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X-efficiency versus Rent Seeking in Chinese banks: 1997-2006

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Abstract

This study demarcates cost-inefficiency in Chinese banks into X-inefficiency and rent-seeking-inefficiency. A protected banking market not only encourages weak management and X-inefficiency but also public ownership and state directed lending encourages moral hazard and bureaucratic rent seeking. This paper uses bootstrap non-parametric techniques to estimate measures of X-inefficiency and rent-seeking inefficiency for the 4 state owned banks and 10 joint-stock banks over the period 1997-2006. The paper adjusts for the quality of loans by treating NPLs as a negative output. The paper shows that Chinese banks have reduced cost inefficiency and reduced X-inefficiency at a faster rate than rent-seeking inefficiency.

Keywords: Bank Efficiency; China; X-inefficiency; DEA.; Bootstrapping

JEL codes: D23, G21, G28

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1. Introduction

In theory, the Chinese banking market has been open to foreign competition since the end of 2006. The strategy of allowing a larger stake holding in the Chinese banking system by foreign banks as a means of improving efficiency has a good academic pedigree. The link between privatization and efficiency improvement in former government owned enterprises is now very much an established finding (Megginson and Netter, 2001). The link between privatization of banking and efficiency improvement is an emerging research area (see Megginson, 2005 for a survey).

Given the recent listing of the major state owned banks and the tacit acceptance of larger stakes by foreign banks in the smaller commercial banks, it is not surprising that bank efficiency in China has become a popular subject of research in recent years. A number of studies of Chinese banking efficiency have been published in Chinese scholarly journals[1] but to date there have been only a few studies that are available to non-Chinese readers[2].

While the gradualist economic reform policies of Deng Xiaoping have transformed management practice and corporate efficiency in the manufacturing sector, it can be argued that the mindset of the corporatist thinking in management continues in much of the state owned enterprises (SOEs) in China, including its banks.

Cost inefficiency relative to 'best practice' is usually blamed on bad management and poor motivation. Following Leibenstein (1966) this efficiency gap is termed 'X-inefficiency'. However, in the context of an economy that has only recently

[1] For example Qing and Ou, (2001); Xu, Junmin, and Zhensheng, (2001); Wei and Wang, (2000); Xue and Yang, (1998) and Zhao (2000) have used non-parametric methods while Liu and Song (2004), Zhang, Gu and Di (2005), Sun (2005) and Qian (2003) have used parametric methods.

begun to open its banking sector, this paper argues that a significant cause of bank inefficiency is 'rent seeking' behavior, rather than X-inefficiency.

This research has three objectives. First it aims to decompose the measure of Cost inefficiency in Chinese banks into Technical inefficiency (sometimes viewed as X-inefficiency), and Rent-seeking inefficiency. This paper argues that while the underutilization of factors is consistent with the notion of X-inefficiency, the wrong factor-mix is indicative of 'rent-seeking'. The decomposition of cost inefficiency into X-inefficiency (technical inefficiency) and rent-seeking inefficiency allows us to examine their evolution over the sample period.

Second, this paper aims to provide an inferential capability to the point-estimates of inefficiency through the use of bootstrapping methods. Third, the bootstrap estimates of inefficiency are use to test various hypotheses regarding the levels and trends in X-inefficiency and rent-seeking inefficiency. The threat of entry of foreign banks into the Chinese market should lead to improved management, which should result in improved technical efficiency and lower cost-inefficiency as incumbent banks attempt to cut costs and consolidate their balance sheets.

This paper is organized on the following lines. The next section outlines the background to the Chinese banking system. Section 3 discusses the methodology of the non-parametric method of estimating bank efficiency and the application of bootstrapping technology. Section 4 reviews the literature and discusses the concept of X-inefficiency and the implications for its measurement in the context of banking. Section 5 discusses the data. Section 6 discusses the results and section 7 concludes.

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[2] Recent exceptions are studies using non-parametric methods by Chen et. al. (2005) and parametric methods by Fu and Heffernan (2005). Other recent studies in English are, Lin and Zhang (2008), Berger et. al. (2008) and Fu and Heffernen (2008).

2. Chinese Banking

In 2005, the Chinese banking system consisted of some 30,000 institutions, including 3 policy banks, 4 state-owned commercial banks, 13l joint-stock commercial banks, 115 city commercial banks, 238 operational entities of foreign banks and the rest made up of urban and rural credit cooperatives and other financial institutions.

Like many economies that have undeveloped financial and capital markets, the banking sector in China plays a pivotal role in financial intermediation. Table 1 below shows that the ratio of total bank assets to GDP has increased from 125%, in 1997, to 205% in 2005. The market is absolutely dominated by the four state owned banks, although their share of the market has been decreasing steadily through competition from the other nationwide banks (Joint-stock banks and some City Commercial Banks).

Table 1: The Chinese banking Market

Variable	1997	2000	2005
Total Assets to GDP	125.6%	147.1%	205.1%
SOB Employment	1,394.8 thousand	1,4936.3 thousand	1,364.2 thousand
SOB Market share % assets	88.0%	71.4%	52.5%
NPL ratio SOB	52.7%	31.5%	10.5%
ROAA SOB*	0.93%	0.78%	0.74%
NIM SOB*	1.8%	1.5%	1.7%
Cost-Income Ratio SOB*	48.2%	59.6%	45.4%

Sources: IMF *International Financial Statistics*, Annual Accounts, China Regulatory Banking Corporation website, *Almanac of China's Finance and Banking*, Bankscope data base, * weighted average by asset share

Return on average assets (ROAA) and net-interest margins (NIM) of the SOBs are respectable by Western standards but are well below levels that would be consistent with economies in the same stage of development (as for example India where NIM would be in the region of 3%). Part of the problem is that interest rates were heavily controlled during this period and partly the large amount of non-performing loans on the books of the commercial banks. The non-performing loans (NPL) ratio of the SOBs has fallen from 52% in 1997 to 10% in 2005.

Faced with the potential of increased competition from the end of 2006 onwards, the big banks have begun the process of restructuring and reducing unit costs. Employment in the state-owned banks has declined in recent years and the major banks have worked to reduce costs as shown in the reduction in the average cost-income ratio.

