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The Empirical Analysis of Scale Economies on Commercial Banks of China[1]

Guotai Chi, Xiufeng Sun, De Yang

Abstract

Based on the parametric approach in the framework of translog cost function with two inputs indexes which are the price of loanable funds and the price of operating expense and three outputs indexes which are deposits, loans and the amounts of investments and securities, this paper evaluates the scale economies and the developing trend of the two kinds of Chinese commercial banks which are both 4 state owned commercial banks and 10 joint-stock commercial banks of China over the period from 1998 to 2003. The empirical study shows that the scale economies of state owned commercial banks are getting better. And the scale economies of joint-stock commercial banks were good in the early years but turn worse since 2002, but they are still better than those of state owned commercial banks. This paper demonstrates that average cost function is better than frontier function. This paper also analyzes the characteristics of scale economies of Chinese primary commercial banks under the small sample and large sample.The first contribution of the paper is that the paper combines the idea of the intermediation approach and the assets approach, and it selects the deposits, the loans and the investments and securities as the production index, so it solves the problems whereas intermediation approach can not reflect the multi-product operating condition and the assets approach can not reflect the deposits condition of Chinese banks. The second contribution of it is that this paper has testified that the average cost function is more suitable than the frontier cost function on estimating the scale economies of banks, which solves the problem of ambiguous choice of function in the research of the scale economies of commercial banks.The third contribution is the demonstration of the shortage of using small sample to estimate banks' efficiencies in China' s financial circumstances through the comparison between large sample and small sample, and it makes up the theory of Chinese commercial banks efficiency. The forth contribution is the empirical analysis that displays the trend of scale economies of state owned commercial banks and joint-stock commercial banks in China and provides reference for solving the scale economy problems of Chinese commercial banks.

Key words: commercial banks; frontier function; parametric approach; scale economy; translog cost function.

1. Introduction

Scale economies of commercial banks mean the change of operating average cost caused by the change of scale in operating process of commercial banks, namely the influence of the change of operating scale on the production and benefits. The incremental returns to scale exist when the increasing ratio of average operating cost is less than the increasing ratio of all outputs; contrarily it is called decreased returns to scale. Returns to scale are constant when these two increasing ratios are equal.

It becomes the common concerned problem for the banking practice and banking study whether expansion of bank scale can improve the efficiency of resource allocation, so as to reduce the average operating cost.

There are two main approaches to estimate the scale economies of commercial banks, that is non-parametric approach and parametric approach.

Based on the linear programming theory and the idea of frontier production presented by Farell (1957) [1], non-parametric approach, mainly Data Envelopment Analysis [2], estimates the scale efficiency indirectly through computing the overall technical efficiencies and pure technical

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efficiencies of commercial banks [3-6]. Its application is simple and convenient because it can estimate the efficiency under small sample. But because of the relaxed restrictions of DEA approach, the computation results of many samples equal 1 [3]. These results conceal the practical difference between such samples. Furthermore, there are some other shortages of non-parametric approach, such as unable to estimate stochastic errors and large dispersing degree of efficiency results and unable to pass significant statistical test [3, 7, 8].

According to Baumol' s (1982) idea about scale economy measured by production elasticity [9], parametric approach estimates the scale economies of commercial banks through computing production elasticity [6, 10, 11] based on the fixed parameters of cost function. The key of the approach is to confirm a proper form of cost function and the approach also has strict requirements for the amount of sample. Meanwhile, the function form and the amount of sample influence the calculation result. But there is still a problem in the research of estimating the scale economy with both non-parametric approach and parametric approach, which is whether it is correct to analyze the practical scale economy by the frontier approach.

In addition, there is no consensus on the upper limit of assets of scale economies in commercial banks. Wheelock (2001) [5], Rezvanian and Mehdian (2002) [6], Ashton (1998) [10] and Mester (1996) [12] respectively did some researches about the upper limit and got some different results between 1 billion and 7 billion. Although the existence of the upper limit of assets of scale economies is not confirmed, there is a conclusion that the scale economy decreases if the scale of assets increases, and there are better scale economies in the medium-sized banks. Chuanzhan Xu (2002) [11], Junyang Xi (2003) [8] and Xu Zhao (2000) [13, 14] get the conclusion that scale economies are bad in state owned commercial banks but good in joint-stock commercial banks in China through empirical study. In the reason analysis, they explained factors of the non-performing loan ratio and resource allocation efficiency, but they did not analyze the developing trend of scale economies of China' s commercial banks [7, 11, 14].

