AN ABSTRACT OF THE THESIS OF

Keyi Lu for the degree of Master of Science in Economics presented on June 10, 2009.

Title: The Chinese Banking Industry: Efficiency, Concentration, and Profitability

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High concentration and low efficiency have plagued the Chinese banking industry since the establishment of the national banking system in China. Recently, foreign banks have been allowed to enter the Chinese market, and small and medium-sized commercial banks have expanded their market share. At the same time, Chinese bank efficiency and profitability have increased year by year. The objective of my study is to analyze the relationship between industry concentration and efficiency and the relationships among efficiency, concentration, and profitability in Chinese banking industry. My study consists three parts. First, I use data envelopment analysis to examine the efficiency of 17 Chinese banks from 1996 to 2007. Then, I analyze the relationship between efficiency and industry concentration. In the third part, I test to see if market power and/or efficiency explain bank profitability.

The Chinese Banking Industry: Efficiency, Concentration, and Profitability

by

Keyi Lu

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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Keyi Lu, Author

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The Chinese Banking Industry: Efficiency, Concentration, and Profitability

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May 31, 2009

Abstract

High concentration and low efficiency have plagued the Chinese banking industry since the establishment of the national banking system in China. Recently, foreign banks have been allowed to enter the Chinese market, and small and medium-sized commercial banks have expanded their market share. At the same time, Chinese bank efficiency and profitability have increased year by year. The objective of my study is to analyze the relationship between industry concentration and efficiency and the relationships among efficiency, concentration, and profitability in Chinese banking industry. My study consists three parts. First, I use data envelopment analysis to examine the efficiency of 17 Chinese banks from 1996 to 2007. Then, I analyze the relationship between efficiency and industry concentration. In the third part, I test to see if market power and/or efficiency explain bank profitability.

1. Introduction

The Chinese banking industry has had a high degree of concentration, and the efficiency of Chinese banks is much lower than that of banks in other developed countries. Since the 1990s, China has allowed foreign investment in Chinese banks. Since 2001, China has allowed the entry of foreign banks into the Chinese banking industry. Subsequent entry increased competition in Chinese banking and forced Chinese banks to improve their efficiency in order to survive and maintain their market share.

In this paper, I will use a nonparametric method, data envelopment analysis (DEA), to measure efficiency in the Chinese banking industry. I will also analyze the relationship between concentration and efficiency, and between efficiency and profitability in the Chinese banking industry. Most studies about bank efficiency rely on the frontier approach which uses regression analysis. This requires the estimation of a frontier production or cost function.

There are three main advantages of DEA. First, unlike the regression approach, DEA does not require a specific functional form to construct the frontier. Second, we do not need to normalize the input and output variables. For example, we can use the number of laborers, the amount of operating expense, and the percent of the non-performing loans to measure inputs and outputs. Third, DEA gives us the efficiency of each input, which is useful when trying to improve firm efficiency. Fourth, DEA can be used when there are multiple inputs and multiple outputs.

There are studies about the Chinese banking industry, but most of them focus on the trend in efficiency without analyzing the causes of efficiency. In addition,

because these studies cover five to eight years worth of data, it is difficult to observe a long-term trend in efficiency overtime.

There are some important results from my study. First, I derive the trend in efficiency over a 12 year period for 17 Chinese banks using DEA and analyze the causes of efficiency change. Second, I conclude that efficiency is negatively correlated to industry concentration. Finally, I investigate the causes of firm profitability in Chinese banking. I find empirical support for the efficient structure hypothesis and reject the traditional collusion hypothesis. That is, efficiency, not market power, is driving firm profitability.

2. The Chinese Banking System

The Chinese banking industry has been highly concentrated since it was established in 1979. Berger, Hasan and Zhou (2007) argue that the rapid growth of the China's economy may be largely linked to the globalization of trade, but that China has yet to globalize its banking sector. Chinese banking is dominated by four very large state-owned banks, the 'Big Four', which own about three-fourths of industry assets[1]. In addition, China's legal and financial systems are not well developed, even by the standards of most developing nations (Berger et al. 2007).