Up until 1995, control of the banking system remained firmly under the government and its agencies[3]. Under state control, the banks in China served the socialist plan of directing credits to specific projects dictated by political preference rather than commercial imperative. Since 2001 foreign banks and financial institutions were allowed to take a stake in selected Chinese banks. While control of individual Chinese banks remain out of reach for the foreign institution[4], the pressure to reform management, consolidate balance sheets, improve risk management and reduce unit costs has increased with greater foreign exposure.

The theory of market contestability (Baumol, 1982) suggests that incumbent banks will restructure weak balance sheets, reduce costs, and improve efficiency in

[3] According to La Porta, et. al (2002), 99% of the 10 largest commercial banks were owned and under the control of the government in 1995.

[4] There is a cap of 25% on total equity held by foreigners and a maximum of 20% for any single investor, except in the case of joint-venture banks

preparation for the threat of entry. Chinese banks should exhibit less inefficiency, whichever way measured, in 2006 than in 1997.

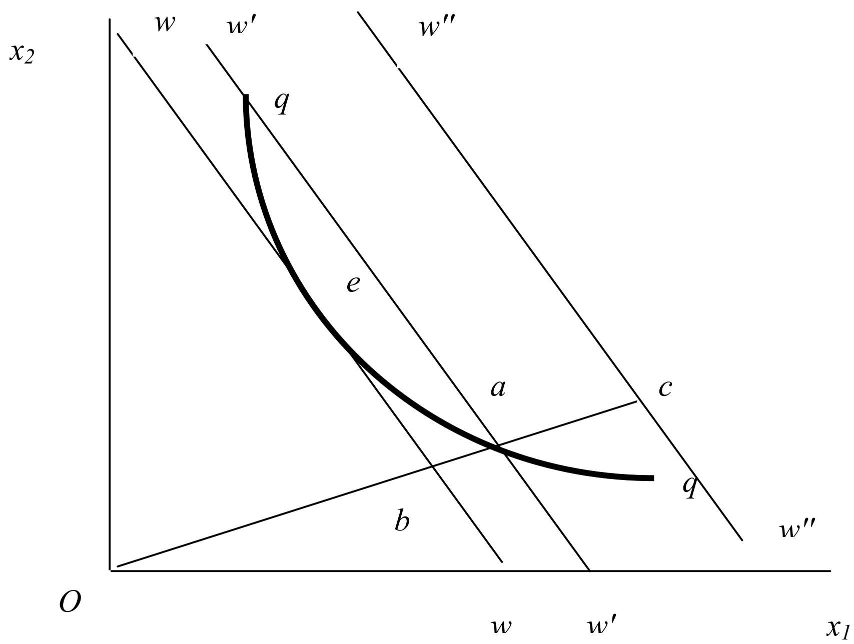
3. Methodology

The basis of the non-parametric method of Data Envelope Analysis (DEA) is the extension by Charnes et al. (1978) (CCR)[5] of the single input-output model of Farrell (1957) to a multiple input-output generalisation. Technical efficiency (TE) is measured as the ratio of projected output (on the efficient frontier) to actual input used. There are a number of papers that describe the methodology of DEA as applied to banking[6], and therefore will not be elaborated here. However, a two-input single-output illustration will aid the understanding of the decomposition of cost inefficiency into its Technical (X-inefficiency) and rent-seeking components.

Figure 1 shows an isoquant *qq* producing a given output with factor inputs x_1 and x_2 and isocost *ww,* which traces the ratio of factor prices. The efficient cost minimising position is shown at *e* where *ww* is tangential to *qq*. However, employing a factor combination shown by point *c*, which is to the right of the isoquant *qq* indicates that the firm is technically inefficient. Efficiency is decomposed into technical efficiency and allocative efficiency (AE).

[5] Charnes et. al (1978) popularised the DEA method. According to Tavares (2002) who produces a bibliography of DEA (1978-2001), there are 3203 DEA authors whose studies cover a wide range of fields. Banxia.com also compiles DEA papers from 1978 to the present.
[6] The most recent being Drake (2004)

Figure 1: Technical Efficiency and Allocative Efficiency



Technical efficiency is measured by the ratio *Oa*/*Oc* (Technical inefficiency is given by *ac*/*Oc*). The cost to the firm is shown by *w″w″* which is parallel to *ww* and passes through point *c*. Cost efficiency (CE) is measured by *Ob*/*Oc* and *Ob/Oa* gives AE[7].

DEA constructs a non-parametric frontier of the best practices amongst the decision-making units (DMUs). An efficiency score for each DMU is measured in relation to this frontier. DEA is relatively insensitive to model specification (input or output orientation) and functional form[8], however the results are sensitive to the choice of inputs and outputs. The weakness of the DEA approach is that it assumes data are free from measurement errors. Furthermore, since efficiency is measured in a

[7] It can be seen from this decomposition that under the assumption of constant returns to scale that AE = CE/TE.

relative way, its analysis is confined to the sample used. This means that an efficient DMU found in the analysis cannot be compared in a straightforward way with other DMUs outside of the sample.

One of the criticisms levelled at the DEA approach is that it produces estimates of efficiency that are not open to statistical inference. In other words if a DMU has a score of 0.95, in what statistical sense is it 5% inefficient relative to the benchmark? Without the capability for statistical inference, non-parametric methods would be weak alternatives to parametric methods of estimating efficiency. However, uncertainties also exist in the estimation of efficiency using DEA. The most obvious uncertainty is what comes from measurement error. Measurement error in the context of data on Chinese banks is particularly marked. There are three potential sources of error; firstly differences between local bank's accounting procedures and those of international bodies, secondly differences between local bank's accounting conventions and thirdly, researcher assumptions relating to the generation of missing observations. Other uncertainties arise from the estimation of the efficiency frontier; changes to the inputs and/or outputs can cause large differences in the resulting scores. Furthermore there may be errors in the sampling variation caused by the difficulty in obtaining a sufficiently large and consistent sampling frame.