Aiming at whether it is correct to estimate the scale economy with frontier approach and the shortage problem of the trend analysis of scale economies of China' s commercial banks, this paper uses the parametric approach to deduce the estimating method of scale economies of commercial banks combining the data sample from 1998 to 2003 of the 14 primary China' s commercial banks and shows their developing trend. Meanwhile, this paper proves the average function is more effective than the frontier function for estimating the scale economy through contrasting the results of scale economies computed by the frontier function and the average function.

2. The Principle of Parametric Approach for Commercial Banks' Scale Economy

In parametric approach the scale economies of banks are mainly estimated by the production elasticity of the cost function. The expressions of theory cost function, average cost function and marginal cost function of commercial banks are [15]

$$C = f(Y,W);\ AC = C(Y,W)/Y;\ MC = \partial C(Y,W)/Y, \tag{1}$$

where C is the annual inputs cost of commercial banks; W is the vector of banks' inputs price, $W=(w_1,w_2,...,w_m)$; Y is the vector of banks' outputs, $Y=(y_1,y_2,...,y_n)$.

The scale economy is estimated from the equation (2) :

$$SE = \frac{AC}{MC} = \frac{C(Y,W)/Y}{\partial C(Y,W)/\partial Y} = \frac{\partial Y/Y}{\partial C(Y,W)/C(Y,W)} = \left(\frac{\partial \ln C(Y,W)}{\partial \ln Y}\right)^{-1} = E_Y{}^{-1}. \tag{2}$$

The literatures aboard have only given the formula of scale economy and have not given the derivation process. The literatures in China only use the formulas provided by foreign papers straight away. Therefore, it makes trouble for readers to master this parametric approach.

This paper provides the detailed deduction course that shows readers the measure theory of scale economy.

Under the condition of multi-product, $MC = \sum MC_i$. Equation (2) can be expressed as:

$$SE = \frac{AC}{MC} = \frac{C(Y,W)/\sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} \partial C(Y,W)/\partial y_i} = \left(\sum_{i=1}^{n} \frac{\partial C(Y,W)/C(Y,W)}{\partial y_i / \sum_{i=1}^{n} y_i} \right)^{-1} = \left(\sum_{i=1}^{n} \frac{\partial \ln C(Y,W)}{\partial \ln y_i} \right)^{-1} = \left(\sum_{i=1}^{n} E_{y_i} \right)^{-1}, \quad (3)$$

where y_i is the i-th output; E_{yi} is the production elasticity of the i-th output, which is characterized by output and input price variable; other parameters are defined the same as the parameters above. The detailed deduction of equation (3) shows the measure principle of scale economy.

Cost function is usually expressed by logarithm forms and its expressions can be regarded as multi-variable linear function. So it can estimate the bank' scale economy with the form as $(\sum E_{y_i})^{-1} = (\sum \partial \ln C / \partial \ln y_i)^{-1}$, which is obtained from cost function directly. In order to make the computation easy this paper uses the sum of all outputs elasticity ($\sum E_{yi}$) to express scale economy. When $\sum E_{yi}$ =1, it shows that the increase ratio in production scale is consistent with the ratio of total cost, that is, scale economy does not exist; when $\sum E_{yi}$ >1, it shows that the increase ratio in production scale is less than the ratio of total cost, which means scale economy is inefficient; when $\sum E_{yi}$ <1, it shows that scale economy exists [6, 11].

3. The Scale Economy Measure Model

3.1. The Cost Function

The traditional cost functions include Cobu-Dauglas cost function (C-D), Constant Elasticity of Substitution cost function (CES), Variable Elasticity of Substitution cost function (VES) and translog cost function [16]. C-D cost function is widely used due to its simple form. The application of CES and VES cost function is limited by their complicacy. Translog cost function is derived from the expansion of the second-order Taylor series based on the CES. Translog and C-D function are both the special examples of CES in their function forms. The translog function can transform into C-D cost function if we ignore the effect of cross variable in translog cost function.

Now the C-D [17] and translog cost function [6, 8, 11, 19] are widely used in economy research field. But C-D cost function is not suitable for estimating scale economy because it supposes constant returns to scale in its function form. Whereas the translog cost function provided by Chistensen and Jorgenson (1973) is more efficient for its characteristics, namely good flexibility, easy estimation and allowance of non-constant returns to scale.

