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Full Length Research Paper

Operating strategies of banks in China: Analysis of operational and profitability efficiency

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This paper conducts a comparative analysis of banks operating in China using a two-stage model, which evaluates their operational efficiency (OE) and profitability efficiency (PE). The study period spanned through 2004 to 2006 and data envelopment analysis (DEA) was used in the study's analysis. The results showed that large and older banks are generally more efficient than small and new ones in operational efficiency. However, while small efficient banks are easily used as benchmarks, large efficient banks are deemed as competitive niche players. This means that the large banks have better competitive power than the small ones.

Key words: Data envelopment analysis, bank efficiency, two-stage, operational efficiency, profitability efficiency.

INTRODUCTION

The Chinese government started the reform since 1979, when it keeps reforming its financial system. In November 2001, Mainland China officially became a WTO member toward internationalization. After joining the WTO, Mainland China had to open the domestic financial market to offshore financial institutions. China had already achieved virtually, a sound economic system because of the globalization effect, which makes the competition among worldwide financial corporations to be more and more serious. Therefore, they will play a major force in financial services industry. To analyze the advantage of the banks in China and to pursue the optimal effect, are not the only goals for bank managers, but also the subject of public investors and governmental institutions mutual concern.

However, the bank of China is none other than the pursuit of a greater scope of business and the generation of more profit. Thus, in facing a highly competitive environment, the formulation of a competitive strategy, the strengthening of corporate operations and the upg-rading of the quality of service has become essential for survival. In formulating competitive strategies, one major problem is the measurement of management perfor-mance in the industry, prior to an assessment of advantages and disadvantages. Another problem that is encountered is the determination of factors that affect managerial efficiency.

Based on the two-stage data envelopment analysis (DEA), multiple inputs and outputs were used to measure the managerial efficiency of the banks. This analysis used the two stages of operational efficiency (OE) and profitability efficiency (PE) to compare the banks' perfor-mance. The efficiency differences were investigated and analyzed based on different characteristics of the firms, and the efficiency of older banks was compared with newer ones, as well as any differences in efficiency based on the size of the banks. In addition, management performance was not restricted to production efficiency or cost minimization, but was a more general assessment, involving management and marketing services and sales. However, banks provide financial services through the use of a non-price competition model to meet the needs of customers with high quality services. The development of a bank's investment portfolio will help the bank's overall operating performance.

Based on the measurement of managerial efficiency, a management decision matrix was developed to serve as the basis for an assessment of the competitive strategy of the thirteen banks in China. This will aid each bank in the industry, to gain a greater understanding of the gap be-tween the banks and improve their operational efficiency by providing future operational strategies through analy-sis. Finally, conclusions, recommendations and follow-up

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research proposals will be provided.

LITERATURE REVIEW

There are many applications of the data envelopment analysis method given in the literature, but this study focused only on those that discuss the operating efficiency of a bank. There have been several articles published in journals on the use of DEA in determining efficiency levels in the financial industry (Bauer et al., 1998; Seiford and Zho, 1999; Soteriou and Zenios, 1999; Kao and Liu, 2004; Chen, 2005; Lo and Lu, 2006; Yao et al., 2007). The efficiency approach has been applied to numerous settings for several years, including the financial services sector. Since the first application of DEA to banking efficiency, by Sherman and Gold (1985), many subsequent studies have been conducted. In view of the fact that the traditional one-stage DEA method is incapable of reflecting sufficient management information about a company's production process, the production process is analyzed by dividing the actual sequential process into two parts and treating the outputs of the first stage as the inputs for the second stage. The same concept can be applied more than once, in that the outputs of the second stage can be treated as the inputs of a third stage and can be used to develop a continuous production process, which is called the multiple-stage DEA. Seiford and Zhu (1999) first suggested the use of the two-stage DEA method, to divide a commercial bank's production process into two stages (marketability and profitability). Subsequently, Lo and Lu (2006) used DEA with a two-stage production process that included profitability and marketability performance.

In addition, Luo (2003) applied DEA to a sample of 245 large banks. This study provided evidence that large banks were achieving relatively low levels of marketing efficiency. There were 34 banks (about 14%) that achieved high levels of profitability performance, but low levels of marketing performance. Also, the results indicated that the geographical location of the banks did not seem to be related to either the profitability or marketability efficiency levels.