The bootstrap procedure for non-parametric frontier models is set out in Simar and Wilson (1998, 2000a, 2000b). The efficiency scores calculated with the original data are used to construct pseudo data. The bootstrap procedure is based on the idea that there exists a Data Generating Process (DGP), which can be determined by Monte Carlo simulation. By using the estimated distribution of the DGP to generate a large number of random samples, a set of pseudo estimates of the efficiency scores $\hat{\theta}_i$

[8] Hababou (2002) and Avkiran (1999) provide a relatively thorough discussion of the merits and limits of the DEA.

are obtained. However this 'naive' bootstrap yields inconsistent estimates (Simar and Wilson, 2000a). We follow the homogeneous bootstrap procedure that produces consistent values of $\hat{\theta}_i$ from a kernel density estimate as given in Simar and Wilson (2000b). Following the Simar-Wilson method, 1000 bootstrap values of the individual DMU for all types of efficiency scores are generated in each year[9]. The appendix provides a description of the algorithm.

4 Literature Review

Most studies of banking efficiency have focussed on the developed economies[10]. While there have been some studies of other Far Eastern economies[11], the number is small in comparison. Indeed, from Berger and Humphrey's (1997) survey of 130 studies of frontier analysis in 21 countries, only 8 were about developing and Asian countries (including 2 in Japan). Studies on US financial institutions were the most common, accounting for 66 out of 116 single country studies.

A number of efficiency studies of Chinese banks have emerged in recent years, using both DEA and stochastic frontier analysis[12]. The consensus of finding from the DEA studies is threefold. First, because of the continued banking reform programme technical inefficiency has been declining over time. Second, average bank efficiency is lower in the state owned banks (SOBs) than in the joint stock banks. Third, the gap between the two has been narrowing in recent years.

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9 Recent bootstrapping applications to DEA have been conducted by Löthgren and Tambour (1999); in the case of banking efficiency by Casu and Molyneux (2003); and in the case of Chinese rural credit cooperatives, Dong and Featherstone (2004).

10 See for example Drake and Hall (2003), Cavallo and Rossi (2002), Elyasiani and Rezvanian (2002), Maudos et al. (2002), Drake (2001) Altunbas and Molyneux (1996) and Molyneux and Forbes (1993)

11 See Rezvanian and Mehdian (2002), Hardy and di Patti (2001), Karim (2001), Laevan (1999), Katib and Matthews (1999), Chu and Lim (1998), Bhattacharyya et al. (1997) and Fukuyama (1995)

12 In addition to the papers cited in footnote 1, other studies by Chinese scholars that have used non-parametric techniques include Xu, Junmin and Zhensheng (2001), Zhang and Li (2001), Fang et. al. (2004). Studies using parametric methods include

Studies of bank efficiency have used the terms technical efficiency and X-efficiency interchangeably as if they were the same thing. While similar in concept they are not necessarily the same. The concept of technical efficiency derives its basis in the neo-classical theory of the firm and assumes profit maximising behaviour. A firm or a bank may be technically inefficient for technical reasons such as low training or low human capital levels of managers and workers, or the use of inferior or out-of-date technology. The diffusion of new technology is not instantaneous and some firms or banks may lag behind others in the acquisition and utilisation of new technology. With further training and updating of capital, the firm or bank can expect to move towards the efficient frontier described by the isoquant in Figure 1. X-inefficiency is not caused by the variability of skills or the time variability of technology diffusion but by the use and organisation of such skills and technology.

Berger, Hunter and Timme (1993) argue that X-inefficiency constitutes 20% or more of bank costs. Poor motivation and weak pressure resulting in under utilization of factors of production, is part of what Leibenstein (1975) describes as 'organisational entropy'. X-inefficiency arises as a result of low pressure for performance. Some institutions would be protected by government regulation that would reduce the external pressure of competition. But even with a higher degree of pressure from the environment, firms may have organisational deficiencies so that management signals and incentives are lost in the hierarchy of the organisation.

An alternative interpretation of X-inefficiency is 'rent seeking' in the sense of Buchanan (1980) and Tullock (1967, 1980). Rent seeking in its basic form is the appropriation of surplus in the process of production or exchange without any real contribution to the process of either. Where there are government regulations on

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Zhang, Gu and Di (2005), Chen and Song (2004), Liu and Liu (2004), Sun (2005), Qian (2003), Chi, Sun and Lu (2005), Yao, Feng and Jiang (2004) enterprise, barriers to entry and other anti-competitive rules, officials have the opportunity to extract rents through the mechanism of bribery and corruption. Therefore the term rent seeking has been generally associated with extortion, bribery and corruption.

However, a hidden but much more pervasive type of rent seeking is the extraction of larger budgets for bureaucracies and what results in the non-pecuniary rewards to workers in government owned enterprises[13]. The prestige of the senior bureaucrats is enhanced if the size of the workforce is expanded to be larger than necessary to meet production targets. Similarly, offices are more grandiose, holidays are longer, and benefits are greater and so on.

Bogetoft and Hougaard (2003) suggest that the existence of X-inefficiency in production is the outcome of a rational decision making process that represents on-the-job compensation to managers. Whereas X-inefficiency is viewed by Leibenstein (1966, 1978) as non-maximising behaviour, Stigler (1976) argues that its existence is symptomatic of firms maximising their individual utility functions. Given a production function, a given set of inputs and factor prices, the bureaucrat minimises costs subject to a Williamson (1963) type utility function that includes in it arguments the level of output and a subset of factor inputs[14]. In other words for the i[th] bank, given the *K* factor inputs, the bureaucrat minimises costs subject to his utility U_i given by an utility function which contains the *M* outputs and a subset *J* of factor inputs, assuming a standard neo-classical technology.

$$\min \Delta_m = \omega_k' x_{k,i} - \lambda\left(U_i - U\left(y_{m,i}, x_{j,i}\right)\right)$$

[13] See Tullock (1967) or McKenzie and Tulloch (1975) Chapter 17.
[14] In the case of Williamson (1963) the utility function of the manager includes reported profit and expenditure on staff.

