The University of
Nottingham

research paper series

China and the World Economy

Research Paper 2010/11

Banking Reform and Efficiency in China: 1995-2008

By

Chunxia Jiang and Shujie Yao

GEP

Leverhulme Centre
for Research on Globalisation and Economic Policy

The Authors

Chunxia Jiang is a lecturer in Economics, Middlesex University Business School.

Shujie Yao is professor and head of the School of Contemporary Chinese Studies, University of Nottingham, and special chair professor of Economics, Xi'an Jiaotong University.

Banking Reform and Efficiency in China: 1995-2008

by

Chunxia Jiang and Shujie Yao

Abstract

Employing the one-step stochastic frontier analysis (SFA) approach, this paper examines bank efficiency in China, paying special attention to the ownership, selection effect and dynamic effects of governance changes on bank performance. Bank efficiency has improved over the data period 1995-2008. The estimated average cost and profit efficiencies are 74% and 63% respectively. Joint Stock Commercial Banks (JSCBs) and City Commercial Banks (CCBs) outperform State-owned Commercial Banks (SOCBs). The results suggest a strong selection effect for foreign investors. Foreign ownership participation has a negative effect on profit efficiency in the long-term while initial public offerings (IPOs) improve bank profitability in the short-term. The research findings have important implications on future bank reforms in China in the aftermath of the current financial crisis.

Outline

1. *Introduction*
2. *Banking efficiency in developing and transition countries*
3. *Brief history of Chinese banking system and its reform*
4. *Methodologies, model specification and data*
5. *Empirical results*
6. *Conclusions and policy implications*

Non-Technical Summary

China achieved an annual GDP growth of over nine per cent during the past 30 years, becoming the third largest economy in the world next to the USA and Japan. Along with economic reforms, China's banking system has undoubtedly contributed to this miracle and has become more influential in world financial markets. The banking system has been subject to piecemeal but well-planned reforms since the 1980s with more radical banking reform triggered by China's WTO entry in 2001. By 'touching stones to cross the river', banking reform has achieved important results. By 2009, three Chinese banks, namely Industrial and Commercial Bank of China (ICBC), China Construction Bank Corporation (CCBC), and Bank of China (BOC), were rated as the world's three largest banks in terms of market capitalization.

This study employs a one-step SFA model to estimate cost and profit efficiency for 47 commercial banks over the period 1995—2008 to evaluate bank performance and investigate the impacts of reform strategies on bank performance. It uses market average input prices when estimating cost and profit efficiency, unlike most efficiency studies that use endogenously determined bank specific input prices, which is in contradiction with the assumption of cost and profit functions that firms face exogenous input prices in competitive markets. Estimated cost efficiency and profit efficiency average at 74% and 63%, respectively, and both have improved over data period. State-owned banks are the most cost efficient banks, however, it is argued that higher level of non-performing loans (NPLs) have inflated their estimated cost efficiency. Profit efficiency appears to be a better performance measure, under which SOCBs become the least profitable banks and CCBs turn out as the most efficient ones. The selection effect indicators suggest that more profitable banks have been selected for IPOs. In the long-term, both foreign ownership and IPOs tend to improve cost efficiency but worsen profit efficiency. Although results show the effect of foreign ownership and IPO strategies are not as effective as expected, they are essential successful steps in China's long match to modernize its banking system. The subsequent reform should ensure well established corporate governance structure functioning via fundamental change in bank management and operations.

1. INTRODUCTION

China achieved an annual GDP growth of over nine per cent during the past 30 years, becoming the third largest economy in the world next to the USA and Japan. Along with economic reforms, China's banking system has undoubtedly contributed to this miracle. As China becomes more integrated with the world, its banking system has become more influential in world financial markets. By 2009, three Chinese banks, namely Industrial and Commercial Bank of China (ICBC), China Construction Bank Corporation (CCBC), and Bank of China (BOC), were rated as the world's three largest banks in terms of market capitalization. The subject is of interest in terms of the role of these banks in providing a degree of financial stability to the world system in the recent financial crisis and its continuing aftermath.

The banking system has been subject to piecemeal but well-planned reforms since the 1980s to better serve economic development and maintain social stability. More radical banking reform was triggered by China's WTO entry in 2001 to ensure that Chinese banks are viable in an open financial market since 2007. By 'touching stones to cross the river', banking reform has achieved important results. It is of great interest to empirically examine bank performance and to investigate the impacts of reform strategies, thereby providing policy makers with valuable information for future reform in the aftermath of the current financial crisis. Despite a wealth of bank efficiency literature, there are only a handful of studies investigating bank efficiency in China. None of them simultaneously examines the ownership effect, selection effect and the dynamic effect of governance changes on bank performance. This paper attempts to

bridge the gap and contribute to existing literature in the context of developing countries and bank privatization.

Employing a one-step SFA model, this paper estimates cost and profit efficiency for 47 commercial banks over the period 1995—2008. This is by far the largest dataset on the Chinese banking industry. Most efficiency studies use endogenously determined bank specific input prices by dividing total factor expenses by the total units of factors employed, which is in contradiction with the assumption of cost and profit functions where firms face exogenous input prices in competitive markets (Mountain and Thomas, 1999). In fact, in literature only a few studies have addressed this issue[1]. This study uses market average input prices to resolve this problem. Estimated cost efficiency and profit efficiency average at 74% and 63% respectively. Both cost and profit efficiencies have improved over data period. In a cost efficiency model, SOCBs are the most efficient banks while Foreign Banks (FBs) are the most inefficient ones. It is found that non-performing loans (NPLs) have inflationary effect on cost efficiency for banks with high level of NPLs. This finding suggests that profit efficiency is a better performance measure. In the profit efficiency model, SOCBs become the least profitable banks and CCBs become the most efficient ones. The selection effect is found for IPOs in the profit efficiency model, that is, more profitable banks have been selected for IPOs. But adverse selection effect is found for both foreign ownership participation and IPOs in the cost efficiency model. In the long-term, both foreign ownership and IPOs tend to improve cost efficiency but worsen profit efficiency.

---

[1] Patti and Hardy (2005), Berger and Mester (2003), DeYoung and Hasan (1998), Bos and Kool (2006) and Koetter (2005).

The rest of this paper is organized as follows. Section two reviews literature on bank efficiency in developing and transition countries. Section 3 introduces the Chinese banking system and banking reform. Section 4 outlines research methods. Section 5 analyzes empirical results and section 6 concludes.

