

Technical Efficiency of Commercial Banks in China: Decomposition into Pure Technical and Scale Efficiency

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Abstract

This study examines the technical efficiency of commercial banks in China during the period 2001-2007 by employing the non-parametric approach, namely, Data Envelopment Analysis (DEA). Technical efficiency is further decomposed into pure technical and scale efficiency to determine the sources of inefficiency of the commercial banks in China. Results found that commercial banks in China on average are relatively technically inefficient. In addition, technical inefficiency of the commercial banks in China has its origin in pure technical inefficiency. This means that the commercial banks are facing problem in the allocation of resources between its input and output mix. A significant reduction in technical efficiency is found in foreign-owned commercial banks from 2003 to 2006. This might be due to higher operation costs for employing more factors of production in their expansion process after China entered WTO and the gradual deregulation in the banking system.

Keywords: *commercial banks, technical efficiency, DEA*

JEL classification: *G21, D21, C14*

1. Introduction

Banking industry in the developing countries has long been recognized for its role as a channel of monetary policy transmission due to the under-developed capital market. Firms in these countries depend heavily on bank lending to finance their business activities. Therefore, efficiency of the banking system remains an important issue in developing countries to guarantee the

smoothness of the monetary policy transmission process and also to provide better pricing and services to the banking customers.

China's legal and financial systems are not well-developed and lag behind the standard of most developing nations (Berger, Hasan and Zhao, 2009). Hence, the Chinese banking system might be extremely vulnerable in terms of long-term survival especially after China entered the World Trade Organization (WTO) in December 2001. In addition, Cull and Xu (2005) found that the inefficient banking sector together with poor legal and financial infrastructure affected the economic development in China and hence, the banking industry needed to improve its efficiency level so that it could further contribute to the country's economic expansion. Consequently, this study aims to estimate the technical efficiency of the commercial banks in China from 2001 to 2007 by employing a non-parametric approach, namely, the Data Envelopment Analysis (DEA). Hence, this study focuses on the Chinese banking efficiency after China's entry into WTO. Next, the study further decomposes the technical efficiency into pure technical and scale efficiency in order to identify the sources of inefficiency of the commercial banks in China.

Even though China had maintained high growth during the past decades, this might not continue indefinitely without an efficient banking system. According to Berger, Hasan and Zhao (2009), China's high growth rate was mainly due to the excess funds available for investment as a result of high savings rates and trade surpluses. Therefore, efficient allocation of funds is being viewed as unnecessary as compared to the other developing countries that were faced with a shortage of funds. Nevertheless, such imbalances might not lead to the long-term sustainability of economic performance in China. Therefore it is crucial for the country to strive for efficient allocation of resources through an efficient banking system.

In addition, commercial banks in China have been facing intense competition brought by the foreign banks in the recent years as a result of the deregulation of foreign entry under WTO. Therefore, bank managements should carefully plan their banking operations in order to guarantee the long-term survival of the Chinese banks in both domestic and international markets. Thus, this study intends to provide a better understanding to the banks' decision-makers of their status quo in the national banking industry and further assist them in making an appropriate adjustment in managerial policies to improve the banks' efficiency level.

Section 2 provides a brief background of the Chinese banking system while Section 3 reviews the studies of banking efficiency in China. The method employed to estimate the banks' efficiency scores is presented in Section 4, together with the discussion on the variables employed in this study. Section 5 discusses the findings of the study. Section 6 concludes.

2. Background of China's Banking Industry

The Chinese banking system is dominated by four large state-owned banks which accounted for more than half of the banking industry assets in China (Table 1). Besides that, the state-owned banks have been relatively inefficient and characterized by a huge amount of non-performing loans as a result of lending directed by the local authorities. Consequently, the banking sector reform in China is lagging behind reforms in other economic sectors.

