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WTO Challenges and Efficiency of Chinese Banks

Shujie Yao, Chunxia Jiang, Genfu Feng and Dirk Willenbockel*

Abstract: After joining the WTO in December 2001, China was given 5 years to completely open up its banking market for international competition. Chinese banks have been renowned for their mounting non-performing loans and low efficiency. Despite gradual reforms, the banking system is still dominated by state ownership and encapsulated monopolistic control. How to raise efficiency is a key to the survival and success of domestic banks, especially the state-owned commercial banks. Two important factors may be responsible for raising efficiency: ownership reform and hard budget constraints. This paper uses a panel data of 22 banks over the period 1995-2001, and employs a stochastic frontier production function to investigate the effects of ownership structure and hard budget constraint on efficiency. Empirical results suggest that non-state banks were 8-18% more efficient than state banks, and that banks facing a harder budget tend to perform better than those heavily capitalized by the state or regional governments. The results shed important light on banking sector reform in China to face the tough challenges after WTO accession.

Keywords: WTO, Efficiency, Banking, China

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1. Introduction

China has experienced rapid economic growth for more than a quarter century since economic reforms started in 1978. In the meantime, the banking sector has been subject to a process of fundamental structural change and reform. The key objective of reform was to change the sector from a centralized, state-owned, monopolistic and policy-driven to a decentralized, multi-ownership, competitive and profit-oriented system.

Despite the significant changes and reforms in the past decades, the banking system in China is still renowned for its low efficiency and mounting non-performing loans (NPLs), making further reforms more and more difficult and challenging. As China joined the World Trade Organization (WTO) in December 2001, the domestic banking market will have to be completely open up for competition with foreign banks and other overseas financial institutions. Many foreign banks have now entered China for business activities involving foreign currency transactions. The Hong Kong and Shanghai Bank Corporation (HSBC) is now allowed to do business in Shanghai involving transactions in Renminbi, the Chinese currency. In two years time, all foreign banks will be able to do any business that can be done by domestic banks. By June 2004, there were already 100 foreign banks conducting Renminbi businesses in 13 large cities, and 53 of them were allowed to do such businesses with domestic enterprises (People's Daily, 2004).

The time scale for intense competition is short, but most domestic banks, especially the four large state-owned commercial banks, are still ridden with mounting NPLs and low efficiency. The task to make these banks competitive with international banks such as HSBC is undoubtedly onerous and extremely challenging for the Chinese authorities.

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4 In response to the immediate challenges, the central government has decided to speed
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6 up the pace of reforms. Apart from bailing out a huge sum of NPLs from the four
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8 state-owned banks, the state council has decided to support the Bank of China and
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10 China Construction Bank with \$45 billion from its total foreign exchange reserves of
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12 \$403 billion. This is by far the boldest and toughest decision of the government to
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14 convert the big state banks into truly commercial institutions. The implication is that
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16 these two banks will become joint-stock companies, which will soon be placed in the
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18 stock exchanges. If this reform is successful, a similar reform measure will be applied
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20 to the other two state banks, the China Industrial and Commercial Bank and the China
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22 Agricultural Bank.
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26 One theoretical rationale for the latest banking reform is provided by the agency theory.
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28 In the past, whenever the state banks ran into difficulty, the principal (the state) had to
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30 bail them out. The agents (the bank managers), knowing that the principal was the
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32 ultimate resort of help, lent relentlessly to whatever clients they considered to be
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34 trustworthy, resulting in mounting NPLs that could never be recovered. By turning the
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36 state banks into joint stock companies, the incentive structure changes, and it is hoped
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38 that the state will never have to bail them out in the future. In the short run, the state has
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40 a responsibility to remove all or much of the NPLs to generate a fresh capital structure
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42 similar to that of a truly commercial bank so that the banks can compete with foreign
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44 entrants on a level playing field. In the long term, the state banks will have to be entirely
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46 responsible for their own profits and losses without political or administrative
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48 interference.
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52 A second theoretical perspective on the banking reform is related to budgetary
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54 constraints. In the past, soft budget constraints meant that state banks were largely
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56 capitalized using state funds. In the future, once they are listed in the stock market, they
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58 have to rely more and more on raising capital from shareholders, rendering them to be
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60 responsible for shareholders' interests rather than state or local government interests.
The competitiveness of these banks will depend on their ability to earn profits and

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4 paying dividends to shareholders.
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8 Whether the motivation of reform is based on the principal-agent problem, or on the
9 impact of budgetary constraints, the ultimate goal is to increase efficiency and
10 competitiveness of domestic banks. Whether this goal can be achieved depends on the
11 answers to the following two questions. First, can ownership reform and hard budget
12 constraints help improve efficiency? Second, can China change the ownership structure
13 of its banking system and subject all the state banks to hard budgets in such a short time
14 before foreign banks flush into the country for competition?
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24 In this paper, we aim to answer the first question based on available data and
25 information. We cannot answer the second question, as it is not yet clear how quickly
26 the state council can move to re-capitalize the four large state banks.
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32 To answer the first question, we employ a stochastic frontier production function and
33 use panel data of 22 state-owned and non-state banks for the period 1995-2001. Two
34 hypotheses are tested. First, joint stock or non-state banks are more efficient than the
35 state-owned banks. Second, banks that are subject to a harder budget constraint are
36 more efficient than banks that are subject to a softer budget.
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44 The regression results support both hypotheses and show that the average efficiency
45 level is 63% in the data period, which is relatively low compared with that of the US or
46 European banks. Two factors are found to have a significant impact on the level of
47 efficiency: ownership characteristics and equity/asset ratio. On average, non-state
48 banks outperform state banks by 8-18% depending on whether the output of banking is
49 measured by the amount of loans or by profitability. The equity/asset ratio measures the
50 extent of risk taken by banks. It also reflects the extent to which banks are subject to a
51 hard budget. If a bank is well capitalized by the state, the equity/asset ratio is high, and
52 hence less reluctant to take risk. It is found that banks with a high equity/asset ratio are
53 less efficient because they are better capitalized, less risk-taking, and hence subject to a
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4 softer budget constraint.
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8 The empirical results not only support our hypotheses, but also support the government
9 efforts to reform the state banks through changing their ownership structure and
10 subjecting them to a hard budget. Whether the state can successfully transform the state
11 banks, however, remains a challenging issue for the future, but is beyond the scope of
12 this paper.
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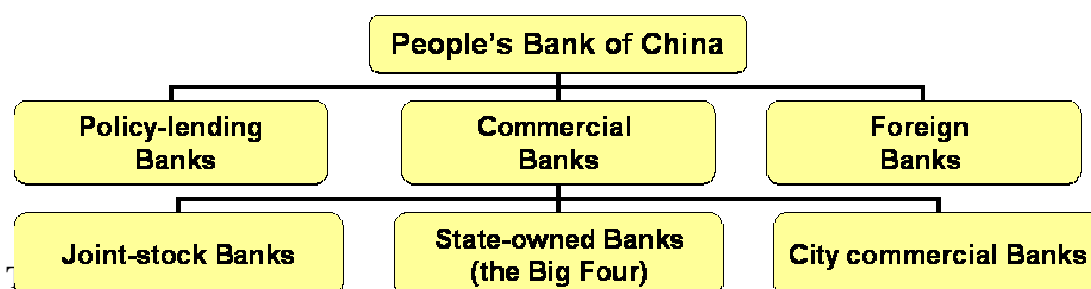
18 The rest of this paper is organized as follows. Section 2 provides background
19 information on the Chinese banking system. Section 3 reviews the literature on
20 efficiency studies, paying special attention to the banking sector. Section 4 discusses
21 methodological issues, including model specifications and data. Section 5 presents and
22 evaluates regression results. Section 6 concludes.
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30 31 32 **2. Bank reform and WTO challenges** 33

