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DECOMPOSITION OF THE EFFICIENCY OF THE CHINESE STATE-OWNED COMMERCIAL BANKS AT THE PROVINCIAL LEVEL

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Abstract

This study adopts a bank production function approach to the measurement of banking efficiency at the provincial level in the Chinese state-owned commercial banking sector from 1998 to 2003. Applying Data Envelopment Analysis and efficiency decomposition analysis, this paper has revealed a significant level of pure technical input inefficiency and, to a lesser extent, scale inefficiency across the provincial branches of all the banking groups. The study has also uncovered the extent of inefficiency in individual banking inputs and provincial branches. Finally, the provincial-level efficiency is further decomposed into within-banking-group and between-banking-group effects.

Key words: banking efficiency measurement, DEA, efficiency decomposition, Chinese SOCBs

JEL Classification: C14, G21, D24

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1. Background of the study

Over the past two decades, rapid advances in globalisation and financial integration, technological progress, and demographic changes have created significant new challenges and opportunities for national economies. In such a fast-evolving global competitive environment, banking and financial services play a vital role in helping the economy and society respond effectively to generate the liquidity, flexibility and dynamism that are required to meet the challenges and take full advantage of any opportunities. As China's economy keeps growing at a spectacular speed and also becomes ever more closely integrated into the world economy, the Chinese banking and financial sector has received increasingly careful scrutiny by both Chinese domestic and foreign analysts and policymakers. In recognition of the vital role of modern banking and financial intermediary services, since the inception of China's "open-door" policy in 1979 the Chinese government has been constantly pushing for a gradual but ever wider and further-reaching banking reform programme. A major plank of the reform programme is to improve the efficiency and competitiveness of the big four Chinese state-owned commercial banks (SOCBs), as the SOCBs still play a dominant role in funding economic growth, supporting economic reform and maintaining social stability in China (Liu, 2004).

Despite the substantial difficulty in obtaining adequate and reliable data on Chinese banking[1], a growing body of empirical research has shed light on various aspects of the effectiveness of this reform programme in recent years (e.g., Li, et al., 2001; Chen, et. al., 2005; Fu and Heffernan, 2007, 2008; Lin and Zhang, 2008). The literature to date has focused on the financial performance of the banking groups as a whole (Li, et al., 2001) and how the performance relates to the asset structure and ownership of individual banking groups as well as the structure of the Chinese banking market (Chen, et. al., 2005; Fu and Heffernan, 2007, 2008; Lin and Zhang, 2008). What has generally emerged from these studies is that, compared with banks of other ownership types, such as domestic joint-stock, foreign-domestic joint stock, domestic private and foreign ownership, the SOCBs are heavily burdened with problems of bad loans, low efficiencies and poor financial performance. Despite the huge effort put into the reform programme for nearly three decades, there is so far limited improvement in the relative inefficiency or underperformance of the SOCBs. It might be argued that if the Chinese SOCBs operated in a genuinely competitive market environment, they would perhaps have gone out of business a few years ago. It then becomes even more puzzling that the recent floatation of three of the four Chinese SOCBs received unprecedented levels of enthusiasm from both Chinese domestic and international investors. Various explanations might be offered that are based on the irrationality or rationality hypothesis of investors' behaviour, but it is also likely that the true nature and state of the competitiveness of the SOCBs are still not properly measured and understood. A sound assessment of the competitiveness

[1] Such difficulties include very limited disclosure of financial information due to lack of regulatory requirement, inconsistent accounting standards across banking groups and misreporting of information even in official data sources (see a detailed discussion in Li, et al., 2001).

and performance of the Chinese SOCBs in the broad context of the special characteristics and structure of the Chinese economy compounded by the forces of globalisation remains a challenge for analysts and policymakers.

A comprehensive assessment of such issues is beyond the remit of the current study. The purpose of this study is to focus on one core aspect of competitiveness of Chinese SOCBs – their operational efficiency within each banking group. In contrast to the existing studies that treat the four state-owned banking groups as four decision-making units (DMUs) alongside other banking groups of different ownership structures, this study focuses exclusively on the big four SOCBs and treats their provincial branches as individual DMUs[2]. There are several reasons for doing this. First of all, the SOCBs differ substantially from other types of banks in terms of scale of operation, governance and market conditions. Whilst the SOCBs have branch networks across the entire country and their business operations are subject to severe policy interventions and protection, many other types of banks (e.g. joint-stock or private) only operate within very specific locations and under highly competitive market conditions. Since the efficiency measures of individual banks are relative to the most efficient peers that are selected in the sample, the measures are very sensitive towards the selection of samples. It is little wonder that due to different samples being selected, as well as differences in the variables and estimation methods adopted, the empirical measures of efficiency of Chinese banks differ substantially. For example, in a study on the cost x-efficiencies of the SOCBs and other types of banks in the 1990s by Chen, et al. (2005), the SOCBs were found to be more x-efficient than the joint-stock banks, contradicting the results in Fu and Heffernan (2007, 2008). By restricting the samples to the SOCBs in the current study, the results may be more comparable and convincing. Second, by treating the provincial branches of the SOCBs as DMUs, the present study has overcome a statistical problem common among all the existing studies that arises from the small number of DMUs selected and hence a lack of degree of freedom.

In light of the market conditions and data limitations, this study adopts a bank production function approach in the spirit of Baltensperger (1980), Santomero (1984) and Berger and Humphrey (1997) to examine the efficiency of the Chinese SOCBs over the period 1998-2003[3]. Applying Data Envelopment Analysis (DEA) and decomposition analysis, this paper conducts a thorough investigation into the technical input efficiencies of the Chinese SOCBs at the provincial level. Although the DEA technique has been employed in various existing studies of banking efficiency in China, the present study extends the empirical work in a number of ways.

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[2] Each of the four banking group has hundreds or thousands of branches in each of the thirty-one provinces, autonomous regions and directly administered municipalities on Mainland China. As detailed data are only available at the provincial/municipal level, each province or municipality under a banking group is treated as a DMU and the term "provincial branch" here refers to all the branches of a particular group within a particular province. Therefore, there should be 124 DMUs. But due to data omissions in official publications, the actual number of DMUs in this study is 122.

[3] 2003 is the latest year for which there is a full set of data for conducting the present DEA analysis.

First, for the first time this study examines banking efficiency of the SOCBs at the provincial level and almost all the provincial branches for the big four banking groups, viz. China Construction Bank (CCB), Industrial and Commercial Bank of China (ICBC), Agricultural Bank of China (ABC) and Bank of China (BOC) have been included. Using the DEA technique, the present study has obtained values for *total input efficiency, pure technical efficiency, scale efficiency* and *returns-to-scale characteristic* for all provincial branches of the SOCBs. As data on banking costs, revenues and profit is generally unavailable at the provincial level due to confidentiality reasons[4], such analysis provides an informed judgement on the efficiency and competitiveness of the SOCBs using data that is more accurate and more readily available. The empirical findings also reveal valuable information for judging the scale economy, unit cost of production and thus potential profitability of the banking groups. Second, the total input efficiency of each provincial branch is decomposed into the product of within-banking-group and between-banking-group efficiencies to separate the efficiency arising from within the provinces from the efficiency arising from the banking group as a whole. The rationale for such a decompositional analysis is that due to historical and political reasons, individual banking groups may be particularly advantaged or disadvantaged relative to the other groups. It is useful to empirically find out whether or not and to what extent this hypothesis is true. Moreover, the within-group versus between-group decomposition analysis can reveal the effectiveness of the banking reform programmes at the micro (province/branch) level as compared with the efforts at the mezzo (group/market) level. In short, the empirical results can enable policymakers and the management of SOCBs to target specific operational areas for further efficiency improvement.

