (TE).

There are five approaches, namely, stochastic frontier approach (SFA), distribution-free approach (DFA), thick frontier approach (TFA), DEA and free disposal hull (FDH) to measure a bank's X-efficiency. Due to the assumptions imposed on the sample data in areas like the functional form of the best-practice frontier, the treatment of the error terms and the distributions assumed for inefficiency and random errors, the first three methods were classified as parametric, while the others were non-parametric methods. These frontier measurements are believed to be superior to those financial ratio indicators because the numerical efficiency ratings and the ranking of the firms estimated by them are more comprehensive and objective (Cooper, 2007).

3.3 Literature of X-efficiency Studies

Summarizing the previous frontier efficiency studies, average efficiency scores of 88%-94% for the US banks, about 85% for the developed economies, 76%-82% for the EU banks and around 68% for the emerging markets were usually identified (Fu and Heffernan, 2007). Normally, these studies were focused on three aspects, the comparison of private, foreign and public ownership (Weill, 2003; Kraft and Tirtiroglu, 1998; Taci and Zampieri, 1998; Opiela, 2000; Hasan and Marton, 2003); the effects of mergers and acquisitions (Berger and Humphrey, 1992; Rhode, 1993; Shaffer, 1992), and the influence of foreign entry and deregulation (Unite and Sullivan, 2003; Chen, 2001; Claessens et al, 2001; Hao, 2001).

For the ownership structure of banks, it had been argued that privatization was an effective way to improve corporate governance, increase bank competition and to realize an optimal allocation of scarce financial resources. One specific form of such private ownership, foreign control was particularly welcomed by the Chinese reformers because it not only had the merit of private ownership but also had other advantages, such as sharing their know-how in organization as well. However, contrary to the above theoretical rational in favor of private ownership and foreign control, results from prior studies were ambiguous (Weill, 2003; Opiela, 2000; Hasan and Marton, 2003; Sturm and Williams, 2004; Borovicka, 2007; Mahajan et al. 1996; Chang et al., 1998; DeYong and Nolle, 1996; Berger et al., 2000). Such inconsistency was explained as the result of the excessive cost incurred when foreign banks

combine their own management pattern with local banks or due to their inability to integrate into the local markets.

The effect of merger and acquisition on bank efficiency (M&A) has drawn attention of scholars since the 1980s when a large M&A wave among the US banks started. Earlier studies based on the 1980s data identified little improvement, around 5% after consolidation (Berger and Humphrey, 1992; Peristiani, 1997; Rhoades, 1993) while later studies employing 1990s data showed significant positive effect (Rhoades, 1998; DeToung, 1997; Akhavein, et al., 1997; Berger and Mester, 1999). Results outside the US were also mixed. Efficiency outcomes could be heavily influenced by the specific characteristics of the merged banks and also the economic environment of the country during particular periods (Lin, 2005; Resti, 1998; Avkiran, 1999; Drake and Hall, 2003)

Efficiency studies of financial liberalization and deregulation generally confirmed obvious positive effects, except for the European market (Berg et al., 1992; Zaim, 1995; Canhoto and Dermine's, 2003; Girardone et al., 2004; Sturm and Williams, 2004; Casu and Philip, 2003; Caus and Girardone, 2004). After extensive integration and EU legislative harmonization processes, their impacts on European bank efficiency were still not clear-cut.

Recently, some researchers began to compare the efficiency among different nations or to test the consistency among different frontier measurement methods (Pastor et al., 1997; Bos and Kolari, 2005; Berg et al., 1993; Ferrier and Lovell, 1990; Bauer et al., 1998; Weill, 2004). Employing data of 683 US banks, study of Bauer et al. (1998) reported consistent efficiency scores, best performance identities and banking rankings generated by either parametric or non-parametric approaches. However, outcomes between the two groups were not mutually consistent, with much lower efficiency scores estimated by DEA.

Apart from all those studies done on the US or European banks, efficiency studies of the emerging economies, especially China have become increasingly popular. Early works mainly focused on analysing the process of banking reform, the relationships between banks' performance and foreign banks participation and factors that attract

foreign banks' investment. However, most of them were published in Chinese and were unavailable to foreign scholars. Within the limited number of publicly accessible literatures, later efficiency studies using frontier techniques normally concluded that the overall efficiency of the Chinese commercial banks had been enhanced substantially after reforms and in general, JEBs were more efficient than their state-owned counterparts (Berger et al., 2005; Chen et al. 2005; Fu and Heffernan, 2007; Yao et al. 2007).

