Board independence and Chinese banking efficiency: a moderating role of ownership restructuring

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Abstract

This study investigates how Chinese banking sector reforms have affected the relationship between banking performance and bank board structure. The study analyzes data from listed commercial Chinese banks between 2000 and 2013, and banking efficiency scores are estimated using the stochastic frontier approach (SFA) and data envelopment analysis (DEA). The impact of board structure and structural reforms on banking efficiency is further analyzed using panel data regression. We find that board independence has a negative influence on banking efficiency, but it becomes positive when the banks are listed on the stock market. This finding confirms the soft-budget constraint theory, which holds that large banks are less efficient than smaller ones as the former can more easily obtain financial support during times of distress. Further, the listing of state-owned banks positively moderates the relationship between board independence and banking efficiency. The study contributes to the literature on banking reforms, board structure, and banking efficiency. It confirms the theoretical basis for Chinese banking reforms and that banking efficiency has improved since the ownership restructuring.

Keywords Banking reforms · China bank performance · DEA · SFA · Banking efficiency · Board independence

JEL Classification G20 · G21 · G38 · D61

1 Introduction

Bank performance is indicated by many factors, such as its profitability, diversification of its portfolios, investment decisions, market power, and market share (Bikker and Bos 2005). Banks must improve their efficiency to maintain their performance,

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profitability, and competitiveness in today's highly challenging environment. Tripe (2003) finds that using simple accounting ratios to assess a bank's performance is inadequate. Similarly, Sherman and Gold (1985) argue that returns on assets and investment are not effective measures to gauge a bank performance. Instead, they suggest multiple-input, multiproduct performance criteria. Lampe and Hilgers (2015) find that the most frequently adopted performance measures in the recent literature on banking efficiency are data envelopment analysis (DEA) and stochastic frontier analysis (SFA). The efficiency of banks is highly related to performance and to having effective systems for risk management and compliance. Given this, boards should thoroughly evaluate banks' risk management systems, acknowledging that in today's world, bank operating systems are complex and interconnected with the economic well-being of entire countries. Along these lines, there have been some important initiatives, with financial authorities drafting and implementing new frameworks for corporate governance, compliance, and risk management in the banking industry. Notably, it has been argued that failures and weaknesses in banking institutions' corporate governance efforts are what led to the recent financial crisis (Kirkpatrick 2009).

In developing and transitioning economies, well-functioning banking sectors have facilitated economic growth and development (Porta et al. 2002). Some argue that state ownership of banks has allowed governments to channel capital to sectors with high social returns but with weak financial standing. This keeps social returns high in sectors that are unable to attract private capital. In this sense, the profit-oriented private sector may not strike the right balance between social and economic objectives (Huibers 2005). In both political and economic theories, however, state ownership has been linked to inefficiency for a number of different reasons. For example, state-owned banks often face soft-budget constraints, precipitating moral hazard problems, which in turn lead to inefficiency.

China is a prime example of a setting in which this has occurred. Over the past three decades, China introduced a series of economic reforms, resulting in the significant development of its financial system. In the pre-reform era, however, China had a mono-banking system, with only one bank in the country performing both central and commercial activities: the People's Bank of China (PBOC). Through the financial sector reforms, China established numerous financial institutions with more complex and diversified structures. Some of the main reforms have been restructuring the state-owned "Big Four" banks through capital injection; carving out non-performing loans; transitioning from state to multiple ownership of banks; and modifying the banking sector to be more competitive and market oriented (García-Herrero et al. 2009; Jiang et al. 2009). In China, the Big Four state-owned banks dominated the banking sector, with almost 70% of the country's total financial assets until 2006 (García-Herrero et al. 2009). The Big Four have also dominated financial intermediation, controlling more than 75% of the capital in the Chinese economy (Jiang et al. 2009), and they are significantly more leveraged as a result of soft-budget constraints and the policy of lending to insolvent state-owned enterprises (Yao et al. 2008).

Thus, China's state-owned banks are considered inefficient in allocating capital. Several financial researchers have compared the efficiency of the Big Four

state-owned banks with the efficiency of other Chinese domestic commercial banks (Xu et al. 2015). However, extant studies on Chinese bank efficiency are still somewhat limited, and they have tended to focus on comparisons between city commercial banks, state-owned banks, and joint stock banks. In contrast, studies on the theoretical rationale behind the financial sector reforms and on how corporate governance changes have affected Chinese banking efficiencies have been rare.

One salient example of structural reform is that state-owned Chinese commercial banks were listed on the Shanghai Stock Exchange, with IPOs announced for common investors. In 2006, the Industrial and Commercial Bank of China (ICBC) was listed on the stock market, and five percent shares were offered to the general public. This became the world's largest IPO to date (generating approximately 22 billion USD). These banking sector reforms are a dynamic, ongoing process in China, and for this reason, it is difficult to assess how they have affected the efficiency of the Chinese banking sector as a whole.