The rest of the paper is organised as follows. Section 2 briefly maps out the key milestones of the Chinese banking reform programme concerning the SOCBs since 1979 and depicts their recent positions in the Chinese economy. Section 3 highlights the relevant market conditions and conceptualises the business model of the SOCBs for the period under investigation. This section also critically questions the monopolistic competition model that is commonly adopted by existing studies. It is worth pointing out that although the empirical analysis covers the period from 1998 to 2003, the qualitative discussion will cover some more recent developments in the Chinese banking sector where partial empirical evidence is available. Section 4 implements the empirical DEA and decomposition analyses. The major findings are presented and discussed in Section 5. The final section offers some concluding remarks.

2. Stages of reforming the Chinese SOCBs

As the Chinese banking reform programme concerning the whole sector has been extensively discussed in the literature (see, e.g., Li, et al., 2001; Chen, et. al., 2005; Fu and Heffernan, 2007, 2008; Lin and Zhang, 2008), this section only attempts to map

[4] Although such data exist for the whole banking groups, there is a significant extent of distortion to the data arising from government interference, as is discussed in more detail in a later section.

out the key milestones in the reform process concerning the state-owned banks. Broadly speaking, the reform process can be divided into the following four key stages.

1) Separation of the People's Bank of China (PBC) from commercial banking and establishment of specialised state-owned banks (1979 – 1993). Before 1979, China's economy operated under a central planning system and the PBC played the dual role of being both the Central Bank and the commercial bank. As a matter of fact, the PBC was not functioning as a normal banking institution but rather as an auxiliary resource allocation mechanism in a central-planning economy. The amounts and destinations of bank loans as well as the interest rates were all determined by the State Planning Commission together with the central fiscal and monetary authorities (Ministry of Finance and the PBC). As a major plank of the market-oriented economic reform programmes that started in 1979, the Chinese government began to reform and restructure the banking system. The focus of the early stage of the banking reform was on the establishment of the PBC exclusively as the central bank, together with the establishment of state-owned specialised banks and the acceptance of entry by foreign banks from 1979. The specialised banks, including the Industrial and Commercial Bank (ICBC), China Construction Bank (CCB), Bank of China (BOC) and Agriculture Bank of China (ABC), were set up from 1979 to 1984 to serve the specific needs that arose from the implementation of the Chinese government economic plans in designated economic sectors.
2) Commercialisation of the big four state-owned specialised banks (1994 – 1998). In order to separate policy needs from commercial considerations within the state-owned specialised banks, several policy-oriented banks such as China Development Bank, the Export-import Bank of China and Agricultural Development Bank of China were set up under the direct control of the State Council in 1994. The restriction on each banking group to operate in designated areas of business was also removed.
3) Management of assets and especially non-performing loans of the SOCBs (1998 – 2002). Throughout the 1980s and 1990s, since the SOCBs were obliged to lend almost exclusively to the inefficient state-owned non-financial sectors, a significant amount of bad loans had accumulated. Towards the end of the 1990s, the official estimate of the proportion of bad loans among the SOCBs was over 25%, although unofficial estimates put it at much higher figures. So a pressing agenda for the subsequent reform programme was to make the SOCBs commercially viable. Apart from an initial injection of 27 billion Yuan (around US$3.3 billion) into the capital base of the SOCBs, the Chinese government also set up four asset management companies (AMCs) in 1999 specifically to resolve the huge amount of non-performing loans of the SOCBs. The AMCs took over about 1.4 trillion Yuan (equivalent to US$170 billion at the exchange rate of 1999) of non-performing loans (NPLs), which amounted to 15.6% of the total assets of the four banks. Each AMC had a

charter for ten years and was supposed to recover as many of the NPLs as possible through debt-to-equity swap, bankruptcy arrangement proceedings and debt-restructuring. Nevertheless, the official figure for the proportion of non-performing loans among the SOCBs still stood at 25% at the end of 2002[5].

4) Partial flotation and strategic alliance with foreign financial institutions (since 2003). With China's accession to the WTO in 2001, the Chinese government's effort to reform the banking and financial services also accelerated. Another significant step taken by the government to make the SOCBs commercially viable was to recapitalise them before listing them on the stock markets. Over the period 2004 - 2005, the Chinese government injected US$60 billion of foreign exchange reserves into the capital of BOC, CCB and ICBC before these banks were successfully listed on the Hong Kong Stock Exchange in 2005 and 2006. The floatation of these banks attracted unprecedented level of interests, including interest from foreign financial institutions that were eager to enter the potentially lucrative Chinese banking market. Legions of well-known international banking and financial institutions, having gained incremental access to the market since China's admission to the World Trade Organization, are buying minority stakes in Chinese banks (and other Chinese financial institutions) as well as expanding their limited branch networks in the country. Currently, restructuring of ABC is underway and it is likely to be floated in the near future.

At the same time as establishing state-owned market-oriented commercial banks, the Chinese government has also gradually opened up the Chinese banking market to competition from banks of alternative ownership structure, such as private banks, domestic joint-stock banks formed by local governments and corporations, domestic-foreign joint-stock banks, and foreign banking and financial institutions. Currently there are twelve national shareholding banks, more than 100 city commercial banks, and tens of thousands of urban and rural credit unions. The latter types of banks compete aggressively with the SOCBs in the household retail banking market as well as the business banking market for the non-state-owned and local collectively-owned industries and businesses, particularly the fast growing, highly efficient and profitable small- to medium-sized enterprises (SMEs). It is no surprise that the SOCBs have been steadily losing market share over recent years. For example, the SOCBs' shares of total banking assets, loans and deposits were 84.9%, 84.3% and 88.5% respectively in 1998. By 2005 these shares dropped to 56.1%, 50.1% and 79.9%. In the same period, the assets of joint-stock commercial banks trebled and their market share increased from 13% to 15%.

Despite the relative decline, due to their vast banking infrastructure as well as political and historical reasons, the SOCBs still dominate the retail banking market

[5] Unless stated otherwise, all the figures in this study are derived by the authors from the data contained in the Almanac of China's Finance and Banking.

and the business banking market for the state-owned enterprises. In 2005, the SOCBs accounted for a market share of 63% of consumer deposits and 70% of consumer loans. On the corporate side, the SOCBs shared 75% of the deposits and about 70% of corporate loans in 2005. As China's bond and equity markets are still at the nascent stage, the SOCBs remain the most important source of finance for Chinese non-financial institutions (see Table 1 below) and the largest employers of banking employees (56% in 2005).