For example, Using DEA, most of the studies were able to confirm that the Chinese commercial banks were mainly DEA inefficient. The technical efficiency of the JEBs were 10-20% higher than the SOBs (Wei and Wang, 2001; Zheng and Zhang, 2004; Li and He; 2005; Zhao et al., 2002; Zhang, 2003; Li et al., 2005), except Chen et al. (2005) claimed that the performance of the SOBs were superior after deregulation. Studies also found that the inefficiency of the JEBs were mainly because of failing to realize scale efficiency, while for the SOBs, PTE accounts for a bigger percentage. Later studies employing parametric method—SFA generally supported the above findings and some of them further analyzed the factors that influence bank efficiency, like ownership structure, ratio of equity to total asset, etc. (Yao et al., 2004; Yao et al., 2007; Zhang, 2003; Qian, 2003; Zhang and Cao, 2005; Wang and Tan, 2007).

As IPOs of Chinese commercial banks have only become popular in recent years, few studies have analyzed the effect of listing on banks efficiency. In Liu and Song's (2004) study, they concluded that within those joint-equity banks, listed banks, such as China Merchant Bank (CMB) and Pudong Development Bank (PDB), had a higher than average efficiency score. However, they did not track the efficiency change of a particular bank before and after its listing due to data constraints, and were unable to say whether the IPO was an effective way of improving banks efficiency. Employing panel data of 14 listed banks over 1999-2007, this paper aims to overcome this obstacle and to provide some evidence on stock listing and efficiency enhancement.

4. Methodologies and Data Description

Since the beginning of the frontier efficiency study, the debate over the best efficiency measurement methods has never stopped. The parametric approaches presupposed the shape of the frontier, making it hard to divide the estimated inefficiency from specification errors. The non-parametric methods which eliminate the influence of random errors are also subject to criticism. In empirical work, researchers normally choose a particular approach based on the characteristics of data. In this study, we would apply the non-parametric approach, DEA as it imposes fewer requirements on the input and output variables.

4.1 Data Envelopment Analysis—DEA

Charnes, Cooper and Rhodes (1978) extended the single input-output model of Farrell (1957) and introduced DEA. In their original study, they described DEA as a non-parametric linear programming technique which provided a new way of efficiency measurement. The relative efficiency of a particular decision making unit (DMU) could be calculated by computing the ratio of outputs to inputs. The basic input-oriented[3] DEA model, CCR, which was proposed by Charnes, Cooper and Rhodes (1978), could be illustrated as the following:

Assuming a set of DMUs, $j = 0, 1 \ldots n$, consumes m different inputs to produce s outputs. More precisely, DMU_j uses amount x_{ij} of input i to produce amount y_{rj} of output r and we further assume that $x_{ij} \geq 0$, $y_{rj} \geq 0$. In this situation, the efficiency of each DMU can be determined by the maximum of the ratio of weighted outputs to weighted inputs subject to the condition that the virtual output to input ratio of every DMU, including itself must not exceed unity. This mathematical programming problem for particular DMU with the subscript 0 could be illustrated as the following:

$$\max h_0 = \sum_{r=1}^{s} u_r y_{r0} \Big/ \sum_{i=1}^{m} \upsilon_i x_{i0} \qquad (3)$$

[3] Input orientated model focus on estimating the extent of input that could be reduced while maintaining output levels. While the output-orientated model investigates the extent of outputs could be increased for a given input level. Lovell (1993) suggested that if a producer could control the amount of its inputs,

subject to

$$\sum_{r=1}^{s} u_r y_{r0} \Big/ \sum_{i=1}^{m} \upsilon_i x_{ij} \le 1 \text{ for } j=1, \ldots, n,$$

$$u_r, \upsilon_i \ge 0 \text{ for all } i \text{ and } r.$$

where y = outputs, x = inputs; $y_{rj} = r_{th}$ output of DMU j, $x_{ij} = i_{th}$ input of DMU j; u_r and υ_i are coefficients of r_{th} output and i_{th} input that maximize h_0; $i = 1 \ldots m$, $r = 1 \ldots s$ and they are the index of DMUs' inputs and outputs respectively.

