Efficiency Analysis of the elements of China's commercial banks Based on the Malmquist Index Model

Wenbin Ma [1, a] Yingxi Chen[2, b]

[1]Economics and Management School, Chongqing Normal University, Chongqing, China;

[2] Economic Trade Department of Guangdong University of Finance, Guangzhou 510521, China;
[a]hhtg01@163.com, [b]cqtg2014@163.com

Keywords: Commercial banks,Bank efficiency, DEA,Malmquist index

Abstract. Given the rapid development of the Chinese banking industry, commercial banks are increasing their asset sizes simultaneously.China has several commercial banks in the forefront of global banking.The efficiency of small-sized, medium-sized and large-sized banks have become central to the healthy development of the Chinese banking industry.This study uses the data envelopment analysis Malmquist index to analyse the efficiency of Chinese commercial banks from 2005 to 2014.

Introduction

Bank efficiency has recently been the focus of considerable attention from scholars.Studies before the 1990s have mostly identified the economy of scale and scope as the main sources of efficiency for commercial banks, including X-efficiency, cost efficiency and profit efficiency.Berger and Humphrey[1](1997) empirically analysed the efficiency of U.S. banks by conducting stochastic frontier analysis and identified the size, organisation and government supervision of banks as the main influencing factors of bank efficiency.Maudos and Pastor[2] (2003) measured the efficiency of commercial banks in Spain from 1985 to 1996 via data envelopment analysis (DEA)and determinedthat the profit efficiency of commercial banks was lower than their cost efficiency.Tetsushi Homma[3] (2014) observed an intriguing growth–efficiency dynamic throughout the life cycle of banksand showed that the efficient structure hypothesis dominated the quietlife hypothesis in terms of economic effects.TianshuZhao[4] (2013) determined that consumers were faced with high switching costs because of the weak competitiveness of the loanmarket.In summary, although domestic and foreign scholars have produced fruitful research on the efficiency of commercial banks, they have mostly focused on the performance of banks before the financial crisis.Their methods for measuring bank efficiency mainly include non-parametric data estimationvia DEA and parametric translog cost function estimation.This study addresses these gaps in the literature by combining DEA with the Malmquist efficiency index to analyse the efficiency of commercial banks in China between 2005 and 2014.

Design method

DEA was initially a linear programming technique developed by Farrell (1957) and Charnes (1978). Sherman and Gold (1985) were the first to apply this technique to the banking sector.

The Malmquist index is constructed on the basis of the distance function. The reciprocal distance function is defined as the Farrell technical efficiency, whereas the input distance function is defined as the distance between the point of production and the ideal point near the minimum input level.

By using the period of t technology T^t as a reference, the output angle of the Malmquist index can be expressed as follows:

$$M_0^t(x_{t+1}, y_{t+1}, x_t, y_t) = d_0^t(x_{t+1}, y_{t+1}) / d_0^t(x_t, y_t) . \quad (1)$$

By using the t+1 period T^{t+1} as a reference, the output angle of the Malmquist index can be expressed as follows:

$$M_0^{t+1}(x_{t+1}, y_{t+1}, x_t, y_t) = d_0^{t+1}(x_{t+1}, y_{t+1}) / d_0^{t+1}(x_t, y_t) . \quad (2)$$

To prevent arbitrariness in determiningthe differences that result frommodelling Caves based on Fisher's ideal index, the geometric mean from the t phase to the t+1 phase of the Malmquist productivity change index is measured as follows:

$$M_0^{t,t+1}(x_{t+1}, y_{t+1}, x_t, y_t) = \left[\frac{d_0^t(x_{t+1}, y_{t+1})}{d_0^t(x_t, y_t)} \times \frac{d_0^{t+1}(x_{t+1}, y_{t+1})}{d_0^{t+1}(x_t, y_t)} \right]^{\frac{1}{2}} , \quad (3)$$

Whereas (x_{t+1}, y_{t+1}) and (x_t, y_t) denote the vector of the input and output of the t+1 and t phases,whereas d_0^t and d_0^{t+1} are expressed in the t period to denote the time distance function of T and t+1.

TheMalmquist index has favourable properties and can be decomposed into constant returns.By using the comprehensive technical efficiency change index (TEC) and technological progress index, the decomposition process can be expressed as follows:

$$M_c^{t,t+1}(x_{t+1}, y_{t+1}, x_t, y_t) = \frac{d_c^{t+1}(x_{t+1}, y_{t+1})}{d_c^t(x_t, y_t)} \left[\frac{d_c^t(x_{t+1}, y_{(t+1)})}{d_c^{t+1}(x_{t+1}, y_{t+1})} \times \frac{d_c^t(x_t, y_t)}{d_c^{t+1}(x_t, y_t)} \right]^{\frac{1}{2}} . (4)$$

