Research on China's Commercial Banks Rating and Ranking Based on DEA

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ABSTRACT

China's commercial banks are confronted with fierce competition from advanced big commercial banks abroad, which have much better performance in non-performing loans (NPLs) than China's commercial banks. In this case, efficiency rating and ranking of China's commercial banks are of great importance. We treat the rate of non-performing loans (NPLs) as an undesirable output from the operating process of commercial bank and utilize cross efficiency of DEA (Data Envelopment Analysis) to evaluate and rank China's commercial banks between 2006 and 2008 horizontally and vertically. In the end we will propose our conclusion.

Keywords: Rate of Non-Performing Loans (NPLs); Undesirable Output; Data Envelopment Analysis (DEA); Cross Efficiency

1. Introduction

After three decades of reform and development, China's banking sector has made considerable progress and development. According to the report of the CBRC, as to the end of 2009, total assets of commercial banks in China is 78799.05 billion yuan, non-performing loan ratio was 1.80%. China's commercial banks are the traditional five state-owned commercial banks that include Industrial and Commercial Bank of China, Agricultural Bank of China, China Construction Bank and Bank of Communications, and they also include China Merchants Bank, city commercial bank, Shanghai Pudong Development Bank. For other twelve national banks, there are over 130 city commercial banks. Domestic and international research on the efficiency of commercial banks is from two aspects: one is from economies of scale and scope of the economic angle, the main focus of research is the existence of economies of scale, the extent to whether economies of scope to exist. Benston, Hanweck and Humphrey (1982) made with the banks on expansion, the bank's average cost of line was relatively flat U, medium-sized banks in the scale efficiency better than that of large banks and small banks, but not the larger more good [1]. Economies of scope of the bank is basically associated with the scale of the study, while the scope of the specific role of the economy itself are few. On the other hand, there is the use of cutting-edge analysis of the efficiency of bank efficiency, representation is the data envelopment analysis (DEA) [2] and Stochastic Frontier

Analysis (SFA) [3]. Traditional financial indicators of law Conclusion simple, easy to accept, but the flaw is financial ratio can not reflect the bank's relationship between inputs and outputs; and a description of financial indicators is are not comprehensive, nor it is suitable for long-term description of the actual efficiency of the bank. In addition, because of various social and historical reasons, China's commercial banks, especially state-owned commercial banks have accumulated a large amount of bad loans for commercial banks in various financial and non-financial evaluation of the comprehensive efficiency of how to consider the output of non-performing loans that are not ideal worthy of analysis.

Charnes, Cooper and Rhodes in 1978 founded the first DEA model-CCR model, marking the DEA (Data Envelopment Analysis, DEA) method of the official birth. It is a new area in operations research, management and cross-study mathematical economics [4,5]. DEA is a non-parametric evaluation methods, the main model to evaluate the use of mathematical programming with multiple input multiple output departments or units (Decision making units, DMU) relative effectiveness. Distinctive feature of DEA is its input and output need not consider the functional relationship between, and do not require pre-estimated parameters, the weight of any assumptions, to avoid subjective factors, directly through the output and input ratio between the weighted and calculated decision-making single-input-output efficiency. Since DEA has this unique advantage, significant development has

been achieved in the past 20 years. Much theoretical research have been conducted and practical application of the results have been introduced. It can be said, DEA has become the field of management science and systems engineering in an important and effective tool for mathematical analysis. Data envelopment analysis to evaluate the efficiency, one can get a lot of useful management information. For example, by detecting invalid horizontal decision-making unit of the direction of efficiency improvement; productivity improvement through the analysis of longitudinal studies. In addition, DEA (weak) efficiency and Pareto (weak) optimality is equivalent and they also have a good relationship.

2. The Consideration of the Non-Ideal Output DEA Cross Efficiency Evaluation

DEA considered multi-input and multi-output problems, from the view of decision-making science, inputs and outputs can be used as indicators of the object being evaluated, and always the desired results is that it produces more outputs using less inputs. But the consideration of the input and output are to be desirable and the undesirable inputs, outputs, such as a steel plant in the production of steel at the same time, emissions of the large number of SO_2, CO_2 and dust and other pollutants; steel is the expected output, SO_2, CO_2 and dust are not expected outputs. Suppose there are n a decision making unit, j, m kind of a decision making unit consumption of inputs X_{ij} ($i = 1, 2, \cdots, m$) to produce s kind of desirable outputs Y_{rj} ($j = 1, 2, \cdots, s$) and t species the undesirable output Z_{kj} ($k = 1, 2, \cdots, t$). Hailu and Veeman (2001) in the use of DEA evaluation of the efficiency of the Canadian paper industry the undesirable output as investment point of view, the following model [6]:

$$\theta_d = \text{Min}\,\alpha$$
$$s.t. \sum_{j=1}^{n} \lambda_j z_{lj} \leq z_{ld}, \ l = 1, \cdots, t$$
$$\sum_{j=1}^{n} \lambda_j x_{kj} \leq \alpha \times x_{kd}, \ k = 1, \cdots, m \quad (1)$$
$$\lambda_j \geq 0 \quad j = 1, \cdots, n$$