As bank operating systems are exceedingly complex and intertwined with the economic wellbeing of entire countries and regions, the role of bank boards become more important. Hence, the ownership structure of a bank and the composition of its board will, up to a large extent, define the bank's risk management capabilities—in other words, its ability to assess and assume a level of risk that is appropriate for its size, complexity, and scale of operations. Bank board composition and structure also affect the bank's performance. In the US, increased board size and independence have been found to detract from bank performance, while gender diversity improved it (Pathan and Faff 2013). Diverse boards exhibit a range of skills and knowledge; they tend to implement effective monitoring mechanisms and ultimately enhance overall banking efficiency (Boitan and Nitescu 2019).

In this context, investigating whether Chinese commercial banks have become more efficient following ownership-structure reforms is interesting. This study also examines whether these reforms have moderated the relationship between banking efficiency and board composition. The primary aim is to investigate the impact of financial sector reforms and corporate governance changes on the efficiency of all listed commercial banks in China from 2000 to 2013, a time when third-stage banking reforms were being implemented in the Chinese banking sector. This study also examines the theoretical basis and implications of the banking reform from the perspectives of the principal-agent and soft-budget constraint theories. It investigates ownership reforms by comparing Chinese commercial banks' mean efficiency scores before and after they were listed on the stock exchanges. The impact of board structure on banking efficiency is also analyzed, taking into consideration a moderating role of ownership restructuring in Chinese banks. Furthermore, soft-budget constraint impacts on Chinese banks are examined by splitting Chinese commercial banks into two categories (Big Four and non-Big Four) and comparing their mean efficiency scores. Moreover, the size of the effect on banking performance is examined to validate the soft-budget constraint theory.

This paper contributes to the literature on banking efficiency and corporate governance in the Chinese context in several ways. It confirms the theoretical basis of the structural reforms introduced in the Chinese banking sector during the past few decades. Big banks have become more efficient since they were listed on the stock

market. Moreover, corporate governance practices have improved since the ownership restructuring reforms. Board independence had a negative influence on banking efficiency, but the influence became positive when the banks were listed on the stock market. It is also observed that the size of the bank hinders banking efficiency. This finding supports the soft-budget constraint theory, as larger banks can access financial support more easily during times of financial distress. Thus, they are less efficient than small ones.

The rest of the paper is structured as follows. Section 2 explains the theoretical foundation and empirical evidence of banking efficiencies. Section 3 explains the research methodology of the study. Section 4 highlights and discusses the empirical results. Finally, Sect. 4 concludes the paper.

2 Literature review

Chinese banks' efficiencies have improved during the most recent years, but to what extent this is the case is still under debate (Barros et al. 2011). Many empirical studies suggest that financial reforms have promoted competition among banking institutions in both mature and emerging economies. Recently, banking efficiency has been used as a proxy for bank competition, in the sense that a more efficient bank is expected to attain a greater market share than a less efficient one would (Leuvensteijn et al. 2011; Schaeck and Cihák 2010, 2013). Since the 1980s, a series of significant and progressive bank reforms have reshaped the banking system in China. Despite these reforms, Chinese banking efficiency is found to be relatively low compared to that of its international peers (Fungáčová et al. 2013; Soedarmono et al. 2013).

Liang et al. (2013) study Chinese banking efficiency and show that in China, the Big Four banks are less efficient than other banks and that public banks are less efficient than private ones. Sun et al. (2013) show that banking efficiency has a positive relationship with strategic investors but a negative relationship with the level of regional economic development. Wang and Wang (2014) argue that the main source of banking inefficiency is staff expenses and bad loans. Yin et al. (2013) examine the positive impact of the World Trade Organization's accession on Chinese banking efficiency. Jiang et al. (2013) find that bank efficiency improves after privatization in terms of revenue generation and efficiency gains in both the short run and the long run.

Luo and Yao (2010) show that Joint Stock Commercial Banks (JSCBs), on average, have higher technical, cost, and profit efficiencies than those of state-owned banks. Fung et al. (2012) compare the efficiencies of JSCBs and State-Owned Commercial Banks (SOCBs) and do not find a significant difference between them in terms of pure technical efficiencies. However, they do find significant differences between the two groups in technical and scale efficiencies. Asmild and Matthews (2012) study the effect of financial reforms on banking efficiencies in Chinese commercial banks during 1997–2008, comparing results from different sub-sample periods. Jiang et al. (2013) find that state-owned banks in China are less efficient than JSCBs and City Commercial Bans (CCBs) from 1997

to 2008. However, Chen et al. (2015a) demonstrate that nine state-owned banks are the most efficient. Xu et al. (2014), on the other hand, apply the relatively new approach of profit elasticity (PE) introduced by Boone (2008), as the concept of relative profit differences (RPD). After analyzing a large sample of banks operating in China during 1996–2008, they conclude that the overall competition in the Chinese banking sector improved after the financial reforms. We thus propose the following hypothesis.

> H1: The Big Four banks became more efficient after they were listed (after ownership restructuring) on the stock market.