One problem of equation (3) is that the solution it generated is infinite. Charnes et al. (1978) worked out this issue by adding one more constraint: $\sum_{i=1}^{m} \upsilon_i x_{i0} = 1$ and therefore the above equation with the restriction can be illustrated as:

$$\max z = \sum_{r=1}^{s} u_r y_{ro} \qquad (4)$$

subject to

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \le 0$$

$$\sum_{i=1}^{m} v_i x_{io} = 1$$

$$u_r, v_i \ge 0$$

Solving equation (4) by its 'dual'[4], the envelop-formed model could be expressed as the following:

[4] For detailed proof, see Cooper et al. 2006, appendix A.4. The "Duality Theorem" suggests that: *"(i) In a primal-dual pair of linear programs, if either the primal or the dual has an optimal solution, then the other one does also, and the two optimal objective values are equal; (ii) If either the primal or the dual problem has an unbounded solution, then the other has no feasible solution; (iii) If either problem has no solution then the other problem either has no solution or its solution is unbounded."*

$$\min \quad \theta \tag{5}$$

subject to

$$\sum_{j=1}^{n} x_{ij}\lambda_j \le \theta x_{io} \quad i = 1, 2, ..., m;$$

$$\sum_{j=1}^{n} y_{rj}\lambda_j \ge y_{ro} \quad r = 1, 2, ..., s;$$

$$\lambda_j \ge 0 \quad j = 1, 2, ..., n.$$

$\lambda = (\lambda_1, ..., \lambda_n)^T$ is a non-negative vector of variables. When $\theta = 1, \lambda_0 = 1, \lambda_j = 0 (j \neq 0)$, a feasible solution of DPL could be found. In general, the optimal θ, denoted by θ^*, is less than 1. Moreover, due to the nonzero assumption of the data, the constraint $\sum_{j=1}^{n} y_{rj}\lambda_j \ge y_{ro}$ forces λ to be nonzero as $y_{ro} \ge o$ and $y_{ro} \neq 0$. Therefore, the estimated efficiency of particular DMU θ^* is bounded between (0, 1].

This basic form of CCR model assumed that all the DMUs were operated under CRS[5] whereas even in a homogeneous environment, such assumption could be hardly achieved. By adding one more constraint, $\sum_{j=1}^{n} \lambda_j = 1$, Banker, Charnes and Cooper (1984) improved the original model and make the evaluation of the returns-to-scale effect possible. In our study, we will apply both of the CCR and BCC model to get a more objective measure of bank efficiency.

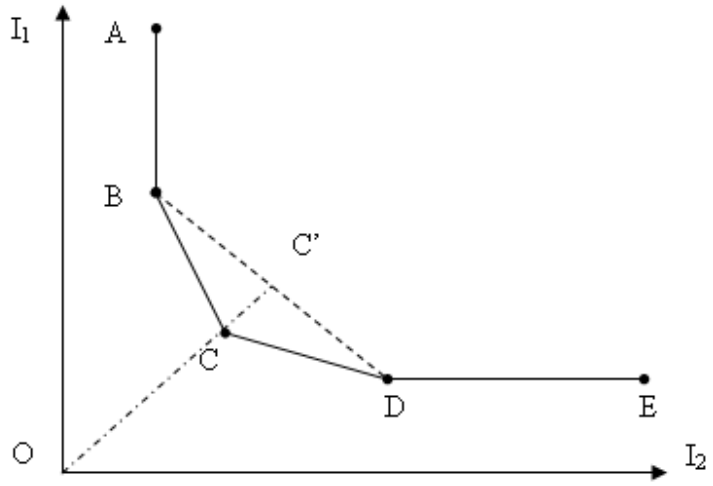
4.2 Measurement of Super Efficiency

One weakness of DEA is that it could grant many DMUs the highest level of efficiency simultaneously. The size of the sample is not large enough compared with the number of input and output variables. Andersen and Petersen (1993) overcame this obstacle by proposing a super-efficiency model. It enabled the ranking among efficiency DMUs become possible. Changing the reference set of the original CCR

[5] When running DEA, the analyst is often concerned with the nature of returns to scale that would best reflect the operations of the DMUs in the sample. CRS implies that outputs would increase proportionately to additional inputs. Conversely, VRS means a disproportionate rise or fall in outputs when inputs have increased. Normally, it has two types, increase returns to scale (IRS) or decrease returns to scale (DRS).

model, the super-efficiency model provides the same efficiency score for those inefficiency DMUs while generates larger than '1' scores for those efficient DMUs (Figure 2).

Figure 2 Super-efficiency Measurement of the DMU



The solid line ABCDE is the efficiency frontier estimated by the CCR model and I_1 and I_2 are two different inputs. Take DMU C as an example, when we use the super-efficiency model to estimate its efficiency score, C itself will be excluded by the reference set and its efficiency score is represented by the ratio: TEc= OC'/OC $\geq$ 1. It means that the efficient DMU C could expand its input by TEc and still be efficient in the whole sample. Therefore, the bigger the TEc score assessed by the super-efficiency model, the more efficient the DMU is.