3.2 Scale Economy Model Based on Translog Cost Function

Comparing with other cost functions, translog cost function has four merits [19]: The first one is that the production elasticity and price elasticity can be directly computed by the partial derivative of cost function; The second one is that there is no transcendent restriction of the probability of factor substitution, that is to say the elasticity of factor substitution is variable; The third one is that production elasticity is variable; The fuorth one is that the mutual substitute item among factors is permitted. Therefore, this paper adopts translog cost function to measure the scale economies of Chinese commercial banks based on equation (4).

$$\ln C = A + \sum_{i=1}^{m} B_i \ln w_i + \sum_{j=1}^{n} C_j \ln y_j + \frac{1}{2} \sum_{i=1}^{m} \sum_{k=1}^{m} D_{ik} \ln w_i \ln w_k + \frac{1}{2} \sum_{j=1}^{n} \sum_{l=1}^{n} E_{jl} \ln y_j \ln y_l + \sum_{i=1}^{m} \sum_{j=1}^{n} F_{ij} \ln w_i \ln y_j + \varepsilon. \quad (4)$$

lnC is the natural logarithm of real cost; lnw_i is the natural logarithm of the i-th input price, i=1,2,…,m; lny_j is the natural logarithm of the j-th output, j=1,2,…,n; ε is the stochastic error; A, B_i, C_j, D_{ik}, E_{jl}, F_{ij} are the unknown parameters.

According to the Shephard' s lemma of cost minimization, the cost minimization factor equation of translog cost function is obtained.

$$S_i = \frac{\partial \ln C}{\partial \ln w_i} = B_i + \sum_{k=1}^{m} D_{ik} \ln w_k + \sum_{j=1}^{n} F_{ij} \ln y_j. \quad (5)$$

The restrictions required by the symmetry and homogeneity are as following:

$$D_{ik}=D_{ki}\ ,\ E_{jl}=E_{lj}\ ,\quad \sum_{i=1}^{m} B_i = 1, \sum_{k}^{m} D_{ik} = 0, \sum_{i=1}^{m} F_{ij} = 0. \tag{6}$$

According to the measure principle of scale economy expressed in equation (3), the scale economies of China' s commercial banks are estimated based on translog cost function [6].

$$SE = \left(\sum_{j=1}^{n} E_{y_j} \right)^{-1} = \left(\sum_{j=1}^{n} \frac{\partial \ln C}{\partial \ln y_j} \right)^{-1} = \left(\sum_{j=1}^{n} (C_j + \sum_{l=1}^{n} E_{jl} \ln y_l + \sum_{i=1}^{m} F_{ij} \ln w_i) \right)^{-1}. \tag{7}$$

The situation of scale economy can be analyzed by the estimated results of $\sum E_{yi}$. The distinguishing principle is as defined earlier in section 2.

3.3. The Determination of Input and Output Indexes

There are mainly three methods to select input and output indexes, namely production approach, intermediation approach and asset approach.

It is accepted in current studies that the input items can be chosen from annual expenses of loanable funds, total expenses of fixed assets and total salaries and welfare expenditure, but the calculations are not the same [3, 5-7]. Because financial report forms of domestic commercial banks are not consistent, the data of annual salaries and welfare expenditure are hard to get. So some literatures estimate them in terms of the proportion (e.g. 10%) of total cost [17, 20], but this may reduce actual difference between banks reflected by the index, resulting in false results.

Production approach regards banks as units that produce all kinds of deposits and loans with labors and capitals. This approach identifies the outputs with the amounts of all kinds of business accounts [17, 21]. Because each account with different sum of deposits provides different value for banks, identifying inputs with the accounts is not correct.

Intermediation approach regards banks as financial intermediary and identifies bank' s outputs with the amount of deposits and loans. It solves the disadvantage of ignoring money of accounts in production approach. But intermediation approach only concerns the deposits and loans of banks without considering other investment operations. The disadvantage of this approach is that it insufficiently considers in banks' rising operations [17, 21].

Asset approach also regards bank as financial intermediary. It strictly defines bank' s outputs as the asset items in the balance sheet and it mainly contains the sum of loan and investment. However the approach can not consider banks' operating base, that is, deposit condition. The approach is used widely [3-6] [17, 21].