2. BANK EFFICIENCY IN DEVELOPING AND TRANSITION COUNTRIES

Despite voluminous literature on bank efficiency, most studies have been undertaken in the US and in European countries. In the last two decades, there has been a rapid development of empirical research in developing and transition economies where market-oriented banking reform has been either completed or underway. Before reform their banking systems shared many commonalities. For instance, banks were functionally segmented by economic sectors; they showed a lack of management skills and credit analysis systems; the banking systems were commonly dominated by state-ownership with poor asset quality and weak oversight institutions (Claessens 1998).

Bank reform has been highlighted on the policy agenda in most transition economies and developing countries. The primary objective is to improve the efficiency of resource allocation and to strengthen the financial foundation of the economy. Although reform strategies vary across countries, reform measures generally include lowering entry barrier, privatization, enhancing the supervisory framework, liberalizing interest rates, and removing credit controls. As a result, efficiency studies attempt to capture the effect of deregulation, financial liberalization, foreign bank entry, and ownership change.

Ownership has been an important issue. The primary concern is how to find the optimal ownership and management structure which can better tackles the principal-agent problem (Spong *et al*. 1995). State ownership has been prevalent in transition and developing countries. The argument for state ownership is that governments are able to channel funds to sectors and projects with low financial but high social returns. On the other hand, state ownership is commonly blamed for poor performance due to various reasons. State ownership theoretically means all citizens are co-owners who in practice have no power and no incentive to influence and monitor the management of state banks. This free-rider problem leaves governments the only effective representative agent (Huibers 2005). Governments, however, have multiple (often conflicting) goals other than pure profit maximization. Another reason is the lack of market discipline on inefficient SOCBs and inadequate means of punishing wrong-doing bank managers. The management of private banks is under pressure to improve bank efficiency as inefficient management would be replaced and banks may be bankrupt when facing financial distress.

Empirical research generally shows a negative association between bank efficiency and state ownership. In transition economies, state-owned banks are found to be significantly less efficient than their private counterparties (Bonin *et al*. 2005a; Fries and Taci 2005; and Yao *et al*. 2007). There are some exceptional studies. For example, Chen (2005) found that state banks outperformed other types of banks.

As to foreign banks, a home field advantage hypothesis argues that domestic institutions are generally more efficient than foreign-owned institutions due to organizational

diseconomies to operate and monitor from a distance and limited access to soft qualitative information. In contrast, a global advantage hypothesis argues that foreign institutions can be more efficient because of superior managerial skills and high quality human capital inherited from foreign owners (Berger *et al.* 2000).

A tendency has been found that the home field advantage hypothesis holds in developed countries while the global advantage hypothesis holds in developing countries (Claessens *et al.*, 2001). In developed countries, it is evident that the home field advantage hypothesis holds (Berger *et al.*, 2000; De Yong and Nolle, 1996; Sathye's, 2001; Chang *et al.*, 1998; and Peek *et al.*, 1999). In developing and transition economies, the empirical results are less conclusive. A limited form of global advantage hypothesis is supported by Bonin *et al.* (2005b) and Kraft *et al.* (2006) while Rao (2005) and Jiang *et al.* (2009) find the home field advantage hypothesis holds in United Arab Emirates and China, respectively.

Privatization has been a major strategy to improve bank performance by constructing good governance and management structure. Empirical research has shown clear performance improvements after privatization in developing countries and transition economies (Boubakri *et al.* 2005; Berger *et al.* 2005 and Williams and Nguyen 2005). Foreign ownership participation in domestic banks and bank IPOs are two common privatization methods. Foreign ownership participation is expected to bring in advanced technology, modern banking techniques and superior managerial skills. Empirical literature has found improved performance after foreign investment (Fries and Taci 2005 and Bonin *et al.* 2005b). IPOs are expected to incorporate the disciplining role of

the capital markets on banks and listed banks are found to be more efficient than unlisted ones (Berger and Mester 1997).

Only in recent years the study of bank efficiency in China has attracted serious attention. Existing studies consistently report improved efficiency after more than two decades of reforms. Most studies (Kumbhakar and Wang, 2005; Berger et al., 2009; Yao, *et al*., 2007; Fu and Heffernan, 2007; and Jiang *et al*. 2009) suggest that JSCBs are more efficient than SOCBs with one exception of Chen *et al*. (2005) that find SOCBs outperform JSCBs. This paper distinguishes itself from existing studies by using market average input prices to estimate cost and profit efficiency and jointly examining ownership effect, selection and dynamic effects of governance changes on bank efficiency.

3. BRIEF HISTORY OF CHINESE BANKING SYSTEM AND ITS REFORM

Since the late 1970s, the Chinese banking system has entered into a reforming period, aiming at creating a multi-ownership, competitive and market-oriented banking system. This period can be sub-divided into four stages. The first stage was an initial institutional restructuring period during 1979-84, beginning with the creation of a two-tier banking system. The People's Bank of China became the central bank with the main objectives of maintaining price stability, supervising financial institutions, conducting clearance, and issuing bank notes. The commercial banking operations were taken over by four specialized state-owned banks, known as the "Big Four". The Agricultural Bank of China (ABC) undertook rural banking businesses. ICBC (established in 1984) focused on commercial banking activities in urban areas. CCBC dealt with fixed assets investment of the government and urban large construction projects while the BOC

conducted foreign currency transactions. Each bank had its own economic sector to serve and there was no competition among them.

The subsequent reform was to deepen institutional restructuring during 1984-94, focusing on deregulations to create a competitive banking system. Since the early 1980s, foreign banks and domestic joint-stock banks were allowed to enter the market. Most nationwide or regional JSCBs were launched with shareholding ownership structures—an institutional breakthrough in banking industry. Operational restrictions on four specialized state banks were removed. These banks were allowed to enlarge their business scope and to compete with one another and JSCBs and they were expected to be profit-driven institutions. However, the "Big Four" still played a strong role in promoting economic growth and maintaining stability. Commercial banking practices and skills were hardly developed.