Table 1 shows the total assets of banking institutions in China from 2003 to 2007. Table 1 indicates that there is a gradual reduction in the percentage of total assets of the state-owned commercial banks in the Chinese banking industry. In addition, Table 1 also shows an increase in the percentage of total assets of joint-stock commercial banks and foreign-funded banks among the banking institutions over the years. These might be due to the further deregulation process in the Chinese banking system with the lifting of geographic and customer restrictions together with other non-prudential restrictions on foreign banking operation on 11th December 2006 (*Almanac of China's Finance and Banking 2007*). The increments might enhance the competition level of the banking industry and eventually create the awareness of the banks to further improve their operation level for long-term sustainability. This is proven with the reduction of non-performing loan ratio of the major commercial banks from 23.7 per cent at the end of 2002 to 7.5 per cent at the end of 2006 (*ibid.*).

3. Literature Review

Studies on the technical efficiency of the Chinese banking system are limited and were mostly done in the early 2000s. Wei and Wang (2000) studied the technical efficiency of the commercial banks in China and found that on average, the newly founded banks were relatively more technically efficient than the state-owned commercial banks. The result is supported by Zhao, Zhong and Jiang (2001) and Kumbhakar and Wang (2005) who found that the state-owned banks were least efficient as compared to other banking institutions in the country. Besides that, Kumbhakar and Wang (2005) also found that there was a positive relationship between bank efficiency and financial deregulation.

In terms of cost efficiency, Chen, Skully and Brown (2005) compared the cost efficiency of the Big Four state-owned commercial banks with the state-owned joint equity banks in China from 1993 to 2000 using the Data Envelopment Analysis method. Their findings suggest that the Big Four state-owned commercial banks and smaller joint-equity banks were relatively cost-efficient compared to the medium-sized joint-equity banks. Besides that, their results also supported the view of Kumbhakar and Wang (2005) that financial

Table 1 Total Assets of China's Banking Institutions, 2003-2007 (100 million yuan)

	2003		2004		2005		2006		2007	
	Total	%								
Policy banks	21,247.0	7.68	24,122.5	7.63	29,283.2	7.82	34,732.3	7.90	42,781.0	8.13
State-owned commercial banks	160,511.7	58.03	179,816.7	56.91	210,050.0	56.06	242,363.5	55.15	280,070.9	53.25
Joint stock commercial banks	29,598.6	10.70	36,476.0	11.54	44,654.9	11.92	54,445.9	12.39	72,494.0	13.78
Urban commercial banks	14,621.7	5.29	17,056.3	5.40	20,366.9	5.44	25,937.9	5.90	33,404.8	6.35
Rural commercial banks	384.8	0.14	565.4	0.18	3,028.9	0.81	5,038.1	1.15	6,096.7	1.16
Rural cooperatives banks	—	—	—	—	2,750.4	0.73	4,653.6	1.06	6,459.8	1.23
Urban credit cooperatives	1,468.3	0.53	1,786.8	0.57	2,032.7	0.54	1,830.7	0.42	1,311.7	0.25
Rural credit cooperatives	26,509.2	9.58	30,767.0	9.74	31,426.7	8.39	34,502.8	7.85	43,434.4	8.26
Non-bank financial institutions	9,100.0	3.29	8,726.8	2.76	10,161.9	2.71	10,594.1	2.41	9,717.0	1.85
Postal savings bank	8,984.4	3.25	10,849.6	3.43	13,786.8	3.68	16,122.0	3.67	17,687.5	3.36
Foreign-funded banks	4,159.7	1.50	5,822.9	1.84	7,154.5	1.91	9,278.7	2.11	12,524.7	2.38

Source: *Almanac of Banking and Finance 2007*.

deregulation contributed positively towards bank efficiency especially in the mid-1990s. Similar conclusion was also reached by Fu and Heffernan (2007) who found that cost efficiency of banks was higher during the first phase of bank reforms. However, Fu and Heffernan (2007) found that the joint-equity banks were more cost-efficient than the Big Four state-owned banks. Furthermore, cost efficiency increased with the listing of banks' shares in the stock market.