Table 1: Source of finance for China's domestic economy (%)

	2001	2002	2003	2004	2005	2006 (first half)
Bank loans	75.9	80.2	85.1	82.9	78.1	86.8
Government bonds	15.7	14.4	10	10.8	9.5	1.4
Corporate bonds	0.9	1.4	1	1.1	6.4	6.1
Equity issuance	7.6	4	3.9	5.2	6	5.6
Total	100	100	100	100	100	100

HSource: Hansakul (2006).

More recently, the main thrust of banking reform has been directed at the competitive capabilities and efficiency within individual banking groups of the SOCBs. Significant amounts of resources and efforts have been deployed to increase their business scope, improve banking and financial services, strengthen the internal management and risk control systems, and increase operational autonomy. Since 2002 the SOCBs have gained more autonomy in deciding their deposit and lending rates. Moreover, apart from the traditional wholesale and retail banking businesses, the Chinese SOCBs have also adopted the universal banking model to venture into other fee-based or capital-gains-based banking and financial investment activities (apart from investing in the stock market). Due to the increasing complexity and risk of modern banking, the SOCBs have implemented measures to instil an independent credit culture and equip their credit managers with modern systems to monitor various elements of risks. These include the 10-plus loan classification system and plans to set up the internal rating-based loan systems (consistent with Basle II regulations). The risk function has been separated from the business function. Internal audit and compliance systems have also been strengthened to safeguard against fraud through system upgrading and staff training[6]. At the operational level, the SOCBs have implemented changes to consolidate operations and increase efficiency. During 2002-2005 the number of branches of the big four has declined by 27% while the number of employees has declined by 7%. How successful such efforts are in improving banking efficiency and competitiveness within individual banking groups remains an open question and is the key task of the current study.

3. Current market conditions and business model of the Chinese SOCBs

[6] Source: various issues of the Almanac of China's Finance and Banking.

Given the dominant positions of the SOCBs and the market-oriented reforms for nearly three decades, it is perhaps not surprising that existing studies of the Chinese banking sector have typically assumed the SOCBs to be profit maximisers under a monopolistically competitive market structure (see, e.g., Fu and Heffernan, 2007, 2008). In a standard monopolistically competitive model, the firms have complete discretion over the design and launch of their products, the prices to charge, the markets to compete in, and the price and non-price aspects to compete against or collude with their rivals. However, in the Chinese SOCB sector during the study period, such conditions were far from reality. Although the Chinese SOCBs had come a long way to be commercially viable, they were still severely restricted to function independently as profit maximisers, largely due to historical reasons and policy interventions. The SOCBs were, and are still, closely monitored and regulated in their corporate governance, deposit-taking and lending decisions and the deposit-lending interest spread. Their flow of funds was largely allocated on a geographical and sectorial formula basis and they had little control over their cost bases. As a legacy of the historical administrative division of business scopes coupled with the very nature of banking that is based on information, reputation, trust and network between the bank and the clients, the SOCBs and the colossal state-owned industrial sectors are inextricably linked to maintain stability in national output and particularly employment. In a sense, the SOCBs were still playing the role of the "treasurer" for the state-owned corporations. Therefore, the Chinese government always stands ready to rescue any failing SOCBs through capital injections and taking-over of bad assets[7].

The business model of the SOCBs was also shaped by the stage of China's economic development in general and banking development in particular. Compared with established foreign banks, the Chinese domestic banks, particularly the SOCBs, have many disadvantages. Although the basic structure of a modern banking system is in place, the management of specific business areas such as credit and risk remains primitive. Despite a significant rise in the capital adequacy ratio achieved by capital injection by the government, stripping off bad assets, and stock market floatation, the formation and accumulation of bad assets still haunt the SOCBs disproportionally as a result of the ties with the state-owned enterprises. The rapid development of the stock markets and venture capital markets in China pose an increasing challenge to the banking sector's traditional sources of commercial income and thus the profit model.

[7] The SOCBs' defence against market risk is not always or exclusively policy intervention. One further buffer for the SOCBs to withstand the problem of significant proportion of NPLs is the very high liquidity level in the economy that arises from impressive economic growth at an annual rate of 8-10% for nearly two decades and also a culture of high savings ratio by Chinese households. In the past decade, the annual average growth rate in total banking assets, deposits and lending is almost twice the growth rate in real GDP. The ratio of banking assets to GDP in China increased from 151.8% in 2000 to 245.2% in 2005, suggesting a very high level of liquidity in the Chinese economy that is very similar to the level in the Euro area (see also Fu and Heffernan, 2007). This high level of liquidity has enabled the SOCBs to spread the burden of NPLs over a rapidly expanding asset base and over a longer time horizon.

The new fee-based or capital-gains-based businesses also face tough challenges as China has little history or culture of paying for banking and financial services. If the SOCBs were to move rapidly to a pure profit-based market model, it would entail significant levels of unemployment in the SOCB sector itself and probably a credit crunch for the state-owned enterprises – an economic as well as political risk too high for the Chinese government to bear.

Therefore, it can be argued that the most appropriate conceptual framework for describing the conduct of SOCBs is the principal-agent theory. A full development of the principal-agent model of the conduct of the Chinese SOCBs is beyond the scope of the current study. Nevertheless, it can be argued that the institutional framework and economic conditions in general and the market conditions in the banking sector in particular were prone to the occurrence of the principal-agent problem in the Chinese banking market. A possible solution to the problem is for the agents (managers of the SOCBs) and the principal (the government) to share the growth dividend arising from the continuing rapid growth of the Chinese economy. With the government readily willing to act as the ultimate insurer and underwriter, each SOCB's objective is to maximise its market power that is manifested through their market share of deposits, loans and the size and quality of the client base. In other words, the competition among the SOCBs mainly took the form of non-price competition. In the meantime, the principal (the government) maintains control through a number of mechanisms including direct involvement in the corporate governance and control of the cost base to influence productivity, efficiency and profitability of the SOCBs.

This characterisation of the behaviour of the SOCBs is consistent with empirical observation. As is already mentioned above, the growth in banking assets, deposits and loans has been spectacular in recent years across all the SOCBs, but the growth in the more market-oriented and riskier businesses has been rather limited. Although the business scope of the SOCBs is expanding, the traditional banking businesses still remain the dominant source of commercial income for the SOCBs (see Table 2). Non-interest income accounted for only around 10% of total income for the Chinese SOCBs (with the only exception of ABC that recorded a 26% share of non-interest income in 2005), compared with roughly 48% for the global banking market. Therefore, the traditional market for deposits and loans still remain the main battleground for the SOCBs.

Further evidence to show that the SOCBs are unlikely to behave as profit maximisers comes from the usual measures of financial performance for business firms. As Table 3 reveals, the usual measures of financial performance such as ROA and ROE for the SOCBs are simply unreliable and subject to huge swings over time. This is simply because the business operations of the SOCs were subject to frequent government interference such as asset-stripping and capital injections. Thus, all the data on costs, income and profits are substantially distorted market outcomes (see Table 3).