34 35 36 **2.1 Banking system reform** 37 38 39

40 Throughout the pre-reform period 1949-78, the Chinese banking
41 system was entirely dominated by the People's Bank of China
42 (PBOC), which acted as a central bank and the only commercial bank
43 in the country (Dai, 2003). Following economic reforms since 1978,
44 the banking system has undergone significant changes. The first
45 change was the breaking up of PBOC into two arms, the central bank
46 and the commercial operation. The central bank still retains the name
47 PBOC. The commercial operation was split into four specialized
48 state-owned banks, or the Big Four in the rest of this paper: the
49 Agricultural Bank of China (ABC), the China Construction Bank
50 (CCB), the Bank of China (BOC), and the Industrial and Commercial
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Bank of China (ICBC). The banking system was overwhelmingly dominated by the PBOC and the Big Four until the mid-1990s when some non-state banks and joint-stock banks were allowed to run businesses throughout the country (Wong and Wong, 2001). The present banking system in China can be illustrated in Figure 1. Figure 1 China's banking system



provided services mainly to state-owned enterprises (SOEs) within a designated sector of the economy. They were operating as some well-encapsulated monopolistic institutions, with no responsibility and incentives to penetrate and compete across regions and sectors. The ICBC provided services to commercial and industrial activities in the urban areas. The ABC was responsible for rural finance. The BOC mainly focused on foreign exchange dealing and foreign businesses. The CCB provided services to urban large construction projects. Each of the Big Four had provincial and local branches and each branch operated within a designated region under the administrative control and guidance of the respective local authority. As a result, all banks and their local branches had their own servicing niches, ruling out any possibility of free competition. Another factor was that the Big Four acted as governmental agencies in a planned economy. They were effectively arms of government administration to implement production plans projected by the State and Regional Planning Commissions. They extended loans to SOEs on the basis of fulfilling the national and regional production plans, regardless of profitability, resulting in huge volumes of NPLs and losses (Wong and Wong, 2001).

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6 Since the early 1980s, the banking system has experienced some changes, and the
7 intention of such changes is to move the state banks away from being driven by policy
8 towards being driven by profit and competition. In the process of transition, the
9 government has assumed concrete steps to reform in order to create a more competitive
10 and efficient system. The first step was to remove the limits that a specialized bank had
11 to serve a designated sector in order to create a competitive market-based financial
12 system in 1985. However, the competition was limited because the operations of the
13 Big Four were subject to frequent intervention by the central and local governments.
14 The local branches were under government control and much of the lending activities
15 were still driven by the needs of policy makers.
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28 The second step was the establishment of three policy banks in order to take over the
29 function of extending policy loans from the Big Four in 1994. Nevertheless, the state
30 commercial banks still play a significant role in policy lending. The serving and lending
31 capacity of the specialized policy banks are unable to meet the need of policy lending
32 previously provided by the Big Four due to the lack of a branch network and capital.
33 Moreover, the state commercial banks are often subject to pressure from both the
34 central and regional authorities to make loans to their preferred sector and enterprises.
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44 The third step was the reorganization of the central bank in an effort to eliminate local
45 government interference at the end of 1998. The PBOC merged provincial-level
46 branches into nine large regional branches. Local governments no longer have the right
47 to appoint senior officials for the local branches of PBOC as they did before.
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54 The fourth step was the establishment of four asset management companies (AMCs) in
55 order to unload NPLs from the Big Four in 1999. These AMCs, namely Cinda Asset
56 Management Company, China Great Wall Asset Management Company, Oriental
57 Asset Management Company, and China Huarong Asset Management Corporation, are
58 paired with CCB, ABC, BOC and ICBC, respectively. AMCs were expected to help the
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4 Big Four to clean up their balance sheets and to make them more competitive. In
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6 addition, a five-classification loan standard scheme has been applied to all domestic
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8 banks in order to control the NPL ratio of new loans.
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11 Apart from reforming the Big Four, the state allowed regional banks or even non-state
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13 banks to be established and to compete with the Big Four. The establishment of
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15 joint-stock commercial banks has injected vigor into the Chinese banking industry by
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17 creating a new source of competition. In addition, 90 local banks, known as city
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19 commercial banks, were formed by consolidating former local urban cooperatives. City
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21 commercial banks all adopted a shareholding ownership structure and were restricted
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23 geographically within their own localities. These joint-stock banks operate on a pure
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25 commercial basis focusing on profit maximization and market share.
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30 Having assumed effective measures in a step by step manner, much headway has been
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32 made in enhancing the competitiveness and efficiency of the banking system. Currently,
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34 an open and competitive system has been primarily established, comprising the PBOC
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36 as the central bank, along with the Big Four as mainstay, joint-stock commercial banks
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38 as growth engines, local commercial banks and foreign banks as complementarities.
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40 However, despite a rapid expansion of non-state banks, the Big Four still
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42 overwhelmingly dominate the Chinese banking industry. The four firm concentration
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44 ratios of total assets, loans and deposits were respectively 84.93%, 84.26%, and
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46 88.51% in 1998, whilst the four firm concentration ratios of profits was only 55.33%
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48 (Wong and Wong, 2001). These rough indicators suggest that the Big Four are large but
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50 much less profitable than other types of banks, an issue of interest to be investigated in
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52 this paper.
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54 55 **2.2 Facing WTO challenges** 56

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58 Although much progress has been made on reforming the banking system, the Big Four
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60 still face with many internal and external challenges. The internal plight is the huge

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4 volume of NPLs, resulting from policy lending to loss-making SOEs. The external
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6 plight is the lack of operational experiences in a market-based financial system, brought
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8 about by the specialization of the Big Four to serve the SOE sector. The current
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10 competitive position of Chinese banks is insufficient to compete with foreign banks
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12 with immense financial muscles and international experience. For example, the second
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14 largest bank of the UK, the Royal Bank of Scotland, generated £6.19 billion of pre-tax
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16 profit in 2003. Its workforce was only 120,000, implying that each employee generated
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18 on average more than £50,000 (or \$90,000) of profit. Obviously, none of the Chinese
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20 Big Four would be able to compete with the Royal Bank of Scotland if there were no
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22 protection.

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26 Table 1 compares the performance between the Bank of China, China's best
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28 performing state bank, and three top world-class banking groups, Citibank, HSBC and
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30 Credit Agricole in 2002.

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34 Table 1 Comparison of profitability level in 2002 (%)

	Net income/ equity	Net income/ assets	Net interest revenue/ assets	Operating profit / assets
Citibank	15.29	1.27	4.36	7.16
HSBC	12.2	0.938	2.07	3.58
Credit Agricole	7.18	0.42	1.24	2.69
Bank of China	4.61	0.303	1.50	0.44

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49 Source: Bankscope.

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52 In all the four main indicators of performance, the Bank of China is greatly
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54 outperformed by any of the other banks. The Bank of China's profit/assets ratio is only
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56 a small fraction of that of Citibank. Its net income/equity ratio is only one fourth of that
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58 of Citibank, and its net income/asset ratio is just one third of that of HSBC.
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In the past, there were high entry barriers and business restrictions for foreign banks, including geographic restrictions and entry requirements. Under the WTO rules, there is no restriction on foreign currency business upon accession in all parts of the country. For Renminbi (RMB), or local currency business, however, the opening process as shown in Table 2 is gradual in terms of time and locality. The geographic restriction is phased out in six stages. Upon accession, RMB business by foreign banks is allowed in four large cities, Shanghai, Shenzhen, Tianjin and Dalian. It will then be expanded to Guangzhou, Zhuhai, Qingdao, Nanjing and Wuhan within one year of accession, to Jinan, Fuzhou, Chengdu and Chongqing within two years, to Kunming, Beijing and Xiamen within three years, to Shantou, Ningbo, Shenyang and Xian within four years, and to all parts of the country within five years (i.e., 2006) after accession.