Yin et al. (2013) suggest that the banking reforms in China improved the efficiency of resource allocation, easing investment constraints in state-controlled firms and reducing the financial constraints in non-state-controlled listed firms. Ning (2011) estimates that the state-owned commercial banks show a "V" trend in terms of technical efficiency, other commercial banks show stable scores, and city commercial banks show a gradual increase.

Ding et al. (2015) suggest that as a result of policy variables such as reserve requirement ratios, open market operations, and interest rate spreads by the PBOC, the cost efficiencies of Chinese banks have improved. Chen et al. (2015b) study the overall bank risk that may endogenously enter into a bank's production process. This is an undesirable byproduct in the estimation of a bank's total factor efficiency as well as in the estimation of the total factor efficiency of each production process. Tan and Floros (2013) confirm a positive and significant relationship between the level of risk (loan-loss provision as a fraction of total loans) and banking efficiency scores of Chinese commercial banks. Further, they show a significant and negative relationship between the level of risk and capitalization. Accordingly, the following hypothesis can be set forth:

> H2: Highly capitalized banks (with soft-budget constraints) are less efficient than banks that are less capitalized (with hard-budget constraints).

Board size is more important in banking compared to other industries as a result of the sensitivity of bank operations (Caprio and Levine 2002). Large boards tend to perform their managerial oversight role competently by using more resources (Upadhyay and Sriram 2011). Compared to non-financial firms, banks tend to have larger boards because they are better able to solve complex problems. (Adams and Mehran 2012). At the same time, other studies have reached different conclusions. Jensen (1993) suggests that larger boards tend to have free-riding problems and meeting attendance issues. Janis (1983) argues that groupthink—which is the pressure to find a unanimous decision and avoid disagreement with the majority—can occur on a larger board. Further, larger boards may be more difficult to coordinate and may require more time to reach a consensus.

However, there is mixed empirical evidence on the relationship between large board size and financial institution performance. Some studies document that in terms of banking performance, board size is irrelevant (Erkens et al. 2012; Hardwick et al. 2011). Houston et al. (2012) investigate banks engaging in regulatory

arbitrage by means of cross-border M&A. They find that banks engaging in this practice have a larger board size but that their efficiency is not improved and may even suffer as a result. Other studies find either a positive (Adams and Mehran 2012; Aebi et al. 2012; Beltratti and Stulz 2012) or U-shaped (de Andres and Vallelado 2008; Grove Patelli et al. 2011) relationship between board size and banking performance, while others find a negative relationship between these factors in China (Liang et al. 2013). In the light of above-mentioned studies, we examine the hypothesis below.

H3: Board size has a positive impact on banking efficiency.

Earlier studies provided evidence that in developed countries, corporate governance plays a very important role in banking operations (Adams and Mehran 2012; Adams et al. 2010). The independence of directors on boards is a central theme in governance, but the corporate governance literature does not provide conclusive evidence on this subject. One of the most important tasks of a board of directors is to effectively monitor management. This is applicable in all sectors, but it is especially true in the banking industry (Macey and O'Hara 2003). Liang et al. (2013) suggest that the number of board meetings and of independent directors have significant positive impacts on bank performance and asset quality. This is plausible, as banks are accountable to shareholders, creditors, clients, and depositors.

Guaranteeing board effectiveness is a challenging task. It has been argued that the independence of boards is crucial for effective monitoring. The core idea behind having an independent board (with outside directors) is to limit agency costs. Through independent boards, the functions of decision making and decision control can be separated. One strand of the literature suggests that boards with independent directors have fewer conflicts of interests and reduced agency problems. Rowe et al. (2011) find that the percentage of non-executive directors has a significant positive impact on performance while that of executive directors has a significant negative impact. Further, better-governed banks performed well during the crisis period (Francis et al. 2002). On the other hand, Coles et al. (2008) find no statistically significant impact of the number and/or percentage of outside directors on firm performance. Another strand of the literature indicates that while independent directors enhance monitoring quality, they may lack sufficient firm-specific knowledge, leading to sub-optimal decisions (Harris and Raviv 2008). Agrawal and Knoeber (1996) show that independent boards decrease firm value.

In transition economies, most of the recent literature focuses on the performance of non-financial firms and the political connections of top management (Wu et al. 2012; Grove et al. 2011). Politically connected boards might reduce the benefits of reforms, as they allow more government interference in decisions and create incentive structures oriented toward government objectives. Banks with politically connected boards are more likely to pursue political and social objectives at bank expense, which would be detrimental to performance. Other researchers study the Chinese banking sector and find that political connections affect banks' lending decisions to the private sector (i.e., Ding et al. 2010; Grove et al. 2011). Core et al. (1999) document that the percentage of outside directors on a board who are over age 69 is associated with weaker corporate governance

and in turn, higher executive compensation. Firth et al. (2009) suggest that older directors might lack the incentive, energy, and required knowledge to actively monitor and advise top management. In light of the aforementioned theoretical and empirical evidence, we formulate the following hypothesis.

H4: Board independence has a positive impact on banking efficiency.