The third stage of banking reform was the commercialization of banks during 1994-2003. The year 1995 marked the beginning of bank commercialization when the Law of the People's Republic of China on Commercial Banks was enacted. The "Big Four" were legally defined as state-owned commercial banks (SOCBs) and they were expected to be profit-driven and operationally independent. Their policy lending functions were taken away by the three newly established policy banks[2]. However, these policy banks lacked branch network and capital as well as serving and lending capacity. They were unable to meet the needs of policy lending previously fulfilled by the "Big Four". Central and local governments frequently intervened in the operations

---

[2] Namely the China Development Bank, the Import-Export Bank of China, and the Agricultural Development Bank of China

of SOCBs resulting in huge NPLs in the 1990s. Meanwhile, the Chinese economy experienced overheating and the transitional reform of state-owned enterprises (SOEs) was deepened in the 1990s. NPLs in SOCBs grew even faster while bank capital adequacy ratios declined steadily. By 1999, SOCBs became financially insolvent and the banking system became weak and vulnerable. The total amount of NPLs in SOCBs was estimated at RMB 3.3 trillion (Chinese Currency) under a four-category loan classification system, accounting for 41 per cent of GDP for the year. To treat the ailing banking system, the central government launched the first round of SOCBs bailouts in 1998-99. Fresh capital of RMB 270 billion was injected into SOCBs in 1998 through bonds issues and NPLs of RMB 1.4 trillion were transferred to four newly-created asset management companies. SOCBs' balance sheets were cleaned up, while the reform had not addressed the deep-rooted issues of incentive and efficiency.

In 2003, the central government initiated radical banking reforms to modernize the banking system in response to the challenges brought about by China WTO entry in 2001 that the Chinese government committed to fully opening up the banking sector by the end of 2006. Using the state's massive foreign exchange reserves, the government injected US$ 22.5 billion into BOC and CCBC respectively in 2003 and US$ 15 billion into ICBC in 2005. NPLs were stripped off from them, amounting to RMB 475 billion in 2004 and RMB 705 billion in 2005. After financial restructuring, these SOCBs were partially privatised by attracting foreign investors and undergoing IPOs. Foreign investors reacted positively with a surge in 2004 and a peak in 2005. For example, Bank of America acquired a nine per cent stake in CCBC and Goldman Sachs, Allianz and American Express acquired a 10 per cent stake in ICBC. The Royal Bank of Scotland

together with Merrill Lynch and Hong Kong tycoon Li Ka-shing bought a 10 per cent stake in BOC[3]. Subsequently, these SOCBs successfully made their IPOs on the Shanghai and Hong Kong Stock Exchanges. The market reaction was highly positive from the second half of 2006. By 2009, ICBC, BOC and CCBC became the world top three banks by market capitalization. Successful IPOs and their subsequent extraordinary performance on the stock markets was a cornerstone for the overall success of China's further bank reform. The reform of the last big SOCB—ABC is underway and the government announced to inject $30 billion to ABC in early 2009 (sourced from various press releases).

Along with institutional and financial restructuring, a series of comprehensive and concrete reforms were implemented to liberalize the financial market and strengthen a prudent regulatory and supervisory framework. Actions included the removal of credit quotas in 1998, the introduction of capital adequacy requirements, the adoption of an internationally accepted five-category loan classification system, NPLs reduction and control, and so forth. Banking reform has achieved staged progress. By 2009, a multi-layered banking system has taken shape, comprising of a central bank of the PBC, a regulatory and supervisory body of the China Banking Regulatory Commission, four partially privatized SOCBs, 13 JSCBs, 112 CCBs, FBs, along with a vast number of other small financial institutions.

---

[3] See Berger *et al.* (2009) for more details

4. METHODOLOGIES, MODEL SPECIFICATION AND DATA

The preferred estimation technique is SFA, developed by Aigner, Lovell, and Schmidt (1977). SFA pre-specifies a functional form and decomposes error terms into a random error (v_i) and inefficiency (u_i). It assumes that inefficiencies follow an asymmetrical half-normal distribution and random errors follow a symmetric standard normal distribution. Actually, the SFA is criticized for its pre-specified functional form and distributional assumptions. However, because of the separation between random errors and inefficiencies, the SFA is more appropriate over the non-parametric method in efficiency studies in transition and developing countries where problems of measurement errors and uncertain economic environments are more likely to prevail (Fries and Taci 2005).

A two-step procedure is commonly employed to estimate a cost and/or profit frontier to derive inefficiencies in the first step and to regress the estimated inefficiencies against a set of possible determinants in the second step. This two-step procedure suffers from serious econometric problems. Inefficiencies are assumed to be identically distributed in the first step but they are assumed to have a functional relationship with a set of variables in the second stage (Kumbhakar and Lovell 2000). An alternative one-step estimation procedure overcomes these problems. This paper adopts a one-step model proposed by Battese and Coelli (1995). It is assumed that non-negative cost inefficiencies are a function of firm-specific variables and they are independently distributed as truncations of normal distributions with constant variance but with means that are a linear function of observable variables.

A generalized Battese and Coelli (1995) cost model is shown by three equations. Equation (1) shows the cost frontier.

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

where i and t denote firm and time; $\ln y_{it}$ is the logarithm of the cost of production of the i-th firm; x_{it} is a k×1 vector of the logarithm of input prices and output of the i-th firm; V_{it} a random variable assumed to be iid. $N(0, \sigma_v^2)$ and independent of U_{it}; U_{it} are non-negative cost inefficiency, which are assumed to be independently distributed as truncations at zero of the $N(m_{it}, \sigma_u^2)$ distribution; β is a vector of unknown parameters to be estimated.

Equation (2) shows the inefficiency effects model

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

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

Equation (3) defines cost efficiency for the i-th bank at the t-th time.

$$CE_{it} = \exp(U_{it}) = \exp(z_{it}\delta + W_{it}) \quad (3)$$

The empirical specification of the cost frontier in translog form is shown in Equation (4).