Table 2: Share of interest earnings in total operating revenue

	CCB	ICBC	ABC	BOC
1998	98.3%	76.8%	94.8%	72.5%
1999	95.8%	75.5%	94.8%	73.9%
2000	75.7%	77.4%	91.8%	92.6%
2001	90.0%	69.8%	88.8%	90.0%
2002	94.6%	95.4%	87.9%	79.9%
2003	92.7%	93.7%	85.8%	79.9%
2004	92.2%	83.0%	80.8%	83.9%
2005	93.5%	81.8%	73.7%	87.6%

Source: Authors' calculations from various issues of the Almanac of China's Finance and Banking.

Table 3: Return on assets and return on equity for the Chinese SOCBs

	CCB	ICBC	ABC	BOC
ROA:				
1998	0.06%	0.11%	-0.05%	0.10%
1999	0.23%	0.12%	-0.02%	0.11%
2000	0.07%	0.13%	0.01%	0.07%
2001	0.10%	0.14%	0.05%	0.10%
2002	0.14%	0.13%	0.10%	0.33%
2003	0.01%	0.04%	0.06%	0.15%
2004	1.25%	0.60%	0.05%	0.60%
2005	1.03%	0.53%	0.02%	0.70%
ROE:				
1998	1.08%	1.88%	-0.68%	1.69%
1999	4.64%	2.27%	-0.26%	1.98%
2000	1.63%	2.72%	0.22%	1.17%
2001	2.20%	3.09%	0.87%	1.21%
2002	4.01%	3.47%	2.13%	4.33%
2003	0.22%	1.24%	1.39%	2.46%
2004	25.08%	-5.60%	2.57%	10.22%
2005	16.37%	13.30%	1.31%	11.76%

Source: Authors' calculations from various issues of the Almanac of China's Finance and Banking.

As a summary, given the market conditions under which the SOCBs operated (and are still operating, though to a lesser extent), it is natural for the SOCBs to behave in such a way as to maximise their market share, but the government closely monitor and influence the level of productivity and efficiency of the banks. How successful the individual banks perform in the traditional markets for deposits and loans fundamentally determine their overall competitiveness and financial

performance, particularly during the time period under investigation. It is also questionable to make direct comparisons of the financial or efficiency performance between SOCBs and other domestic banks or foreign banks (as in Li, et. al, 2001; and Lin and Zhang, 2008), since these banks operated under distinctly different market models. A model of banking efficiency and competitiveness of the SOCBs must take these aspects into consideration. This is the conceptual basis for the DEA model that is used for assessing the efficiency level of the SOCBs, as the next section explains in detail.

4. Banking efficiency and DEA

Despite many caveats that are associated with the definition and its empirical measures, it is widely held that productivity (or productive efficiency) lies at the heart of the competitiveness of firms and industries.[8] As the measurement of productivity necessitates the measurement of inputs into and outputs from a production process, the application of the concept in banking requires the appropriate definition of the mode of production for banking and financial services in the national economy and the measurement of banking inputs and outputs. However, serious controversies surround the treatment of banking and financial services as well as the measures of banking and financial output in national accounts and the economics literature (see Triplett, 1990; Fixler and Zieschang, 1991; and Berger and Humphrey, 1992; Triplett and Bosworth, 2004). The controversy stems from the ways in which banking and financial services derive their main sources of income: by applying differential interest rate to borrowers and lenders to obtain net interest income and by explicitly charging fees for the provision of certain services. Because banks do not charge fees for many services they offer to their customers, the service charges are usually insufficient to cover non-interest costs of operation (e.g., wages, rents and materials). Thus banks and financial institutions typically rely on interest income to cover all the operating costs. However, opinions differ on how interest income should be treated in the measurement of banking output and value added.

Traditionally interest is viewed by national accounts statisticians as a transfer payment from borrowers to lenders for the foregone consumption. On this view, interest payments are not considered to be payments for a service rendered, but a form of property income, and so are recorded in the generation of primary income account, but not the production account. This treatment inevitably means that the operating surplus of banks would show as a negative item. As this would give a false impression of the size of the operating surplus of banks compared with other firms, the original system of national accounts (SNA) adopted a somewhat peculiar solution. On the one hand, *net* interest income, alongside other banking services that are explicitly charged for, was counted as part of banking net output. On the other hand, total net interest income was deducted from the total operating surplus for all the other industries so that the calculation of national GDP remained unaffected (the net interest income was

[8] For an excellent review of the literature regarding productivity, see the work by Carlaw and Lipsey (2003).

not allocated to particular industries or final users though). Alternatively, in the bank production function approach to banking output and productivity (see the discussion in Baltensperger, 1980; Santomero, 1984; and Berger and Humphrey, 1997), interest is viewed as a payment for services that banks and financial institutions provide to the economy (payments services, money creation, management of liquidity and risk), to depositors (record-keeping, safe-keeping, and interest payments on deposits) or to borrowers (funding and credit rating). In this view, apart from the explicitly priced banking services, banking output also includes gross interest earnings from bank loans as well as imputed charges for depositor services that banks offer to their customers free of charge. Although there is little difference in the measured net banking output or value added between the above two approaches, the difference in the measured total banking output is substantial with the economists' measure being significantly higher than the national statisticians' measure.

More recently, an eclectic approach has been adopted by economists and national accountants to incorporate the contribution by banking and finance to the national product through a statistical term called Financial Intermediation Services Indirectly Measured (FISIM). In essence, the method assumes that FISIM is purchased implicitly by borrowers paying higher interest than would be necessary if FISIM were charged for explicitly and by lenders receiving lower interest than would be necessary if FISIM were charged for explicitly. FISIM is then allocated to sectors and industries so as to identify the purchase of these services explicitly and to classify them as intermediate consumption, final consumption expenditure or exports according to which sector incurs the expenditure. The implication of the implementation of FISIM is far-reaching – not only banking output, in both net and gross terms, but also the output and value added for both the aggregate economy and the other industrial sectors will all be altered. A simple example here can help to illustrate the issues more clearly. Let L, D, R_L, R_D and I denote the volume of loan, deposit, the bank lending rate, the deposit rate and the net interest income. In the conventional national accounts treatment, the net interest income is defined to be $I = R_L L – R_D D$. In the FISIM framework, there will be a reference interest rate that represents the pure charge for the financial intermediary services that the banks provide to both depositors and borrowers. Let R_F denote this reference rate (which lies between the deposit and lending rates), then the new level of net interest income is $I_F = (R_F – R_D) D + (R_L – R_F) L = I + R_F (D – L)$. Since $D > L$, the new measure of bank net output is larger than the old measure by the amount $R_F (D – L)$, which represents the amount of pure charges for financial intermediary services offered by the banks. It is worth noting that such charges are shared by both depositors and borrowers, hence their income, expenditure and net output have to be adjusted accordingly. However, how the reference rate is determined is still highly controversial (see further discussion in Triplett and Bosworth, 2004).