Ariff and Can (2008) analyzed both cost and profit efficiency of Chinese commercial banks together with the influence of ownership type, size, risk profile, profitability and other key environmental variables on bank efficiency. Using data from 28 commercial banks in China from 1995 to 2004 and employing the DEA techniques, they suggested that Chinese banks were relatively cost-efficient than profit-efficient. Their results were consistent with the findings of Fu and Heffernan (2007) which found the joint-stock banks to be more efficient in both cost and profit as compared to the state-owned banks. This might be due to the fact that joint-equity banks were characterized by better asset quality as compared to the state-owned commercial banks (Yao, Han and Feng, 2008). They also found that the least cost- and profit-efficient banks were more risky, incurred higher operating costs and had more subsidized capital. Fee-based activities were found to have enhanced the efficiency level of the commercial banks in China.

Next, Hu, Su and Chen (2008) examined the cost efficiency of China's nationwide banks by taking into account the effects of the environmental variables. By manipulating the DEA techniques in the estimation of efficiency scores, they found that there was no significant difference of cost efficiency across the banks. They found that nationwide joint-equity commercial banks exhibited higher technical and scale efficiency as compared to the state-owned banks. Their results suggest that the banks' efficiency has declined after the WTO accession and the Asian Financial Crisis in 1997.

Majid, Zulkhibri and Fadzlan (2008) studied the relationship between the efficiency level of China's banking sector and share price performance from 1997 to 2006. The results suggest that ownership structures contributed to the different levels of technical and scale efficiency of commercial banks in China. Besides that, the bank efficiency level depended on bank management quality, size, and bank's diversification towards non-interest income. This is consistent with the findings of Ariff and Can (2008) that fee-based income activities increased the efficiency level of the commercial banks. In addition, the changes in stock return were found to be influenced by the banks' technical efficiency level.

A recent study by Berger, Hasan and Zhao (2009) compared the cost and profit efficiency of the banks in China in relation to different types of ownership structures. By employing data from 38 commercial banks operating

in China from 1994 to 2003, they found that foreign banks were more efficient in both cost and profit and this was followed by private domestic banks. Besides that, their results also found that financial reforms which reduced the state-ownership of banks and increased the role of foreign banking had contributed positively towards the increase in the efficiency level of all the banks in China. Even though the state-owned banks were found to be highly cost-efficient, the results suggest that the banks were less effective in their lending activities. Berger, Hasan and Zhao (2009) highlighted that the banks were practicing skimping behaviour in lending which resulted in a huge amount of non-performing loans in the state-owned banks which contributed to lower revenues.

4. Methodology

This study employs the Data Envelopment Analysis (DEA) to estimate the technical efficiency scores of the commercial banks in China. Besides that, the study further decomposes technical efficiency into pure technical and scale efficiency in order to locate the source of inefficiency. DEA was first introduced by Charnes, Cooper and Rhodes (1978), based on the concept of Pareto efficiency. It is a mathematical approach that is used to develop the production frontier to estimate the efficiency of a particular firm (Casu and Molyneux, 2003). The most efficient banks are said to operate on the frontier and banks below the frontier are considered to be relatively inefficient as compared to the benchmark banks. The main advantage of DEA as compared to the econometric approach is that it does not require *a priori* functional specification of the unknown technology (Fukuyama, 1993; Favero and Papi, 1995).