The Overall Technical Efficiency (OTE) of the profitability performance may predict the likelihood of bank failure. Manandhar and Tang (2002) combined the service-profit chain into their research model and reached the conclusion that the profitability of a firm will ultimately increase when a firm improves the quality of the service delivered to customers. This is because good service quality will have good effects on customer satisfaction and thus, indirectly have a positive influence on profitability. Chen (2002) assessed the management performance of banks in Taiwan, incorporating operating efficiency, marketing efficiency and financial achievements in the study. The results of this research showed significant differences with the pre-calculated efficiencies. Banks with public ownership exhibited superior profitability performance, whereas privately owned banks tend to perform better with regard to operational capabilities. Furthermore, the relatively large banks exhibited superior performance on profitability, whereas the smaller ones tend to perform better with regard to operational capabilities. Roth and Van (1991) highlighted the importance of linking marketing and operational efficiency. Halkos and Salamouris (2004) explored the efficiency of Greek banks using a number of suggested financial efficiency ratios and found that the banks with the largest total assets had the highest efficiency levels. Wide variations in performance showed that increases in efficiency accompanied increases in the size of banks due to mergers and acquisitions. Zhu (2000) used the DEA method to calculate the efficiency of 364 companies and found that the top-ranked companies in terms of revenue do not necessarily hold the top performance rankings for profitability and marketability.

Other numerous studies have also used the DEA method, including Oral et al. (1992), Grifell-Tatje and Knox-Lovell (1999), Sathye (2003), Lozano et al. (2002) and Kao and Liu (2004). In addition, Sathye (2001) offered the important conclusion that, government de-regulation and leadership strategies of merging banks provided operations with significant impact. Yue (1992) proposed that banking inefficiencies were due to numerous input and output deficiencies, which indicated that the banks were at fault rather than the rating scale. This study referred to the relevant literature and the DEA method for a two-stage approach to analyze China's banks.

METHODOLOGY

Defining input-output factors

Banks input and output definitions vary according to different research perspective; however, the most commonly used methods are the production approach and the intermediation approach. The production approach suggests that the bank uses the labor and capital from different capital accounts, which provide working output capital, excluding interest payments, while the intermediation approach treats banks as intermediary bodies, where non-depository account offer businesses financial resources, which they may borrow in the form of business loans, in order to make profit. Thus, many lenders invest their money through banks, investing for the duration of projects by paying various expenses, such as costs, interest charges and the cost of funds for projects, in which banks have invested. Most scholars have used the intermediation approach because the project is relatively easy to calculate, the information is easily obtained and it can show the bank's asset by type, size differences and multiple output characteristics.

However, it should be noted that, the definition and measurement of bank inputs and outputs has long been debated among researchers and there is no definite, commonly agreed choice (Soteriou and Zenios, 1999; Sathye, 2001). This study adopted the intermediation approach for definition of input and output variables.

In this study, managerial efficiency was measured in two-stages: operational efficiency (OE) and profitability efficiency (PE). These types of efficiency are respectively based on the two-stage service provision process, which describes two essential departments of

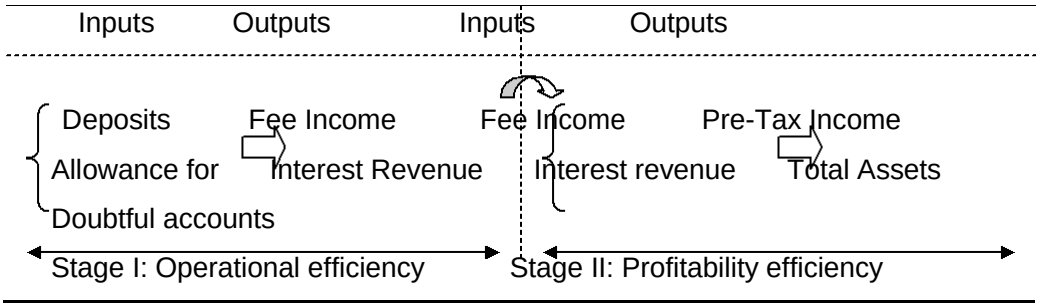

Figure 1. Banks' inputs and outputs in the production process.

Table 1. Descriptive statistics for the database.