Table 2 Opening schedule for the banking sector after WTO accession

Year	Business Scope	Geographic Coverage
2002	No restriction on Foreign Currency	Business RMB business in 9 cities
2003	RMB business to Chinese enterprises	13cities
2004		16 cities
2005		20 cities
2006	RMB business to all Chinese clients	No restriction

Source: WTO data cited in Huang (2004).

Hence, how to reform domestic banks, especially the Big Four, and how to improve their efficiency has become an urgent and important issue of concern after WTO accession. Indeed, the need for reforming the Big Four is due to the pressure of competition from both outsiders and insiders. With China's entry into WTO, domestic commercial banks will face more and more competition and challenges from foreign banks. The Big Four will compete with their sophisticated foreign rivals on an international competitive market basis. With further reform, the Chinese banking

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4 institutions will have unprecedented opportunities to enjoy their increasing weight in
5 the international financial system. The prospect of the Chinese economy also motivates
6 the Big Four to reform themselves.
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10 11 **3. Measuring banking efficiency: a selective review** 12

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14 Over the last half a century, much attention has been devoted to banking efficiency
15 study. Regarding the sources of inefficiency in banking, earlier studies tended to focus
16 on economies of scale by examining whether costs per unit can be reduced by
17 increasing output, and economies of scope by examining whether costs per unit can be
18 lowered by joint production. Empirical studies of scale and scope economies show
19 significant scale economies for medium-sized banks of \$100 million to \$5 billion in
20 assets in the 1980s. However, recent studies indicate that scale economies have
21 increased substantially, existing for large banks of \$10 billion to \$25 billion in assets in
22 the 1990s. The recent merger and acquisition in the UK banking sector provides a good
23 example of scale economies involving huge commercial banks. Such examples include
24 the merger of the Royal Bank of Scotland with the National Westminster Bank, the
25 Bank of Scotland with Halifax, and the earlier acquisition of Midlands Bank by HSBC
26 and the merger of Lloyds and TSB. As for scope economies, however, empirical studies
27 reveal small cost inefficiencies (Saunders, 1999).
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45 More recently, efficiency research has shifted to production efficiency which consists
46 of two components: technical efficiency and allocative efficiency. Technical efficiency
47 refers to the ability of optimal utilization of available resources either by producing
48 maximum output for a given input bundle or by using minimum inputs to produce a
49 given output. Allocative efficiency refers to the ability to achieve the optimal
50 combination of inputs and outputs for a given level of prices (Lovell, 1993). In the
51 context of production efficiency, x-efficiency first introduced by Leibenstein (1966) is
52 attributed to overall objective determinants, such as improvement in management and
53 application of technologies, regardless of size (scale) and product mix (scope). Within a
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4 data set, the best-practice frontier or the worst-practice frontier can be estimated. The
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6 difference between the best-practice frontier and the practice of a particular firm
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8 reflects its x-inefficiency (Reifschneider and Stevenson, 1991, Molyneux et al, 1996).
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12 In the literature, two main controversial issues addressed by researchers are how to
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14 define and measure inputs and outputs of banks and how to determine the best-practice
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16 frontier to evaluate their performance. Indeed, how to measure banking outputs and
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18 inputs is one of the most difficult issues because of the distinct features of banks.
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20 Unlike manufacturing firms producing physical goods, banks not only produce
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22 unidentifiable products—intermediary services, but also provide a wide range of
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24 products—multi-products. A number of measures on banking output have been
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26 employed in early efficiency research, such as the number of deposit and loan accounts
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28 and the dollars in each account.
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32 By emphasizing the basic nature of a bank's production process rather than stock
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34 variables, a services flow offered to customers can be considered as bank output. There
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36 are two main approaches to measure services flow: the production approach and the
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38 intermediation approach. The production approach treats banks as firms producing
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40 different deposit and loan accounts. The number and type of transactions and
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42 documents are considered to be the best measure of bank output. However, such
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44 specific data are generally unavailable and therefore, in practice, the number of deposit
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46 and loan accounts is usually employed as the measure of bank output. The
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48 intermediation approach pioneered by Sealey and Lindley (1977) treats banks as
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50 financial intermediaries channeling funds between depositors and creditors. In the
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52 production process, the value of bank loan and investment is considered to be output,
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54 while labour and deposit capital are treated as inputs. This approach is distinguished
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56 from the production approach by adding deposits to inputs, with consideration of both
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58 operating cost and interest cost (Goddard et al., 2001). Neither the production approach
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60 nor the intermediation approach is perfect, they are complementary instead (Berger and
Humphrey 1997). Each approach emphasizes one side of the role played by banks and

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4 can be applied to different levels of efficiency research. The production approach is
5 appropriate for studying the cost efficiency of banks by addressing the operation costs
6 of banking. The intermediation approach is appropriate for studying the economic
7 differentiation of banks by controlling the overall costs of banking (Ferrier and Lovell,
8 1990). This approach takes interest expenses into account, which is useful not only for
9 examining bank efficiency but also for frontier analysis.
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18 Different estimation techniques have been applied to bank efficiency research. Berger
19 and Humphrey (1997) provides a valuable survey on 130 financial institution efficiency
20 studies in which five main approaches are identified. These approaches can be
21 classified into two main categories — parametric and non-parametric techniques.
22 Parametric technique and non-parametric technique were roughly equally adopted.
23 Overall, their survey shows similar efficiency estimates resulting from parametric and
24 non-parametric techniques. On average, there is about 20% cost inefficiency and about
25 half of profit inefficiency in the US. Studies employing non-parametric techniques
26 obtain lower average efficiency estimates and greater dispersion than studies using
27 parametric techniques. Despite the similarity of average efficiency estimates,
28 disagreement about inefficiency rankings of individual firms exists.
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42 Parametric methods can be subdivided into three main approaches to determine the
43 best-practice frontier. The first approach is the stochastic frontier approach (SFA)
44 developed independently by Aigner, Lovell, and Schmidt (1977) and Meeusen and van
45 den Broeck (1977). SFA specifies a functional form for the cost, profit or production
46 function, which allows inefficiencies to be included in the error term. Two
47 distributional assumptions on the error terms to separate the two components are (1) the
48 inefficiencies follow an asymmetric half-normal distribution, based on the logic that
49 inefficiencies only increase costs above frontier levels, and (2) random errors follow a
50 symmetric standard normal distribution because random fluctuations can either
51 increase or reduce costs (Bauer et al., 1993). Relevant literature on applications of SFA
52 to banking can be found in Ferrier and Lovell (1990) and Bauer et al. (1993). In China,
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4 this approach has been used to investigate grain production and technical efficiency by
5 Yao and Liu (1998). However, to the best of our knowledge there is no such study for
6 the Chinese banking sector. On the other hand, there are many empirical studies for the
7 banking sector in other countries or economies, including Shen (2005) and Huang and
8 Wang (2004) for Taiwanese banks, Elyasiani and Mehdian (1995) and Fare et al (2004)
9 for the US banks, and Girardone et al (2004) for Italian banks.