Corresponding to such controversies, it is little wonder that despite the substantial number of studies on banking output and productivity, there is still no coherent definition of either banking inputs or outputs. In the economic literature, the selection and classification of banking inputs and outputs have been guided by three general

models of banking and are also constrained by data availability in practice. The three general models are "financial intermediation", "production function" and the "hybrid" model. The financial intermediation model is consistent with the traditional national accounts view that any interest-related banking activity is non-productive and the primary role of banks is to offer financial intermediation between depositors and borrowers. In this model, banks use the traditional factors of production (e.g. labour and capital) together with deposits as inputs to produce outputs of loans and other fee-based services (e.g. Sealey and Lindley, 1977). In the production function approach, banks are treated essentially the same as any other non-financial firm – they employ the traditional factors of production, viz. labour and capital, to produce a range of banking and financial outputs, including deposits, loans and other services (see, e.g., Benston and Smith, 1976; Berg, et. al., 1991; Berg, et. al., 1993; Berger and Humphrey, 1991). More recently, a number of researchers have proposed hybrid models that focus on the efficiency of banks in reducing costs or generating revenue/profit (e.g., Hancook, 1985; Berger, et. al., 1993; Berger and Mester, 1997, 2003). In contrast to the earlier two approaches that focus on banking assets and liabilities in measuring technical and scale efficiencies, this third approach focuses on costs and earnings in measuring X-efficiency. Moreover, the classification of inputs and outputs in the hybrid model is also flexible – a financial product can be classified either as an input or an output, depending on whether or not the product makes a negative or positive *net* contribution to bank revenue. Due to severe problems with data availability and reliability in the current context, as discussed earlier, a hybrid model cannot be implemented within this study and thus is not discussed any further.

Insofar as the financial intermediation and the production function approaches are concerned, the fundamental difference between the two is whether or not bank liabilities should be treated as inputs or outputs. It is nonetheless increasingly recognised that banks, like many other non-financial firms, use scarce economic resources to produce a range of banking outputs, including outputs that are offered free-of-charge mainly to depositors. Such outputs include free cheques cashed, automatic teller machine (ATM) transactions, and other transactions services. Although there is no explicit charge for using such services, depositors do pay for these services in the form of interest that depositors forego. Banks accordingly earn implicit revenue from these depositor services. At the same time, banks incur costs for producing the services, in the form of the resources employed in cheque clearing, ATM operations and other transactions services provided to deposit holders. In the spirit of Benston and Smith (1976), what a bank produces facilitates both inter-temporal and intra-temporal transfers of consumption, which corresponds to demands for both deposits and loans. Therefore, in principle a model of bank production and output needs to incorporate both deposit-related and lending-related services as well as other explicitly charged services. In the context of the Chinese SOCBs, there is an additional incentive for the banking groups to compete for deposits in order to support the burden of NPLs that arise largely from lendings to the state-owned enterprises. It is no wonder that the amount of deposits that a branch attracts features prominently in the criteria against which the performance of the

branch is judged by the management. Although a rigorous approach must take the measurement of every element of banking outputs seriously, such an approach is still eluding analysts. Therefore, the present study will adopt the production function approach but employ proxy measures for deposit-related, lending-related and other outputs. Such proxy measures are also widely used in the literature (e.g. see Berger, et al. 1993; Humphrey, 1993; Mester 1997).

Following the literature, the current study uses the number of employees and the number of bank branches as inputs and the total amount of deposits and loans (in RMB Yuan) as outputs. Moreover, the present study also uses the number of cash cards as an input and the amount of card transactions as an output. Since the issuance and maintenance of cards incur additional capital and technology related costs and the average amount of card transactions per card can reflect the cardholders' average spending power, this practice can capture the efficiency of the branches in attracting wealthy individuals who also have demands for other fee-based banking products and services such as personal asset management.

Having clarified the selection of inputs and outputs, the next step is to specify the method for measuring the efficiency of bank branches in transforming inputs into a variety of outputs. Since there are multiple inputs and outputs in the present case, the natural tool of analysis is the non-parametric Data Envelopment Analysis that was originally developed by Charnes et al. (1978). DEA is ideally suited for benchmarking the relative operational efficiency of business units (termed decision making units, or DMUs) against their most efficient peers under similar market conditions and business models when multiple inputs and outputs are involved in the production process. The analysis indicates the necessary changes in individual inputs and outputs of a particular DMU so that the performance of the unit becomes as efficient as its most efficient peers. This method, now routinely adopted in a broad range of application areas, has been applied extensively in the banking and financial service sector. Conditional upon the appropriate choice of inputs and outputs as well as the sample of DMUs, the kind of mathematical programming procedure used by DEA for efficient frontier estimation is found to be comparatively robust (Seiford and Thrall, 1990). Further evidence of the robustness of DEA as compared with other similar estimation methods is presented in Bauer et al. (1998).

The present study focuses on the technical input efficiency of the provincial branches of the SOCBs, that is, the maximum proportional contraction in any observed input that can be achieved if all inputs by a branch contract *radially* as far as possible without detriment to its output levels (Thanassoulis, 2001, p.24). The focus on input efficiency is consistent with real world developments in the Chinese banking sector that was characterised by limited scope for further growth in deposits and loans for the SOCBs due to severe competition from other banks that were expanding rapidly. The estimation of the technical input efficiency is performed under alternative assumptions about the returns to scale characteristic in the production process. Following the original model of Charnes, et al. (1978), which has become widely known as the CCR model, the overall *technical input efficiency* (termed θ^{CCR}) of each branch is estimated under the assumption of constant returns to scale. The CCR model

is also extended to obtain the slacks in inputs and outputs by a two-stage estimation procedure (see, Cooper, et. al., 2002). Let j denote the jth DMU (or bank branch, j = 1, …, N), x_i the ith input (i = 1, …, M), and y_k the kth output (k = 1, …, S), SX_i the slack in the ith input, and SY_k the slack in the kth output. In the first stage, for any particular DMU (denoted by j0) the following linear programming problem is solved to obtain its efficiency score (i.e. θ_{j0}^{CCR}):

Minimise: θ_{j0}

Subject to:

$$\theta_{j0} x_{i,j0} \geq \sum_{j=1}^{N} \lambda_j x_{i,j}, \qquad i = 1,..., M$$

$$y_{k,j0} \leq \sum_{j=1}^{N} \lambda_j y_{k,j}, \qquad k = 1,... S$$

$$\lambda_j \geq 0, \qquad j = 1,..., N$$

$\theta_{j0}^{CCR} = \theta_{j0}^{*}$ where θ_{j0}^{*} is the optimal value of θ_{j0}.