Factors	Mean	SD	Minimum	Maximum
Deposits	229,051,742	223,675,927	7,329,866	720,665,667
Allowance for doubtful accounts	32,191,193	68,968,980	343,632	259,814,000
Fee income	2,704,870	4,721,237	53,843	13,741,667
Interest revenue	38,304,331	59,292,782	1,011,125	203,283,000
Pre-tax income	17,395,627	27,700,450	645,156	92,923,333
Total assets	1,265,161,745	1,889,176,678	44,404,528	6,346,410,333

bank operations. This paper was divided into two stages with six factors being expressed as inputs and outputs in each stage.

The first stage addressed the measurement of marketing efficiency, a bank's ability to generate output in terms of its current personnel and operating expenses, using data based on 2004 to 2006 yearly average values. The input and output data were extracted from the Taiwan Economic Journal (TEJ) data bank. The TEJ data bank is commonly deemed valid, reliable and available to the public. Thus, the operational efficiency model had the following two output variables (fee income and interest revenue). The second stage measured profitability efficiency with input, in terms of its current interest (that is, fee income and interest revenue), while the profitability efficiency model has two outputs (pre-tax income and total assets). The two-stages are as follows.

Stage I (Operational efficiency)

Input factors

(a) Deposits: These include time deposits, demand deposits, check deposits, remittances, foreign currency deposits, etc.
(b) Allowance for doubtful accounts: The discount and loan of allowance for doubtful accounts.

Output factors

(a) Fee income: The banking business of fee revenue.
(b) Interest revenue: Including bank deposits and the interest income from loans.

Stage II (Profitability efficiency)

Input factors

(a) Fee income: The banking business of fee revenue.
(b) Interest revenue: Including bank deposits and the interest income from loans.

Output factors

(a) Pre-tax income: The operating interests added or deducted from the profit and loss of operation after the interests.
(b) Total assets: These variables include current assets, long-term investment, fixed assets and other assets.

From Figure 1, the operational performance model (Stage I) measured a bank's ability to generate revenue, which consisted of two inputs (deposits and allowance for doubtful accounts) and two outputs (fee income and interest revenue), while the profitability performance model (Stage II) measured a bank's attractiveness with two inputs (fee income and interest revenue) and two outputs (pre-tax income and total assets). The output and input factors used in this study were relevant information input and output, respectively (Tables 1 and 2).

This study used the data that were obtained in the 2004 to 2006 period. The input and output data were extracted from the Taiwan Economic Journal (TEJ) data bank, in that the TEJ data bank was commonly deemed as valid, reliable and available to the public. The descriptive statistics of the inputs and outputs in each DEA stage are reported in Table 1. For example, the mean of deposits was approximately NT$229 billion in the sample. In addition, the minimum was approximately NT$645,156 and the mean was NT$17,395,627 for pre-tax income.

This study used the input and output variables of the Pearson correlation verification, to avoid the improper admission of variables, which will affect the accuracy of the results. Correlation analysis results which are related to a certain extent are shown in Table 2.

The DEA methodology

According to the concept of efficiency for performance evaluation

Table 2. Correlation coefficients among inputs and outputs.

Factors	Deposit	Allowance for doubtful accounts	Fee income	Interest revenue	Pre-tax income	Total assets
Deposits	1.000					
Allowance for doubtful accounts	0.741(0.004)	1.000				
Fee income	0.762(0.002)	0.858(0.000)	1.000			
Interest revenue	0.827(0.000)	0.944(0.000)	0.974(0.000)	1.000		
Pre-tax income	0.819(0.001)	0.935(0.000)	0.981(0.000)	0.999(0.000)	1.000	
Total assets	0.827(0.000)	0.928(0.000)	0.983(0.000)	0.999(0.000)	0.999(0.000)	1.000

method, the main comparison was between the input-output relations. DEA efficiency assessment model used the envelope line technology to replace the general economics of individual pro-duction function, whose basic theory was based on Farrell (1957), from the concept of technical efficiency. Three scholars (Charnes et al., 1978) expanded the single input and single output model in the concept of multiple inputs-multiple outputs, to create a form used to assess the decision-making units (decision making unit, DMU) related to efficiency, and which can be used for the non-identical units. For a number of inputs and outputs, various renovations to a single value, obtained for a value of the prefecture institutions' organizational efficiency, were commonly known as the CCR model.

This study used these methods for measuring the efficiency levels of the data envelopment analysis, while the CCR model was used to measure the decision-making units (DMU) operating efficiency. Its theoretical description is as follows.