According to the characteristics and shortages of the above approaches, this paper combines the idea of intermediation approach and asset approach, and it selects input-output index system expressed in Table 1.

Table 1

Inputs and Outputs Indexes System

Index	Index Contents and Calculating Methods
Inputs X	1 Loanable funds x_1 Consisted of Interbank borrowing and each kind deposits and other funds borrowed by central bank 2 Operating Capitals x_2 Consisted of the amount of labors, fixed assets and other operating inputs
Input price W	1 Price of loanable funds w_1 ((commissions expense+ interest expenses)/loanable funds) 2 price of operating cost expense w_2 (operating cost expense/ total assets)
Outputs Y	1 Deposits y_1 (annual average deposits) 2 Loans y_2 (annual average loans) 3 Investments and securities y_3 (Consisted of all kinds of investments and securities)

Notes: Correlation among labors amounts, fixed assets and total assets is significant through statistical test, so this paper evaluates the price of operating cost expense with total assets instead of Operating Capitals.

The indexes of this paper are different in two facets from existing researches in China: The first one is that this paper selects operating capitals as input index considering that numerical value of total salaries and benefits of employees as well as fixed assets depreciation can be easily obtained from daily information channel. In financial report, most banks rank the two items expense as operating cost, which can not only reflect cost expense of labor capital and fixed assets but also reduce the estimation error. The second one is that referring to intermediation approach and asset approach this paper regards loans, deposits and securities and investments as output index. This solves two problems that intermediation approach cannot reflect commercial banks' multi-operating output level and asset approach cannot reflect banks' deposits condition. Although commercial banking are in multi-trend, deposits are still the bases of operating of the commercial banks and they affect banks' survival, so this paper reserves the deposits as output index.

3.4. The Analysis and Choice of Average Function and Frontier Function

3.4.1. The Two Methodologies for Scale Economy Estimation in Parametric Approach

Now there are two methodologies for estimating banks' scale economy in parametric approach: (1) computing with average function [6, 11]; (2) computing with frontier function [10, 12]. This paper testifies that using frontier function will lead the result of deviating practical condition through empirical analysis. So we ought to use average cost function.

3.4.2. Analysis of Disadvantage of Frontier Cost Function

It is well-known that the form of frontier cost function (natural logarithm state) is [3, 6, 8, 11]

$$\ln C = \ln C' + \varepsilon + u = \ln C'(Y,W) + \varepsilon + u\,, \tag{8}$$

where *lnC* is the natural logarithm of real costs of banks' inputs; *lnC'* is the natural logarithm of theoretic minimal cost; *C`(Y,W)* is the function expression of theoretic minimal cost; ε is the stochastic error of measurement; *u* is positive disturbance value reflecting the effects of banks' cost inefficiency.

According to equation (3) of computing banks' scale economy, it can obtain the formula of scale economy under the average cost function

$$SE = \left(\sum_{i=1}^{n} E_{yi} \right)^{-1} = \left(\sum_{i=1}^{n} \frac{\partial \ln C(Y,W)}{\partial \ln y_i} \right)^{-1}. \tag{9}$$

Substituting formula (8) into (9) then we obtain the computing formula of scale economy under the frontier cost function.

$$SE = \left(\sum_{i=1}^{n} E_{yi} \right)^{-1} = \left(\sum_{i=1}^{n} \frac{\partial(\ln C' + \ln \varepsilon + \ln u)}{\partial \ln y_i} \right)^{-1} = \left(\sum_{i=1}^{n} \frac{\partial \ln C'(Y,W)}{\partial \ln y_i} + \sum_{i=1}^{n} \frac{\partial \ln u}{\partial \ln y_i} \right)^{-1}. \tag{10}$$

From equation (10), it could be found that sale economy computed by frontier function contains partial derivative of inefficient item *lnu* to lny_i. However, the existing researches have not found the detail expressions of *lnu*, so they give it up and use $\sum_{i=1}^{n} \frac{\partial lnC'(Y,W)}{\partial lny_i}$ to express [10, 12]. By doing this, it can get the status of scale economy under the minimal input costs' state, that is the best allocating state and the scale economy is the same with that using DEA computing approach. But in fact, no banks can operate under the best allocating state, thus scale economy computed by frontier function deviates practical situation.