Existing studies on Chinese banks show that several JEBs and SOBs could be ranked as fully efficient simultaneously in one sample (Zheng and Cao, 2005; Wei and Wang, 2000). In order to assess the effect of stock listing more precisely by different estimated efficiency scores, this study will run the super-efficiency model after the CCR and BBC models.

5. Data and Results

5.1 Data

Measuring bank outputs and inputs is one of the most difficult and controversial areas in efficiency study. Unlike manufacturing firms producing physical goods, banks provide both intermediary services and a wide range of financial products. Two different approaches, production and intermediation, have been widely used in the literature.

The production approach assumes that profit maximization is banks' key objective. Therefore, the number and type of transactions and related documents is the best output measure while inputs are restricted to physical inputs including labour and capital (Yao et al, 2007). The intermediation approach pioneered by Sealey and Lindley (1977) considers banks as an intermediary between savers and borrowers. As a result, deposits are treated as an input because they are the source of loans and investments. Neither of the two approaches is perfect as each only addresses one side of the role played by banks. In practice, both approaches are used as complementarities to each other.

In this study, we adopt the intermediation approach that treats bank deposits as an input while interest income as an output. The output variables include (1) Total Earning Assets = Loans + Other Earning Assets (including Short-term Investments, Long-term Investments, Deposits with Central Banks, Other Investments, etc.) and (2) Interest Incomes. The input variables include (1) Number of Employees, (2) Fixed Assets and (3) Deposits. As data for the number of employees is seldom disclosed and other resources cannot be used as a substitute, missing values will be estimated in accordance with the change of Total Assets (Liu and Song, 2004; Wang and Tan, 2007).

Most of our data are extracted from Bankscope, consisting of a panel of 14 listed Chinese commercial banks with 125 observations during 1999-2007.[6] For estimating

[6] Data of Ningbo Bank in 1999 are unavailable.

the models, additional data are derived from other sources, including *Chinese Statistical Yearbook* (NBS, various issues), *Almanac of China's Finance and Banking* 1999-2007, websites of People's Bank of China (PBOC) and China Banking Regulatory Commission (CBRC), and annual reports of banks.

5.2 Efficiency Comparison before and after IPO

We first apply the input-oriented CCR model and summarise the results in Table 5. Consistent with earlier studies, the mean efficiency of the Chinese commercial banks is about 0.7 and the JEBs are the best performers among all the banks. On average, efficiency scores of JEBs, SOBs and city commercial banks are 0.81, 0.52 and 0.64 respectively. Despite the latest reforms on SOBs, their performance is still poorer than the other two types of banks (Figure 3). From 125 sample DMUs, 11 are fully efficient but none of them is state-owned.

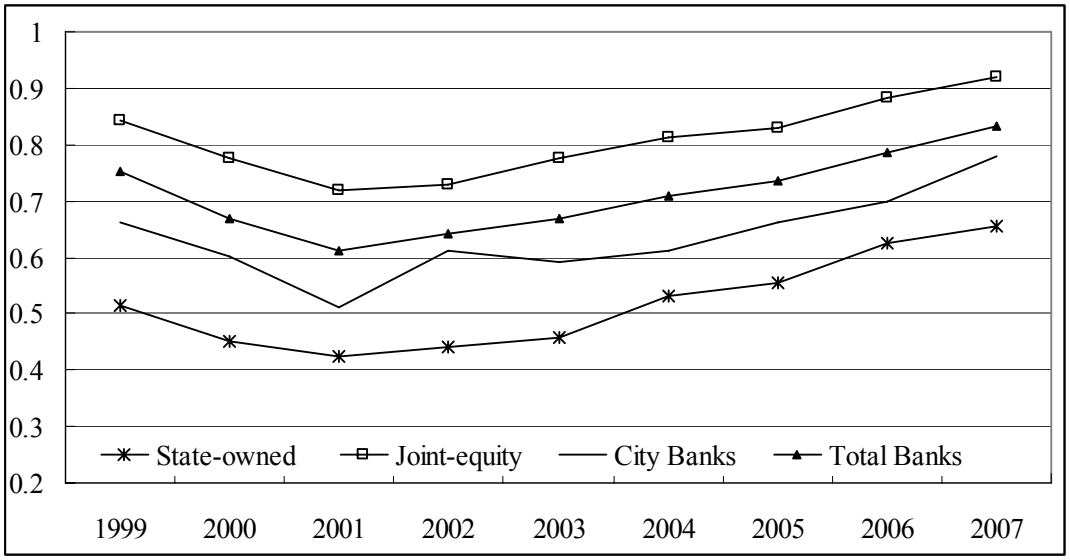
Empirical results support the hypothesis that stock listing is an effective way to improve bank efficiency. Ten out of 14 listed banks raised their efficiency after listing and the efficiency of the Industrial Bank had achieved "1" even before IPO. Under increased pressure of public scrutiny and foreign competition, banks are forced to expand their business operations to emerging areas and allocate their resources more effectively.