CCR model

Charnes et al. (1978) in pursuant to Farrell (1957), assess the efficiency of the theoretical basis, through two inputs and outputs of a single model, and expanded it to the multiple inputs and outputs model. The fixed pay scale, under the assumption of using linear programming method, was used to assess each unit of the relative efficiency. The law is known as the DEA model CCR.

Suppose k is DMUs, each DMU k (k=1,⋯ ,N) using the M input species X_{ik} (i=1,⋯,m;k=1,⋯,N) > 0 production n outputs y_{rk} (r=1,⋯,n;k=1,⋯,N) > 0. As can be seen in a DMU, k is expected to be the efficiency values:

$$\text{Max} \quad H_k = \frac{\sum_{r=1}^{n} u_r y_{rk}}{\sum_{i=1}^{m} v_i X_{ik}}$$

$$\text{subject to} \quad H_k = \frac{\sum_{r=1}^{n} u_r y_{rk}}{\sum_{i=1}^{m} v_i X_{ik}} \le 1 \qquad (1)$$

y_{rk} : amount of the r th output for the k th DMU; X_{ik} : amount of the u v_i : the weight assigned to the i^{th} input; ε: Non-Archimedean quantity is arbitrary to small positive values.

Since Formula (1) in the scores-planning (fractional programming) model is not easy to solve, Charnes et al. (1978) converted the linear programming model as follows:

$$\text{Max} H_k = \sum_{r=1}^{n} u_r y_{rk}$$

$$\text{subject to} \sum_{r=1}^{n} u_r y_{rk} - \sum_{i=1}^{m} v_i X_{ik} \le 0 \qquad (2)$$

$$u_r, v_i \ge \varepsilon \; ; i=1,\text{L},m \; ; r=1,\text{L},n \; ; k=1,\text{L},N$$

Formula (2) at the input items portfolio showed the average value mass of the cases in formula one, while the items for the output which have the maximum average portfolio efficiency mass were used to indicate the relative value. However, its limitations - the number (n + k + m + l), was significantly more than the number of variables (n + k), and can make use of the dual conversion pairs (Duality) mode to reduce restrictions on the number of convenience-type solution as follows:

$$\text{Min} \; H_k = \theta_k - \varepsilon \left(\sum_{i=1}^{m} S_{ik}^{-} + \sum_{r=1}^{n} S_{rk}^{+} \right)$$

$$\text{subject to} \sum_{k=1}^{N} \lambda_k X_{ik} - \theta_k X_{ik} + S_{ik}^{-} = 0$$

$$\sum_{k=1}^{N} \lambda_k X_{ik} - S_{rk}^{+} = y_{rk} \qquad (3)$$

$$\varepsilon, \lambda_k, S_{ik}^{-}, S_{rk}^{+} \ge 0 \; ; i=1,\text{L},m \; ; r=1,\text{L},n \; ; k=1,\text{L},N$$

In Formula (3), S^{-} S^{+} λ $_{ik}$, $_{ik}$ and $_{k}$ for all DMU are best allocated to the DMU combination of linear equations and the weights θ of efficiency of a practical value. S_{i-k} and S_{ik}^{+} are the input and output variables' variance (slack variable), that is, the representative of the actual value and the best efficiency of the difference between the value that can be used to understand S^{-}_{ik} the inputs and outputs of the S^{+} number of room for improvement. When θ = 1, and = = 0, the DMU is said to be relatively efficient. As such, the DMU relative efficiency can be adjusted through the following to achieve optimum efficiency goals:

$$X_{ik}^{*} = \theta_k^{*} X_{ik} - S_{ik}^{-*}$$

Table 3. Operational efficiency ranking (2004 to 2006).

No.	Bank	CCR	Reference group	A and P	Ranking
D1	Shenzhen Development	0.98	D6	0.98	3.5
D2	Ningbo	1	D2	1.24	2
D3	Pudong Development	0.49	D2 D6	0.49	10
D4	Hua Xia	0.85	D2	0.85	7
D5	Minsheng	0.9	D2	0.90	5
D6	Cmbchina	1	D2 D6	2.67	1
D7	Nanjing	0.46	D2	0.46	11
D8	Industrial	0.72	D2	0.72	8
D9	Beljing	0.36	D2 D6	0.36	13
D10	Communications	0.89	D2	0.89	6
D11	ICBC	0.6	D6	0.60	9
D12	China	0.98	D2 D6	0.98	3.5
D13	China CITIC	0.39	D2	0.39	12
	Mean	0.74			
	S.D.	0.24			

Table 4. Profitability efficiency ranking (2004 to 2006).