3.4.3. Choice of Cost Function for Estimating Scale Economy

Without the restriction of inefficient factors, the average cost function expresses the influence of the real input price item and the output item on the banks' real cost. Therefore, the scale economy estimated by the equation (9) of average cost function is closer to practical condition and more efficient than frontier function represented by equation (10).

Considering the above-mentioned discussion, this paper testifies that the scale economy estimated by the average cost function is closer to the fact than by the frontier cost function.

4. Empirical Investigations of Scale Economy

4.1. Illustration of Collecting Sampled Data

Owing to the amount of state owned commercial banks and the joint-stock commercial banks of China is respectively small, so it can not analyze through cross-section data as it does in America and Europe who have selected hundreds of banks in the same year. In order to make up the lack of the sampled data, this paper chooses the financial data over the period of 1998-2002 of the four state owned commercial banks and ten joint-stock commercial banks of China and then it analyzes them through the single cross-section approach, which does not influence the sequence. The data over the period of 1998-2002 is from the Almanac of China' s Finance and Banking, and the data of 2003 are from Annual Report publicized by the fourteen banks online. Because the data of Agricultural Bank of China and Guangdong Development Bank could not be gotten, this paper obtains the data of 2003 by the sum of the data of 2002 and average increasing value in the period of 2000-2002.

The paper is aiming at the research of scale economies of primary commercial banks in China, so it does not consider the data of foreign banks in China. In addition, the paper does not select the city banks' data owing to the scale differences between the city banks and the above mentioned fourteen banks.

4.2. Data of Computing Result

The research selects iterative seemingly unrelated regression and combines sampled data and obtains the parametric estimating value of average cost function under the model of translog cost function, expressed in Table 2.

Under the model of translog cost function, the research using a parametric approach does not require all the parameters pass through the significant test because each index has theoretical and existing value [6, 10, 11].

Expressed in Table 2 parameters A, $B_1(B_2)$, $D_{11}(D_{11},D_{22}$,$-D_{12}$, $-D_{21})$ are significantly different from zero at the 0.01 level and pass the T test; $E_{23}(E_{32})$, E_{33}, $F_{11}(F_{21})$, F_{12} (F_{22}) are significantly different from zero at the 0.05 level and pass the T test; E_{11},$E_{12}(E_{21})$ are significantly different from zero at the 0.1 level and pass the T test. Over sixty percent of all parameters pass the T test and the adjust R^2 of the regression equation is 0.998. These estimate results explain that the system of regression equations has goodness of fit. The estimated parameters of the translog cost function system along with equation (7) are used to calculate scale economies of Chinese commercial banks combining with sampled data. Table 3 presents the results and sequence of $\sum E_{yi}$ value of banks in 2003 from small to large.

Table 2

Parameter Estimates of Regression Analysis

Parameter Symbol	Parameter Estimate Value	t-ratio	Parameter Symbol	Parameter Estimate Value	t-ratio
A	1.888	3.045***	E_{22}	0.725	0.917
B_1 (B_2=1-B_1)	0.390	19.771***	$E_{23}(E_{32})$	0.363	2.109**
C_1	0.238	0.619	E_{33}	-0.151	-2.151**
C_2	0.414	0.493	F_{11} (F_{21})	0.047	2.275**
C_3	0.270	0.945	F_{12} (F_{22})	-0.035	-2.038**
D_{11} (D_{11}=D_{22}= -D_{12}= -D_{21})	0.216	45.322***	F_{13} (F_{23})	-0.005	-0.836
E_{11}	1.160	1.944*	Adj. *R-squared*	0.9980	
E_{12} (E_{21})	-0.984	-1.768*	Sum squared residuals	0.3592	
$E_{13}(E_{31})$	-0.244	0.983			

Note: *** Parameters are significantly different from zero at the 0.01 level; ** Parameters are significantly different from zero at the 0.05 level; * Parameters are significantly different from zero at the 0.1 level.