Subject to
$$y_{m,i} = f_i\left(x_{k,i}\right), m = 1,2,...,M$$
$$f_k' > 0, f_k'' < 0, k = 1,2,.....K \quad (1)$$

Where $f_i\left(x_{k,i}\right)$ is the production function of the i[th] bank.

The first order conditions are:

$$\begin{aligned}
\frac{\partial \Delta_m}{\partial x_j} &= \omega_j + \lambda(U_m' f_j' + U_{x,j}') = 0, j = 1,2,...J; m = 1,2,....M \\
\frac{\partial \Delta_m}{\partial x_z} &= \omega_z + \lambda(U_m' f_z') = 0, z = J+1,...., K-1, K; m = 1,2,..M \\
\frac{\partial \Delta_m}{\partial \lambda} &= U_i - U\left(f(x_{k,i}), x_{j,i}\right) = 0, k = 1,2,....K; m = 1,2,...M
\end{aligned} \quad (2)$$

Assuming $U_{x,j}' > 0$ (positive marginal utility), the FOC show that an allocative inefficiency is created that result in higher factor inputs x_j above that implied by the optimal factor mix. In Figure 1, point *e* defines the optimal factor mix given the observed factor prices, but point '*a'* while allocatively inefficient is the optimal position for the rent-seeking manager. A bank can organise its input factors to be on its production frontier but by using the wrong factor mix. Rent seeking in monopolistic public utilities involves over-staffing, 'elaborate offices and a lot of trips to important conferences' or 'expensive subsidised restaurants' (McKenzie and Tullock, 1981). The wrong factor mix in the case of the Chinese banking sector can be interpreted as excess staffing[15]. The management of the banks may reduce technical inefficiency (X-inefficiency as it has been sometimes interpreted) by moving the cost frontier from *w''w''* to *w'w'*, but would still remain cost inefficient as shown by the gap *ab*/*Oa*. The gap between the minimum cost optimal factor mix and the technically efficient minimum cost associated with the efficient production

[15] In the case of pre-reform China, the bureaucratic bank manager would have been instructed to employ a quota of graduates from the central bank sponsored universities, and schools as well as retirees from the Peoples Army Officer Corps.

frontier with the sub-optimal factor mix (or allocative inefficiency) can be interpreted as the inefficiency associated with 'rent seeking'[16].

5.0 Data

This study employs annual data (1997-2006) for 14 banks; the four state-owned banks (SOB), and ten joint-stock commercial banks (JSB). Data for one of the joint-stock banks was unavailable for 2004 - 2006 (China Everbright); and in those years 13 banks data was used. The total sample consisted of 137 bank year observations. The main source of the data was Fitch/Bankscope, individual annual reports of banks and the *Almanac of China's Finance and Banking* (various issues). The choice of banks was based on the fact that they face a common market and compete nationwide.

Two approaches are normally taken in determining what constitutes bank input and output. Under the intermediation approach, bank assets measure outputs and liabilities measure inputs. In contrast, inputs in the production approach are physical entities such as labour and capital. Deposits are a measure of output. In this study, we consider three sets of outputs. First, we use three inputs and three outputs selected under the intermediation approach for the estimation of technical efficiency. Inputs are the number of employees (*LAB*), fixed assets (*FA*) and total deposits (*DEP*). Outputs are total loans (*LOANS*), other earning assets (*OEA*), and other operating income (*NII*). Although the latter variable remains undeveloped in China, it is selected to reflect the growing contribution of non-interest income to banks' total income.

Second, we consider the quality of the loan portfolio by stripping out non-performing loans (NPLs) from the stock of loans for each bank (*LOANSQ*). In both

[16] Crain and Zardkoohi (1980) suggest that X-inefficiency and rent seeking co-exist and that changes to X-inefficiency are offset by equal changes in rent seeking, so that there is a trade-off between one type of inefficiency against another.

cases, the vector of inputs is the same as in the first case. The argument for adjusting loans for NPLs is to mitigate the effect of the large loan portfolios held by the big-4 SOBs on the efficiency calculation. The unadjusted loan portfolio would bias the efficiency score upwards for the SOBs which have the largest share of loans but also the highest proportion of NPLs.

The inputs for the construction of cost-efficiency additionally require the factor prices of the relevant inputs above. We distinguish between the price of labour (*PL*), price of fixed capital (*PK*) and the price of funds (*PF*). The price of labour is obtained as the ratio of personnel expenses to employees. The price of fixed capital is obtained as operating expenses less personnel expenses divided by fixed assets (less depreciation). The price of funds is obtained from the ratio of interest paid to total funds.

The availability of uniform and comparable data on Chinese banking is a very recent development. Researchers have typically made a number of working assumptions to fill the gaps in data. In general, balance sheet data is available although the data revisions alter the figures from year to year and up until recently the accounting standards of Chinese banks differed from international standards (Ng and Turton 2001). The number of employees are available for the big four state owned banks but not for all of the joint-stock banks over all years. Similarly, the availability of personnel expenses varies across banks. In the years that personnel expenses were not available, the ratio of personnel expenses to total operating expenses in the most recent year to the missing was applied. In the years where the number of employees was not available, the ratio of labour to fixed assets in the most recent year available was applied[17]. Where there were no personnel expenses available, it was assumed that

[17] Fu and Heffernan (2005) assume that the employee growth matches the growth of total assets and they use the average wage paid by state-owned and other types of financial institutions to estimate labour cost.

the bank faced the same capital costs as banks of comparable size, which gave personnel costs as a residual[18].

Table 3 presents the summary statistics of the input and output data for 1997 and 2006 as a snapshot indicator of the scale of the variables used. The high standard deviation is an indication of the dominance of the 4 state owned banks. The table shows how fast earnings assets have grown over this period. The total stock of loans has grown on average by 173% but subtracting for NPLs the growth has been faster by 362%. Other earning assets have grown by 405% in part reflecting the activities of the asset management companies that swapped tranches of the NPLs of the big 4 SOBs for bonds in 1999 and 2001. The most remarkable growth is in non-interest earnings which have grown by 503% reflecting an increasing source of profit for banks that have traditional depended on the banking book for the generation of income.