No.	Bank	CCR	Reference group	A and P	Ranking
D1	Shenzhen Development	0.68	D9	0.68	12
D2	Ningbo	0.9	D7	0.90	3
D3	Pudong Development	0.74	D9	0.74	9
D4	Hua Xia	0.85	D9	0.85	6
D5	Minsheng	0.67	D9	0.67	13
D6	Cmbchina	0.86	D7	0.86	5
D7	Nanjing	1	D7 D9	1.01	2
D8	Industrial	0.88	D9	0.88	4
D9	Beljing	1	D7 D9	1.02	1
D10	Communications	0.75	D7	0.75	7.5
D11	ICBC	0.72	D7	0.72	10
D12	China	0.75	D7	0.75	7.5
D13	China CITIC	0.71	D9	0.71	11
	Mean	0.81			
	S.D.	0.11			

A and P value was used for ranking.

$$y^{*}_{rk} = y_{rk} + S^{+*}_{rk} \quad (4)$$

RESULTS AND ANALYSES

This study used database analyzers for the years 2004 to 2006 for the input and output information of the CCR model, to analyze the operational efficiency (Stage I) and profitability efficiency (Stage II) of banks. In addition, the Anderson and Peterson (A and P) model was applied respectively, to the first and second phases of the efficiency of the assessed banks. The results of the analysis on the two stages of the relative efficiency of the banking values, reference groups, and the A and P efficiency values of sequencing are shown in Tables 3 and 4. The efficiency values for stage one showed that, the thirteen banks were relatively efficient, based on benchmark levels. If the value was less than efficient, within the same industry, it showed a low level of relative efficiency. However, this benchmark was set by the efficiencies of the banks used in the reference groups. For example, Pudong Development bank was used in the reference group for the first stage of operational efficiency. This group also included Ningbo and Cmbchina Bank.

As regard to the study on the efficiency of banks, the A

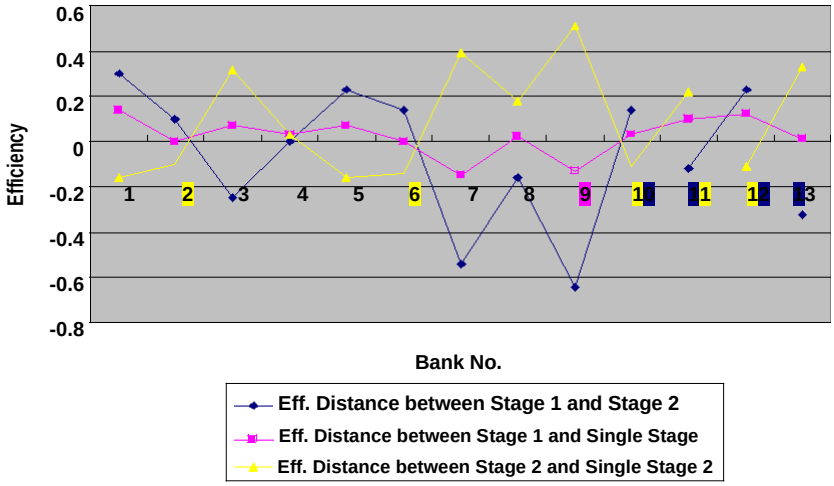

Figure 2. Efficiency distance between the two-stage and single stage.

Table 5. Efficiency scores of banks' performance models.

No	Bank	Operational	Profitability	Size	Date established
		TE	TE		
D1	Shenzhen Development	0.98	0.68	Small	Old
D2	Ningbo	1	0.9	Small	New
D3	Pudong Development	0.49	0.74	Small	New
D4	Hua Xia	0.85	0.85	Small	New
D5	Minsheng	0.9	0.67	Small	New
D6	Cmbchina	1	0.86	Small	Old
D7	Nanjing	0.46	1	Small	New
D8	Industrial	0.72	0.88	Small	Old
D9	Beljing	0.36	1	Small	New
D10	Communications	0.89	0.75	Large	Old
D11	ICBC	0.6	0.72	Large	Old
D12	China	0.98	0.75	Large	Old
D13	China CITIC	0.39	0.71	Small	Old
	Mean	0.74	0.81		

"Large" indicates that the total assets score is above the median, while "Small" indicates that the total assets score is below the median; "Old" signifies the date established prior to 1992, while "New" signifies after 1992.

and P model, which estimates A and P efficiency value, states that the efficiency of its value is greater than one. However, the higher efficiency values expressed are in comparison to other banks, which had higher efficiency performance levels, as shown in Tables 3 and 4 rankings. While the A and P levels were based on efficiency values, in Table 4, the various phases of the operation were shown to have an average overall efficiency value of 0.81, with a standard deviation of 0.11, showing the gap between the greatest efficiency levels.