A series of reforms have been introduced with the ultimate objective of transforming the Chinese banking sector from a government-controlled system to a market-driven commercial one. Foreign directors might bring new technology and modern managerial techniques to a board. They might enhance corporate governance, exercise better supervision, and subsequently, improve firm performance. Oxelheim and Randøy (2003) find a significantly higher value for firms that have foreign, Anglo-American board members using a sample of firms with headquarters in Norway or Sweden. Berger et al. (2010) point out that one mechanism by which minority foreign ownership might increase Chinese banks' efficiency is through assuming positions on a board and "leveraging" these positions to monitor and improve the management of the bank. Thus, the presence of foreign directors on a board might improve Chinese bank performance and asset quality.

A growing body of literature examines the relationship between independent directors and banking performance. Inconclusive evidence suggests that the relationship is influenced by diverse organizational cultures and governance settings in different countries. Therefore, researchers have extended the literature on banking efficiency and governance to address some related issues, such as investigating the political connectedness of boards of directors. A notable exception is Boubakri et al. (2008), they find that newly privatized firms remain politically connected through boards after ownership divestiture, and they perform more poorly than their non-connected counterparts. Ahn et al. (2011) argue that value-destroying acquisitions can occur if firm directors are serving on multiple boards. Similarly, Pathan and Faff (2013) argue that board size and independence had a negative and significant impact on bank performance. However, board gender diversity had a positive and significant impact on performance in the pre-Sarbanes–Oxley Act (SOX) period during 1997–2002. Nevertheless, the positive gender impact on bank performance diminished in both the post-SOX (2003–2006) and financial crisis (2007–2011) periods.

Molyneux and Linh (2014) find that higher compensation of executives negatively impacts Chinese commercial banks' efficiency. Along similar lines, a higher number of unpaid executive directors in bank boardrooms improves banking efficiency except when banks face financial crisis. Then, this positive relationship becomes weaker. It has also been suggested that non-listed banks would have benefited from being listed because, then, they would have had access to the monitoring and advisory services of independent directors. Higher numbers of independent directors might also improve the banking efficiency of Chinese listed commercial banks. Thus, the hypothesis is that independent directors on the board of Chinese banks have a positive impact on banking efficiency after these banks are listed on the stock market.

H5: The listing of state-owned banks on the stock market moderates the relation between board independence and banking efficiency.

3 Research methodology

3.1 Sample selection and data description

The Chinese commercial banking system has various kinds of banks: State-Owned Commercial Banks (SOCBs), Joint Stock Commercial Banks (JSCBs), City Commercial banks (CCBs), and Rural Commercial Banks (RCBs). This study takes a sample of all the listed commercial banks in China during 2000–2013, including from the abovementioned groups. Currently, there are sixteen commercial banks in China that are listed on the Shanghai and Shenzhen stock exchanges. These banks were holding more than 60% of commercial banks' assets in China by the end of 2013. Data from the sample banks are collected from the most reliable sources in China, such as the China Stock Market and Accounting Research (CSMAR) and the Almanac of China Finance and Banking.

3.2 Banking efficiencies tools

The banking efficiencies of Chinese commercial banks are estimated using non-parametric data envelopment analysis (DEA) and parametric stochastic frontier analysis (SFA) techniques.

This study uses an intermediation approach, which enables financial institutions such as banks to be perceived as manufacturing units that convert inputs to outputs, such that banking efficiencies can be estimated through the DEA technique. Deposits and net capital are taken as input variables, while loans, advances, and investments serve as output variables. Extensive literature informed the choice of input and output variable in the data envelopment analysis and its application to the banking industry. The sample size of this study is large enough to satisfy the limitations, such that the DEA technique can be applied. It has been suggested by Nunamaker (1985) that when using the technique, the sample size should be at least three times larger than the sum of inputs and outputs.

This study also uses a parametric approach to stochastic frontier analysis (SFA). In transition economies, measurement errors and economic uncertainties are common, which supports using SFA for the banking efficiency estimation (Fries and Taci 2005). SFA is also well known among researchers, having been employed across a wide range of studies in the banking efficiency literature (e.g., Clark and Siems 2002; Hasan and Marton 2003; Shanmugam and Das 2004). The cost function is as follows:

$$\ln\left(\frac{c}{w_2 z_1}\right)it = \delta_0 + \sum_J \delta_j \ln\left(\frac{y_j}{z_1}\right)it + \frac{1}{2}\sum_J\sum_k \delta_{jk}\ln\left(\frac{y_j}{z_1}\right)it\ln\left(\frac{y_k}{z_1}\right)it$$

$$+ \beta_1\ln\left(\frac{w_1}{w_2}\right)it + \frac{1}{2}\beta_{11}\ln\left(\frac{w_1}{w_2}\right)\ln\left(\frac{w_1}{w_2}\right)it + yeardummies + \ln u_{it} + \ln v_{it}$$

where it indexes the bank and year, respectively; $k = 1,\ldots,4$, which are the four output variables. C represents the bank's total costs. There are four outputs (y): total loans, total deposits, liquid assets, and other earning assets. There are two input prices (w): interest expenses to total deposits and non-interest expenses to fixed assets. There is one fixed input (z): total earning assets. The lnu term represents the bank's efficiency level, and ln v is a random error that incorporates both measurement error and luck. The cost function is estimated using the (lnu + lnv) as a composite error term. The normalization of the bank's total earning assets (z1) reduces heteroskedasticity and allows banks of any size to have comparable residual terms from which the efficiencies can be calculated.