The China Banking Regulatory Commission's (CBRC) annual report of 2007 indicates that there were a total of 8,877 banking institutions, which had 189,921 outlets and 2,696,760 employees. The total assets of the banking sector amounted to 7.74 trillion dollars.[2] The Big Four owned 67 percent of banking assets in 1997, a number that fell to 53 percent by 2007.[3]

For decades, the Chinese government has intervened in the management and operation of Chinese banks. This is due to the fact that banks in China are used to implement macroeconomic policies rather than being independent financial institution with profit as their primarily objective. This is much like the Federal Reserve Banks in the U.S. Although some reforms have been made in the 1980s and 1990s, and

[1] These four banks are owned by the Chinese government, and their assets belong to the government.
[2] China Banking Regulatory Commission (CBRC)'s annual report (2006).
[3] At the end of 2007, there were three policy banks, five large state-owned commercial banks, twelve joint-stock commercial banks, one hundred and twenty four city commercial banks, forty two urban credit cooperatives(UCCs), seventeen rural commercial banks, one hundred and thirteen rural cooperative banks, nineteen village and township banks, four lending companies, eight mutual credit cooperatives, four financial asset management companies, one postal savings bank, fifty four trust companies, seventy three finance companies of enterprise groups, ten financial leasing companies, two money brokerage firms, nine auto financing companies and twenty nine locally incorporated foreign bank subsidiaries.

foreign investment occurred in China's banking industry after China entered the WTO in 2001, the government retains strong control over banks.

With deregulation and greater openness to foreign banks, the market share of the largest banks declined. At the same time, the market share of small commercial banks, rural cooperative financial institutions, city commercial banks, urban credit cooperatives, and foreign-funded banks rose at a relatively fast pace.[4]

[4] This argument is derived by the comparison of data from China Banking Regulatory Commission (CBRC)'s annual report (2005, 2006, and 2007).

3. Literature Review

Many studies examine the efficiency of the Chinese banking industry. The most recent and comprehensive work is Berger's (2007) research on bank ownership and efficiency in China. His work exams the effect of bank reform on the Chinese banking industry. He analyzes profit and cost efficiency, using 266 annual observations (1994–2003) on 38 commercial banks. His sample includes the Big Four, and other state-owned, private domestic, and foreign banks. The banks in his sample own 95 percent of the commercial banking assets. He also examines minority foreign ownership of some of the non-Big four state-owned banks and private domestic Chinese institutions.

Berger's empirical results suggest strong favorable efficiency effects from reforms that reduce state ownership of banks in China and increase the role of foreign ownership. In his paper, there are four output variables: total loans, total deposits, liquid assets, and other earning assets. There are two input prices: interest expense to total deposits, noninterest expense to fixed assets and one fixed input: total earning assets. He estimates a cost function and a profit function with two regressions that include annual dummy variables.

His most important finding concerns the effects of minority foreign ownership. The data are strongly consistent with efficiency gains for this type of foreign investment. For both efficiency concepts (profit and cost) and for both categories of domestic ownership that have minority foreign ownership, minority foreign ownership is associated with higher efficiency.

There are several empirical studies of Chinese banking using DEA. Zhang (2003) uses DEA to evaluate the technical efficiency of commercial banks in China

from 1997 to 2001. His inputs variables include: fixed assets, total operating cost, and staff. The output variables are total loans, investment income, and other income. After comparing the Mamlquist Index for 51 commercial banks in China, he found that the Big Four have the slowest productivity growth. Bonin and Huang (2001) analyze the effect of foreign entry into the Chinese banking system using interest expenses and noninterest expenses as inputs and operating income and total deposits as outputs. They argue that WTO membership does threaten domestic banks.

4. Method

In this study, I use DEA to construct the frontier and then evaluate the efficiency of Chinese banks. The frontier formed from the observation is assumed to be the best practice frontier. DEA is the most popular nonparametric method in frontier analysis. This method was developed by Charnes, Cooper, Rhodes (1978), based on Farrell's (1957) study. DEA was first used to evaluate bank efficiency by Sherman and Gold (1985), and has been widely used (see Chen, Skully and Brown, 2005 and Berg, 1992).