In the second stage, the optimal value θ_{j0}^{*} is used in the following linear programming problem:

Minimise: $$-\sum_{i=1}^{M} SX_i - \sum_{k=1}^{S} SY_k$$

Subject to:

$$\theta_{j0}^{*} x_{i,j0} = \sum_{j=1}^{N} \lambda_j x_{i,j} + SX_i, \qquad i = 1,..., M$$

$$y_{k,j0} = \sum_{j=1}^{N} \lambda_j y_{k,j} - SY_k, \qquad k = 1,... S$$

$$\lambda_j \geq 0, \qquad j = 1,..., N$$

If $\theta_{j0}^{*} = 1$ and $SX_i = 0$ (i = 1,…,M), $SY_k = 0$ (k = 1,…,S), the operation of DMU j0 is defined to be Pareto-efficient, otherwise it is Pareto-inefficient and the extent of technical inefficiency is measured by $1- \theta_{j0}^{*}$. One limitation of the above model, however, is that all the DMUs, regardless of their size, are assumed to be operating under constant returns to scale, which is a very restrictive assumption. Banker et al. (1984) modified the CCR model to allow for the DMUs to operate under variable returns to scale (and the modified model is termed the BCC model). The modification is rather straightforward: the following *convexity constraint* is introduced into the CCR model: $\sum \lambda_j = 1$. The resultant efficiency score for DMU j0 is now termed the

pure technical input efficiency (denoted by θ_{j0}^{BCC}). On the basis of the two efficiency scores, the *scale-efficiency* score for DMU j0 (denoted by θ_{j0}^{S}) can be obtained as: $\theta_{j0}^{S} = \theta_{j0}^{CCR} / \theta_{j0}^{BCC}$. Moreover, using the optimal values for λ (denoted by λ^{*}), the returns-to-scale characteristic of DMU j0 can also be determined as follows: 1) If $\sum \lambda_j^* > 1$ for all the optimal solutions to the CCR model, then decreasing returns to scale (DRS) hold locally for DMU j0; 2) If $\sum \lambda_j^* = 1$ for at least one optimal solution to the CCR model, then constant returns to scale (CRS) hold locally for DMU j0; 3) If $\sum \lambda_j^* < 1$ for all the optimal solutions to the CCR model, then increasing returns to scale (IRS) hold locally for DMU j0. The optimal scale size is at where CRS holds. Given the absence of any data on bank profit at the provincial level, such information is valuable in identifying the potential unit cost of production and thus profitability of the branches.

In the above procedures, all the branches of all the banking groups are pooled together to estimate a *global* efficient frontier against which every branch is compared. However, it is probable that for historical as well as political/administrative reasons, branches within a particular banking group may face a separate *group* efficient frontier from that for another banking group. In other words, irrespective of the efficiencies at the provincial level, a banking group may be intrinsically more effective than the other groups in improving the operational efficiencies of all its branches across the provinces. This is particularly pertinent in the Chinese SOCBs as historically these banking groups were severely restricted in the economic sectors within which they could operate. As a result, the level of efficiency of individual banking groups may be related to the conditions and performance of those economic sectors. Moreover, over different time periods different banking groups received policy priority treatments by the Chinese government, which again may have led to differences in efficiency performance at the group level. Therefore, similar to the procedure developed by Charnes et al. (1981), this study decomposes the technical efficiency score for a provincial branch into the product of *within-banking-group efficiency* and *between-banking-group efficiency*. For convenience such efficiencies are termed *local efficiency* and *group efficiency* respectively in subsequent discussions. *Local efficiency* is obtained by estimating the technical input efficiency of all the provincial branches within the *same* banking group in the first-step estimations. In the second step, the observed input-output levels of all the branches for all the banking groups are replaced by their targeted optimal levels that are calculated from the first-step estimations. All the branches with the new optimal input-output levels are then pooled together to estimate the efficiency score for the branches again. Since in the second step, the inefficiencies at the local level have already been removed by the use of optimal inputs and outputs, any new inefficiency must be due to the group effect. The next section implements the estimation procedures discussed above and presents the main findings.

5. Data and results

All the data for the present study are obtained from the Almanac of China's Finance and Banking[9] (1998-2003 issues). The full dataset contains all the defined inputs and outputs from 1998 to 2003 for the branches of the four banking groups in 31 provinces, autonomous regions and provincial-level municipalities on mainland China (with the exception of Tibet which has partial data), giving rise to a sample size of 122 provincial level DMUs for each year. The following table presents the relative share of the inputs and outputs by each banking group as a whole.

Table 4: Share of inputs and outputs by banking groups (2003, %)

	Branch	Employee	Card	Deposit	Loan	Card Transaction
CCB	18.8	24.2	33.5	23.7	22.7	30.6
ICBC	27.3	27.5	21.5	37.6	37.4	15.7
ABC	40.8	36.1	31.3	23.9	25.0	50.7
BOC	13.1	12.1	13.8	14.8	14.9	2.9
Total	100.0	100.0	100.0	100.0	100.0	100.0

Clearly, ABC has the most extensive banking infrastructure among the four SOCBs, with the largest share in the number of branches and employees and second largest share in the number of cards issued. It also has a significant share of all the outputs, with more than half of the market in card transactions. Compared with ICBC, ABC's relatively smaller shares in deposits and loans were mainly due to the historical and administrative reasons that the operations of ABC were largely restricted to the agricultural sectors and the rural areas whilst ICBC was traditionally the dominant player in the state-owned industrial and commercial sectors. However, over the recent years, ABC was very aggressive in venturing into new business areas such as bank card related businesses. BOC has the smallest market share in either inputs or outputs. This is largely due to the fact that it was primarily dealing with banking businesses involving foreign currencies and thus accessible to a small proportion of domestic individuals and firms. Of course, there are significant variations in market shares of inputs and outputs across all the provinces. By estimating the CCR and BCC models the technical input efficiency scores as well as the decomposed pure technical and scale efficiency scores for all the provincial branches are obtained. Table 5 shows the average efficiency scores for the banking groups from 1998 to 2003[10].

[9] It should be pointed out that the term "bank cards" refers to different measures for the four banking groups at the provincial level in the Almanac of China's Finance and Banking: for ABC, CCB and ICBC, the term contains both cash cards and credit cards, whilst for BOC only credit cards are counted. Therefore, the card-related inputs and outputs for BOC had to be adjusted to be consistent with the figures for the other three groups using a variety of sources including statistical year books for individual provinces.

[10] All the DEA models were implemented in the GAMS modelling system developed by GAMS

Table 5: Group average input efficiencies of the Chinese SOCBs (1998 – 2003)

	1998	1999	2000	2001	2002	2003
Technical:						
All	0.53	0.49	0.51	0.59	0.53	0.61
CCB	0.48	0.40	0.47	0.54	0.62	0.54
ICBC	0.42	0.44	0.46	0.64	0.62	0.74
ABC	0.58	0.50	0.52	0.62	0.40	0.56
BOC	0.62	0.60	0.58	0.56	0.46	0.63
Pure:						
All	0.59	0.55	0.56	0.62	0.57	0.64
CCB	0.52	0.43	0.50	0.55	0.65	0.55
ICBC	0.51	0.54	0.54	0.67	0.66	0.75
ABC	0.69	0.61	0.59	0.64	0.44	0.59
BOC	0.68	0.66	0.62	0.62	0.52	0.66
Scale:						
All	0.90	0.89	0.91	0.96	0.93	0.96
CCB	0.94	0.94	0.94	0.98	0.95	0.97
ICBC	0.88	0.85	0.88	0.96	0.95	0.98
ABC	0.87	0.84	0.89	0.97	0.92	0.95
BOC	0.92	0.92	0.93	0.91	0.90	0.95

Note: due to rounding errors, figures for technical efficiencies do not exactly equal the products of pure technical and scale efficiencies in the table.