The normalization by the last input price (w2) ensures price homogeneity. The profit function will be the same as the cost function when replacing cost with profit.

3.3 Econometric models

The estimated banking efficiencies are then used in different econometric models to determine the impact of financial sector reforms and macroeconomic changes.

$$Banking\ Efficiencies_i$$

$$= \alpha_1 + \sum_{i=1}^{4}\beta_i CG_i + \sum_{j=1}^{2}\beta_j ME_j + \sum_{k=1}^{2}\beta_k Refoms_k + \beta_l BIND * LIST_k$$

$$+ \sum_{m=1}^{2}\beta_m Controls_m + \sum_{n=1}^{13}\beta_n yearsdummies_n$$

The banking efficiencies are proxied as technical (TE), allocative (AE), and economic (EE) efficiency in the DEA approach and as cost efficiency (CE) and profit efficiency (PE) in SFA. The explanatory variables include proxies for corporate governance (CG) variables, such as board size (BS), board independence (BIND), the number of supervisors in the bank (NSUP), and associations among top ten shareholders of a bank (ASSHRD). βi is the coefficient of the corporate governance variables, where $i = 1, 2, 3, 4$. The proxies of macroeconomic (ME) variables are annual GDP growth rate (GDPG) and the interest rate spread between the lending and borrowing rate (INTSP), whereas βj is the coefficient of the macroeconomic variables $j = 1, 2$. The variables related to banking sector reforms (Reforms) in China include a dummy variable for the Chinese listed banks (LIST). If a bank is listed on a stock exchange, it takes a value of 1 and otherwise, it is 0. Another dummy variable refers to the change in capital structure within the sample period (CCS). If a bank changes its capital structure during the sample period, it takes a value of 1, otherwise it is 0, and βk is the coefficient of the banking sector reform variables, $k = 1, 2$. There

are two control variables introduced in the above models: one is the size of a bank (SIZE) and the second is the bank's leverage (LEV), whereas βm is the coefficient of the control variables, m = 1, 2. To study the year effect, a year dummy variable is also added to the models, whereas it is a residual error of the model. The study uses STAT 15 to estimate banking efficiencies via the DEA and SFA techniques. Further, the estimated banking efficiencies are incorporated into the econometric models to run panel data regression with fixed and random effects along with generalized method of moments (GMM). The variables description is presented in the following Table 1.

4 Results

4.1 Banking efficiency descriptive-DEA method

Table 2 presents the estimation of the Chinese listed commercial banks' efficiency scores using the DEA approach. The results show that the overall mean technical efficiency of banks in the sample period is 0.90, which is higher than the average technical efficiency of commercial banks in the world, 0.86. The mean technical efficiency scores of Big Four and non-Big Four banks are 0.97 and 0.87, respectively (Table 2).

4.2 Banking efficiency descriptive-SFA method

The banking efficiency of Chinese banks is also estimated using the parametric approach, SFA. The results show that the overall mean profit efficiency score of listed Chinese commercial banks during the sample period is 0.78, which is considerably lower than the mean technical efficiency scores for Chinese listed commercial banks in the same period (Tables 3, 4, 5),

5 Results and discussion

The purpose of using parametric and non-parametric methods instead of comparing the two techniques is to obtain evidence on the consistency of the results, following Bauer et al. (1998). The overall mean economic efficiency score of all listed Chinese commercial banks estimated using the DEA technique is 0.81 (Table 2), whereas the mean cost efficiency score estimated by the SFA approach for all the listed commercial banks is 0.92 (Table 3). The mean efficiency score estimated by SFA is higher than that estimated by DEA. This is not surprising, given that in the DEA approach, outliers may affect the overall efficiency, allowing banks to depart from the cost frontier. For SFA, the standard deviation of the listed commercial banks' efficiencies is 0.13, which is less than the standard deviation estimated by DEA, 0.19. These findings are in line with the results of Bauer et al. (1998) and with Delis and Papanikolaou (2009).