Table 3

The Scale Economies of the Fourteen Commercial Banks Between 1998 and 2003

Banks	1998	1999	2000	2001	2002	2003	Sequence in 2003
HB	0.9479	0.9475	0.9496	0.9425	0.9287	0.9481	1
CBMC	0.8971	0.9176	0.9358	0.9378	0.9403	0.9483	2
CMB	0.9716	0.9634	0.9414	0.9237	0.9337	0.9487	3
CCB	1.0025	0.9585	0.9462	0.9441	0.941	0.9491	4
GDB	0.9663	0.9557	0.9469	0.9473	0.952	0.9498	5
BC	0.9982	0.9928	0.9766	0.9693	0.9615	0.9536	6
BCO	0.974	0.992	0.984	0.9803	0.9698	0.9565	7
CEB	0.9764	0.952	0.9467	0.9472	0.9503	0.9570	8
SDB	0.9781	0.9785	0.9639	0.9366	0.9509	0.9589	9
ICBC	1.0129	1.0074	0.972	0.9683	0.9619	0.9599	10
IBC	0.945	0.9496	0.9399	0.9569	0.952	0.9622	11
SPDB	0.9591	0.9466	0.9429	0.9375	0.9537	0.9647	12
CIB	0.8951	0.8946	0.9386	0.9546	0.9686	0.9667	13
ABC	1.0194	1.0213	1.0023	0.9851	0.9758	0.9705	14
Annual mean value	0.9674	0.9627	0.9562	0.9522	0.9529	0.9567	—

Notes: HB-- Huaxia Bank, CBMC-- China Minsheng Banking Corp., LTD., CMB-- China Merchants Bank, CCB-- China Construction Bank, GDB-- Guangdong Development Bank, BC-- Bank of China, BCO-- Bank of Communications, CEB-- China Everbright Bank, SDB-- Shenzhen Development Bank, ICBC-- Industrial and Commercial bank of China, IBC-- Industrial Bank Co., LTD, SPDB-- Shanghai Pudong Development Bank, CIB-- Citic Industrial Bank, ABC-- Agricultural Bank of China, the abbreviations are valid for following tables.

In order to testify the average cost function fits the estimating of scale economy much better than that of the frontier cost function, this paper uses the stochastic frontier approach to estimate the parameters of frontier cost function and the scale economies ($\sum E_{yi}$) of Chinese primary commercial banks during the period of 1998-2003 which can be used to compare with the results of average cost function. The results of frontier cost function are in Table 4.

Table 4

The Results of Scale Economy with Frontier Cost Function

Banks	1998	1999	2000	2001	2002	2003	Sequence in 2003
CBMC	0.8936	0.9211	0.9329	0.9364	0.9405	0.9185	1
HB	0.9356	0.9433	0.9606	0.9480	0.9365	0.9511	2
CEB	0.9424	0.9261	0.9341	0.9476	0.9562	0.9598	3
BC	0.9765	0.9505	0.9523	0.9524	0.9635	0.9598	4
ICB	0.9375	0.9540	0.9140	0.9492	0.9618	0.9605	5
CMB	0.9599	0.9695	0.9497	0.9298	0.9499	0.9654	6
CIB	0.8674	0.8805	0.9299	0.9455	0.9658	0.9655	7
CCB	0.9799	0.9535	0.9507	0.9539	0.9596	0.9665	8
BCO	0.9450	0.9634	0.9629	0.9787	0.9793	0.9671	9
SPDB	0.9408	0.9356	0.9367	0.9359	0.9553	0.9682	10
GDB	0.9394	0.9620	0.9475	0.9526	0.9645	0.9685	11
SDB	0.9558	0.9685	0.9603	0.9441	0.9631	0.9707	12
ICBC	0.9834	0.9787	0.9593	0.9661	0.9696	0.9716	13
ABC	0.9676	0.9987	0.9967	0.9911	0.9866	0.9887	14
Annual mean value	0.9445	0.9504	0.9491	0.9522	0.9609	0.9630	--

In order to analyze the influence of the amount of sample on veracity of results, this paper selects the banks' financial data during the period of 2001-2003 and estimates those banks' scale economies ($\sum E_{yi}$) under the small sample, as expressed in Table 5.

Table 5

The Scale Economies between 2001 and 2003 with 42 Swatches

Banks	2001	2002	2003	Sequence in 2003
SDB	0.8573	0.8668	0.8887	1
HB	0.8522	0.8705	0.8902	2
GDB	0.8732	0.8851	0.8913	3
ICB	0.8814	0.9007	0.9028	4
CIB	0.8954	0.9051	0.9153	5
CEB	0.8951	0.9068	0.9161	6
SPDB	0.8823	0.8962	0.9184	7
CMBC	0.8704	0.8957	0.9225	8
CMB	0.9089	0.9137	0.9281	9
BCO	0.9594	0.969	0.9543	10
ABC	0.9896	0.9959	0.9994	11
CCB	0.9938	0.9978	1.004	12
BC	1.0223	1.0207	1.0079	13
ICBC	1.0145	1.0186	1.0235	14
Annual mean value	0.9148	0.9264	0.9379	--

Notes: These efficiencies are estimated based on the results of regression with data in the period of 2001-2003.