Table 5 Efficiency Levels of Chinese Listed Banks before and after IPO--CCR

State-owned banks	Efficiency level		Joint-Equity banks	Efficiency level	
	Before IPO	After IPO		Before IPO	After IPO
BOC	0.59	0.61	BOCOM	0.94	1.00
CCB	0.52	0.63	CITIC	0.85	0.89
ICBC	0.67	0.64	CMB	0.64	0.69
City banks	**Efficiency level**		CMINB	0.80	0.82
	Before IPO	**After IPO**	HXB	0.82	0.71
Beijing	0.87	1.00	Industrial	1.00	1.00
Nanjing	0.72	0.81	PDB	0.94	0.89
Ningbo	0.51	0.52	SDB	--	--

Notes: Full names of the banks are listed in the appendix; for the banks which were listed in 2007, data of 2008 are not available, so their "before IPO" efficiency scores are the efficiency level of 2006 and their "after IPO" efficiency scores are the efficiency level of 2007; SDB was listed on the stock market in 1991, so its information could not be included in this table.

Figure 3 Efficiency of the Chinese Commercial Banks, 1999-2007--CCR



As for scale efficiency, the CCR model reported that all 27 DMUs of SOBs displayed DRS, while for JEBs and city commercial banks, more than 60% of DMUs presented IRS, in line with some earlier studies (Yao et al. 2008a). To exclude the effect of scale economies on bank efficiency, the following runs a VRS model based on BCC.

The BCC model estimates banks' PTE without the influence of scale economy. After removing the negative impact of scale diseconomy, the overall efficiency of Chinese

commercial banks increased sharply to 0.82. Meanwhile, 23 DMUs realized full efficiency by this measure, representing almost 20% of the sample. In particular, the entire SOBs' efficiency scores are "1" in 2007. Under VRS estimation, the average efficiency score of SOBs increased by almost 30% while this ratio for JEBs is just 6%. The efficiency gap between the two groups is greatly reduced. Compared with the previous 30% efficiency deficit, the mean efficiency of SOBs is now just 3% lower than that of JEBs, suggesting that the main source of SOB inefficiency comes from diseconomy of scale. Despite continued improvement of their productivity and profitability, large overhead expenses due to overstaffing and an extensive network of branches make SOBs' overall efficiency inferior to JEBs. For pure technical efficiency (PTE), however, SOBs had already outperformed all the other banks since 2005 (Figure 4).

Figure 4 Efficiency of Chinese Commercial Banks, 1999-2007 (BCC Approach)

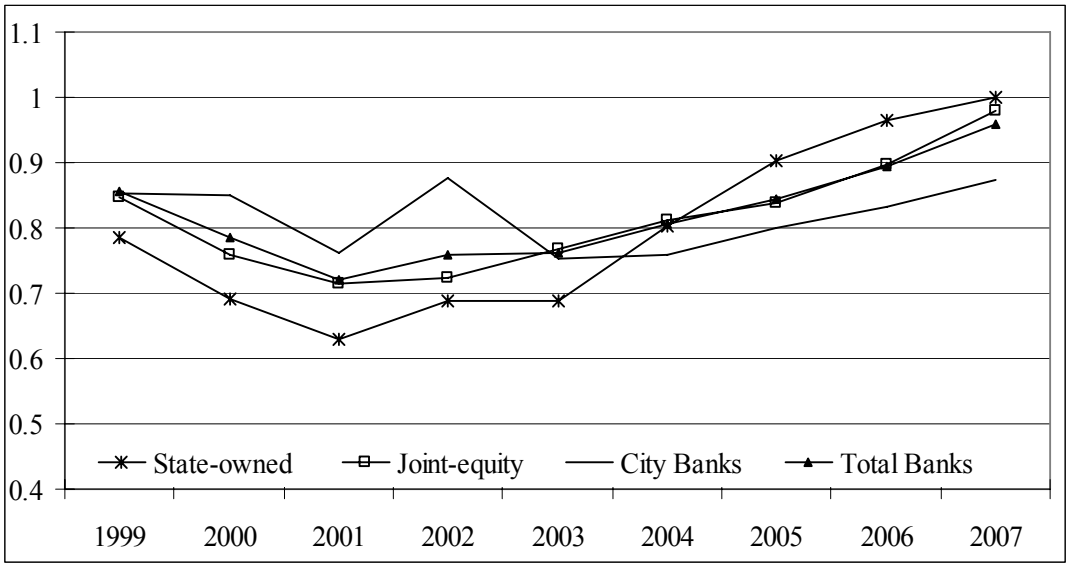


Table 6 compares the VRS efficiency score before and after IPO. The results are not dissimilar to those obtained from the CCR model. The efficiency of ten banks was enhanced after stock listing. For the banks listed on the stock exchanges earlier, such as PDB and CMINB, their efficiencies decreased slightly after IPO. This might have been due to the inactive role the stock market played in the overall financial sector during that period. As the highest possible efficiency score is one, it is impossible to detect any efficiency improvement of a particular bank whose efficiency score was