Banker, Charnes and Cooper (1984) further revised the DEA model and introduced the BCC model which allows for further decomposition of technical efficiency into pure technical and scale efficiency. This study manipulates the input-oriented BCC model with the assumption that a bank chooses to minimize the factors of production given the output level. Equation (1) shows the BCC model for technical efficiency:

$$\begin{aligned}
 \theta^* &= \min \theta \\
 &\text{subject to} \\
 &\sum_{j=1}^n \lambda_j x_{ij} \leq \theta x_{i0} \quad i = 1, 2, \dots, m \\
 &\sum_{j=1}^n \lambda_j y_{rj} \leq y_{r0} \quad r = 1, 2, \dots, s \\
 &\sum_{j=1}^n \lambda_j = 1 \\
 &\lambda_j \geq 0 \quad j = 1, 2, \dots, n
 \end{aligned} \tag{1}$$

where DMU_0 represents one of the n DMUs under evaluation, and x and y are the i th input and r th output for DMU_0 , respectively. λ are unknown weights, and $j = 1, 2, \dots, n$ represents the number of DMUs. The optimal value of θ^* represents the distance of the banks from the efficient frontier. Therefore, the most technically efficient banks are said to have $\theta^* = 1$ and the inefficient banks will have a $\theta^* < 1$.

The sample of this study consists of the selected commercial banks in China from 2001 to 2007. Therefore, the study focuses on the technical efficiency of commercial banks in China after China entered the WTO.

This study employs the intermediation approach by treating bank deposits as an input for the production of financial outputs. It focuses on the traditional banking activities conducted by commercial banks in China, namely the efficiency of the banks in deposit-taking and lending activities. Therefore, the banks' outputs employed in this study are total loans and total investments. The input vectors employed in this study consist of other non-interest expenses, fixed capital and total deposits. Other non-interest expenses are used as a proxy for personnel costs due to the unavailability of personnel costs in the financial statements of the China's commercial banks. Fixed capital is used as the input for capital. Finally, total deposits are used to represent the financial inputs that produce financial outputs. All the data in the analysis are obtained from the banks' annual reports which can be downloaded from IBCA Bankscope. All outputs and input vectors are in USD million.

5. Results and Discussion

The technical efficiency of commercial banks in China is estimated based on the BCC model and further decomposed into pure technical and scale efficiency. Table 2 presents the summary statistics of the technical, pure technical and scale efficiency of the commercial banks in China estimated from 2001 to 2007.

Table 2 Overall Technical, Pure Technical and Scale Efficiency of Commercial Banks in China, 2001-2007

	Technical Efficiency	Pure Technical Efficiency	Scale Efficiency
Mean	0.3142	0.3789	0.8652
Standard Deviation	0.2281	0.2660	0.1585
Minimum	0.0810	0.0950	0.1700
Maximum	1.0000	1.0000	1.0000

Based on the results in Table 2, commercial banks in China are found to be relatively technically inefficient with a reported average efficiency score of 31.42 per cent. This means that commercial banks in China could further reduce their factor of production by 68.58 per cent by maintaining the same output level. Besides that, the reported standard deviation of 0.2281 shows that there is a large dispersion in terms of technical efficiency among the commercial banks in China from 2001 to 2007.

Based on the decomposition of technical efficiency into pure technical and scale efficiency, the results show that the major sources of banks efficiency come from scale efficiency with an average efficiency score of 86.52 per cent. This means that banks' efficiency level increases with the scale of operation. A relatively low pure technical efficiency score suggests that commercial banks are pure technically inefficient and faced with misallocation of inputs and outputs in banking operation.

Next, the detailed analysis of technical efficiency according to the types of ownership is presented in Table 3. The average scores of technical, pure technical and scale efficiency of commercial banks in China are further divided into state-, foreign- and private-owned commercial banks.

Results from Table 3 indicate that foreign-owned commercial banks are relatively technically efficient and this is followed by the state-owned banks and finally the private-owned commercial banks. The results hold for the period from 2001 to 2007. Generally, foreign-owned commercial banks reported a higher average pure technical and scale efficiency score as compared to the state-owned banks and private-owned commercial banks in China.

The private-owned commercial banks are relatively least efficient and this is mainly resulted from pure technical inefficiency. This means that private-owned commercial banks in China experienced misallocation of resources between the inputs and outputs. Therefore, the bank management should re-evaluate their management strategies to further improve the banking operations.