The TEC can be further decomposed into the pure technical efficiency and scale efficiency indexes.Then,type conversioncan be expressed as follows:

$$\begin{aligned} M_{v,c}^{t,t+1} &= \frac{d_v^{t+1}(x_{t+1}, y_{t+1})}{d_v^t(x_t, y_t)} \times \left[\frac{d_v^t(x_t, y_t)}{d_c^t(x_t, y_t)} / \frac{d_v^{t+1}(x_{t+1}, y_{t+1})}{d_c^{t+1}(x_{t+1}, y_{t+1})} \right] \\ &\times \left[\frac{d_c^t(x_{t+1}, y_{t+1})}{d_c^{t+1}(x_{t+1}, y_{t+1})} \times \frac{d_c^t(x_t, y_t)}{d_c^{t+1}(x_t, y_t)} \right]^{\frac{1}{2}} \\ &= PTEC \times SC \times TCP \\ &= TEC \times TCP \end{aligned} . (5)$$

Design of the input–output index system

Based on the production and intermediary methods, combined with the availability of data and the correlation index of variables, the total deposits (X1), net value of fixed assets (X2), operating expenses (X3) and number of employees (X4) are used as the input indicators of the bank, whereas theinterest income (Y1), total pre-tax profit (Y2) and loans (Y3) are used as the output indicators.

Sample selection and data sources

The sample includesthe Industrial and Commercial Bank of China, Agricultural Bank of China, Bank of China, Bank of Communications, China Construction Bank, CITIC Bank, China Everbright Bank, Huaxia Bank, Minsheng Bank, Guangdong Development Bank, Shenzhen Development Bank, China Merchants Bank, Industrial Bank, Pudong Development Bank and 15 other commercial banks, such as the Prudential Bank and the YantaiHousing Savings Bank. The unbalanced panel data cover the years 2005 to 2014and are collected from the 2006 to 2015Financial Statistical Yearbooks and the 2005 to 2015annual reports of each selected bank.

Table 1 Input–Output of Variables.

Index	X1	X2	X3	X4	Y1	Y2	Y3
	Total deposits	Net fixed assets	Operating expenses	Employees	Interest income	Pre-tax profit	Total loans
Observations	150	150	150	150	150	150	150

Changes in total factor productivity levels and trends of Chinese commercial banks

Efficiency value analysis: The super-efficiency DEA model is used to identify the changes in the efficiency of 15 commercial banks in China between 2005 and 2014. Table 2 shows that the efficiency of all these banks exhibits an increasing trend, which is consistent with the social and economic development of the reform and these banks. The average efficiency of these banks in 2005 was 0.781,which increased to 0.913 in 2011.These trends indicate that the efficiency of these banks has been improved to a certain extent over the recent years.However, their mean efficiency level decreased to 0.873 in 2012, increased to 0.902 in 2013 and decreased again to 0.901 in 2014. Such fluctuating trend may be attributed to the global financial crisis that has adversely affected the economic development of China, increasing the risksin the banking industryand subsequently affecting the profitability of these institutions.

Table 2 Efficiency of Chinese Commercial Banks Between 2004 and 2013.

Name	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	total average	total ranking
ICBC	0.730	0.921	0.850	0.758	1.128	0.848	1.076	0.935	1.135	1.076	1.028	4
Agricultural Bank of China	0.690	0.616	0.610	0.747	0.765	0.849	0.813	0.745	0.815	0.780	0.918	15
Bank of China	0.962	0.741	0.750	0.780	0.878	0.944	0.991	0.928	0.908	0.884	0.988	8
China Construction Bank	0.641	0.724	0.714	0.730	1.050	1.080	1.044	0.890	0.981	1.005	1.003	6
Bank of Communications	1.016	0.903	0.687	0.788	0.650	0.819	0.898	0.906	0.880	0.850	0.987	9
CITIC	0.887	0.785	0.822	0.855	0.827	0.969	0.889	0.871	0.894	0.913	1.050	2
Everbright	0.810	1.030	0.821	0.769	0.900	1.006	0.957	0.922	0.890	0.879	1.167	1
Huaxia	0.906	0.923	0.936	0.861	0.963	1.010	0.982	0.880	0.963	0.925	1.029	3
The people's livelihood	0.859	1.006	0.883	1.007	0.826	0.981	0.993	0.857	0.877	0.884	0.979	10
GF	0.739	0.795	0.837	0.862	0.903	0.863	0.886	0.890	0.885	0.879	1.001	7
Shenzhen	0.587	0.666	0.892	0.706	0.730	0.766	0.753	0.746	0.763	0.782	1.020	5
China Merchants Bank	0.790	0.837	0.714	0.773	0.853	0.941	0.881	0.904	0.880	0.850	0.963	13
SocieteGenerale	0.465	0.798	0.829	0.741	0.893	0.788	0.645	0.743	0.830	0.861	0.972	11
Shanghai Pudong Development	1.004	0.847	0.937	0.898	0.960	0.998	0.912	0.895	0.910	0.957	0.966	12
Hengfeng	0.632	0.689	0.754	0.848	0.852	0.831	0.972	0.985	0.923	0.991	0.935	14
The mean	0.781	0.819	0.802	0.808	0.879	0.913	0.913	0.873	0.902	0.901	1.000	

Malmquist index analysis: The statistical data of the selected banks are processed by using the Win4-DEAP software to decompose the Malmquist indexesof these banks between 2005 and 2014.