already unitary after IPO. To overcome this limitation, it is necessary to employ the CRS and VRS super-efficiency models in the next section.

Table 6 Efficiency Scores of Chinese Listed Banks before and after IPO--BCC

State-owned banks	Efficiency level		Joint-Equity banks	Efficiency level	
	Before IPO	After IPO		Before IPO	After IPO
BOC	0.96	1.00	BOCOM	0.94	1.00
CCB	0.80	0.95	CITIC	0.87	1.00
ICBC	0.98	1.00	CMB	0.65	0.70
City banks	**Efficiency level**		CMINB	0.87	0.81
	Before IPO	**After IPO**	HXB	0.72	0.82
Beijing	0.87	1.00	Industrial	1.00	1.00
Nanjing	0.99	1.00	PDB	0.99	0.92
Ningbo	0.63	0.62	SDB	--	--

Notes: Full names of the banks are listed in the appendix; for the banks which were listed in 2007, data of 2008 are not available, so their "before IPO" efficiency scores are the efficiency level of 2006 and their "after IPO" efficiency scores are the efficiency level of 2007; SDB was listed on the stock market in 1991, so its information could not be included in this table.

5.3 Results of Super-efficiency Measurement

The super-efficiency model provides the same efficiency scores for those inefficient DMUs while generates higher than "1" efficiency scores for those efficient DMUs estimated by the traditional DEA. Such measurement enlarges the estimated efficiency differences and makes the efficiency comparison among DMUs more straightforward. Table 7 lists the super-efficiency scores with a VRS assumption. On average, the overall efficiency is improved by 10% assuming VRS and by 6% assuming CRS after listing. For SOBs, their higher efficiency scores are mainly attributed to increased PTE rather than scale economies. The efficiency of Ningbo Bank was raised by 2% assuming CRS but reduced by 1% assuming VRS after IPO. These controversial results suggest that stock listing may improve efficiency in two ways. IPO can improve banks' PTE by imposing more pressure on their operations and helps banks realize their scale economy by making public funding sources more accessible.

Table 7 Super-efficiency of Listed Banks before and after IPO (VRS approach)

State-owned banks	Efficiency level		Joint-Equity banks	Efficiency level	
	Before IPO	After IPO		Before IPO	After IPO
BOC	0.96	1.07	BOCOM	0.94	1.03
CCB	0.80	0.95	CITIC	0.87	1.05
ICBC	0.98	1.00	CMB	0.65	0.70
Average	9.13	1.01	CMINB	0.87	0.81
City banks	**Efficiency level**		HXB	0.72	0.82
	Before IPO	**After IPO**	Industrial	1.00	1.43
Beijing	0.87	1.15	PDB	0.99	0.92
Nanjing	0.99	1.05	SDB	--	--
Ningbo	0.63	0.62	*Average*	0.86	0.97
Average	0.83	0.94			

Notes: Full names of the banks are listed in the appendix; for the banks which were listed in 2007, data of 2008 are not available, so their "before IPO" efficiency scores are the efficiency level of 2006 and their "after IPO" efficiency scores are the efficiency level of 2007; SDB was listed on the stock market in 1991, so its information could not be included in this table.

It is also worth noting that super-efficiency scores for some JEBs, such as BOCOM and Industrial Bank, were as high as 1.79 and 1.42 respectively in 2007. It means that even if their inputs were expanded radically by 1.79 or 1.42 times, they would still operate on the efficient frontier. These two banks have also been chosen as the reference set for inefficient DMUs in most time periods.

The above empirical results show a positive effect of stock listing on bank efficiency based on DEA. However, we have not been able to explain why these efficiency improvements have taken place. This question needs to be answered in the following section where a regression analysis will be conducted to identify the key determinants of efficiency scores.

5.4 Determinant of Banks Efficiency

Bank efficiency can be influenced by various factors, both internal and external. Five variables are included in the following regression analysis, ownership, return on asset (ROA), the ratio of loan loss reserves to total loans (LLR/TL), stock listing, and time

capturing natural technological progress.[7] The dependent variable is the efficiency scores derived with different assumptions from the previous section. The regression results are presented in Table 8.