Table3: Output-Input Variables 1997 - 2006 (million RMB)

Variable	Description	Mean 1997	SD 1997	Mean 2006	SD 2006
LOANS RMB mill	Total stock of loans	430033	657201	1174038	1213224
OEA RMB mill	Investments	205103	301626	1037659	1203155
NII RMB mill	Net Fees and Commissions	862	1922	5200	6141
LOANSQ RMB mill	Loans less NPLs	246365	320844	1139258	1124600
LAB	Total Employed	105138	175233	125953	164260
DEP RMB mill	Total stock of Deposits	604013	891353	2167172	2258284
FA RMB mill	Fixed assets	12831	19398	32562	38745
PL	Unit price of labour	.0631	.0380	.1663	.0811
PF	Unit price of funds	.0502	.0202	.0172	.0025

[18] This was only in the case of the Agricultural Bank of China. The Bank of China was used as the benchmark to calculate the wage share of operational expenses.

PK	Unit price of fixed assets	.6528	.5282	.6478	.2242

Sources: Fitch/Bankscope, *Almanac of China's Finance and Banking* (various) and author calculations from web sources.

6.0 Empirical Results

Table 4 illustrates the results of the bootstrap method for 1997 and 2006 in the case of Technical Efficiency (X-efficiency) for both the NPL-unadjusted and NPL-adjusted loan portfolio of the banks. The table shows the median[19] of the bootstrap estimates, the bias-adjusted values and the confidence intervals. Simar and Wilson (2000a, 2000b) show that the bootstrap estimates are biased but a bias correction will introduce extra noise that may result in a mean-square error (MSE) greater than the MSE of the bias-unadjusted bootstrap values. In the limit the bias corrected MSE will be four times that of the uncorrected estimate and Simar and Wilson caution against the bias correction unless the ratio $\left(\frac{\frac{1}{3}B^2}{\hat{\sigma}^2}\right)$ is greater than unity. Where B is the bias correction and $\hat{\sigma}^2$ is the sample variance of the uncorrected bootstrap values. This condition was satisfied 78-84% of the time for each year in the sample. Although we report the bias-corrected estimates, the non universal satisfaction of the bias correction condition means that the median estimates must be treated with caution.

Table 4: Bootstrap Estimates of Technical efficiency (Bias corrected, median estimates); 1997 & 2006 CRS

Bank	Output	1997				2006			
		TE	Bias Adjusted	Confidence intervals 95%		TE	Bias Adjusted	Confidence intervals 95%	
ABOC	Unadjusted	.9286	.8487*	.8971	.9976	1.0091	.9152*	.9572	1.678
	Adjusted	.4836	.3054*	.4183	.6124	.9482	.7475*	.8952	1.186
BOC	Unadjusted	1.519	.6555	.3619	9.2055	1.3029	.7602*	1.0192	2.7772
	Adjusted	1.4811	.6647	.2369	5.7010	1.3114	.7573*	1.0283	2.3151
CCB	Unadjusted	1.6778	.5959*	1.2848	2.3951	.9999	.9194*	.9695	1.0723
	Adjusted	1.5431	.5635*	1.083	2.4132	1.0112	.8938*	.9742	1.1175
ICBC	Unadjusted	1.0241	.9202*	.9663	1.9762	1.1463	.6562*	.9494	2.1750
	Adjusted	.5462	.2762*	.4348	.8265	1.1633	.6411*	.9555	2.331
BComm	Unadjusted	1.7939	.5570*	1.4080	2.4404	1.4504	.6600*	1.1548	2.0092
	Adjusted	1.6506	.6050*	1.2892	2.2381	1.3978	.6278*	1.1331	1.8989
CITIC	Unadjusted	1.5565	.6379*	1.1937	2.0459	1.4158	.6766*	1.1723	1.914
	Adjusted	1.3964	.7182*	1.1345	1.8470	1.4083	.6295*	1.1670	1.8631
CMB	Unadjusted	1.5789	.6279*	1.2867	2.1975	1.3855	.6990*	1.1908	1.6847
	Adjusted	1.5613	.6431*	1.2238	2.2317	1.3806	.6814*	1.1856	1.6763
CMBCL	Unadjusted	1.9288	.5150*	1.5810	2.6368	1.1009	.8136*	.9937	1.3612
	Adjusted	1.7305	.5863*	1.1903	2.5958	1.0988	.7630*	.9839	1.3716
EVERBRT	Unadjusted	1.0345	.7732*	.9402	1.2845	-	-	-	-
	Adjusted	.8768	.4507*	.6921	1.2044	-	-	-	-
GDB	Unadjusted	1.6470	.6030*	1.2551	2.1861	1.3251	.6625*	1.0678	1.7580
	Adjusted	1.4875	.6751*	1.1845	1.9952	1.2821	.6262*	1.0639	1.6831
HUAXIA	Unadjusted	3.3857	.2944*	2.0423	5.3428	1.6716	.5809*	1.2880	2.0847
	Adjusted	3.4962	.2855*	2.2137	5.3695	1.6464	.5576*	1.3208	2.0790
IBCL	Unadjusted	1.2858	.7795*	.7931	4.867	1.1351	.5808*	.8422	3.1528
	Adjusted	.5601	.2714*	.4360	.8632	1.1194	.8552*	.8764	2.4531
SDB	Unadjusted	1.0533	.9107*	1.0038	1.2363	1.2583	.7768*	1.1027	1.6326
	Adjusted	.9119	.3332*	.6608	1.3266	1.1938	.7464*	1.0349	1.5603
SPB	Unadjusted	2.0651	.9107*	1.5949	2.8071	1.5465	.6232*	1.2231	2.1256
	Adjusted	15.918	.0595*	3.815	47.25	1.4914	.5769*	1.1965	2.0215

* significantly different from unity at the 95% level of confidence

[19] The median estimate provides a more robust measure of the score when the distributions are skewed as in DEA.

Table 5 presents the results of bias corrected bootstrap estimation of X-inefficiency and rent-seeking inefficiency for the Constant Returns to Scale (CRS) assumption. For reasons of brevity we show four years for both types of output.