Table 1 Variable description

Variable name	Abbreviation	Definition	Unit	Source
Dependent variable				
Technical efficiency	TE	Technical efficiency is computed using DEA method	0–1	CSMAR
Allocative efficiency	AE	Technical efficiency is computed using DEA method	0–1	CSMAR
Economic efficiency	EE	Technical efficiency is computed using DEA method	0–1	CSMAR
Cost efficiency	CE	Cost efficiency is computed using SFA method	0–1	CSMAR
Profit efficiency	PE	Profit efficiency is computed using SFA method	0–1	CSMAR
Independent variable				
Financial reforms				
Listing on stock market	List	A dummy variable takes value 1 if listed on stock market otherwise 0	0/1	CSMAR
Change of capital structure	CSS	A dummy variable takes value 1 if bank changed its capital structure during the sample period otherwise 0	0/1	CSMAR
Board composition				
Board size	BS	Logarithm of number of directors in board		CSMAR
Board independence	BIND	Percentage of number of independent directors in board	%	CSMAR
Number of supervisor	SSUP	Logarithm of number of supervisors in board		CSMAR
Association among top ten shareholders	ASSSHRD	Percentage of association among top ten shareholders	%	CSMAR
Macroeconomics indicators				
Change in GDP	GDPG	Percentage change in GDP	%	CSMAR
Interest rate spread	Intsprd	Difference between lending and deposit rates	%	CSMAR
Control variables				
Size of bank	Size	Logarithm of total assets of bank		CSMAR
Leverage	Lev	Debt to asset ratio of the bank	%	CSMAR

Table 2 Efficiency scores of Chinese listed commercial banks—DEA analysis

Years	Overall banks				Big four banks			Non-big four banks		
	No	TE	AE	EE	TE	AE	EE	TE	AE	EE
2000	16	0.85	0.91	0.79	1	0.97	0.97	0.8	0.9	0.73
2001	16	0.86	0.93	0.82	1	0.99	0.99	0.82	0.91	0.76
2002	16	0.89	0.91	0.82	1	0.98	0.98	0.85	0.89	0.77
2003	16	0.9	0.91	0.83	0.94	0.93	0.88	0.89	0.91	0.82
2004	16	0.9	0.91	0.83	0.96	0.92	0.9	0.88	0.91	0.81
2005	16	0.9	0.9	0.82	0.97	0.94	0.92	0.88	0.89	0.79
2006	16	0.92	0.65	0.61	1	0.94	0.94	0.9	0.56	0.5
2007	16	0.91	0.74	0.67	0.98	0.37	0.36	0.88	0.86	0.77
2008	16	0.88	0.88	0.79	0.98	0.92	0.9	0.85	0.87	0.75
2009	16	0.87	0.93	0.81	0.9	0.95	0.86	0.86	0.92	0.8
2010	16	0.94	0.94	0.89	0.99	0.99	0.98	0.92	0.92	0.86
2011	16	0.93	0.92	0.86	1	0.99	0.99	0.9	0.9	0.82
2012	16	0.92	0.95	0.88	0.98	0.99	0.98	0.89	0.94	0.85
2013	16	0.92	0.98	0.91	0.98	0.99	0.98	0.91	0.97	0.88
Mean eff. score		0.9	0.89	0.81	0.97	0.92	0.9	0.87	0.88	0.78
SD eff. score		0.13	0.14	0.19	0.05	0.17	0.18	0.14	0.13	0.19

Table 3 Efficiency scores using SFA—all listed commercial banks of China

Variable	Mean	SD	Min	Max
Profit efficiency	0.78	0.24	0.0098	0.997
Cost efficiency	0.92	0.13	0.2079	0.999

Table 4 Efficiency scores using SFA—big four banks of China

Variables	Mean	SD	Min	Max
Profit efficiency	0.73	0.27	0.034	0.996
Cost efficiency	0.90	0.14	0.207	0.999

Table 5 Efficiency scores using SFA—non-big four banks of China

Variable	Mean	SD	Min	Max
Profit efficiency	0.80	0.23	0.0098	0.97
Cost efficiency	0.93	0.12	0.23	0.999

The mean efficiency scores of Chinese listed commercial banks are compared using the comparison of the means test/t test. Table 6 shows the comparison of the technical, allocative economic, profit, and cost mean efficiency scores of Big Four and non-Big Four banks. The results show that the technical mean efficiency score

Table 6 Comparison of mean efficiency score—Chinese listed commercial banks

Variables	Mean score non-BFS	Mean score BFB	T-stat	P value
TE	0.87	0.97	− 5.1641	0.00***
AE	0.88	0.92	− 1.65	0.09**
EE	0.78	0.90	− 4.17	0.00***
PE	0.8	0.73	1.93	0.054*
CE	0.93	0.90	1.32	0.18

*, **, *** represent significance level at 10%, 5%, and 1%, respectively

of Big Four banks is significantly different from that of non-Big Four banks. Further, the allocative and cost mean efficiency scores of Big Four banks are significantly different from those of the non-Big Four banks at 5% and 1% levels of significance. These results are consistent with Maggie and Heffernan (2007) and with Chen et al. (2005), who show that state-owned banks are more efficient than their counterparts. However, SFA also shows that the mean profit efficiency score of non-Big Four banks is greater and significantly different from mean that of Big Four banks in China at a 1% level of significance. There is no difference in mean cost efficiency scores between Big Four and non-Big Four banks, and this result is in line with the findings of others (Berger et al. 2009; Yao et al. 2007; Cui and Jiang 2009).