Figure 2 shows that all the banks analyzed had a significant difference between their operational and profitability efficiencies with the exception of Hua Xia (the 4th DMU), which had a difference between the two-stage efficiency and the traditional one-stage efficiency that is close to 0. This paper also calculates the absolute value of the difference between the operational and profitability stage efficiencies. This absolute value can be used to indicate differences between the two-stage efficiencies, in that the bigger the absolute value, the better the two-stage DEA method. Also, it can be used to indicate advantages or disadvantages when compared to the one-stage DEA method (Figure 2). For example, in the two stage division of Beljing (the 9th DMU), the difference between the operational and profitability efficiencies can be as high as 0.64 (=1 to 0.36). This suggests that although Beljing may have a profitability advantage, it is extremely inefficient in the fee income and interest revenue aspects.

In Table 5, the mean scores of operational and profitability

Table 6. Summary statistics: TE of size and date established for thirteen banks.

Category	No. of banks	Operational			Profitability		
		Mean	Mamm-Whitney U (P-value)	Kruskal-Wallis χ^2 (P-value)	Mean	Mamm-Whitney U (P-value)	Kruskal-Wallis χ^2 (P-value)
Size							
Large	10	0.82	-0.424 (0.346)	0.180 (0.672)	0.74	-0.678 (0.286)	0.460 (0.498)
Small	3	0.72			0.83		
Date established							
Old	7	0.79	-0.788 (0.222)	0.621 (0.431)	0.76	-1.146 (0.147)	1.313 (0.252)
New	6	0.68			0.86		

Table 7. Reference-share measure in operational performance model.

No.	Bank	Input factor				Output factor				Average rank
		Deposits (%)		Loans (%)		Fee income (%)		Interest revenue (%)		
D2	Ningbo	14.99	(2)	2.47	(2)	4.53	(2)	6.01	(2)	(2)
D6	Cmbchina	85.01	(1)	97.53	(1)	95.47	(1)	93.99	(1)	(1)

Table 8. Reference-share measure in profitability performance model.

No.	Bank	Input factors				Output factors				Average rank
		Fee income (%)		Interest revenue (%)		Pre-tax income (%)		Total assets (%)		
D7	Nanjing	24.23	(2)	17.16	(2)	17.72	(2)	16.96	(2)	(2)
D9	Beljing	75.77	(1)	82.84	(1)	82.28	(1)	83.04	(1)	(1)

models were 0.74 and 0.81, respectively. The table shows that, two of the banks are efficient in both the operational and profitability performance models. From the result of the mean efficiency score, it can be concluded that profitability performance was better than operational performance for these thirteen banks. The operational model showed that large and old banks were more efficient than the small and new banks (Table 6). The operational model results showed that large and old banks were more likely to generate revenue profit. The profitability model can be interpreted, as small-sized banks operate more efficiently than larger banks.

This result also reveals that banks are facing a highly competitive environment in China. On the other hand, the large-sized banks are relatively TE in operation, suggesting that large-sized and old banks have used their managerial expertise to operate banks in an efficient manner. To summarize these results, regardless of the bank's size, the economies of scale are insufficient and banks should consider them as beneficial programs. Banks must identify the input/output values that are most important, or distinguish the banks, which can be treated as benchmarks. In so doing, the ranking lists of the operational and profitability models of all the efficient banks will be given.

In Tables 7 and 8, the reference-share measures were reported for the operational and profitability performance models, with the ranking in parenthesis and ordered by the average rank of the efficient banks. There were four technical efficient banks in the operational performance model in Table 7. However, Cmbchina bank, which in particular is a technically efficient bank, has the reference-share in deposits, loans, fee income and interest revenue and is therefore an important bank in benchmarking. The percentage number is the extent referred to for a particular input/output, while other inputs/outputs are controlled.

The profitability performance model is given in Table 8. Beljing Bank is seen to be a particularly technical efficient bank, having the reference-share in interest revenue, pre-tax income, total assets and an average rank of the first. In Tables 7 and 8, it can be seen that even if these banks are efficient, they are revealed as excessively different in the input/output space to be referenced.