4.3. Analysis and Discussion of Data

4.3.1. Analysis of Scale Economy with Average Cost function

Using the result of each bank' s scale economy in Table 3, we can obtain the number average value of the scale economies ($\sum E_{yi}$) of the state owned commercial banks and the joint-stock commercial banks in six years, expressed in Table 6.

Table 6

The Contrast Scale Economies Between State Owned Commercial Banks and Joint-stock Commercial Banks

Years	1998	1999	2000	2001	2002	2003	Trend
State owned commercial banks	1.0083	0.9950	0.9743	0.9667	0.9601	0.9583	Turning better
Joint-stock commercial banks	0.9674	0.9627	0.9562	0.9522	0.9529	0.9561	Turning better before 2001but turning worse after 2001
State banks VS joint-stock banks	inferior	inferior	inferior	inferior	inferior	inferior	

The data in Table 5 and Table 6 show:

(1) Since 1998 the scale economies of state owned commercial banks have been getting better except the slightly falling of China Construction Bank in year 2003. This is because those state owned banks control the average cost efficiently when they accelerate the growth of the scale and get good effects. It is expressed by the data in (Table 3 and Table 6).

(2) The scale economy condition of the joint-stock commercial banks is changing better and better during the period of 1998-2001, but it is getting worse since 2002. Owing to the relative smaller asset scale compared with the state-owned banks, the join-stock commercial banks do not prepare sufficiently for the increasing scale. So when the asset scale fast increased from 2002 to 2003, the technology of production and management of joint-stock banks cannot meet the requirement, which lead to the adverse control on the average cost. This can be expressed by the sequence of the joint-stock banks in 2003 in Table 3 and by the data in Table 6.

(3) In the entire sample, the average level of scale economies of the joint-stock commercial banks is better than that of the state owned commercial banks. Even when the scale economies of the joint-stock commercial banks are getting worse, they are still better than that of state owned commercial banks in the corresponding period. This testifies that the scale economies of the state owned commercial banks are weak than that of the joint-stock commercial banks [8, 11]. The status could be obtained from the contrasting relation in Table 6.

(4) From Table 3, it is known that the scale economy of China Construction Bank is the best one among all the state owned commercial banks (the 4th in 2003), the next are Bank of China, Industrial and Commercial bank of China. Agricultural Bank of China is the worst one.

(5) In Table 3, under the condition of scale economy computed by the entire sample, the value of $\sum E_{yi}$ distributes between 0.8946 and 1.0213, which is coherent with the foreign research that scale economy has little influence on the cost efficiency of commercial banks [9].

Considering the sample, the asset scales of China' s state owned commercial banks always keep rapid increase, so the paper gets the conclusion that while the asset scale of the state owned commercial banks keeps increasing, they notice and control the influence of the changing scale on the average cost, and they alter the earlier condition that the scale economy is inefficient; the scale economies of the joint-stock commercial banks are always efficient, and they pay attention to control the average cost. But their control become a little inefficient along with the expanding of the asset scale.

4.3.2. The Comparison between Average Cost Function and Frontier Cost Function

Table 7

The Analysis of Scale Economy

$\sum E_{yi}$	Mean	Minimum	Maximum	No. of obs. in $(0,1]$	No. of obs. in $(1,\infty)$
Average cost function	0.9580	0.8946	1.0213	78	6
Frontier cost function	0.9523	0.8674	0.9987	84	0

By contrasting Table 3 and Table 4 and getting the characteristics data of two functions, it could be found out that: (1) the results computed by the frontier cost function show that scale economies of the 14 commercial banks are efficient, but when computed by the average cost function the scale economies of the state owned commercial banks are inefficient over the period of 1998-2000; (2) the average value of scale economy computed by the frontier cost function is lower than the average cost function, namely, the scale economies of commercial banks computed by the frontier cost function are better than the average function; (3) the trend of scale economy computed by the frontier function is not obvious, so that it can not judge which is inferior to the average function.

From the contrasting results, the frontier function overrates the level of scale economies of commercial banks. It cannot reflect the practical situation. This testifies that scale economy estimated by average cost function is better than using the frontier cost function in section 3.4.