Table 3 AnnualAverage MalmquistIndex and its Decomposition.

Year	TEC	TCP	PTEC	SEC	TFPC
2013~2014	1.033	1.160	1.002	1.031	1.198
2012~2013	0.998	0.986	0.989	1.009	0.984
2011~2012	0.975	1.145	1.005	0.97	1.116
2010~2011	0.992	1.161	1.001	0.991	1.152
2009~2010	1.044	1.139	1.008	1.036	1.189
2008~2009	0.980	0.836	0.984	0.996	0.819
2007~2008	0.996	0.783	1.004	0.992	0.780
2006~2007	0.963	1.093	1.019	0.945	1.053
2005~2006	1.006	0.705	0.979	1.028	0.709
The mean	0.999	1.001	1.000	1.000	1.000

According to the time series data, the total factor productivity of China’s banking sector exhibits a deteriorating trend.Between 2012 and 2013, the annual average factor productivity of these banks was only 0.984,their pure technical efficiency index was only 0.989 and their technical progress efficiency index was 0.986.Only the scale efficiency index reached a favourable level during this period (1.009), which indicates the important role of this scale in the total factor productivity growth and overall efficiency of Chinese commercial banks.

Table 4 AverageTotal Factor Productivity and its Decomposition.

Name	**TEC**	**TCP**	**PTEC**	**SEC**	**TFPC**
ICBC	1.027	1.001	1.000	1.027	1.028
Agricultural Bank of China	1.010	0.909	1.015	0.995	0.918
Bank of China	0.981	1.007	1.000	0.981	0.988
China Construction Bank	1.009	0.994	0.999	1.010	1.003
State-owned banks mean	1.007	0.978	1.004	1.003	0.984
Bank of Communications	0.989	0.998	0.999	0.990	0.987
CITIC	1.000	1.050	1.000	1.000	1.050
Everbright	0.978	1.193	0.974	1.004	1.167
Huaxia	1.018	1.011	1.008	1.010	1.029
The people's livelihood	1.003	0.976	1.009	0.994	0.979
GF	0.996	1.005	1.007	0.989	1.001
Shenzhen	0.989	1.031	0.993	0.996	1.020
China Merchants Bank	0.996	0.967	0.996	1.000	0.963
SocieteGenerale	0.996	0.976	0.999	0.997	0.972
Shanghai Pudong Development	1.000	0.966	1.000	1.000	0.966
Hengfeng	1.000	0.935	0.999	1.001	0.935
Joint stock bank mean	0.997	1.010	0.999	0.998	1.006
All mean	0.999	1.001	1.000	1.000	1.000

Table 4 shows the average annual total factor productivity change of 15 commercial banks between 2005and 2014 and its decomposition. The data show that, during the study period, the total factor productivity of joint-stock commercial banks (1.006) is higher than that of state-owned commercial banks (0.984) between 2005 and 2014. Amongst the state-owned commercial banks, the Industrial

and Commercial Bank of China showed the highest factor productivity (1.028),whereas the Agricultural Bank of China showed the lowest factor productivity (0.918).Amongstthe joint-stock commercial banks, China Everbright Bank showed the highest factor productivity (1.167).These results may be attributed to several reasons. Firstly, the innovations in and the application of electronic information technology have allowed commercial banks to improve their financial products and services as well as their management,which have subsequently improvedtheir technical efficiency levels. Secondly, although the four major state-owned banks have a significant size advantage compared with joint-stock banks, the redundancy and efficiency of numerous institutions are low and relatively weak in business innovation and management issues because of the influence of the ownership and management philosophy. Joint-stock banks improve their competitive ability by developing new businesses and improving their services.Given their different objectives, the efficiency levels of these two types of banks significantly vary.

Conclusion

We propose several strategies for improving the productivity of Chinese commercial banks. Firstly, the interest rate must be reformed.Government control over these rates has resulted in the inefficient management of commercial banks, which, in turn, has hindered these institutions from making a profit. Secondly, these commercial banks must be innovated to improve their business innovation and management abilities. Such innovationcan be achieved by expanding intermediate businesses, encouraging the development of lucrative new businesses and promoting mergers and acquisitions.Thirdly, the property rights of state-owned banks must be reformed by introducing foreign strategic investors and absorbing domestic private capital and public listings.Through these efforts, commercial banks can diversify their equities and securecompetitive positions in the market.

References

[1] Berger, A. N. and Humphrey, D. B., Efficiency of Financial Institutions: International Survey and Direction for Future Research, European Journal of Operational Research, 98(1997)175-212.

[2]Maudos& Pastor, Cost and Profit Efficiency in the Spanish Banking Sector（1985~1996）：A Non-parametric Approach. Applied Financial Economics, 13(2003) 1-121.

[3] Tetsushi Homma, oshiroTsutsui.Firm growth and efficiency in the banking industry:A new test of the efficient structure hypothesis, Journal Banking and Finance, 3(2014),143-153

[4]TianshuZhao,KentMatthews,VictorMurinde., Cross-selling, switching costs and imperfect competition in British banks,Journal of Banking and Finance , 12(2013)5452-5462.