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18 The other two parametric approaches are the distribution free approach (DFA) and the
19 thick frontier approach (TFA). DFA assumes that efficiency differences are stable over
20 time. The estimated efficiency of each firm is the difference between its mean residual
21 and industrial mean residual on the frontier. TFA has no restriction of distributional
22 assumption. TFA estimates provide an overall level of efficiency rather than point
23 efficiency estimates for individual firms. This approach has been employed in Berger
24 and Humphrey (1997), Bauer et al. (1993) and Drake and Simper (2002).

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34 Unlike parametric techniques that specify a functional form for the production function,
35 non-parametric techniques impose fewer restrictions on the production frontier.
36 Non-parametric methods can be divided into two subcategories: data envelopment
37 analysis (DEA) and free disposal hull (FDH). DEA is a linear programming method
38 used for estimating efficiency of decision making units. DEA creates a production
39 frontier directly based on a particular data set of firms rather than a specific functional
40 form. The distance from the best-practice frontier reflects a firm's inefficiency
41 (Charnes et al. 1978). Examples of DEA applications in banking are Ferrier and Lovell
42 (1990). In China, one recent application of the DEA technique is found in Zheng et al.
43 (2003) on state-owned enterprise performance. FDH is a special case of DEA by
44 relaxing the hypothesis of convexity (Berger and Humphrey, 1997). DEA has been
45 widely applied in many recent empirical studies, including Hauner (2005) for German
46 and Austrian banks, Ataullah et al (2004) for Indian and Pakistani banks, Casu and
47 Molyneux (2003) for European banks, and Favero and Pari (1995) for Italian banks.
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Each approach to determine the efficiency frontier possesses certain advantages and disadvantages. Non-parametric technique allows efficiency to vary over time and does not require prior assumptions about the distribution of inefficiency across observations. However, its important drawback is the assumption of no random errors influencing bank performance. Ignoring the existence of potential errors, the effects of omitted errors may be included into efficiency estimates (Berger and Humphrey, 1997). Another drawback of the non-parametric technique is the neglect of price effects on efficiency—allocative efficiency, addressing only technological efficiency. As to the parametric technique, a crucial disadvantage is the pre-specified functional form for efficiency frontier, which may result in an inaccurate efficiency measurement (Berger and Humphrey, 1997). Given that we use a panel data of 22 banks covering 6 years, there will be significant variations of efficiencies across different kinds of banks in different time periods. In other words, the effects of random errors could be large. As a result, the parametric approach, especially the stochastic frontier production function approach, is considered to be most suitable for this study.

4. The stochastic frontier production model

4.1 A theoretical model

This study adopts the intermediation approach to measure bank inputs and outputs since its key concern is to identify the main determinants of efficiency. Outputs of banks are defined as the book value of pre-tax profit, and/or the book value of loans. This is because the specific frontier production model does not allow multi-outputs. The value of loans includes short-term, medium and long-term, and other loans, after deducting loan loss reserves. The value of pre-tax profit is an accounting item. Bank inputs are defined as fixed assets, deposit, equity and labour in both profit and loan models.

Previous studies have adopted a two-stage estimation procedure with shortcoming of

the inconsistency in its assumptions concerning the independence of the inefficiency effects in the two estimation stages. This study adopts a single-stage estimation technique proposed by Battese and Coelli (1995) and Coelli (1992), with an assumption that non-negative technical inefficiency effects are 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 model shown below allows the estimation of both technical change in the stochastic frontier and time-varying technical inefficiencies.

$$Y_{it} = \beta_0 + \beta_t t + \beta x_{it} + (V_{it} - U_{it}) , \quad i=1, \dots, N; t=1, \dots, T, \quad (1)$$

where i and t denote firm and time, Y_{it} the logged output variable, x_{it} a vector of logged input variables, V_{it} a random variable assumed to be distributed with mean zero and a constant variance $N(0, \sigma_v^2)$, β a vector of unknown parameters to be estimated, U_{it} a non-negative random variable associated with technical inefficiency of production, which is assumed to be independently distributed as truncation at zero of $N(m_{it}, \sigma_u^2)$.

The specification of the technical inefficiency effects, U_{it} , is

$$U_{it} = \delta_0 + \delta_t t + \delta z_{it} + W_{it} , \quad (2)$$

where z_{it} is a vector of explanatory variables associated with technical inefficiency of production over time, δ a vector of unknown coefficients to be estimated, W_{it} a random variable defined by the truncation of the normal distribution with zero mean and variance σ^2 .

The technical efficiency of production for the i -th bank at the t -th time is defined as:

$$TE_{it} = \exp(-U_{it}) = \exp(-z_{it}\delta - W_{it}). \quad (3)$$

The time trend variable t included in the stochastic production function (1) accounts for neutral technical progress at a constant rate, while the presence of t in the inefficiency function (2) is for 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 a movement towards or off the frontier (Yao and Liu, 1998).

4.2 An empirical model

Because bank output can be measured as profit or the value of loans, the same production function is estimated in two different versions. One uses pre-tax profits as output, the other the value of loans. The profit model is shown in equations (4) and (5). The loan model has the same structure and explanatory variables as the profit model.

$$\ln(\text{profit}_{it}) = \beta_0 + \beta_1 t + \beta_2 \ln(\text{Fixedasset}_{it}) + \beta_3 \ln(\text{Deposit}_{it}) + \beta_4 \ln(\text{Equity}_{it}) + \beta_5 \ln(\text{Labour}) + V_{it} - U_{it} \quad (4)$$

$$|U_{it}| = \delta_0 + \delta_1 \ln(E/A \text{ ratio}) + \delta_2 \text{Ownership} \quad (5)$$

where subscripts i and t respectively denote banks and time; \ln denotes natural logarithm. In this model, output is measured by profit before tax, while inputs are measured by fixed assets, deposit, equity and labour. In the inefficiency function, two explanatory variables are bank-specific variables—equity/assets (E/A) ratio and ownership characteristic which are expected to have effects on inefficiency. In estimation, the ownership variable takes the value of one for non-state banks and zero for state-owned banks.

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4 Equity includes share or/and own capital, as well as retained profits. Assets include
5 loans, fixed assets and other assets. It can also be defined as total liabilities plus equity,
6 where total liabilities include deposits, borrowing from other institutions and other
7 funds. If a bank is capitalized and supported by the state, equity also includes state
8 capital. If a bank is a joint-stock company, part of its equity will be share capital. As
9 total assets include loans, a bank is subject to higher risk with a lower E/A ratio, as for a
10 given amount of equity, the bank is exposed to more liabilities. If a bank is well
11 capitalized with support from the government, E/A can be increased if total liabilities
12 are fixed. The recent efforts of the state council to inject \$45 billion to BOC and CCB
13 are to help them raise the E/A ratio, and hence reduce their risk. An earlier effort by the
14 government to use AMCs to remove some NPLs from the Big Four served the same
15 purpose.
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30 Hence, the E/A ratio can be interpreted in different aspects. A lower E/A may mean that
31 the bank is less capitalized and subject to a harder budget constraint, but it has to take
32 more risk in order to increase loans to its clients. If the government is involved in
33 changing the E/A ratio, different banks will be subject to different budget constraints.
34 Usually, the state will support the state-owned banks, helping them to have a lower E/A
35 ratio than the non-state banks, *ceteris paribus*. As a result, if the E/A ratio is negatively
36 associated with efficiency, it implies that soft budget will lead to low efficiency, or *vice*
37 *versa*.
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4.3 Data

52 The data are obtained from Bankscope for 22 commercial banks over the period
53 1995-2001. Of the 22 banks, 2 have data for 1996-2001, 7 for 1995-2000, and the rest
54 for 1995-2001, forming an unbalanced panel data set. In terms of ownership, the
55 sample banks include the Big Four, 11 shareholding banks, and 7 small commercial
56 banks that are ultimately owned by one of the Big Four or state council. The summary
57 statistics of banking outputs and inputs are reported in Table 3.
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Table 3 Summary statistics, mean values of 22 banks 1995-2001 (billion yuan)

variables	1995	1996	1997	1998	1999	2000	2001
Pre-tax profit	6.81	8.26	9.19	8.49	8.50	8.77	7.81
Loan	745.5	903.3	1004.6	1142.2	1214.7	1210.7	1359.9
Fixed assets	13.52	19.22	20.15	22.46	29.80	36.41	32.97
Deposit	334.27	406.07	512.72	604.70	716.04	820.51	920.97
Equity	48.28	49.12	50.75	94.42	93.25	96.24	97.31
E/A ratio (%)	6.67	6.115	6.955	8.25	8.135	8.165	8.172

Source: Calculated by authors based on data for sample period obtained from Bankscope: <http://bankscope.bvdep.com>.