The adjustment of loans for NPLs has had a significant effect in worsening the X-inefficiency score of a number of banks but in particular the State Owned Banks (excluding Bank of China). This should not be a surprise as the SOBs (the first 4 in Table5) have a larger concentration of NPLs than the JSBs over the sample. However by 2006 the NPL ratio for all the banks declined significantly so that the difference between the two measures produces minimal difference between the two measures of X-inefficiency.

Table 5: Bootstrap Estimates of Inefficiency (Bias corrected, median estimates); 1997-2006 (%) CRS

Bank	Output	1997		2000		2003		2006	
		X-ineff	Rent	X-ineff	Rent	X-ineff	Rent	X-ineff	Rent
ABOC	Unadjusted	14.5	50.5	27.6	36.6	4.7	54.3	8.5	47.5
	Adjusted	69.5	27.8	54.8	21.1	28.5	38.9	25.3	37.2
BOC	Unadjusted	34.5	25.6	33.9	0.0	43.9	0.0	24.0	8.6
	Adjusted	33.5	55.1	31.9	0	44.1	0	24.3	10.4
CCB	Unadjusted	7.9	52.9	42.7	25.3	16.0	37.0	34.7	13.2
	Adjusted	72.4	23.8	42.0	24.8	15.5	35.3	35.9	13.7
ICBC	Unadjusted	22.1	30.2	36.2	25.1	19.4	23.9	12.6	26.8
	Adjusted	72.9	23.7	48.7	17.8	11.4	36.2	14.4	27.0
BComm	Unadjusted	40.1	15.7	46.3	0	17.1	38.7	8.5	42.4
	Adjusted	43.7	50.0	45.9	0	19.2	37.2	10.6	40.7
CITIC	Unadjusted	44.3	6.7	39.3	23.8	36.6	10.6	34.0	8.3
	Adjusted	39.5	49.3	38.0	22.8	38.1	11.2	37.2	6.2
CMB	Unadjusted	36.2	17.6	25.4	34.6	52.1	0	32.3	3.1
	Adjusted	28.1	64.1	24.0	26.5	52.1	0	37.1	0
CMBCL	Unadjusted	37.2	17.1	22.1	26.5	25.2	13.1	30.0	0
	Adjusted	35.7	51.0	18.2	28.7	25.7	11.2	31.9	0
EVERBRT	Unadjusted	48.5	2.9	41.5	16.0	35.1	6.1	-	-
	Adjusted	41.4	51.5	38.8	17.9	32.5	21.5	-	-
GDB	Unadjusted	22.7	37.9	29.5	34.6	15.3	33.6	18.6	22.0
	Adjusted	54.9	38.5	35.9	28.3	16.1	48.0	23.7	19.4
HUAXIA	Unadjusted	39.7	15.4	23.6	36.0	31.0	20.0	33.7	11.8
	Adjusted	32.5	59.1	30.4	19.7	28.1	22.3	37.4	10.0
IBCL	Unadjusted	70.6	0	26.6	34.4	32.4	18.1	41.9	0
	Adjusted	71.4	0	22.9	33.2	28.9	21.3	44.2	0
SDB	Unadjusted	8.9	56.3	23.1	41.3	18.1	29.2	22.3	18.1
	Adjusted	66.7	26.3	31.7	32.8	21.4	28.4	25.4	18.5
SPB	Unadjusted	51.3	0	33.9	31.6	40.9	0.9	37.8	0
	Adjusted	94.4	0	33.3	30.5	44.7	0	42.0	17.0

Three questions can be asked about the bootstrap estimates as a whole and three hypotheses can be tested. First, is there a significant difference between the level of X- and rent-seeking inefficiency between the SOBs and JSBs and what differences do the NPL adjustment to loans make? The theory of rational inefficiency would suggest that there is a trade-off between X-inefficiency and rent-seeking inefficiency and if there is a strong preference for rent-seeking, X-inefficiency should be lower relative to Rent-seeking inefficiency. Second is there evidence that inefficiency is being reduced over time? The impending opening up the banking market under WTO rules would suggest that all banks would be 'upping their game' by improving relative cost efficiency, which implies that relative X-inefficiency and rent-seeking inefficiency should decline over the period. Third, if there is evidence of inefficiency reduction, is there a difference between the speed of reduction of X-inefficiency and Rent-Seeking inefficiency?[20] We explore these questions in turn.

Table 6 below examines the difference in group means of inefficiency using a non-parametric (Mann-Whitney) test. The first two rows of Table 6 show that mean estimate of X-inefficiency and rent-seeking inefficiency don't come from the same population and that contrary to the prediction of the rational inefficiency hypothesis, rent-seeking inefficiency is not greater than X-inefficiency on either measure of output. The first two rows of Table 6 show the means of X-inefficiency and rent-seeking inefficiency for all the banks with the two different measures of output.

Table 6: Mean inefficiency, Unadjusted loans and NPL adjusted loans

Measure	X-inefficiency	Rent-seeking Inefficiency	z value

[20] The SOBs have in the past been used by the state to employ graduates from the central bank sponsored universities and to place retiring officers from the Peoples Liberation Army. Consequently, rent-seeking inefficiency should decline at a slower rate than X-inefficiency

Unadjusted	34.0%	18.5%	4.59***
NPL - Adjusted	28.1%	18.8%	7.35***
Unadjusted SOB	28.9%	19.4%	1.33
Unadjusted JSB	36.1%	18.2%	0.74
Adjusted SOB	16.1%	23.8%	4.74***
Adjusted JSB	32.9%	16.8%	2.19**

*** significant at the 1%, ** significant at the 5%

There is a clear statistical difference between the mean level of X-inefficiency and rent-seeking inefficiency over the full sample period. Average rent-seeking inefficiency is lower than X-inefficiency for all banks. Stronger differences emerge when the sample is split between SOBs and JSBs. The next four rows show the mean inefficiency breakdown separated by SOB and JSB for the two different measures of output. There is no statistical difference in the mean levels of X-inefficiency and rent-seeking inefficiency of the SOBs and the JSBs when loans are unadjusted. However, stripping out NPLs from Loans produces clear differences. Rent-seeking inefficiency is significantly higher in the SOBs than JSBs. So evidence of rational inefficiency is more prevalent in the SOBs once the loan portfolio is adjusted for quality.