In summary, while small efficient banks are frequently referenced, large efficient banks can hardly become benchmarks. This result is quite reasonable, since the

Table 9. Four combinations from two kinds of efficiencies.

No.	OE	PE	Bank name
1	High	High	Ningbo, Hua Xia and Cmbchina
2	High	Low	Shenzhen Development, Minsheng, Communications and China
3	Low	High	Nanjing, Industrial and Beljing
4	Low	Low	Pudong Development, ICBC and China CITIC

The notation 'high' indicates that the efficiency score is above the mean and 'low' means that the efficiency score is below the mean.

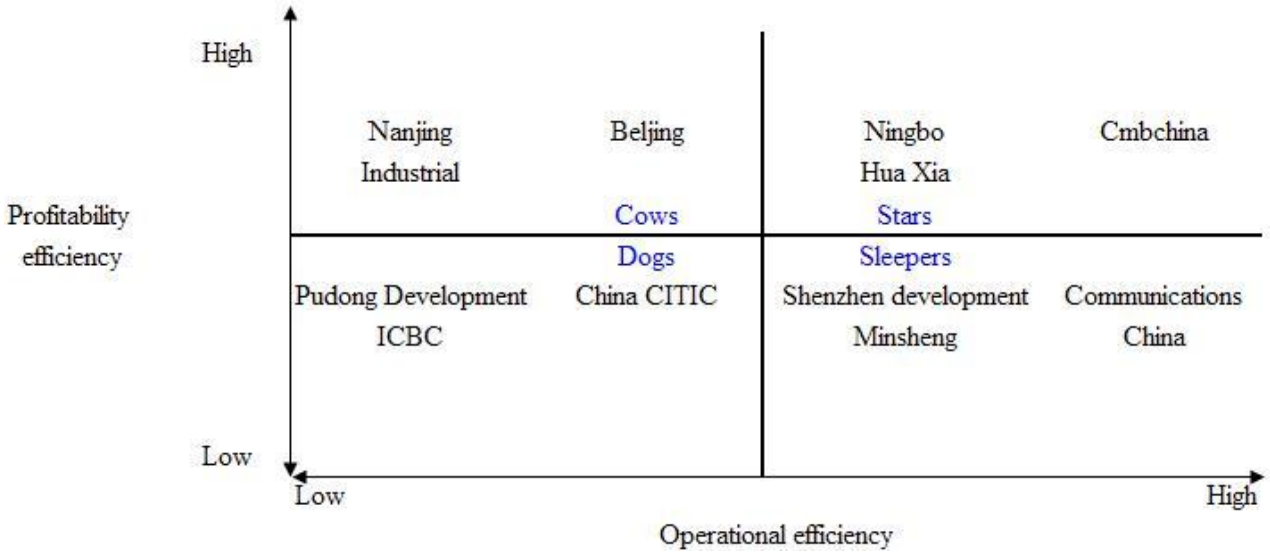

Figure 3. Profitability and operational efficiency in cross-tabulation.

scale of the various inputs (for example, deposits) is more easily attained for small-sized banks. It is relatively difficult to imitate the scale of a large efficient bank. In terms of managerial implication, this phenomenon can be explained by it being hard for large banks to be imitated because of their large scale. This is why, the bigger a bank is, the more possible it is for it to survive a merger or acquisition. Therefore, these ranking lists give a clear and stable indication of the banks that should be pointed out as benchmarks for others. In addition, Table 9 gives four cases of efficiency combinations to provide individual evidence for the relationship between the two kinds of efficiency.

Table 9 shows that three banks are in the "stars" category, characterized by high OE and high PE. Conversely, three banks are characterized by low OE and low PE (Groups 1 and 4). It can be argued that Group 4 banks should rearrange their inputs, in order to improve their performance. Group 3, which includes three banks, shows characteristics of low OE and high PE, indicating that their bank services (outputs) are unable to meet their market demand. By using Table 9 to further distinguish the important differences between the operational and profitability efficiencies, a cross-tabulation is presented in Figure 3.