5. Results and interpretations

5.1 The profit model

Maximum-likelihood (ML) estimates of parameters in the profit model are obtained using a modification of the computer program, FRONTIER 4.1 (Coelli, 1996). These ML estimates and the standard errors are reported in Table 4.

Table 4 Regression results, dependent variable = ln (profit before tax)

Variables	ML estimates	T-Value
A. Production Function		
Intercept	0.8469	5.5502
Time	-0.0940	-6.6178
Fixed-asset	0.1611	2.6673
Deposit	0.3503	4.6373
Equity	0.3311	2.6200
Labour	0.1020	0.8928
B. Inefficiency Function		
Intercept	-10.9032	-6.2360
Equity/Asset Ratio	4.3702	13.6217
Ownership	-2.8344	-4.8537
C. Variance parameters		
Sigma-squared	3.8463	4.3056
Gamma	0.9951	237.3926
D. Diagnosis and other information		
LR test	146.4644	
Ln (likelihood)	-95.5927	
Number of observations	154	
Number of years	7	
Number of cross-sections	22	
Average technical efficiency	0.6300	

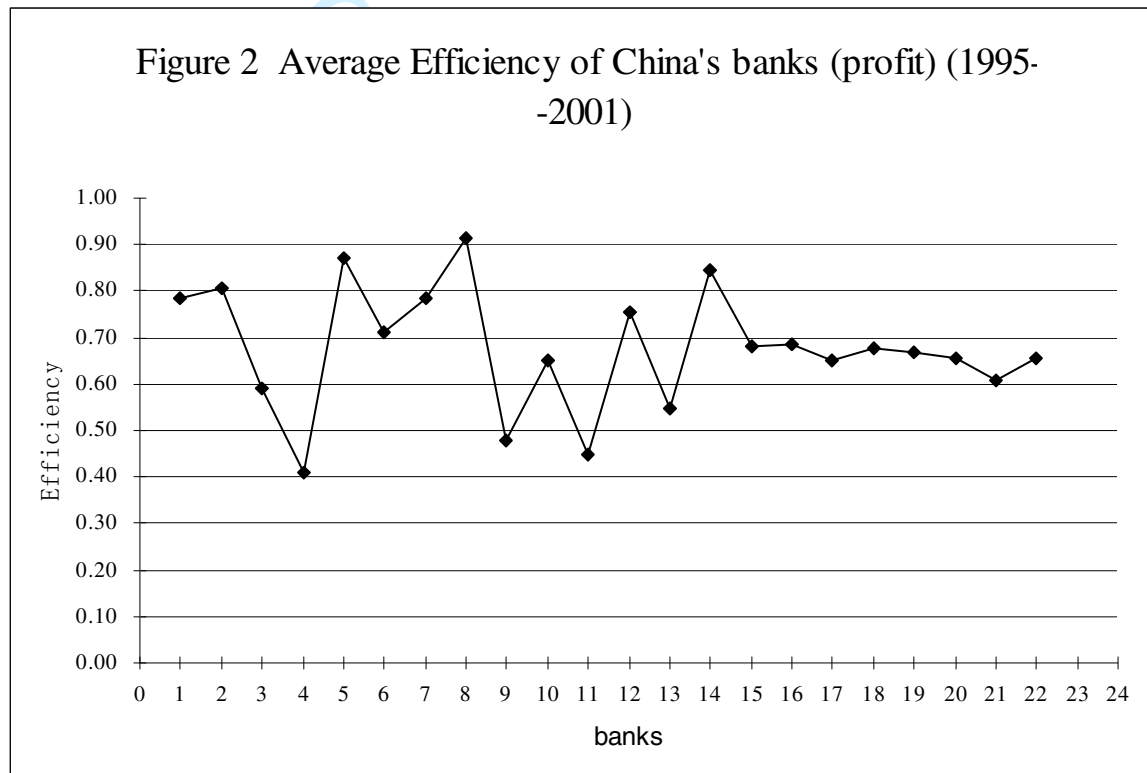
Notes: (1) All the variables are in natural logarithms.

(2) Negative sign in the inefficiency function indicates that the variable has a positive effect on production efficiency and *vice versa*.

The signs of the estimated coefficients are as expected and all coefficients are statistically significant at or below the 5% critical level except that for labour. The insignificance of the estimated labour coefficient is not surprising given that most banks may be still overstaffed even after many years of reforms. The estimated coefficients for fixed-asset, deposit and equity are their elasticities with respect to profits. Deposit and equity have roughly the same value of elasticity at 0.3503 and 0.3311, respectively. The elasticity of fixed-asset is relatively small at 0.1611, but it is significant. The presence of the one-sided error component is justified by the LR test, which is highly significant. The estimates of variance ratio ($\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$) of

0.9951 indicates that the inefficiency element U_{it} is stochastic.

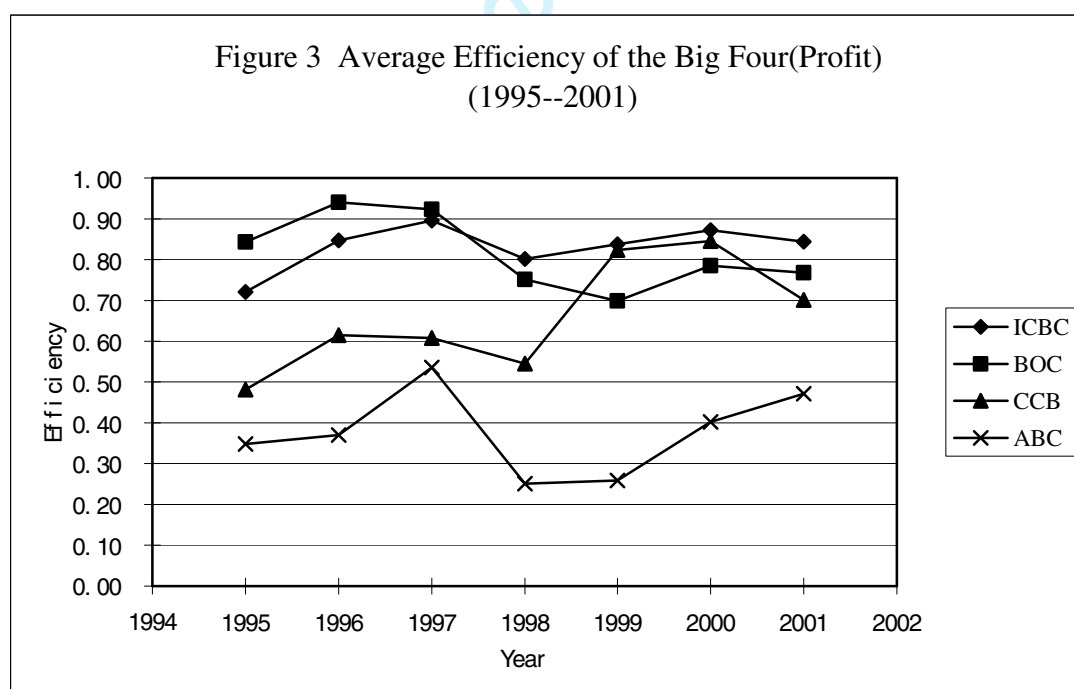
The average level of technical efficiency over the sample period is 63%, leaving a gap with the maximum possible level of 37%. The average estimated efficiencies of 22 banks are plotted in Figure 2. The most efficient bank is China Merchants Bank Co Ltd with an average technical efficiency of 91.23%, whilst the most inefficient bank is ABC with an efficiency of 40.95%. Wide efficiency differentiations across banks observed here indicate that there is a substantial potential for improving the overall efficiency of Chinese banks.