$$\ln(TC/w_2 z_2) = \alpha + \sum_{i=1}^{3} \beta_i \ln(Y_i/z_2) + \sum_{k=1} \psi_k \ln(W_k/w_2) + \sum_{r=1} \phi_r \ln(Z_r/z_2) + \tau_1 T$$

$$+ \frac{1}{2} \sum_{i=1}^{3} \sum_{j=1}^{3} \beta_{ij} \ln(Y_i/z_2) \ln(Y_j/z_2) + \frac{1}{2} \sum_{k=1} \sum_{m=1} \psi_{km} \ln(W_k/w_2) \ln(W_m/w_2)$$

$$+ \frac{1}{2} \sum_{r=1} \sum_{s=1} \phi_{rs} \ln(Z_r/z_2) \ln(Z_s/z_2) + \frac{1}{2} \tau_{11} T^2$$

$$+ \sum_{i=1}^{3} \sum_{k=1} \varpi_{ik} \ln(Y_i/z_2) \ln(W_k/w_2) + \sum_{i=1}^{3} \sum_{r=1} \kappa_{ir} \ln(Y_i/z_2) \ln(Z_r/z_2)$$

$$+ \sum_{k=1} \sum_{r=1} \sigma_{kr} \ln(W_k/w_2) \ln(Z_r/z_2) + \sum_{i=1}^{3} \eta_i \ln(Y_i/z_2) T$$

$$+ \sum_{k=1} \eta_k \ln(W_k/w_2) T + \sum_{r=1} \eta_r \ln(Z_r/z_2) T + \ln v_{it} + \ln u_{it} \qquad (4)$$

where TC is the total costs of a bank in a given year; Y_i are outputs; W_k are input prices; Z_r is fixed netputs; T is a time trend; v_{it} are identical and independently distributed random errors, which are independent of u_{it}; u_{it} are non-negative inefficiencies; X_n are adjusted values of logged outputs so that they fall within the interval $[0.1 \times 2\pi, 0.9 \times 2\pi]^4$ and $\alpha, \beta, \psi, \phi, \tau, \varpi, \kappa, \sigma, \eta, a,$ *and b* are parameters to be estimated.

The standard restriction of linear homogeneity in input prices is imposed by normalizing the costs (profits) and input prices by one arbitrarily chosen input price--the price of fund. Total costs, profits, output variables and netputs are normalized by total assets to control for scale biases and heteroskedasticity. To derive profit efficiency, an alternative profit frontier is estimated by assuming that banks can exercise a degree of market

---

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

power in setting output prices (Berger and Mester 1997). The specification of alternative profit frontier is identical to the cost frontier except the dependant variable of total costs is replaced with profit and the inefficiency term becomes $-\ln u_{it}$.

The empirical inefficiency effect model is shown in Equation (5).

$$u_{it} = \delta_0 + \sum_{a=1}^{10} \delta_a CG_{it} + \delta_{11}t + \delta_{12}GDP + \varepsilon_{it} \qquad (5)$$

where t is a time trend; CG_{it} is a vector of governance effect indicators; GDP is a proxy of macroeconomic environment.

Employing a modified version of the intermediation approach (Sealey and Lindley 1977), this paper defines three outputs--total loans, other earning assets and deposits; two inputs--cost of fund and cost of labour; and one netput--equity. Table 1 provides the summary statistics. Data are collected from BankScope complemented by the Almanac of China's Finance and Banking (1986-2008) and the China Statistical Yearbook (1995-2008). This paper focuses on commercial banks only and classifies banks into four types: SOCBs, JSCBs, CCBs[5] and FBs. The sample of 481 observations covers major commercial banks in China.

Theoretically, the price of labour and the price of physical capital should be measured separately. Due to the lack of separate data on labour (i.e. personnel expenses), the price of labour and physical capital is defined as the ratio of non-interest expenses to total

---

[5] CCBs have been constructed as joint-stock commercial banks, but they are restricted to operate within their municipalities' localities and subject to certain local government intervention. Their management are also very different from that of JSCBs. Therefore, CCBs are separated from JSCBs to gauge the effect of different governance structure on bank performance

assets as in Hasan and Marton (2003). Labour and physical capital markets are defined by bank types. Market average prices of labour and physical capital are the un-weighted average of the prices the other banks belonging to the same bank type excluding the banks' own price (Koetter, 2005). The price of funds is defined as the ratio of total interest expenses to total interest bearing funds. Two fund markets are identified. One is a national fund market for domestic banks as the interest rate structure is set by the central bank and commercial banks have been strictly restricted in setting interest rates on deposits and borrowings. Another fund market is for foreign banks as they were not allowed to collect deposits from domestic public before 2007 and therefore their funding sources are different from those of domestic banks. The market average price of fund is computed as the un-weighted average of the prices the other banks excluding the banks' own price.

Table 1: Sample Descriptive Statistics

	Mean	SD	Medium	Minimum	Maximum
Total costs	19.777	62.103	1.456	0.007	684.391
Total profit	4.858	13.651	0.830	0.001	125.251
Gross Loans	285.611	646.375	20.125	0.058	3475.165
Other Earning Assets	204.866	514.318	18.414	0.064	3859.252
Total Deposits	403.244	971.905	29.064	0.109	6250.627
Equity	25.173	64.166	3.422	0.001	463.282
Market price of fund	0.027	0.021	0.020	0.009	0.180
Market price of labour	0.011	0.003	0.010	0.001	0.023

Note: all variables in RMB billion except for input prices. All variables at 1995 price level.

The inefficiency effect model includes 11 governance effect indicators defined in Table 2. The first four are ownership indicators -- *CCB, JSCB, SOCB, and FBs.* For all periods, these dummy variables equal one for such a bank and zero for all other banks. The variable of *Listed Bank* is used to explore the relationship between the listing status of

banks and performance. The dummy equals one for listed banks and zero for unlisted banks[6].

Table 2 Inefficiency effect indicators

Ownership Effect Indicators	
CCBs	Equals 1 for CCBs and 0 otherwise.
JSCBs	Equals 1 for JSCBs and 0 otherwise.
SOCBs	Equals 1 for SOCBs and 0 otherwise.
FBs	Equals 1 for FBs and 0 otherwise.
Listed Banks	Equals 1 for listed banks and 0 otherwise.
Selection Effect Indicators	
Selected for foreign acquisition	Equals 1 for banks underwent foreign acquisition and 0 otherwise.
Selected for IPO	Equals 1 for banks underwent IPO and 0 otherwise.
Dynamic Effect Indicators	
Underwent foreign acquisition --ST	Equals 1 after foreign acquisition, 0 before acquisition and all other banks
Underwent IPO--ST	Equals 1 after IPO, 0 before IPO and all other banks
Underwent foreign acquisition --LT	Number of years since foreign acquisition, 0 before acquisition and all other banks
Underwent IPO--LT	Number of years since IPO, 0 before IPO and all other banks

Note: the first indicator—*CCBs* is excluded from the estimation for comparison purposes.