Table 8 Determinants of Bank Efficiency

Factors	Coefficient	Std. Error	t	p>| t |
Constant.	0.68105	0.04174	16.32	0.000
Ownership	-0.12223	0.02286	-5.35	0.000***
IPO	0.08276	0.03920	2.11	0.037**
ROA	0.16098	0.06150	2.62	0.010**
LLR/TL	-0.0052	0.00588	-0.88	0.380
t	0.00060	0.00742	0.08	0.936

Notes: *** means the variable is significant at 1% level and ** means the variable is significant at 5% level.

Three variables, ownership, IPO, and ROA, are found to have significant effects on efficiency. The negative sign of 'ownership' means that on average, JEBs are the most efficient banks, 12.2% more efficient than SOBs and 24.4% more efficient than city commercial banks. The sign and size of the coefficient on IPO implies that stock listing can improve bank efficiency by 8%, *ceteris paribus*. Two financial ratios measuring profitability (ROA) and asset quality (LLR/TL) are shown to have a positive impact on efficiency although the coefficient on LLR/TL (loan loss reserves to total loans) is not significant statistically. A higher ROA ratio means that banks could generate more profits for certain assets and hence more efficient. The LLR/TL ratio reflects the financial strength of banks. A higher ratio means that banks are exposed to lower level of credit risk and thus are expected to be more efficient.

6 Conclusion Remarks

After a series of bank reforms, Chinese reformers adopted privatization through stock listing as the final step of strengthening bank performance. Starting from 1999, the government injected funds or stripped-off NPLs totalling RMB 2.62 trillion from the SOBs to help them build up a sound balance sheet. In October 2005, the pilot bank CCB was successfully listed on the HKSE, followed by other two large state-owned

[7] For ownership, '0' represents joint-equity banks, '1' state-owned banks and '2' city commercial banks. For stock listing, '1' represents listed and '0' otherwise.

banks, BOC and ICBC in 2006. During the same period, six JEBs or city commercial banks were also listed on the stock exchanges in China and Hong Kong. By the end of 2007, 14 Chinese commercial banks had been listed and the market reacted positively, coincided with a bullish run of the Chinese stock markets.

Although financial markets throughout the world have plummeted caused by the US credit crunch from 2007 and the subsequent world-wide financial crisis from October 2008, the annual reports of most Chinese commercial banks still show encouraging results (Appendix III). This raises our central research question whether China's recent efforts to privatise SOBs through stock listing has helped improve banking efficiency.

Employing data of 14 listed banks during 1999-07, DEA results using different estimation techniques with alternative assumptions provide potent evidence that banking efficiency in China has been improved. The average efficiency of the sample banks was improved by 10% over the data period measured by the CRS super-efficiency approach. It is suggested that IPO not only improves efficiency by imposing a hard-budget constraint on banking operations as after listing the state will not be obliged to bail out failing SOBs, but also helps banks realize their scale economy through raising capital from investors. Such positive effect is further confirmed by a regression analysis which identifies a few important determinants of efficiency scores. Among the key determinants, IPO stands out to be an important and significant factor. On average, IPO helped banks to raise their average efficiency by about 8%. In addition, the regression results also show that JEBs are the most efficient banks, more efficient than SOBs and city commercials banks. The city commercial banks are the least efficient and their low efficiency could have been due to diseconomy of scale.

The empirical results provide important insights into the Chinese banking reforms during the past few years. Privatization via stock listing has proved to be effective in improving banks efficiency. Information related to these listed companies is more readily available to investors and thus making them subject to increased pressure of public scrutiny. Following the listed SOBs, the state has injected another $19 billion

to the Agricultural Bank of China (ABC), on 21 October 2008, aiming to strengthen its balance sheet before it can also be listed in a later stage.

From the beginning of 2008, the share prices in two Chinese stock markets have plumped by over 70%. The sharp drop of share values in China took place before stock markets in the rest of the world suffered severe losses from October 2008 caused by the world-wide financial crisis. Both internal and external shocks to the Chinese stock markets raise further research questions as to whether the haste of the Chinese government to list the large SOBs and other mega-size state-owned enterprises was a main reason responsible for the stock market bubble and its burst during 2005-08 (Yao and Luo, 2008c). If this is the case, the effect of IPO on bank efficiency may need more time to be testified. However, the preliminary results in this paper based on the data before the stock market crash provide indisputable evidence of efficiency improvement. As a result, we conclude that IPO is an effective way to raise bank efficiency with a caution that further research needs to be done as more data become available.