It is assumed that the output can not expect the same proportion with the reduction of inputs, you can get the following model:

$$\theta_d^{EI} = \text{Min}\,\alpha$$
$$s.t. \sum_{j=1}^{n} \lambda_j y_{ij} \geq y_{id}, \ i = 1, \cdots, s$$
$$\sum_{j=1}^{n} \lambda_j z_{lj} \leq \alpha \times z_{ld}, \ l = 1, \cdots, t \quad (2)$$
$$\sum_{j=1}^{n} \lambda_j x_{kj} \leq \alpha \times x_{kd}, \ k = 1, \cdots, m$$
$$\lambda_j \geq 0 \quad j = 1, \cdots, n$$

Model (2) of the dual model is as follows:

$$E_{dd} = \max \sum_{r=1}^{s} u_{dr} y_{rj} \Big/ \sum_{i=1}^{m} \left(v_{di} x_{ij} + w_{dk} x_{kj} \right) \leq 1$$
$$s.t. \sum_{r=1}^{s} u_{dr} y_{rj} \Big/ \sum_{i=1}^{m} \left(v_{di} x_{ij} + w_{dk} x_{kj} \right) \leq 1$$
$$j = 1, 2, \cdots, n$$
$$u_{dr} \geq 0, v_{di} \geq 0, w_{dk} \geq 0 \quad (3)$$
$$r = 1, 2, \cdots, s,$$
$$i = 1, 2, \cdots, m,$$
$$k = 1, 2, \cdots, t$$

Write model (3) the optimal solution. Obviously, for other decision making unit j, can also be the optimal solution.

Cross Efficiency is a cross-Sexton *et al.* (1986) put forward years, the method is the traditional CCR model for the improvement and perfection, mainly using combination of self-assessment and peer assessment to eliminate the traditional CCR model to rely solely on self-assessment system to be efficient Evaluation of the state. Sexton, etc. to arrive at the definition of output obtained in considering the case of non-ideal weight calculation of cross-efficiency [7].

$$E_{dj} = \frac{1}{n} \frac{\sum_{j=1}^{n} \sum_{r=1}^{s} u_{rd}^* y_{rj}}{\sum_{j=1}^{n} \sum_{i=1}^{m} \sum_{k=1}^{t} \left(v_{id}^* x_{ij} + w_{kd}^* x_{kj} \right)} \quad (4)$$

3. Commercial Bank of China Comprehensive Efficiency

3.1. The Selection of Decision Making Units and Data Sources

Taking into account data availability and representation, the paper selected five state-owned commercial banks in China including Industrial and Commercial Bank of China, Agricultural Bank of China, China Construction Bank and Bank of Communications and China Merchants Bank, CITIC Bank, Shanghai Pudong Development Bank, Huaxia Bank, China Minsheng Bank, Shenzhen Development Bank, Industrial Bank, China Everbright Bank and Guangdong Development Bank, the national joint-stock commercial banks, nine banks, and Beijing Bank, Prudential Bank, Bank of China Zhejiang, represented by three city banks, as Evaluation of the decision making unit, and selected the 2006-2008 three-year data, can better account of the commercial banks during this period changes in overall efficiency. Banking data used in this Annual Report from the banks and the "China Financial Yearbook".

3.2. Determination of Evaluation Index System

In this paper, the main representative of the literature on domestic and international inputs, outputs taking into

account the DEA method to define and apply the requirements of the target, select the index system as follows (**Table 1**) [1,3].

3.3. Evaluation Results

According to the model (3) and model (4) to solve the efficiency of commercial banks in the Chinese values and sort the following **Table 2**.

3.4. Analysis Results

Calculated from the above results the following conclusions:

1) The efficiency of Chinese commercial banks has generally risen from 2006 to 2008, indicating that performance of China's commercial banks after conducting a series of financial reform is overall good. The highest efficiency is 2007, which compared to 2006 increased by 8.07% overall, and efficiency values above 0.8 are also the most number of commercial banks. Efficiency value in 2008 decreased slightly compared with 2007, indicat-

ing the beginning of 2007 by the US subprime mortgage crisis and subsequent financial crisis in China started to have a series of banking, commercial banking industry significantly increased risk of, the indicators show a decline.

2) Five state-owned commercial banks, development

Table 1. Efficiency of Chinese commercial banks comprehensive evaluation system.