We use the Farrell Input-Saving Measure of Technical Efficiency, F_i (y, x), to evaluate the efficiency of Chinese banks by the following linear programming model:

$$F_i(y_\tau, x_\tau) = \min \lambda:$$

$$\sum_{t=1}^{T} z_t y_t \geq y_t,$$

$$\sum_{t=1}^{T} z_t x_{tn} \leq \lambda x_{n,t}, n = 1, \ldots, N$$

$$z_t \geq 0, \qquad t = 1, \ldots, T$$

The Farrell Index of Technical Efficiency is F_i (y, x) = 1/ D_i (y, x). The denominator is the Shephard's (1953) input distance function, which is defined as D_i (y, x) = sup {λ: x/ λ Є L(y)}, where x is a vector of inputs, y is output, L(y) = {x: x can produce y} is the input requirement set, and λ is an efficiency index. The distance function seeks the maximal feasible contraction of the given input vector x.[5]

[5] For further discussion, see, Färe and Grosskopf (1996, 2004).

5. Data and Results

I employ annual data on 17 Chinese banks during the period of 1996 to 2007 for a total 204 observations. Given the interest expense(x_1), operating expense(x_2), interest income (y_1), and other income (y_2), where x_1 and x_2 are input variables, and y_1 and y_2 are output variables, we can construct the frontier, and get the Farrell Input-Saving Measure of Technical Efficiency, F_i (y, x). Because the interest and operating expenses are the main inputs in Chinese banking, because they account for more than 90% of the total input. Operating expenses include business taxes and surcharges, wages, administrative expenses, provisions for impairment losses, and other operating expense. Interest income is the main component of the output, other income includes fee and commission income, investment income, foreign exchange income , and other operating income. To investigate the relationship between profitability and efficiency, I use total revenue to total assets (ROA) to measure the performance of banks.[6]

The banks in our sample own about 90% of the banking assets in the country. The input and output data from 1996 to 2005 come from China Financial Statistics Yearbook published by National Bureau of Statistics of China. The input and output data of 2006 and 2007 come from the annual reports of each bank. The data about the total assets and the assets of the Big Four banks comes from CBRC Annual Reports edited by China Banking Regulatory Commission.

[6] Previous studies have used total equity to total capital to measure profitability in banking (Berger, 1995).

Because of government restrictions on small and medium sizes commercial banks, returns to scale in banking are likely to be constant.[7] Assuming constant return to scale and strong disposability, we can get the Farrell Input-Saving Measure of Technical Efficiency F_i (y, x/ C, S) for each bank in each year. Given that the Big Four may behave differently than other banks, I divide the sample into three different groups: the Big Four, other banks (all other banks in our samples except for Big four), and all banks. Table 1 presents the geometric means of F_i (y, x/ C, S) for different groups for each year. Note that the scores range from 0 to 1, a score of 1 means this bank operate on the frontier, which is the most efficient bank in our sample, and if the score is smaller, the bank is less efficient.

These results are easier to see graphically in Figure 1 and 2. They reveal an increasing trend of both the geometric means and the standard deviation. The efficiency of banks was relatively low from year 1997 to 2000. One reason for this may be the Asian financial crisis, which happened in July, 1997. Efficiency has increased since 2001, and the F_i score is very high in 2002 and 2003. One possible reason for this is that China has committed to opening the banking sector to foreign banks after its WTO accession in December 2001. This policy caused a big change in concentration in banking of China.

The entry of foreign banks and foreign capital brought advanced technology and new management systems to China. Chinese banks were aware of this, and appear to have responded to increased competition by improving their efficiency. From Figure 2, we see that the standard deviation in efficiency rose after 2003. This

[7] Instead, I could have assumed variable returns to scale, but I follow Zhang (2003), who assumed constant returns in banking. Future work might focus on this issue, as discussed in Färe and Grosskopf (1994).

may be due to the fact that foreign capital was invested in some of our sample banks, such as the Guangdong Development Bank (GDB), Bank of Communication (BCOMM), and China merchants bank (CMB). These banks have much greater efficiency, perhaps due to the technological transfers. For example, in 2004, the efficiency score for all banks is about 0.7272, but the efficiency score for CMB is 1, SPDB is 0.95, and BCOMM is 0.91. This result is consistent with Berger et al. (2007), that minority foreign ownership may increase efficiency of Chinese banks.