Besides that, Table 3 also shows that the state-owned and domestic private-owned commercial banks in China experienced a reduction in technical efficiency during the period from 2001 to 2002. The state-owned commercial banks experienced a reduction in technical efficiency of about 6.44 per cent but started to increase back in the subsequent years.

On the other hand, the foreign-owned banks' technical efficiency increased by 7.70 per cent during the period from 2001 to 2002. However, the reduction in technical efficiency can be seen in the period from 2003 to 2006. Relatively low technical efficiency is found to be a result of lower pure technical efficiency scores in these years due to the mismatch in the production mix. This situation might be due to the further deregulation by

Table 3 Technical, Pure Technical and Scale Efficiency of Commercial Banks in China, 2001-2007

	2001	2002	2003	2004	2005	2006	2007
	Technical Efficiency						
State-owned	0.3753	0.3109	0.3188	0.3323	0.3824	0.3551	0.4452
Foreign	0.5138	0.5908	0.5108	0.4260	0.3912	0.4072	0.5569
Private	0.2738	0.2727	0.2788	0.2831	0.2837	0.2788	0.3104
	Pure Technical Efficiency						
State-owned	0.5757	0.4393	0.4543	0.4936	0.6065	0.5918	0.7163
Foreign	0.6808	0.6625	0.6712	0.5309	0.4279	0.4317	0.6171
Private	0.3140	0.3253	0.3246	0.3240	0.3226	0.3201	0.3592
	Scale Efficiency						
State-owned	0.6710	0.7737	0.7525	0.7241	0.6801	0.6858	0.6572
Foreign	0.8258	0.8565	0.7840	0.8040	0.8966	0.9306	0.9011
Private	0.8809	0.8922	0.8964	0.9010	0.8945	0.8741	0.8845

China's government that had encouraged more foreign banks to set up their subsidiaries and branches in the country. When the foreign banks expand their businesses, it will inevitably result in higher operating costs to employ more factors of production in their expansion process and thus, a reduction in technical efficiency in the short-run is unavoidable. In year 2007, it can be seen that the foreign-owned banks' technical efficiency improved by 14.97 per cent.

6. Conclusions

This study has examined the technical efficiency of commercial banks in China during the period from 2001 to 2007 by employing a non-parametric approach, namely, the Data Envelopment Analysis.

The results show that the commercial banks in China on average are relatively technically inefficient. This might be due to the underdeveloped banking system in the country and as highlighted by Berger, Hasan and Zhao (2009), China's legal and financial systems are not well-developed and not up to the standard of most developing nations.

In addition, the decomposition of technical efficiency into pure technical and scale efficiency shows that on average, the commercial banks in China are having problem in the allocation of resources between their inputs and outputs mix. This is especially true in the case of the private-owned commercial banks. The results here are consistent with the findings of Hu, Su and Chen (2008) that the private-owned joint-equity commercial banks are relatively pure technically inefficient. The misallocation of resources of commercial banking in China might be a result of management complacency in the banking operation because of less intense competition in China's banking industry. Therefore, the opening-up to foreign banking by the authorities might contribute to a more healthy and competitive environment.

A significant reduction in technical efficiency is found in the case of the foreign-owned commercial banks during the period from 2003 to 2006 with the source of inefficiency being pure technical inefficiency. The deregulation of China's banking system has encouraged foreign banks to set up their subsidiaries and branches in the country and thus, it has inevitably resulted in higher operation costs for employing more factors of production in their expansion process. Hence, a reduction in technical efficiency in the short-run cannot be avoided. Nevertheless, technical efficiency of the foreign-owned banks improved by 14.97 per cent in the year 2007. This clearly indicates that foreign-owned banks have gained from operational efficiency after having successfully established their banking operation in China.