Note: The numbers on the X-axis represent individual banks (see appendix A for detail).

As the Big Four have a dominant position in the banking industry and are the focus of imminent reform, it is worth looking at their efficiency levels in detail. The average efficiencies of the Big Four during the data period are plotted in Figure 3. ABC is the least efficient bank in terms of profitability. Its efficiency also fluctuates drastically over time. On the other hand, its efficiency rose slightly with the same pattern as that of

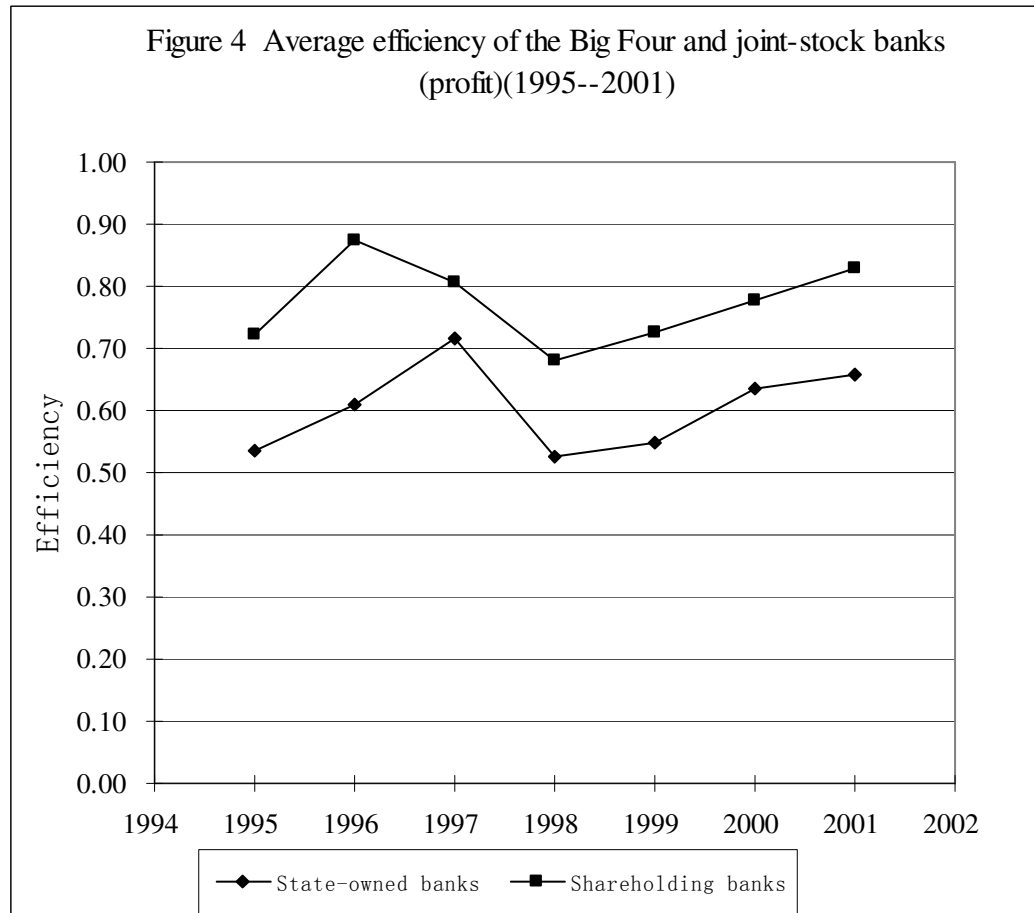
ICBC and BOC from 1995. The CCB enjoyed significant efficiency gain after suffering a systemic shock in 1998, when the Asian Financial Crisis hit China hard. However, the efficiency of CCB declined sharply in 2000 and 2001, while that of ICBC and BOC decreased slightly and that of ABC increased instead. The efficiency of ICBC and BOC exhibited a similar and stable pattern. Both ICBC and BOC achieved efficiency gains for two years from 1995 and underwent a decline from 1997, again coincided with the Asian Financial Crisis. The ICBC picked up efficiency growth in 1998 and sustained a steady increase thereafter. The efficiency of BOC deteriorated further up to 1999 and improved in the next two years. The average technical efficiencies of ICBC and BOC were 78.28% and 80.55% respectively, much above the industrial average and even above the average of joint-stock banks of 77.48%. This result indicates an encouraging exception of state-owned commercial banks, which could be as efficient as joint-stock banks.



The estimated coefficients in the inefficiency model are of particular interest to this study. The technical inefficiencies are regressed on two explanatory variables: E/A ratio

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4 and ownership characteristic. The E/A ratio has a positive impact on inefficiencies.
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6 Banks are more efficient with a low E/A ratio which reflects more risk-taking. In other
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8 words, well-capitalized banks are less efficient, confirming our hypothesis on budget
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10 constraints. If banks are subject to a soft budget, such as the state-owned banks, their
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12 capital assets are mainly raised from state funds. But if banks are subject to a hard
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14 budget, they have to raise capital from shareholders. One consequence is that they will
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16 tend to be less capitalized, and hence have to take more risk to make profits (Koch and
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18 MacDonald, 2000).

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21 Another explanatory variable is ownership characteristic measured by a dummy
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23 variable taking a value of 0 for state-owned banks and a value of 1 for joint-stock banks.
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25 As reported in the second part of Table 4, ownership has a significant impact on
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27 technical efficiency with an estimated coefficient of -2.53. The negative sign indicates
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29 that joint-stock banks are more efficient. The impact of ownership characteristic on
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31 bank efficiency is depicted in Figure 4. Joint-stock banks are found to have
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33 outperformed state-owned banks by about 18 percentage points over the data period.
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35 The estimated average technical efficiency of state-owned banks is 59.61% and that of
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37 joint-stock banks is 77.48%. This result suggests that ownership structure is an
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39 important variable in explaining the variations of overall inefficiency. Moreover, Figure
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41 4 exhibits a similar trend of technical efficiencies between state-owned and non-state
42
43 banks. The average efficiencies of state-owned and non-state banks increased from
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45 1995 to reach a peak in 1996 and 1997, respectively. During the Asian Financial Crisis,
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47 the efficiency level declined and touched the lowest point in 1998. Thereafter, the
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49 average technical efficiencies of both state and non-state banks increased steadily over
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51 the last four years of the data period. These similar trends reflect both the external as
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53 well as the internal shocks. External shocks were largely triggered by the Asian
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55 Financial Crisis, but the internal shocks reflected the government's efforts to improve
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57 banking efficiency during the post-crisis period. Our results suggest that the tightening
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59 policy in the aftermath of the Financial Crisis had paid a high dividend.
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5.2 The loan model

The picture that emerges from the loan model is similar to that of the profit model, as shown in Table 5. The signs of the coefficients are consistent with that of the profit model and all coefficients are statistically significant except for labour. The estimated coefficients for fixed-asset, deposit and equity are 0.0841, 0.4606 and 0.6232, respectively. Deposit and equity have stronger impact than in the profit model. The negative coefficient of year indicates that the output level tends to decrease by 1.09% per year over the data period. The LR test and the estimates of variance ratios also confirm the presence of a one-sided error component which represents the stochastic inefficiency component U_{it} .