Two selection effect indicators—*Selected for Foreign Acquisition and Selected for IPOs*—are designed to see whether better performing banks are selected for governance changes. Dummies equal one for such a bank for all periods and zero otherwise. Dynamic governance indicators are defined to examine the effects of governance changes by comparing bank performance before governance changes with their subsequent performance after changes. Two short-term dynamic indicators—*Underwent*

---

[6] Selection effect has taken account of the effect of IPOs up to 2009.

Foreign Acquisition (ST) and *Underwent IPO (ST)*--measure the timing following governance changes. The dummies equal zero prior to governance change and one after the changes. Two long-term dynamic indicators--*Underwent Foreign Acquisition--LT* and *Underwent IPO—LT*--measure the number of years following a governance changes. The dummies equal zero prior to governance change for all banks and one starting from the change. The inefficiency effect model also includes a time trend variable and GDP growth as a proxy of macroeconomic condition.

5. EMPIRICAL RESULTS

Estimation results of the cost and alternative profit functions are reported in Panel A and Panel B of Table 3.

Table 3 Estimation of cost and alternative profit frontiers using market average prices

|	
Panel A: Cost frontier	
Gamma ($\gamma \equiv \sigma_u^2 / \sigma_v^2 + \sigma_u^2$)	0.94***
Sigma-squared ($\sigma^2 \equiv \sigma_v^2 + \sigma_u^2$)	0.44***
Log likelihood function	-86
LR test of one-sided error	83
Mean cost efficiency	0.74
Panel B: Alternative profit frontier	
Gamma ($\gamma \equiv \sigma_u^2 / \sigma_v^2 + \sigma_u^2$)	0.89***
Sigma-squared ($\sigma^2 \equiv \sigma_v^2 + \sigma_u^2$)	0.64***
Log likelihood function	-237
LR test of one-sided error	229
Mean profit efficiency	0.63

Notes: '***' signifies significance at 1 % levels

Estimated γ is 0.94 and 0.89 in the cost and profit frontiers respectively, indicating a large part of the total composite error term attributable to inefficiency. LR test are 83 and 229, confirming the existence of a one-sided error within the composite error term.

The mean cost efficiency and profit efficiency are 74 per cent and 63 per cent, respectively. The results suggest that banks spend 26 per cent more than the minimum possible cost while earning 37 per cent less profit than the maximum possible profit of a best practiced bank using the same bundle of inputs under the same conditions.

Figure 1 plots mean cost efficiency and profit efficiency by year. Cost efficiency increase by about 17 percentage points from 60 per cent in 1995 to 77 per cent in 1998. While SOCBs had made efforts to reduce costs by closing branches and dismissing labour, the main reason for the improvement is believed to be the significant cut in interest rates. For example, the interest rate on one-year deposits dropped by two-thirds from 10.98 per cent in 1995 to 3.78 per cent in 1998, reducing interest costs on deposits.

The cost efficiency level remained stable thereafter until an increase in 2008. Profit efficiency was table at a low level of 50 per cent, reflecting poor quality of assets. Thereafter, profit efficiency experienced a steady increase from 50 per cent in 2000 to 85 per cent in 2007. The turnaround in 2000 was a direct consequence of the NPLs off-loading from SOCBs. Subsequent improvement was attributable to improved bank management and operational skills as well as further off-loading of NPLs from SOCBs in 2003 and 2005. In 2008 cost efficiency increased while profit efficiency declining, perhaps reflecting that profit efficiency is more sensitive to the shock of global financial crisis starting in 2007.

Figure 1 Mean efficiency level (1995-2008)
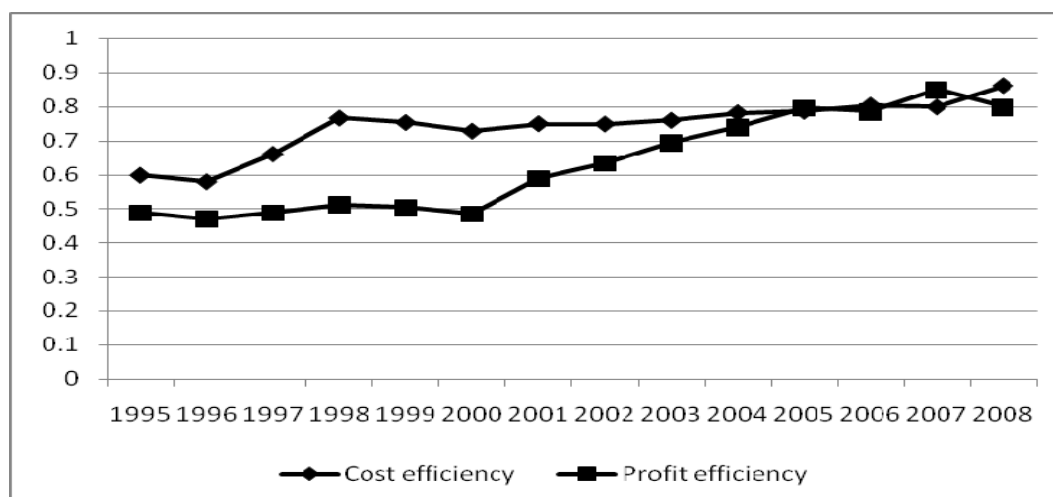
Results from the inefficiency effects model (reported in Table 4) are of particular interest as they offer insights into the ongoing banking reform.

Table 4 Results of the inefficiency effect model

	Cost efficiency	Profit efficiency
Ownership effect indicators		
FBs (δ_1)	0.69***	-0.04
JSCBs (δ_2)	-0.38**	1.20***
SOCBs (δ_3)	-0.77***	3.11***
Listed banks (δ_4)	-1.76***	-0.31
Selection effect indicators		
Selected for foreign acquisition (δ_5)	0.35**	-0.77**
Selected for IPO (δ_6)	1.34**	0.01
Dynamic effect indicators		
Underwent foreign acquisition-ST (δ_7)	-0.09	0.20
Underwent foreign acquisition-LT (δ_8)	-0.15**	0.21***
Underwent IPO-ST (δ_9)	0.44	-1.01*
Underwent IPO-LT (δ_{10})	-0.28**	0.13
t (δ_{11})	-0.12***	-0.27***
GDP (δ_{12})	1.57***	-2.6***

Notes: a. FB = foreign bank, JSCB = joint-stock commercial bank, SOCB = state-owned commercial bank, IPO = initial public offering; b. *, **, *** signifies significance level at 10 per cent, 5 per cent and

1 per cent respectively; c. Negative sign of the estimated coefficient indicates that the particular variable has a positive effect on cost or profit efficiency and *vice versa*.