In Figure 3, the operational and profitability TE provide a two-by-two matrix to classify the banks, which fell into four quadrants (stars, cows, sleepers and dogs), which are similar to the classifications done by the Boston Consulting Group. Splitting them partly, using the median created high and low groups of operational and profitability efficiencies. The banks in each of the groups are summarized as follows. High operational and profitability efficiencies included the Ningbo, Hua Xia and Cmbchina banks. They should keep their strength in the operational and profitability stages by occasionally justifying their strategies of total, loans, fee income, interest revenue, pre-tax income and total assets. These banks appear to be good role models and can be treated as benchmarks by others:

1. Low operational and profitability efficiencies - These banks can increase their business or the sales of products, to get more income and reduce bank loans, so as to increase their profitability opportunities.

2. High operational efficiency and low profitability efficiency - These banks can increase their operating efficiency with more interest revenue, so as to increase their

their profitability opportunities.

3. High profitability efficiency and low operational efficiency - To reduce the amount of loans and increase revenue, these banks can improve banking operations.

An increase in the sales of goods or services will increase income. They should also continue to maintain their high profitability efficiency.

MANAGERIAL IMPLICATIONS

From this analysis, it appears that each of the banks has its own advantages and disadvantages, when it comes to operational and profitability efficiencies. The good and poor performances among the banks can be divided into four types, in which different strategies are likely to enhance business efficiency in each (Figure 3).

Strategies for companies with better operational and profitability capabilities

The operational and profitability efficiencies of these banks are above the medians for the banks. The banks that belong to this category include: the Ningbo, Hua Xia and Cmbchina banks. Out of these, Ningbo had the best operational efficiency (an efficiency value of 1). These three banks attempt to maintain their operational advantages, while also trying to enhance their profitability strategies (raise revenue to increase their profitable opportunities). Likewise, other banks should simultaneously improve their operational and profitability strategies (business expansion to increase revenue, or reduce loans to increase profitable opportunities).

Strategies for companies with lower operational and profitability efficiencies

The operational and profitability capabilities of these banks are below the medians for the banks. The banks that belong to this category include: Pudong Development, ICBC and China CITIC Banks. These banks should try to strengthen their operational and profitability efficiencies.

Strategies for banks with better operational efficiency, yet poorer profitability efficiency

Banks that belong to this category have an operational efficiency above the industry median standard, yet their profitability efficiency is below the mean value. Examples of these banks are: Shenzhen Development, Minsheng, Communications and China. These banks have good operational efficiency, but poor profitability efficiency, suggesting that these companies should particularly improve their profitability strategies and increase their operating efficiency with more interest revenue, so as to increase their profitability opportunities. The other eight banks (Nanjing, Industrial and Beijing) should strengthen their operational strategies, while adjusting their profitability strategies as well.

CONCLUSION AND FUTURE RESEARCH

Assessing the many aspects of a bank's performance and rating its efficiency is a broad area for research. Published studies and DEA technology have been used to explore this topic; however, there are still some important issues left untouched. Therefore, the purpose of this paper was to measure the operational efficiency and profitability efficiency of the banks in China. Two models (operational efficiency and profitability efficiency) were included with the DEA analysis of the efficiency levels of twenty-three banks for the years 2004 to 2006. The results of this study show that, the two-stage DEA method of analysis can better indicate managerial efficiency and can help the banks at various stages to understand their specific advantages and disadvantages more thoroughly and clearly.

It is felt that these findings should provide practical help to banks by showing them how to change their strategies to suit their particular circumstances. The results of this study, with regards to the operational and profitability efficiencies of the thirteen banks, show that the Cmbchina bank was ranked first in the operational model, but Beljing bank was ranked first in the profitability model. Thus, it was shown that a bank may look at the efficiency of other banks to find a target of their own. Additionally, the fact that the banks had an overall average profitability efficiency of 0.81 indicated that they squandered 19% of their resources. The non-contribution of output was the primary non-technical reason for the overall level of efficiency. Non-technical efficiency factors are part of the decision-making by managers. However, any error caused by non-managers over such a short period of time is beyond control; and their solution must depend more on long-term planning to improve the organisation. Larger and older banks are generally more efficient than smaller and newer banks in the operational model. On the other hand, older banks are classified into a zone of stars, including the Ningbo, Hua Xia and Cmbchina bank. This means that new banks have a better competitive power than old ones.

Finally, China's financial system will move toward business diversification, and banks will continue to enhance their operating efficiency, which will be worthy of a follow-up study. Furthermore, due to the fact that this study was limited to the years 2004 to 2006, follow-up research should expand the scope of time and other variables considered.

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