The second and third questions are addressed by modelling the dynamics of both type of inefficiency. Pooling the data, we use SURE estimation to model the rate of convergence of X-inefficiency (**XI**) and rent-seeking inefficiency (**RI**). The dependant variable is respectively the change in X-inefficiency (Δ**XI**) and rent-seeking inefficiency (Δ**RI**). The speed of convergence is captured by the negative coefficient on the lagged values of **XI** and **RI** respectively. The larger the absolute value of the negative coefficient, the faster the rate of convergence.

We use lagged values of bank-specific variables as controls. A one-year lag is specified as a means of eliminating potential endogeneity in the determining variables. The lagged bank cost-income ratio (COST_1) is operational cost to total revenue) is an indicator of management competence; the higher the cost-income ratio the higher the level of inefficiency. The lag of the natural logarithm of total assets is used as a proxy for the size of the bank (SIZE_1). The lag of fee income (FEE_1) as a percent of total revenue is an indicator of management flexibility in diversifying the output of the bank and higher values would be expected to be associated with lower levels of inefficiency. The variable FOR indicates the share of foreign ownership of the bank and may be associated with lower levels of inefficiency. Interaction terms for different speeds of adjustment between the big 4 SOBs and the joint-stock banks are captured by XI_BIG4_1 and RI_BIG4_1. The Non-performing loans ratio (NPL) indicates past management failures and would be associated with higher levels of inefficiency. Table 7 presents some selected results.

Table 7: All banks, 1997-2006, SURE estimation, SE values in parenthesis

	Unadjusted		**Adjusted**	
Dep Variable	**ΔXI**	**ΔRI**	**ΔXI**	**ΔRI**
Intercept	.6624*** (.146)	.2484** (.124)	.6075*** (.141)	-.0077 (.0400614)
Ln(SIZE_1)	-.0293*** (.010)	-.0260*** (.010)	-.0261*** (.009)	-
FEE_1	-.0215*** (.007)	0.0114* (.006)	-.0195*** (.005)	-
COST_1	-	0.0025*** (.001)	-	0.0012* (.001)
FOR	-	0.0041*** (.002)	-	-
NPL	-	.0012*** (.001)	-	-
RI_1	-.1363** (.066)	-.7403*** (.071)	-.2908*** (.071)	-.3111*** (.060)
XI_1	-.7335*** (.074)		-.6373*** (.088)	-
B4*XI_1	.2044*** (.007)	-	-	-
B4*RI_1	-	0.4051*** (.109)	-	-
R^2	0.4118	0.5031	0.3496	0.1888

The first thing to note about the results of Table 7 is that the coefficient on the lagged measures of inefficiency are negative and statistically significant indicating a significant decline in both types of inefficiency over time. The negative effect of the lag in rent-seeking inefficiency on the level of X-inefficiency highlights the trade-off between the two types of inefficiency. The lagged operational cost-income ratio explains rent-seeking inefficiency rather than X-inefficiency indicating the focus of costs towards factor hoarding.

Looking at the NPL unadjusted results first it can be seen that an interaction term for the SOBs show that the speed of decline in both types of inefficiency was faster in the case of the JSBs than the SOBs. However, the rate of decline in X-inefficiency was faster than the rate of decline of rent-seeking in the SOBs. In this respect, the results of this paper differ strongly from the findings of Chen *et al* (2005) who find no trend improvement in bank efficiency[21].

Once loans are adjusted for NPLs the speed of decline slows and there is no statistical difference in the speed of decline of inefficiency between the two types of banks. However, the speed of decline of rent inefficiency is slower than the decline in X-inefficiency. This is explained by the extraordinary increase in the balance sheets of the Chinese banks that has resulted in the reduction in X-inefficiency for the non-benchmark banks. However, the social problems associated with dealing with inherited over-staffing and over-branching is likely to produce a slower speed of adjustment of rent-seeking inefficiency particularly in the case of the state-owned banks.

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[21] Chen et. al (2005) uses a wider data frame of banks, including regional joint-stock banks and international trust and investment companies. It can be argued that the use of DMUs that do not compete in the same geographical market or product is a violation of the homogeneity requirement of DEA.

7.0 Conclusion

This paper has used non-parametric methods to conduct an analysis of inefficiency in a sample of Chinese banks. The estimates of bank inefficiency were buttressed with bootstrapping techniques to enable statistical inference. In general, the estimates from bootstrapping support the view that relative efficiency has improved. We have partitioned cost inefficiency into X-inefficiency and rent-seeking inefficiency in the spirit of the rational inefficiency model. Inefficiency in Chinese banking is made up of both X-inefficiency and rent-seeking inefficiency. Adjusting for the quality of the loan portfolio, this paper shows that bureaucratic rent-seeking is more prevalent in the state-owned banking sector than in the JSBs.

Bureaucratic rent seeking is a rational response to a particular set of incentives based on protectionist policy. It would be no surprise to learn that over the years of protected growth, as the banks were vessels for the channelling of unprofitable loans to state-owned enterprises, the banking sector was forced to develop rent seeking strategies and act as employment sponges for the educated youth in China. While the dismantling of protection and the listing of the state-owned banks and the plans to list joint stock banks will alter the incentive structure for managers, the trend reduction in rent-seeking inefficiency will be balanced by social and political constraints – particularly those faced by the SOBs.

We find that once Loans are adjusted for NPLs, the speed of decline of rent-seeking inefficiency is slower than that of X-inefficiency. This suggests that banks have inherited rent-seeking strategies that are more difficult to reduce than X-inefficiency. The finding that X-inefficiency is being reduced faster than rent-seeking inefficiency is an indicator that Chinese bank managers are doing the best they can in improving efficiency given the constraints.