Ownership effect indicators examine the performance of banks with different ownership. In cost efficiency model (shown in Figure 2), the coefficient on FBs (δ_1) is positive and significant but the coefficients on JSCBs (δ_2) and SOCBs (δ_3) are all negative and significant, suggesting that FBs are less efficient than domestic banks. The results provide evidence for the home field advantage hypothesis. SOCBs are the most efficient banks at mean of 82 per cent followed by JSCBs at mean of 79 per cent. In the profit efficiency model (Figure 3), a very different picture emerges. CCBs[7] are the most profitable banks at mean efficiency of 77 per cent. FBs outperform major domestic banks—JSCBs and SOCBs, providing weak evidence for the global advantage hypothesis.

The average profit efficiency of SOCBs (δ_3) is estimated as 36 per cent, substantially below the industrial average by 27 percentage points and below the best performers (CCBs) by 41 percentage points. SOCBs operated at a rather low efficiency level of about 10 per cent for the first four years and from 1999 their profit efficiency increased steadily for another four years. Since 2003 SOCBs improved profit efficiency at a much faster speed and became in line with other banks in 2005. This pattern coincided with major SOCBs reforms—the first round of capital injection and NPLs off-loading in 1999 and the restructuring of SOCBs since 2003 onwards.

---

[7] The actual average performance of CCBs would be lower than our estimates. The sample includes only 24 CCBs out of 112 for those data available for at least five years. Banks with better management and performance are more likely to make data publicly available.

Figure 2 Mean cost efficiency by bank types (1995-2008)
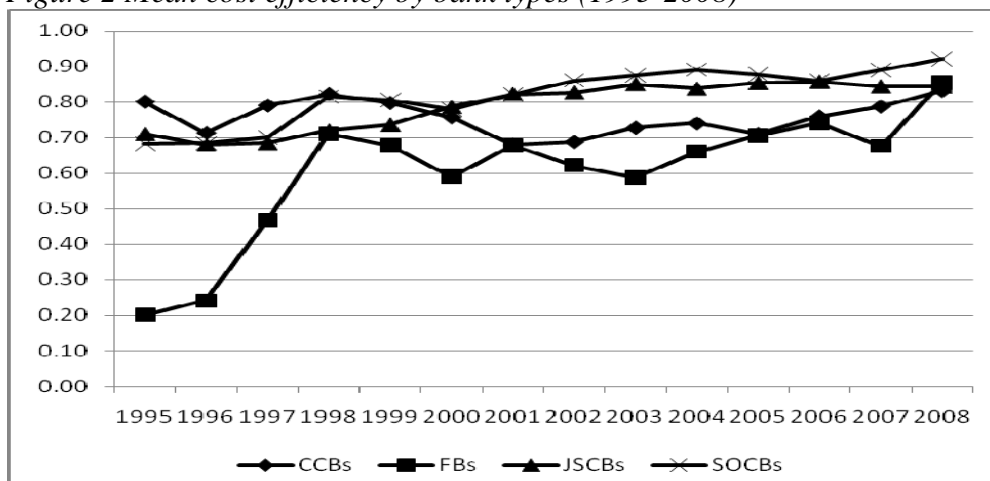
Notes: CCB = city commercial bank, FB = foreign bank, JSCB = joint-stock commercial bank, SOCB = state-owned commercial bank.

Figure 3 Mean profit efficiency by bank types (1995-2008)
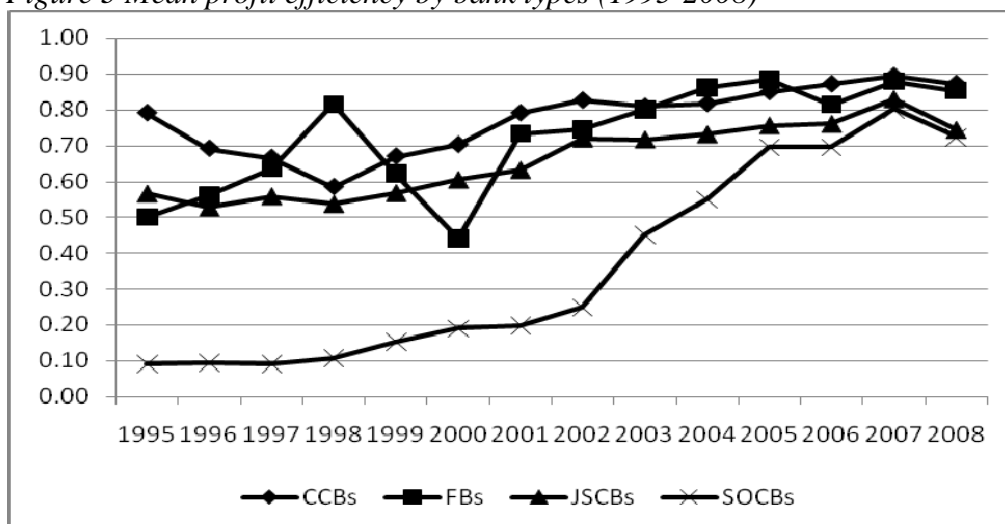
Notes: CCB = city commercial bank, FB = foreign bank, JSCB = joint-stock commercial bank, SOCB = state-owned commercial bank.

A puzzle has come to our attention that SOCBs are the most cost efficient banks but they are the most unprofitable banks. Our explanation to this puzzle is the huge amount of NPLs in SOCBs has an inflationary effect on cost efficiency. As detailed data on NPLs are not available in China, researchers have to include NPLs in total loans as an output. This inclusion inflates cost efficiency but not profit efficiency because no profits could be generated from NPLs. This effect also explains the pattern of cost efficiency

movement shown in Figure 1. Cost efficiency dropped slightly in 2000, which may be (partially) attributable to the transfer of NPLs of RMB 1.4 trillion from SOCBs in 1999. In the subsequent 7 years, cost efficiency crept along at an agonizingly slow pace totalling 5 percentage point increase while profit efficiency increased by 37 percentage points at a much faster pace. One possible explanation is that cost efficiency had increased but the increase was offset by the decreasing inflationary effects of NPLs.