For the Chinese SOCBs as a whole, there was clear evidence of significant levels of operational inefficiency as compared with the most efficient provincial branches – the average score was 53% in 1998 and then fluctuated between 49% and 59% until it improved to 61% in 2003. The generally low level of efficiency was primarily due to the low pure technical efficiency, which was 59% in 1998 and 64% in 2003. The low pure technical efficiencies were reflected in the loss of efficiency for all the inputs. At the start of the study period, compared with the efficient targets, around 57% of branches, 49% of employees and 49% of cards for the whole sector could have been cut to achieve the same or even higher level of outputs. In 2003, despite the significant reductions in the number of branches and employees over the years of further reform, the percentage of wastage was still 42% for branches, 45% for employees and 39% for cards. Therefore, the cost-cutting measures by the banking groups did have the desired effects, but the effects were only partial and the process of reform was very slow. These results are consistent with the gradualist approach to economic and banking reform adopted by the Chinese government to avoid potentially large scale unemployment and credit crunch problems that could arise from a "shock-therapeutic" approach. Some other benefits of the reform started to be evident at the end of the period. For example, the pure technical efficiency started to

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improve for the whole sector in 2003, and the average scale efficiency increased steadily from 0.9 in 1998 to 0.96 in 2003.

Having briefly examined the overall efficiency performance of the whole SOCB sector, the focus now turns to the performance of individual banking groups. As Table 5 shows, BOC was the clear leader in operational efficiency in the first half of the period but its leading position was taken over by ICBC in the second half. The performance of ICBC in the second period was particularly noticeable as this group was the worst performer in the first three years. The other groups showed a mixed fortune over the period. CCB had the lowest score for 3 out of the 6 years and was at the bottom of the league table in 2003. ABC came second in the table in the first four years but its position dropped to the bottom in 2002 and second from the bottom in 2003. More detailed results regarding various aspects of the operational efficiencies are reported in Table 6.

Table 6: Operational efficiencies of individual groups of the SOCBs (1998-2003)

	1998	1999	2000	2001	2002	2003
No. of Pareto-efficient provinces:						
CCB	3	2	3	4	4	4
ICBC	2	1	1	2	5	5
ABC	3	2	2	3	1	2
BOC	6	6	5	4	2	4
No. of branches operating at CRS:						
CCB	3	2	3	4	4	4
ICBC	2	1	1	2	5	5
ABC	4	2	2	3	1	2
BOC	7	6	5	4	2	4
No. of branches operating at IRS:						
CCB	10	18	21	16	1	4
ICBC	11	10	11	5	2	16
ABC	6	8	8	3	5	7
BOC	15	18	17	19	12	22
No. of branches operating at DRS:						
CCB	18	11	7	11	26	23
ICBC	17	19	18	23	23	9
ABC	20	20	20	24	24	21
BOC	9	7	9	8	17	5
% of target level - by no. of branches						
CCB	46.9	38.3	45.9	53.4	56.7	52.9
ICBC	36.7	34.3	35.3	57.4	42.0	67.9
ABC	38.2	36.0	34.0	50.5	38.1	55.0
BOC	50.7	48.9	47.0	48.8	28.7	56.0
% of target level - by no. of employees						
CCB	41.9	36.3	42.7	43.7	59.4	47.0
ICBC	42.0	43.7	46.3	63.1	62.4	73.6
ABC	57.5	50.4	51.4	61.1	19.6	35.3
BOC	61.9	59.8	58.0	55.1	46.4	62.7
% of target level - by no. of cards						
CCB	44.5	35.9	45.5	53.5	61.9	53.0
ICBC	39.2	40.9	43.3	64.3	59.6	73.6
ABC	57.2	50.5	51.7	61.9	40.3	55.5
BOC	62.1	59.9	58.0	56.4	45.9	62.7

Note: % of target level is expressed as the ratio between the level of an input that a DMU would require were it operating as efficiently as its most efficient peer and the actual level of that input. Thus, 1 minus this figure can be regarded as the percentage of wastage in that input.

A number of significant results have emerged. First, among the 122 provincial

branches, just over 10% operated at an efficient scale (13% in 1998 and 12% in 2003). Around half of branches operated at decreasing-returns-to-scale (52% in 1998 and 48% in 2003), suggesting that these branches were operating at a scale that is above the most productive level. Given the dominance of interest income in banks' total revenue and the very limited autonomy by the banks to change their interest rates, it can be deduced that these branches were not operating at the profit-maximising scales and thus could benefit from a reduction in their scales of operation. The problem was particularly acute for CCB and ABC throughout the period. ICBC also experienced a significant problem of DRS in every year apart from 2003. In contrast, the most significant problem for BOC over the entire period was IRS, thus there was scope for many branches in this group to increase the scale of operation. Second, related to the problem of above-optimal operational scales, there was also a significant problem of surplus inputs of branches, employees and bank cards. Relatively speaking, ICBC had the least surpluses whilst CCB and ABC had the most surpluses in all the inputs. The problem of surplus labour was particularly severe for ABC. To shed further light on the areas where improvement is required, the decompositional analysis of local versus group efficiencies is conducted and the results are presented in Table 7.

Table 7: Local and group efficiencies of the SOCBs (1998 – 2003)

	1998	1999	2000	2001	2002	2003
SOCBs:						
Local	0.70	0.73	0.70	0.68	0.68	0.68
Group	0.77	0.71	0.76	0.90	0.85	0.94
CCB:						
Local	0.64	0.66	0.72	0.61	0.68	0.54
Group	0.80	0.68	0.66	0.90	0.96	0.99
ICBC:						
Local	0.79	0.80	0.77	0.76	0.69	0.76
Group	0.53	0.56	0.61	0.86	0.92	1.00
ABC:						
Local	0.75	0.84	0.73	0.73	0.71	0.74
Group	0.74	0.60	0.77	0.85	0.66	0.78
BOC:						
Local	0.63	0.62	0.61	0.60	0.64	0.66
Group	1.00	0.99	0.99	0.99	0.87	0.98

It is clear that for the whole sector of SOCBs, efficiency at the local provincial level declined but efficiency at the group level generally improved over the entire period. Moreover, efficiency at the group level dominated efficiency at the local level and the gap was rising in recent years, suggesting that in general the source of inefficiency was from the local level. Therefore, further efficiency gain can be obtained more effectively by targeting reform efforts at the micro/branch level than at the group level. Insofar as the individual banking groups are concerned, BOC was the most efficient at the group level. This is not really surprising given this group's

significant exposure to international markets and foreign competition. Nevertheless, compared with the most efficient peers within the BOC group, the level of local efficiency was the lowest among the four banking groups. Again, this result was not really surprising as it is expected that those provinces in the interior parts of China were not as exposed to foreign-currency related businesses as their counterparts located in the east coastal provinces. In the remaining three groups, some interesting contrasts have emerged. Although ABC was not the worst performer in the first few years, it fared worst in the efficiency score by 2003. For CCB and ICBC, although these two groups compared unfavourably with the BOC in the first few years, they had become almost as efficient as BOC in 2002 and 2003. Therefore, ABC seemed to be particularly disadvantaged in its operational efficiency over the study period. At the local level, the level of inefficiency was very significant across all the banking groups, especially within the CCB group.