Finally, it is important to note that as a result of the world financial crisis, the three listed Chinese banks emerged to become the top three largest banks in the world in market values and profitability in 2008 and 2009, significantly outperforming all the western banking giants. In retrospect, the bank reform in China from 1998 to 2006 provided a sound capital and institutional basis for the listed banks to withstand the most severe financial crisis in the world since the 1930s. They became the biggest winners in the world financial system as many of the western banks endured massive losses in share prices and profits. The systematic meltdown of the western banks was the most important factor responsible for the crisis. In contrast, the relative strength of the Chinese banks was a great hope for the Chinese and the world economy during the crisis.

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Appendix I

Name of the Bank	IPO Date	Name of the Bank	IPO Date
Shenzhen Development Bank	03/04/1991	Bank of China	05/07/2006
Pudong Development Bank	10/11/1999	ICBC	27/10/2006
Minsheng Bank	19/12/2000	Industrial Bank	05/02/2007
China Merchant Bank	09/04/2002	CITIC	27/04/2007
Huaxia Bank	12/09/2003	Ningbo Bank	19/07/2007
China Construction Bank	27/10/2005	Nanjing Bank	19/07/2007
China Bank of Communications	23/06/2005	Beijing Bank	19/09/2007

Appendix II Names and Abbreviations of National Commercial Banks in China

Abbreviations	Full Name of the Banks
BOC	Bank of China Limited
BOCOM	Bank of Communications Co. Ltd
Beijing	Beijing City Commercial Bank
CCB	China Construction Bank Corporation
CITIC	China CITIC Bank
CMB	China Merchant Bank
CMINB	China Minsheng Banking Corporation
HXB	Hua Xia Bank
ICBC	Industrial & Commercial Bank of China
Industrial	Industrial Bank Co. Ltd
Nanjing	Nanjing City Commercial Bank
Ningbo	Ningbo City Commercial Bank
PDB	Shanghai Pudong Development Bank
SDB	Shenzhen Development Bank Co., Ltd.

Appendix III:

Share prices, market values and profits of selected banking giants in the world

		Dec-98	Dec-01	Dec-05	Dec-07	Dec-08	Mar-09
BOC	Share price				0.90	0.43	0.51
	Market cap.				229.69	110.30	129.59
	profit before tax	1.03	1.88	7.54	13.51	12.76	
ICBC	Share price				1.11	0.52	0.58
	Market cap.				371.76	173.01	192.52
	profit before tax		1.83	8.96	17.75	21.27	
CCB	Share price				1.35	0.56	0.63
	Market cap.				315.12	130.96	147.68
	profit before tax	0.25	1.31	7.77	15.49	17.52	
RBS (UK)	Share price	5.21	7.91	9.80	8.57	0.72	0.35
	Market cap.	4.52	21.84	31.21	99.55	11.85	5.80
	profit before tax	1.67	6.23	13.65	19.47	-59.37	
HSBC (Hong Kong)	Share price	8.11	11.70	16.04	16.89	9.51	5.50
	Market cap.	65.40	108.06	177.10	194.99	112.32	94.68
	profit before tax	6.57	8.00	20.97	24.21	9.31	
Citigroup (US)	Share price	23.19	47.10	48.53	29.44	6.71	2.53
	Market cap.			265.80	147.06	38.89	13.94
	profit before tax			28.56	0.78	-53.06	
BoA (US)	Share price	30.06	31.48	46.15	41.26	14.08	6.82
	Market cap.	51.82	49.08	156.91	183.11	70.64	43.68
	profit before tax	8.05	10.46	24.48	20.92	4.43	

Note: When the share price data of 31 December 1998 do not exist, we use the earliest 1999 January figure instead; Share price: $ US dollar; Market cap: $ US dollar billion; Profit before tax: $ US dollar billion; the market cap. is calculated by the author using the following formula: Market cap.=No of shares * share price; the exchange rate we use are from: http://finance.yahoo.com/currency-converter?u#from=GBP;to=USD;amt=1;

	Dec-98	Dec-01	Dec-05	Dec-07	Dec-08	Mar-09
RMB:$				7.3046	6.8346	6.8359
£:$	1.664	1.4562	1.72	1.98	1.46	1.43
HKD:$	7.7459	7.8003	7.7536	7.7979	7.7506	7.7504

Source: share prices: http://www.google.com/finance, http://finance.yahoo.com/ and http://www.sse.com.cn/sseportal/webapp/datapresent/queryindexcnp?indexCode=000001&indexName=; profit and number of shares: official websites of the banks, e.g. RBS: http://www.rbs.com/, Citigroup: http://www.citigroup.com/.