Moreover, ABC had the highest NPL ratio among SOCBs, which was almost six times that of ICBC and BOC, seven times that of CCBC in 2005. The balance of ABC's NPLs amounted to RMB 740 billion. Surprisingly the estimated mean cost efficiency is 84% -- the highest among SOCBs. Apparently NPLs' inflationary effect had significant influence here. Therefore we argue that cost efficiency estimates may be misleading and profit efficiency provides more accurate information at least in the case of China. The following analysis is mainly based on the results from the profit efficiency model while using the cost model as a complement. For example, JSCBs are more profitable than SOCBs by 30 percentage points but less cost efficient by only 3 percentage points so we conclude that JSCBs outperform SOCBs.

Listed banks (δ_4) are not statistically more profitable than non-listed banks but they are more cost efficient. The selection effect indicators are used to examine the performance of banks subsequently being selected for IPOs or by foreign investors. The estimated coefficient on *Selected for IPOs* (δ_5) shows no selection effect for IPOs while banks picked up by foreign investors (δ_6) are more profitable (but less cost efficient).

The dynamic effect indicators exams the impact of reforms on bank efficiency by comparing their performance before and after governance changes. Foreign ownership participation is found to have no impact on banks' subsequent profitability in the short-term (δ_7) but a negative impact in the longer term (δ_8). IPOs strategy is found to improve bank profitability in the short-term (δ_9) but such gains tend to fade in the longer term (δ_{10}). This may be because of the "window-dressing effect" before going public and therefore such gains may be unsustainable in the long-term. On the other hand, foreign ownership participation and IPOs improve cost efficiency in the long-term, implied by the negative and significant coefficients in the cost efficiency model.

It seems that the main driving factor of efficiency improvement seems to be those one-off bailout measures rather than IPOs and foreign acquisition strategies as expected. Future research should focus on controlling NPLs' inflationary effect when estimating cost efficiency for more robust results. The year variable (δ_{11}) in the inefficiency effect model captures temporal changes in inefficiency against the shifting frontier. Both cost efficiency and profit efficiency have improved as time passes. A healthy GDP growth (δ_{12}) offers a favourable macroeconomic condition which has a positive impact on profit efficiency but not on cost efficiency.

6. CONCLUSIONS AND POLICY IMPLICATIONS

This paper examines cost and profit efficiency of 47 commercial banks in China for the period 1995-2008. There are two contributions to the existing literature on bank efficiency studies in China.

First, the dataset is by far the largest and most comprehensive for the Chinese banking industry, covering all the major commercial banks before and after their IPOs, hence providing sufficient empirical evidence to test all the hypotheses presented at the beginning of the paper. In particular, we are to examine the ownership, selection and dynamic effects of governance changes on bank efficiency within the same analytical framework. Second, both the cost and profit efficiency models are used to compare the performance of different types of banks under different circumstances, allowing us to make more comprehensive and objective comparisons on the performance of different types of banks in different time periods. The use of market average input prices also improve the quality of our estimates therefore enhance the reliability of our findings.

Bank efficiency has improved over the data period. Profit efficiency has improved at a faster rate than cost efficiency. Estimated industrial average profit efficiency and cost efficiency are 63 per cent and 74 per cent, respectively. The inclusion of NPLs in total loans inflates cost efficiency. Hence, profit efficiency is a more appropriate performance measure over cost efficiency when banks have high level of NPLs.

Ownership is found to influence efficiency significantly. CCBs are the most profitable banks, surpassing the most inefficient SOCBs by 40 percentage points. FBs are more profitable than major domestic banks of JSCBs and SOCBs, providing weak evidence for the global advantage hypothesis. SOCBs are the most inefficient banks. Our results show a strong cherry picking effect that foreign investors have selected more profitable banks to take minority stakes.

As for the dynamic effects of governance changes, foreign ownership participation appears to have increased profit inefficiency in the long run although they have initially picked up more profitable banks. This could be caused by investing activities and more prudential practices, such as more loan loss provision and investment in upgrading technology. These activities will sacrifice profitability at present or in the near future but will benefit the banks in the long run. The IPO strategy is found to improve profit efficiency in the short-term but gains tend to fade in the long-term. Short-term gains are largely attributable to one-off reform before going public rather than from expected good corporate governance.

Although our results show the effect of foreign ownership and IPO strategies are not as effective as expected, they are essential successful steps in China's long match to modernize its banking system. Chinese government has made considerable efforts on attracting foreign strategic investors for its major banks in the hope of foreign owners bringing in superior managerial skills and new technologies. Banks have also been encouraged and actually pushed to go public to become competitive in a free market environment.

The main purpose is to construct good corporate governance structure and improve bank performance. Given the fact that most foreign acquisition and IPOs took place after 2004, it may need more time to realize their effect. Moreover, the upper limit of foreign ownership in domestic banks is still 25 per cent and that for a single foreign investor is 20 per cent while the central government holds a majority controlling stake. It is

doubtful whether foreign investors have sufficient power and ability to influence decision making processes in order to apply their operational and managerial skills.

Furthermore, fundamental change in bank management and operations is a complex process. The decision-making process needs to be changed from policy-oriented to profit-driven. This also requires effective and enforceable steps to ensure corporate governance functioning in the long term and to prevent SOCBs from stepping back to their previous managerial and operational behaviours. Policy makers should be aware of the possibility that reform outcomes may depart from the initiative purposes. Bank performance should be closely monitored and any adverse signs should be followed up to ensure banking reform is still on track.

Partial privatization and government intervention might hinder and postpone the success of reforms. The Chinese government has partially privatized SOCBs but still retains a controlling stake that facilitates government intervention in SOCBs' operations. Existing information and evidence suggest that government intervention still persists and whether it could be reversed in the near future is uncertain. The key to bank reform success is fundamental shifts in banks' management and operations away from a policy orientation. This is unlikely to happen as long as the government has an incentive and power to intervene in SOCBs' operations.

BILIOGRAPHY

Aigner, D., Lovell, C.A.K. and Schmidt, P. (1977) 'Formulation and estimation of stochastic frontier production models', *Journal of Econometrics*, 6: 21-37.

Battese, G.E. and Coelli, T.J. (1995) 'A model for technical inefficiency effects in a stochastic frontier production function for panel data', Empirical Economics, 20: 325-32.