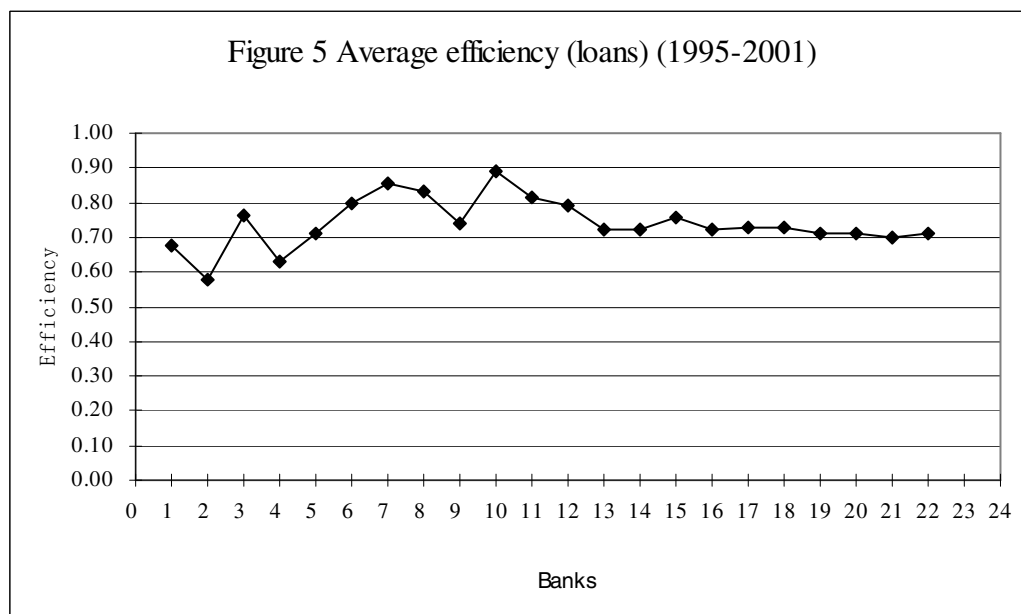
Table 3 Regression results, dependent variable = ln (loans)

Variables	ML estimates	T-Value
A. Production Function		
Intercept	0.1909	1.6207
Time	-0.0109	-0.6404
Fixed-asset	0.0841	2.4651
Deposit	0.4606	11.5178
Equity	0.6232	9.5670
Labour	0.0860	1.2203
B. Inefficiency Function		
Intercept	-0.2683	-1.9051
Time	0.0268	1.4709
Equity/Asset Ratio	0.4525	7.3413
Ownership	-0.2756	-6.4406
C. Variance parameters		
Sigma-squared	0.0347	8.6795
Gamma	0.1141	0.5730
D. Diagnosis and other information		
LR test	92.2811	
Ln (likelihood)	40.7622	
Number of observations	154	
Number of years	7	
Number of cross-sections	22	
Average technical efficiency	0.6392	

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*.

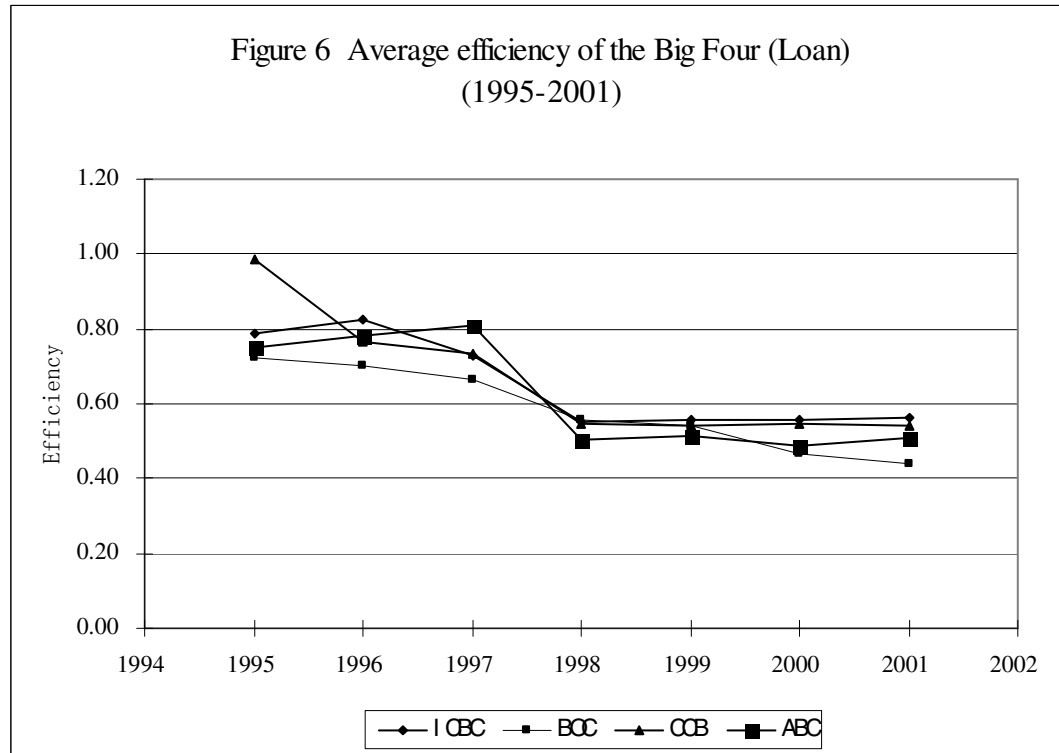
The estimated average technical efficiency is 63.91%, which is slightly higher than in the profit model. The average estimated efficiencies for 22 individual banks are graphed in Figure 5. The most efficient bank is China Minsheng Banking Corporation with an average technical efficiency of 89%, while the most inefficient bank is the Bank of China (BOC) with an average technical efficiency of 58.03%.



Although the estimated coefficients on the time trends in the frontier production model and the inefficiency function are insignificant, they reveal a declining trend over time. The negative coefficient on the time trend in the frontier production function indicates that the production frontier moved downward by 1.09% annually. The positive coefficient on the time trend in the inefficiency function reveals that the inefficiencies of production tended to increase by 2.68% per year. This implies that both efficiency and the production frontier moved downward over the data period.