Table 7 shows comparisons of mean efficiency scores and corporate governance indicators (i.e., board size, board independence, number of supervisors, and associations among top ten shareholders of Big Four banks) before and after being listed on the Shanghai and Shenzhen stock exchanges. The listing process for the Big Four banks was part of the ownership and structural banking reforms in China. Comparing these banks' mean efficiency scores before and after the listing indicates whether the ownership reforms are theoretically based from the perspective of the principal-agent problem. The results show that the mean efficiency scores of the Big Four banks (technical, allocative, economic, cost, and profit) improve significantly after listing at the stock market. Moreover, board size, board independence, and the

Table 7 Comparison of mean efficiency score and board composition—big four banks of China

Variable	Before listed	After listed	T-stat	P value
TE	0.89	0.94	1.72	0.081*
AE	0.83	0.89	1.875	0.072*
EE	0.78	0.86	1.723	0.083*
PE	0.55	0.76	7.33	0.00***
CE	0.88	0.94	2.2	0.02**
BIND	0.32	0.34	1.52	0.06*
BS	9.78	15.5	15.46	0.00***
NSUP	5.2	7.8	9.88	0.00***
ASSHRD	2.2	2.1	1.26	0.18

*, **, *** represent significance level at 10%, 5%, and 1%, respectively

number of supervisors also increase significantly at Big Four banks after the listing, while associations among top ten shareholders are insignificant. These results are in line with the extant literature (e.g., Hasan and Marton 2003; Bradley et al. 2003; Cui and Jiang 2009; Fries and Taci 2005).

5.1 Regression results

Table 8 presents the results of panel regression analysis. Evidently, banking sector reforms have significantly improved Chinese banking efficiencies. The study uses two proxies for Chinese banking sector reforms: the listing of Chinese banks on the stock exchanges and the changes in capital structure. The results indicate that listing the Chinese commercial banks on the Shanghai and Shenzhen Stock Exchanges has a positive and significant impact on technical, economic, and profit efficiencies of banks. However, listing does not affect the allocative and cost efficiency scores of banks. The change in capital structure has no impact on banking efficiency scores, while bank size has a significant negative impact. These findings lend support for a theoretical foundation (the soft-budget constraint theory) for the ongoing banking reforms in China. The results show that compared to small banks, large banks are negatively associated with efficiency scores. The leverage of a bank appears to have an insignificant impact on bank technical efficiency in China.

Corporate governance practices in the Chinese banking sector have improved over time. Board size has a positive and significant impact on profit and cost efficiencies and has no significant impact on the remaining banking efficiencies. On the other hand, board independence has a significantly negative impact on all efficiency measures except allocative efficiency. These results bring into question the relationship between banking efficiency and the independence of board directors, and they also provide contextual insight into the Chinese banking system. Independent directors have less of an effect on bank efficiency when subjected to political or government pressure. But when banks are listed on the stock market, independent directors have a positive impact on Chinese banking efficiency. This suggests that the ownership restructuring has enhanced corporate governance mechanics in commercial banks.

Associations among the top ten shareholders have a positive and significant impact only on the technical efficiency score, while the number of supervisors has a positive and significant impact on all efficiency scores except allocative efficiency. These results are in line with the previous literature (e.g., Ding et al. 2010; Firth et al. 2009). Liang et al. (2013) also document the importance of board size, board independence, and corporate governance in Chinese banking performance.

A possibility exists for reverse causality, which can influence the results of the study. In other words, banking efficiency may affect the governance mechanisms of banks. The potential endogeneity concerns when analyzing the impact of board size on bank performance are omitted variables, reverse causality, and measurement errors (Adams et al. 2010). They also conduct a comprehensive study on the endogeneity between board structure and firm performance from a theoretical perspective. To address potential endogeneity issues between governance, reforms, and

Table 8 Panel regression—all Chinese listed commercial banks

Variable	TE	AE	EE	PE	CE
Constant	−0.41 (−1.28)	1.36*** (3.99)	0.67 (1.21)	1.78*** (3.01)	0.66** (2.02)
BS	−0.005 (−1.12)	−0.001 (−0.31)	−0.09 (−1.04)	0.014** (2.66)	0.006** (2.32)
BIND	−0.23** (−1.99)	−0.13 (−1.03)	−0.29* (−1.67)	−0.36* (−1.72)	−0.091* (−1.69)
NSUP	0.109** (2.73)	0.037 (0.86)	0.12* (1.93)	0.027* (1.79)	0.005** (2.69)
ASSHRD	0.02* (1.94)	−0.016 (−0.87)	0.007 (0.29)	0.031 (0.94)	−0.002 (−0.15)
CSS	−0.033 (−1.57)	0.02 (0.89)	−0.003 (−0.11)	0.01 (0.27)	−0.014 (−0.65)
LIST	0.048* (1.87)	0.03 (1.02)	0.08** (2.37)	0.126** (2.41)	−0.035 (−1.21)
LIST × BIND	0.35* (1.86)	0.025 (1.03)	0.12** (2.15)	0.413* (1.89)	0.81** (2.67)
INTSP	0.028 (0.52)	−0.11* (−1.85)	−0.14* (−1.79)	−0.16* (−1.82)	0.142** (2.38)
GDPG	0.002 (0.62)	−0.035*** (−7.04)	−0.027*** (−4.12)	−0.003 (−0.38)	−0.016*** (−3.13)
SIZE	−0.041*** (−5.37)	−0.014* (−1.80)	−0.043*** (−3.48)	−0.031** (−2.38)	−0.005* (−1.71)
LEV	0.056 (0.56)	−0.16 (−1.44)	−0.23 (−1.52)	0.36* (1.84)	0.076 (0.68)
Obs	244	244	244	244	244
F-Stat	12.75	10.47	11.38	9.29	10.23
P-value	0.00	0.00	0.00	0.00	0.00
R2	0.31	0.29	0.28	0.19	0.20
Hausman Chi Square	0.48	0.57	0.71	0.28	0.35
P-value	0.49	0.44	0.39	0.59	0.25

*, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. The values represent the regression coefficients of the respective variables. Those in parentheses are t-values

Table 9 GMM results

Variable	TE	AE	EE	PE	CE
Constant	1.06 (0.23)	1.72*** (0.00)	0.61 (0.21)	0.3886*** (0.00)	0.5553* (0.08)
BS	−0.18 (0.20)	−0.12 (0.32)	−0.13 (0.41)	0.2681** (0.01)	0.04** (0.04)
BIND	−0.663*** (0.00)	−0.53 (0.011)	−0.29* (0.07)	−0.39* (0.04)	−0.15* (0.08)
NSUP	0.04* (0.07)	0.38 (0.34)	0.17* (0.09)	0.08* (0.07)	0.21** (0.03)
ASSHRD	0.45** (0.04)	−0.25 (0.18)	0.06 (0.27)	0.2927 (0.13)	−0.0178 (0.88)
CSS	0.03 (0.13)	0.16 (0.97)	−0.03 (0.13)	0.0279 (0.43)	−0.0036 (0.82)
LIST	0.48* (0.08)	0.06 (0.41)	0.05** (0.02)	0.032** (0.03)	−0.0176 (0.35)
LIST × BIND	0.14* (0.07)	0.14 (0.11)	0.11** (0.03)	0.05* (0.07)	0.067** (0.03)
INTSP	0.42 (0.19)	−0.42* (0.04)	−0.16* (0.07)	−0.40 (0.14)	0.17** (0.04)
GDPG	0.031 (0.40)	−0.28*** (0.00)	−0.031** (0.04)	−0.0056 (0.53)	−0.019** (0.02)
SIZE	−0.09*** (0.00)	−0.15* (0.02)	−0.043*** (0.00)	−0.04** (0.03)	0.1371** (0.01)
LEV	0.36 (0.18)	−0.12 (0.45)	−0.26 (0.52)	0.22* (0.06)	0.0157 (0.87)
Obs	244	244	244	244	244
Hansen's J Chi Square	0.02	0.08	0.61	0.06	0.79
Hansen's J P-value	0.89	0.78	0.43	0.81	0.37

*, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. The values represent the regression coefficients of the respective variables. Those in parentheses are t-values

efficiency, this study uses the System GMM method. The robustness of the results is confirmed by employing the GMM technique. This ensures that there is no endogeneity among variables (Table 9).

6 Conclusions

This study aims to examine the impact of ongoing banking reforms, institutional restructuring, and corporate governance practices on Chinese banking efficiencies. To demonstrate the economic and theoretical rationale behind the Chinese banking sector reforms, the performance of big banks is observed before and after their stock market listings. The results show that the Big Four banks perform better in terms of efficiency after being listed, confirming that the ongoing banking reforms indeed have a theoretical foundation. Big Four banks' profit and cost efficiencies improve after stock market listing, revealing the presence of a principal-agent conflict in Chinese banks. It appears that the structural ownership reforms are helping banks sort out these principal-agent problems and thus, improve their profit and cost efficiencies.

This study also tests another theoretical implication of the banking reforms in China: the soft-budget constraint theory. It is thought that highly capitalized banks (with soft-budget constraints) are less efficient compared to less capitalized ones (with hard-budget constraints). Bank size is used as a proxy for bank capitalization, and the results of different models suggest that size (capitalization) has a negative association with technical, allocative, economic, profit, and cost efficiencies. This confirms that banks with hard-budget constraints perform better than those with soft-budget ones.

This study further investigates aspects of board structure, such as board size, board independence, the number of supervisors, and other corporate governance variables (e.g., associations among top ten shareholders). These factors influence banking efficiencies in varying patterns depending on the estimation technique. For example, board size does not affect the efficiency of Chinese banks when the DEA method is used to perform the estimation. However, size has a positive and significant impact on banking efficiencies when performing the estimation with SFA. Independent directors detract from banking efficiency before the listings, but the interaction between the listings and the independent directors has a positive influence on banking performance. This demonstrates that as a result of ownership restructuring, board independence can improve performance in Chinese banks.

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