Berger, A.N., Clarke, G.R.G., Cull, R., Klapper, L. and Udell, G.F. (2005) 'Corporate governance and bank performance: a joint analysis of the static, selection, and dynamic effects of domestic, foreign, and state ownership', Journal of Banking and Finance, 29: 2179-221.

Berger, A.N., De Young, R., Genay, H. and Udell, G.F. (2000) 'Globalization of financial institutions: evidence from cross-border banking performance', Brookings-Wharton Papers on Financial Service, 3: 23-158.

Berger A.N., Hasan, I. and Zhou, M. (2009) 'Bank ownership and efficiency in China: what will happen in the world's largest nation?' Journal of Banking and Finance, 33: 113-30.

Berger, A. N. and Mester, L. J. (1997) 'Inside the black box: what explains differences in the efficiencies of financial institutions?' Journal of Banking and Finance, 21: 895-947.

Berger, A.N. and Mester, L.J. (2003) 'Explaining the dramatic change in performance of US banks: technological change, deregulation, and dynamic changes in competition', Journal of Financial Intermediation, 12: 57-95.

Boubakri, N., Cosset, J.C., Fischer, K. and Guedhami, O. (2005) 'Ownership structure, privatization, bank performance and risk taking', Journal of Banking and Finance, 29: 2015-41.

Bos, J. and Kool, C. (2006) 'Bank efficiency: the role of bank strategy and local market conditions', Journal of Banking and Finance, 30: 1953-74.

Bonin, J.P., Hasan, I. and Wachtel, P. (2005a) 'Bank performance, efficiency and ownership in transition countries', Journal of Banking and Finance, 29: 31-53.

Bonin, J.P., Hasan, I. and Wachtel, P. (2005b) 'Privatization matters: bank efficiency in transition countries', Journal of Banking and Finance, 29: 2155-78.

Chang, C.E., Hasan, I. and Hunter, W.C. (1998) 'Efficiency of multinational banks: An empirical investigation', Applied Financial Economics, 8: 689-96.

Chen, X., Skuly, M. and Brown, K. (2005) 'Banking efficiency in China: application of DEA to pre- and post- deregulation eras: 1993-2000', China Economic Review, 16: 229-45.

Claessens, S. (1998) 'Comment on banking in transition economies', Journal of Money, Credit, and Banking, 30: 651-5.

Claessens, S., Demirguc-Kunt, A. and Huizinga, H. (2001) 'How does foreign bank entry affect domestic banking markets?' Journal of Banking of Finance, 25: 891-911.

DeYoung, R. and Hasan, I. (1998) 'The performance of de novo commercial banks: a profit efficiency approach', Journal of Banking and Finance, 22: 565-87.

DeYoung, R. and Nolle, D. E. (1996) 'Foreign-owned banks in the United States: earning market share or buying it?' Journal of Money, Credit and Banking, 28: 622-36.

Fries, S. and Taci, A. (2005) 'Cost efficiency of banks in transition: evidence from 289 banks in 15 post-communist countries', Journal of Banking and Finance, 29: 55-81.

Fu, X. and Heffernan, S.A. (2007) 'Cost X-efficiency in China's Banking Sector', China Economic Review, 18: 35-53.

Hasan, I. and Marton, K. (2003) 'Development and efficiency of the banking sector in a transitional economy: Hungarian experience', Journal of Banking and Finance, 27: 2249-271.

Huibers, F.E. (2005) 'Initial public offerings', in G.Caprio, J.L. Fiechter, R.Litan and M.Pomerleano (eds) The Future of State-Owned Financial Institutions, Washington, D.C.: Brookings Institution Press, pp. 315-44.

Jiang, C., Yao, S. and Zhang, Z (2009), 'The Effects of Governance Changes on Bank Efficiency in China: A Stochastic Distance Function Approach'. *China Economics Review*, 20 (4), 717-731.

Koetter, M. (2005) 'Measurement matters--Input price proxies and bank efficiency in Germany', Deutsche Bundesbank discussion paper, 2005-01.

Kraft, E., Hofler, R. and Payne, J. (2006) 'Privatization, foreign bank entry and bank efficiency in Croatia: a Fourier-flexible function stochastic cost frontier analysis', Applied Economics, 38, 2075-88.

Kumbhakar, S.C. and Lovell, C.A.K. (2000) Stochastic Frontier Analysis, Cambridge: Cambridge University Press.

Kumbhakar S.C. and Wang, D. (2007), 'Economic reforms, efficiency and productivity in Chinese banking', Journal of Regulatory Economics, 32, 105-129

Mahajan, A., Rangan, N. and Zardkoohi, A. (1996) 'Cost structures in multinational and domestic banking', Journal of Banking and Finance, 20, 283-306.

Mountain, D.C. and Thomas, H. (1999). 'Factor price misspecification in bank cost function estimation', Journal of International Financial Markets, Institutions and Money, 9: 163-82.

Patti, E.B. and Hardy, D.C. (2005) 'Financial sector liberalization, bank privatization, and efficiency: evidence from Pakistan', Journal of Banking and Finance, 29: 2381-406.

Peek, J., Rosengren, E.S. and Kasirye, F. (1999) 'The poor performance of foreign bank subsidiaries: Were the problems acquired or created?' Journal of Banking and Finance, 22: 799-819.

Rao, A. (2005) 'Cost frontier efficiency and risk-return analysis in an emerging market', International Review of Financial Analysis, 14: 283-303.

Sathye, M. (2001) 'X-efficiency in Australian banking: an empirical investigation', Journal of Banking and Finance, 25: 613-30.

Sealey, C.W. and Lindley, J.T. (1977) 'Inputs, outputs and a theory of production and cost at depository financial institutions', Journal of Finance, 32: 1251-66.

Spong, K., Sullivan, R. and DeYoung, R. (1995) 'What makes a bank efficient? A look at financial characteristics and bank management and ownership structure', Federal Reserve Bank of Kansas City Financial and Industry Perspectives.

Williams, J. and Nguyen N. (2005) 'Financial liberalization, crisis, and restructuring: a comparative study of bank performance and bank governance in South East Asia', Journal Banking and Finance, 29: 2119-54.

Yao, S., Jiang, C., Feng G. and Willenbockel, D. (2007) 'On the efficiency of Chinese banks and WTO challenges', Applied Economics, 39: 629-43.