Finally, the study presents the six-year average technical and scale efficiency scores for all the provincial branches of the Chinese SOCBs over the examination period. Not surprisingly, provinces on the eastern coast and the major cities were associated with much higher technical input efficiency scores than those provinces in the interior parts of China, although the difference in scale efficiency was rather limited. Therefore, the cross-province differences in technical input efficiency mainly arose from the differences in pure technical efficiency. The charts in the Appendix show the distribution of efficiency scores among all the provincial branches. Apparently, with the exception of 2001 and 2003, the peak of the distribution occurred at an efficiency level of less than 50%. By 2003, the provincial branches were more uniformly distributed across the efficiency range of 0.4 to 1, suggesting an across-the-board, albeit limited, efficiency improvement.

Table 8: Average technical input efficiency of SOCBs across Chinese provinces and major cities (1998 – 2003)

Provinces	CCB	ICBC	ABC	BOC
Beijing	1.00	1.00	0.69	1.00
Tianjin	0.66	0.53	0.51	0.73
Hebei	0.36	0.50	0.57	0.51
Shanxi	0.59	0.64	0.49	0.48
Inner Mongolia	0.37	0.48	0.44	0.43
Liaoning	0.54	0.64	0.47	0.72
Jilin	0.41	0.72	0.37	0.79
Heilongjiang	0.49	0.70	0.57	0.78
Shanghai	0.95	0.89	0.87	1.00
Jiangsu	0.39	0.65	0.48	0.50
Zhejiang	0.63	0.48	0.51	0.42
Anhui	0.30	0.42	0.43	0.43
Fujian	0.78	0.70	0.85	0.45
Jiangxi	0.51	0.61	0.42	0.39
Shandong	0.44	0.63	0.44	0.44
Henan	0.49	0.71	0.60	0.43
Hubei	0.27	0.44	0.33	0.64
Hunan	0.29	0.33	0.35	0.55
Guangdong	0.44	0.64	0.39	0.71
Guangxi	0.45	0.39	0.55	0.43
Hainan	0.42	0.50	0.46	0.65
Chongqing	0.54	0.34	0.39	0.47
Sichuan	0.54	0.44	0.41	0.57
Guizhou	0.32	0.29	0.54	0.47
Yunnan	0.29	0.38	0.55	0.63
Tibet	0.96	-	-	0.89
Shaanxi	0.42	0.57	0.55	0.43
Gansu	0.55	0.54	0.67	0.69
Qinghai	0.53	0.59	0.82	0.39
Ningxia	0.43	0.41	0.75	0.47
Xinjiang	0.38	0.48	0.46	0.38

Table 9: Average scale efficiency of SOCBs across Chinese provinces and major cities (1998 – 2003)

Provinces	CCB	ICBC	ABC	BOC
Beijing	1.00	1.00	0.99	1.00
Tianjin	0.94	0.98	0.97	0.94
Hebei	0.97	0.81	0.82	0.98
Shanxi	0.97	0.94	0.94	0.97
Inner Mongolia	0.98	0.97	0.97	0.97
Liaoning	0.95	0.76	0.86	0.96
Jilin	0.94	0.91	0.94	1.00
Heilongjiang	0.96	0.83	0.83	1.00
Shanghai	0.99	0.91	0.97	1.00
Jiangsu	0.97	0.82	0.71	0.92
Zhejiang	0.92	0.94	0.83	0.96
Anhui	0.98	0.98	0.91	0.99
Fujian	0.97	0.99	1.00	0.98
Jiangxi	0.98	0.85	0.95	0.98
Shandong	0.93	0.80	0.79	0.96
Henan	0.83	0.84	0.76	0.99
Hubei	0.97	0.87	0.83	0.91
Hunan	0.95	0.97	0.97	0.98
Guangdong	0.77	0.69	0.73	0.75
Guangxi	0.99	0.99	0.99	0.98
Hainan	0.98	0.97	0.99	0.99
Chongqing	0.90	0.96	0.99	0.80
Sichuan	0.98	0.94	0.86	1.00
Guizhou	0.92	0.99	0.90	0.90
Yunnan	0.94	0.99	0.96	0.95
Tibet	0.98	-	-	0.89
Shaanxi	0.98	0.94	0.95	0.92
Gansu	0.99	0.98	0.92	0.94
Qinghai	0.99	0.96	0.94	0.56
Ningxia	0.99	0.95	0.94	0.72
Xinjiang	0.97	0.98	0.97	0.81

6. Conclusions

Given the significance of banking and finance in the modern economy and the still dominant position of the SOCBs in the Chinese banking sector, substantial resources and efforts have been deployed by the Chinese government to improve the level of efficiency and competitiveness of the SOCBs in recent years. How successful the efforts have turned out to be remains an open question. A combination of conceptual problems with a proper definition of the banking production process and the lack of consistent and reliable data for the Chinese SOCBs has made the empirical

assessment difficult to carry out. By adopting a banking production function approach, and using data on banking inputs and outputs that are relatively reliable, the present study focuses on the measurement of technical input efficiency and scale efficiency of the SOCBs at the provincial branch level. On the whole, the empirical results represent rather uncomfortable readings for the Chinese policymakers and management of the SOCBs. For the whole sector of SOCBs, the level of technical input efficiency remained very low throughout the study period, even though there was a small improvement in 2003. The technical input inefficiency was mainly due to pure technical inefficiency, but also to scale inefficiency. Despite the substantial reduction in the number of branches and employees over recent years, the problem of surplus branches and employees was still significant in 2003. A related problem was that around half of the provincial branches were operating at an above-optimal scale (larger than the most productive scale size), particularly among CCB, ICBC and ABC. In contrast, the most significant scale problem for the BOC group was increasing returns to scale (i.e. operating below the most productive scale size). Therefore, for the first three groups, further efforts should be directed at consolidating existing banking inputs (e.g. branches) further, whilst for BOC the main focus should be on further expanding banking outputs and new business opportunities.

Looking at the sources of inefficiency from an administrative point of view, different patterns have emerged among the banking groups. For BOC, the inefficiency is almost entirely due to local inefficiency in the provinces whilst the group as a whole remained efficient throughout the study period. ICBC and CCB made significant improvements over the years and by 2003 were almost as efficient as BOC. Therefore, by the end of the study period, there was little difference in operational efficiency at the group level among CCB, ICBC and BOC. In contrast, the group level efficiency for ABC stayed low until the end of the study period. It seemed that the Chinese government's efforts to prepare CCB, BOC and ICBC for stock market floatation in recent years had put ABC in a considerably disadvantaged position in terms of operational efficiency. It remains to be seen whether or not the on-going effort by the Chinese government to float ABC will bring its efficiency performance in line with the other three groups. Moreover, compared with the efficient provincial branches, the majority of the provincial branches were operating at a too low level of technical efficiency. A casual inspection of the empirical results reveals that the inefficient branches were mostly but not always located in the interior parts of China, suggesting a potential link to the state of economic and banking development in different provinces. However, a detailed explanation of the inter-provincial differences in banking efficiency is left as a future research agenda.

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Appendix: Distribution of efficiency scores among provincial branches