Indicators type	Indicators denomination
Input	Number of employees (X1)
	Interest expense (X2)
	Non-interest expenses (X3)
	Total assets (X4)
output	Non-interest income (Y1)
	Interest income (Y2)
	Non-performing loan ratio (Y3)

Table 2. The calculated values and the associated sorting efficiency (Sorting according to the commercial bank annual report).

DMU	Bank abbreviation	2006		2007		2008	
DMU1	ICBC	0.71153	5	0.81365	3	0.73663	5
DMU2	ABC	0.4732	13	0.54165	14	0.4396	16
DMU3	BOC	0.59371	10	0.80627	4	0.70595	7
DMU4	CBC	0.77541	2	0.8375	2	0.78351	2
DMU5	BC	0.67222	9	0.67154	9	0.61544	11
DMU6	CITIC	0.3771	17	0.74433	6	0.7612	4
DMU7	HXB	0.52175	11	0.52308	16	0.60022	14
DMU8	CMBC	0.76933	3	0.73135	8	0.84554	1
DMU9	SDB	0.4623	14	0.5488	13	0.68991	9
DMU10	CMB	0.7576	4	0.76758	5	0.72496	6
DMU11	CIB	0.68294	7	0.73142	7	0.78337	3
DMU12	SPDB	0.68212	8	0.66265	10	0.69173	8
DMU13	CEB	0.45686	15	0.55549	12	0.63754	10
DMU14	GDB	0.37719	16	0.56677	11	0.57015	15
DMU15	BCCB	0.47924	12	0.53466	15	0.60485	13
DMU16	HSBC	0.70273	6	0.35303	17	0.39627	17
DMU17	CZB	0.93352	1	0.88056	1	0.61182	12
Average		0.61346		0.66296		0.65875	

ICBC, Industrial and Commercial Bank of China Limited; ABC, Agriculture Bank of China; BOC, Bank of China; CBC, China Construction Bank; BC, Bank of Communications; CITIC, Industrial Bank; HXB, Huaxia bank; CMBC, China Minsheng Banking Corp. Ltd.; SDB, Shenzhen Development Bank; CMB, China Merchants Bank; CIB, China Industrial Bank Co., Ltd; SPDB, Shanghai Pudong Development Bank; CEB, China Everbright Bank; GDB, Guangdong Development Bank; BCCB, Beijing City Commercial Bank; HSBC, Hongkong and Shanghai banking corporation; CZB, China Zheshang Bank.

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banks a steady progress, their efficiency values were slightly increased, but in the face of financial crisis in 2008 showed some decline, the state-owned commercial banks in the overseas investment need to be further improved. It should be noted that the Agricultural Bank of China Sui Ran a series of reforms and development, but because of its non-performing loans significantly behind the performance of other commercial banks, the efficiency values in all 17 commercial banks is always in the downstream level, the reform efforts need to be further strengthened.

3) National joint-stock commercial banks, CITIC Bank, Industrial Bank and China Minsheng Banking progress obviously, efficiency and value their upward trend of violent and sorting, in which CITIC Bank, the most obvious progress. The remaining four selected national joint-stock commercial banks in developing more stable, the efficiency of their value is also made progress every year. It should be noted that the joint-stock commercial banks in the country by the financial crisis than the state-owned commercial banks is small, the overall efficiency and value in the financial tsunami continued to rise.

4) City commercial banks, Bank of Beijing develop more stable, Prudential Bank in 2007 and 2008 show significant deterioration compared to 2006, the efficiency value of the half fell to about 2006; and Bank of China Zhejiang before 2008 failed to extend for two years strong, relatively large step backward, the financial crisis began to manifest.

5) In general it appears that national joint-stock commercial banks outperform state-owned commercial banks and city banks, especially in the face of the financial crisis should be better, on the one hand shows that China's successful reform of commercial banks, on the other hand the traditional state-owned banks and new city development and reform of commercial banks provides a good reference.

4. Conclusion

Based on the DEA method of dealing with undesirable outputs, and use of cross-efficiency of 17 Chinese commercial banks efficiency evaluation and sorting, from the evaluation results, and present some of the basic results of the evaluation have been consistent. Advantage of DEA has also been fully reflected: 1) Not only indicate The merits of the banks from qualitative perspective, but also give a quantitative improvement through the projector adjustment programs; 2) Weight is given without prior, the use of cross-efficiency is benefit to keep justice and objective, and can get more economic information and management information. It is noteworthy that, in the evaluation of commercial banks using DEA analysis, can be more integrated, such as principal component analysis and cluster analysis methods to identify different types of integrated efficiency of commercial banks the most important factor, and then targeted to be improved.

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