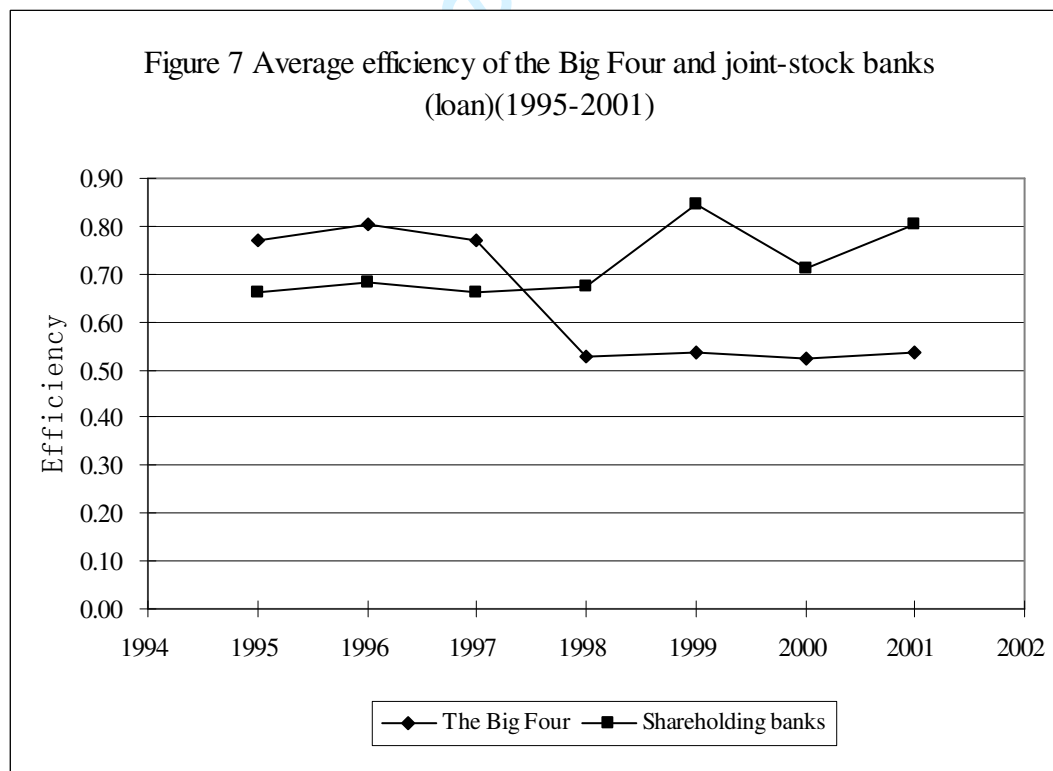
The efficiency of the Big Four is shown in Figure 6. A different picture emerges compared with that of the profit model. The average estimated efficiencies for the Big Four have a similar trend and level. Efficiencies of the Big Four are stable over the first three years of sample period, followed by a downward slump in 1997. Again this is coincided with the Asian Financial Crisis. Later on, the efficiency level of the Big Four roughly remained unchanged except for BOC, which experienced a decline. This result is perhaps an evidence of government intervention on lending decisions. During and after the Asian Financial Crisis, the state council ordered the Big Four to lend about 100 billion yuan per year of special loans to boost the domestic economy.

Different pictures from the profit and loan models can perhaps be attributed to the distinct degree of government intervention on banks. Direct government intervention resulted in a similar efficiency trend and level among the Big Four in the loan model. The Big Four still acted as government's arms in a policy-driven financial system despite many years of reform to reduce intervention and policy lending.



As for the inefficiencies, they are also influenced by the E/A ratio and ownership characteristic. The elasticity of E/A ratio is 0.4525 and statistically significant, indicating a positive impact on inefficiencies. It is consistent with the result of the profit model. Again, ownership is found to have different impact on inefficiency with an estimated coefficient of -0.2756, which is small but significant. The smaller impact of ownership characteristic on bank inefficiencies compared to that of the profit model can be considered as evidence that both state-owned banks and joint-stock banks are both subject to government intervention in lending. The impact of ownership characteristic on bank efficiency from 1995 to 2001 is shown in Figure 7. The Big Four are more

efficient than the joint-stock banks in the first three years by 10 percentage points. In 1998, the efficiency of the Big Four encountered a sharp downward slump from 76.90% to 52.68%, while that of the joint-stock banks remained unchanged. During the last three years, joint-stock banks became more efficient than the Big Four. This result is different from that of the profit model in which joint-stock banks are 18% more efficient than the state-owned banks throughout the sample period. However, joint-stock banks are still more efficient than the state-owned banks by 8 percentage points on average over the sample period. This result is attributable to the different degree of government intervention. Although government can influence lending decision of both state and non-state banks, the extent of intervention on the latter tends to be less than on the former.



6. Conclusions

The estimated average efficiency of the sample banks is quite low at 63% in both the profit and loan models, but not fundamentally different from that of previous studies for other countries. In the literature, the average efficiency score is about 80% for the US banks (Berger and Humphrey, 1997). The difference of efficiency estimates is consistent with the fact that Chinese banks are more subject to government control and intervention despite many years of reform.

The Big Four have a dominant position in the banking industry. They were given a legal status in 1995, the first year of our data period, as commercial banks with a principal objective of making profits. However, after many years of reforms, the efficiency level was still low and did not improve significantly over time. On the one hand, it suggests that government intervention in lending decision still persists, on the other hand, it reveals that there exists a great potential for efficiency improvement.

In this paper, we hypothesize that ownership reform and change of budgetary constraints should lead to more competition and hence greater efficiency gains. Our data set provides information for constructing a stochastic frontier production function indicating that joint-stock banks outperform state-banks by 18% in profitability and 8% in loans. The empirical results also 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. The results have important policy implications on bank reforms in China in face of the WTO challenges in the immediate future.

As China has to open up its banking market for international competition, domestic banks have to become more efficient as quickly as possible. Two fundamental reforms are needed. First, the state banks, which have enjoyed a dominant position, have to become truly commercialized, to be entirely free from government control and

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4 intervention, to be re-capitalized so that their capital structure will resemble that of a
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6 western commercial bank, to have a better corporate government and incentive
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8 structure so that internal efficiency can increase as rapidly as possible. The second
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10 reform is to allow more and more medium and small banks to enter the market and
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12 compete with the state banks. The number of small and medium banks has increased
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14 enormously in recent years, but most of them are still under control by regional or local
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16 governments. Most of them are not well managed and may lack the economies of scale
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18 and scope to compete with foreign banks.

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21 Although the empirical results in this paper confirms that ownership reforms and
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23 change of budgetary constraints can force banks to become more efficient, the
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25 problems faced by the Chinese banks are so many and so difficult that it may take many
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27 more years for them to compete successfully with foreign banks. The most recent
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29 decision to re-capitalize BOC and CCB is a significant step towards this direction.
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31 However, whether this reform is successful will depend on how the Big Four respond to
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33 the new reform method. We have not paid much attention to the problem of NPLs
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35 which is estimated to be as high as 30-40%, although the official figure is only 15-20%.
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37 If banks are still ridden with so much NPLs and if corporate governance is still heavily
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39 influenced by politics, the chance of success is very small. Hence, our conclusion is that
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41 China will have to face more pains in the near future when foreign large banks enter the
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43 domestic market and compete head on with the Big Four. This is where the real fight
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45 will begin and more radical reform measures have to be taken not only on
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47 re-capitalization but also on appointment of senior management and the way that banks
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49 are currently managed.
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Appendix A: Name of Chinese banks

Bank name	corresponding number
Industrial & Commercial Bank of China (The) – ICBC	1
Bank of China	2
China Construction Bank	3
Agricultural Bank of China	4
Bank of Communications	5
CITIC Industrial Bank	6
Shanghai Pudong Development Bank	7
China Merchants Bank Co Ltd	8
China Everbright Bank	9
China Minsheng Banking Corporation	10
Guangdong Development Bank	11
Hua Xia Bank	12
Industrial Bank Co Ltd	13
Bank of Shanghai	14
Shenzhen Development Bank Co., Ltd.	15
Sin Hua Bank Limited	16
Kwangtung Provincial Bank (The)	17
Kincheng Banking Corporation	18
National Commercial Bank Ltd.	19
China State Bank Ltd.	20
Yien Yieh Commercial Bank Ltd.	21
China & South Sea Bank Ltd., (The)	22

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