Finally, the results of this study are consistent with the existing literature including Zhao, Zhong and Jiang (2001), Kumbhakar and Wang (2005) and

Hu, Su and Chen (2008), in which the foreign-owned commercial banks are found to be relatively technically efficient as compared to the state-owned banks. As stated by Majid, Zulkhibri and Fadzlan (2008), differences in ownership structures contribute to the different levels of technical and scale efficiency of commercial banks in China. Besides that, the results also show that financial deregulation and China's entry into WTO did benefit commercial banking in China as well as provide opportunities for the foreign investors to expand their banking business in China.

Note

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References

- Ariff, M. and L. Can (2008), "Cost and Profit Efficiency of Chinese Banks: A Non-parametric Analysis", *China Economic Review*, Vol. 19, pp. 260-273.
- Banker, R.D., A. Charnes and W.W. Cooper (1984), "Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis", *Management Science*, Vol. 30, pp. 1078-1092.
- Berger, A.N., I. Hasan and M. Zhao (2009), "Bank Ownership and Efficiency in China: What Will Happen in the World's Largest Nation?", *Journal of Banking & Finance*, Vol. 33, pp. 113-130.
- Casu, B. and P. Molyneux (2003), "A Comparative Study of Efficiency in European Banking", *Applied Economics*, Vol. 35, pp. 1865-1876.
- Charnes, A., W.W. Cooper and E. Rhodes (1978), "Measuring the Efficiency of Decision Making Units", *European Journal of Operational Research*, Vol. 2, pp. 429-444.
- Chen, X., M. Skully and K. Brown (2005), "Banking Efficiency in China: Application of DEA to Pre- and Post-deregulation Eras: 1993-2000", *China Economic Review*, Vol.16, pp. 229-245.
- China Finance Society (2007), *Almanac of China's Finance and Banking*, Beijing: China Financial Publishing House.
- Cull, R. and L. C. Xu (2005), "Institutions, Ownership, and Finance: The Determinants of Profit Reinvestment among Chinese Firms", *Journal of Financial Economics*, Vol. 77, pp. 117-146.
- Favero, C.A. and L. Papi (1995), "Technical Efficiency and Scale Efficiency in the Italian Banking Sector: A Nonparametric Approach", *Applied Economics*, Vol. 27, pp. 385-395.
- Fu, X. and S. Heffernan (2007), "Cost X-efficiency in China's Banking Sector", *China Economic Review*, Vol. 18, pp. 35-53.
- Fukuyama, H. (1993), "Technical and Scale Efficiency of Japanese Commercial Banks: A Nonparametric Approach", *Applied Economics*, Vol. 25, pp. 1101-1112.

- Hu, J.L., Y.Y. Su and C.P. Chen (2008), "Efficiency of Nationwide Banks in China", *The Journal of American Academy of Business*, Cambridge, Vol. 13, pp. 84-90.
- Kumbhakar, S.C. and D. Wang (2005), "Economic Reforms, Efficiency, and Productivity in Chinese Banking", State University of New York-Binghamton Working Paper.
- Majid, A., M. Zulkhibri and S. Fadzlan (2008), "Bank Efficiency and Share Prices in China: Empirical Evidence from a Three-Stage Banking Model", MPRA Working Paper No. 12120.
- Wei, Y. and L. Wang (2000), "Studies of Chinese Commercial Banks' Efficiencies: A Nonparametric Analysis", *Journal of Financial Research*, Vol. 237, pp. 88-96.
- Yao, S., Z. Han and G. Feng (2008), "Ownership Reform, Foreign Competition and Efficiency of Chinese Commercial Banks: A Non-Parametric Approach", *The World Economy*, Vol. 31, pp. 1310-1326.
- Zhao, Z., J. M. Zhong and Z. S. Jiang (2001), "An Analysis of the Efficiency of State-owned Banks with Examples", *South China Financial Research*, Vol. 16, pp. 25-27.