However, we must still interpret the results with caution. The improvement in efficiency is in terms of the benchmark banks, which are themselves 'best-practice' Chinese banks. The real benchmarks should be foreign banks competing on an equal footing or foreign banks operating in their home countries under similar conditions of development and risk. However, the argument of this paper is that there have been significant improvements in bank efficiency. The main message of this paper is that while Chinese banks may not be in the best shape they could be to meet the challenges of post 2007, they are in better shape than they have ever been.

Appendix

The bootstrap algorithm is summarised in the following steps. The algorithm is run on MATLAB and the codes are available from the authors on request.

Step 1. Compute the original DEA efficiency scores using the linear programming model (equation 1) and let $\hat{\delta}_i = 1/\hat{\theta}_i$;

Step 2. Since radial distances are used, we will refer to the polar coordinate of the input vector of each DMU x defined by its modulus $\omega = \omega(x) = \sqrt{x'x}$ and its angle $\eta = \eta(x) \in \left[0, \frac{\pi}{2}\right]^{K-1}$ where for j=1,…, K-1, $\eta_i = \arctan(x_{j+1}/x_1)$ if $x_1 > 0$ and $\eta_i = \frac{\pi}{2}$ if $x_1 = 0$. Then translate the data into polar coordinates: $(y_i, \eta_i, \hat{\delta}_i)$, $i = 1, \ldots$, K. And form the augmented matrix $\widetilde{L}$ by: $L = \lfloor y_i \quad \eta_i \quad \hat{\delta}_i \rfloor$, $L_R = \lfloor y_i \quad \eta_i \quad 2 - \hat{\delta}_i \rfloor$,

$$\widetilde{L} = \begin{bmatrix} L \\ L_R \end{bmatrix}$$

Step 3. Compute the estimated covariance matrices $\hat{\Sigma}_1$, $\hat{\Sigma}_2$ of L and L_R by

$$\hat{\Sigma}_1 = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix} \qquad \hat{\Sigma}_1 = \begin{bmatrix} S_{11} & -S_{12} \\ -S_{21} & S_{22} \end{bmatrix}$$

where S_{11} is $(M+N-1)\times(M+N-1)$, $S_{12} = S'_{21}$ is $(M+N-1)\times 1$ and S_{22} is scalar, and compute the lower triangular matrices L_1 and L_2 such that $\hat{\Sigma}_1 = L_1 L'_1$ and $\hat{\Sigma}_2 = L_2 L'_2$ via the Cholesky decomposition.

Step 4. Choose an appropriate bandwidth *h* as described in Simar and Wilson (2000b) using the information in $\widetilde{L}$, $\hat{\Sigma}_1$, $\hat{\Sigma}_2$.

Step 5. Draw *K* rows randomly, with replacement from the augmented matrix $\widetilde{L}$ and denote the result by the $K \times (M+N)$ matrix $\widetilde{L}^*$; compute $\bar{z}^*$, the $K \times 1$ row vector containing the means of each column of $\widetilde{L}^*$.

Step 6. Use a random number generator to generate a $K \times (M+N)$ matrix ε of i.i.d. standard normal pseudo-random variates; let $\varepsilon_{i.}$ denote the *i*th row of this matrix. Then compute the $K \times (M+N)$ matrix ε^* with the *i*th row $\varepsilon_{i.}^*$ given by $\varepsilon_{i.}^* = \varepsilon_{i.} L_j'$ so that $\varepsilon_{i.}^* \sim N_{M+N}(0, \hat{\Sigma}_j)$ where j=1 if the *i*th row of $\widetilde{L}^*$ was drawn from rows 1, . . . , *K* of $\widetilde{L}$, or j=2 if the *i*th row of $\widetilde{L}^*$ was drawn from rows (*K* + 1), . . . , 2*K* of $\widetilde{L}$.

Step 7. Compute the $K \times (M+N)$ matrix $\Gamma = (1+h^2)^{-1/2}(M\widetilde{L}^* + h\varepsilon^*) + i_K \otimes \bar{z}^*$ where $M = I_K - (1/K)i_K i_K'$ is the usual $K \times K$ centring matrix with I_K denoting an identity matrix of order *K*, i_K an $K \times 1$ vector of ones, and ⊗ denotes the Kronecker product.

Step 8. Partition Γ so that $\Gamma = [\gamma_{i1} \quad \gamma_{i2} \quad \gamma_{i3}]$, where $\gamma_{i1} \in R_+^M$, $\gamma_{i2} \in [0, \pi/2]^{K-1}$ and $\gamma_{i3} \in (-\infty, +\infty)$ for *i* = 1, . . . , *K*. Define the $K \times (M+N)$ matrix of bootstrap pseudo-data L^* such that the *i* the row z_i^* of L^* is given by

$$z_i^* = \begin{cases} (\gamma_{i1} \quad \gamma_{i2} \quad \gamma_{i3}) & \gamma_{i3} \geq 1 \\ (\gamma_{i1} \quad \gamma_{i2} \quad 2-\gamma_{i3}) & otherwise \end{cases}$$

Step 9. Translate the polar coordinates in L^* to Cartesian coordinates. This yields the bootstrap sample $\{(x_i^*, y_i^*)\}_{i=1}^K$.

Step 10. For the given point (*x*, *y*), compute $\hat{\theta}^*(x, y)$ by solving the DEA program taking $\{(x_i^*, y_i^*)\}_{i=1}^K$ as the benchmarks and compute the bias-corrected efficiency scores $\widetilde{\theta}(x, y) = \hat{\theta}^2 / \hat{\theta}^*$

Step 11. Repeat Steps 5~11, obtain another group of bias-corrected efficiency scores, reducing the input vector of each DMU x into $\widetilde{\theta}x$. Compute the cost efficiency scores using equation(2) from the reduced inputs and outputs.

Step 12. Similar to Step 11, obtain rent-seeking-efficiency scores (the difference between cost-efficiency score and technical (x)-efficiency score)

Step 13. Repeat Steps 5~12 B (=1000) times to obtain a set of bootstrap estimates $\left\{\tilde{\theta}_b(x,y)\right\}_{b=1}^{B}$ and cost efficiency scores and x-efficiency scores.

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