4.3.3. The Discussion on the Amount of Sample

The efficiency results in Table 3 and Table 5 are computed respectively by samples of 84 swatches and 42 swatches. Although the final sequence of results is not extremely consistent, both of the results reflect the similar changing trend, namely, the average efficiency of scale economies

of Chinese commercial banks gradually descends during 2001-2003. In addition, the result in Table 5 is coherent with the thesis that scale economies of state owned commercial banks are inefficient and the scale economies of the joint-stock commercial banks are better in domestic research [11]. But from the basic theory of statistics, the result computed by the large sample is more accurate than by the small sample.

From the contrasting result in Table 3 and Table 5, it is known that the estimated result of the scale economy is restricted by the sample. When using small sample to estimate scale economy, no matter it uses parametric approach or non-parametric approach there exists shortage. Due to the relative little information contained in the small sample, it could cause the big error of the value of parameter, so the estimating criterion is different from that of the large sample. For example, under the two constraints conditions, the scale economy of Industrial and Commercial bank of China is turning better under the large sample, but it is turning worse under the small sample. Under the small sample, the lack samples of banks with total assets over trillion will lead the estimated value of the parameter to error and then make the scale economy inaccurate.

So it is known that if it can obtain large amount of samples, the efficiency result will be more accurate in the efficiency research of Chinese commercial banks. Although the result computed by the small sample is inaccurate, the result still has probative sense.

5. Conclusion

5.1. The Primary Results of Analysis

This paper uses the idea of intermediation approach and asset approach for reference, and refers to the financial data of Chinese 14 main commercial banks between 1998 and 2003. Through the parametric approach in the framework of a translog cost function, this paper selects two inputs indexes which are the price of loanable funds and the price of operating expense and three outputs indexes which are loans, deposits and the amounts of investments and securities, and evaluates the scale economies of 14 banks and the rank in 2003. The main analysis results are expressed as below:

(1) During the period of 1998-2003, only the scale economies of the four state owned commercial banks are inefficient over the period of 1998-2000, and in other time the scale economies of Chinese main commercial banks are efficient. This can show that China' s commercial banks' control on the blight brought by the increasing scale is effective after 2000.

(2) The average level of scale economies of the state owned commercial banks are lower than that of the joint-stock commercial banks every years; In 6 years of the samples, the average level of scale economies of the state owned commercial banks are turning better, but the average level of scale economies of the joint-stock commercial banks are turning better in the early 4 years and turning slightly worse in the last 2 years.

(3) According to Table 3, the improving effect on the scale economy of China Construction Bank is the best among the state owned banks, then it is Bank of China. Industrial and Commercial bank of China ranges the third and Agricultural Bank of China is the last one. Observing the changing trend, it could learn about that the four state owned commercial banks make efficient efforts on improving the level of the scale economy.

5.2. Characteristic and Contributions

This paper makes use of the idea of parametric approach and applies average function form of the model of translog cost function and researches on the scale economies of Chinese commercial banks.

(1) This paper combines the idea of intermediation approach and asset approach, and it selects deposits, loans and investments and securities as output index, and it solves the problem that intermediation approach can not reflect the multi-operating circs of banks and the problem that asset approach can not reflect the deposit condition which is the operating base of banks. Using the price of operating expense to substitute the price of labor capital and the fixed input

solves the problem that the salaries and benefits of employees are difficult to obtain and it avoids the phenomenon that index can not reflect the information factually.

(2) This paper puts forward the thesis that scale economy computed by the average cost function is better than the frontier cost function, which has been proved by academic deduction and empirical investigation. And it corrects the mistakes on the scale economies of commercial banks estimated by the frontier function. Meanwhile, this paper makes up the theoretic system of the parametric approach using in the research of commercial banks` efficiency and solves the problem that the choice of the function form being undefined in the research of commercial banks' scale economies.

(3) According to the parametric approach, this paper contrasts the scale economies of Chinese commercial banks under the large and small sample and explains the characteristic and shortage of scale economy computed by the small sample under Chinese financial circumstances. It shows that parametric approach and non-parametric approach are both interfered by sample in the research of Chinese commercial banks` efficiency.

(4) Through empirical study, the paper shows the trend of scale economies of Chinese commercial banks and testifies the scale economies of state owned commercial banks are inferior to the joint-stock commercial banks.

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