One consequence of this increased competition is its affect on concentration. The concentration of an industry is an indicator of the number and size distribution of firms in an industry. It is defined as

$$HHI = \sum_{t=1}^{N} s_i^2$$

where s_i is the market share of firm i in the market, and N is the number of firms in the market. The HHI can range from 0 to 1. Concentration is greater as HHI approaches 1. The HHI increases both as the number of firms in the market decreases and as the disparity in size between those firms increases.[8]

In this paper I measure market share in assets, a method commonly used in banking. Estimates of HHI and the standard deviation of market share (MS) can be found in Table 2. In addition, HHI is plotted over time in Figure 3.

The data show that HHI decreases from 1996 reaches the lowest point in 2005, and is lowest from 2005-2007. According to the antitrust division of the United States Department of Justice, markets are defined as moderately concentrated when

[8] United States Department of Justice, antitrust division, http://www.usdoj.gov/atr/public/testimony/hhi.htm

HHI arranges between 0.1 and o.18 and are defined as highly concentrated when HHI exceeds 0.18.[9] We can see that the Chinese Banking industry from being concentrated to moderately concentrated industry during the sample period.

To investigate the relationship between HHI and Efficiency in Chinese banking, I will first calculate the correlation between them. These results are reported in Table 3 for the entire sample, the Big Four and other banks. In every case the correlation coefficient is negative. The correlation for all banks is -0.690405925. The correlation between HHI and the standard deviation of efficiency is -0.411518113. This suggests that the entry of foreign capital and foreign banks lowered concentration and improved efficiency.

Consistent with previous studies, I use three variables to explain efficiency in the Chinese banking industry. For example, Berger, Hasan and Zhou (2007) argue that foreign investment and foreign ownership has a positive effect on efficiency in Chinese banking. Zhao and Ling (2001) analyze data from 1993-1998, and find that a better macro-economic environment is associated with higher efficiency in Chinese banking. The variables I adopt in my regression are HHI, gross domestic product (GDP), and Foreign capital. I use the following OLS regression model,

$$EF = \beta_0 + \beta_1 GDP + \beta_2 Foreign\ K + \beta_3 HHI, \qquad (1)$$

where EF is Farrell Input-Saving Measure of Technical Efficiency, GDP is gross domestic product of China from 1996 to 2007 (in us dollars), Foreign K is the foreign

[9] United States Department of Justice, antitrust division, http://www.usdoj.gov/atr/public/testimony/hhi.htm

capital in Chinese banking industry(in us dollars). The results are presented in table 4.[10]

We can see that the coefficients for GDP and Foreign capital are very small and the coefficient on HHI is relatively big. However, we cannot reject our null hypothesis that the efficiency score do not have significant relation with HHI with a 95 percent confidence interval. From my regression results, concentration does not appear to have a significant effect on Chinese banking efficiency.

Next, I analyze the effect of efficiency on profitability. There are two main hypotheses about the relationship between a firm's performance and market structure. One is the traditional collusion hypothesis (Bain, 1951), which states that by lowering the cost of collusion between firms, higher market concentration will result in higher than normal profits. The other hypothesis is the superior efficiency hypothesis, which proposes that the most efficient firms are the most profitable and grow in size, which increases industry concentration (Demsetz, 1973; Smirlock, 1985; Smirlock et al., 1984, 1986; Evanoff and Fortier, 1988; Molyneux et al., 1994). The following model can be used to distinguish one hypothesis from the other.

$$\pi = \beta_0 + \beta_1 CR + \beta_2 MS + \alpha' X, \qquad (2)$$

where π is a measure of a firm's performance, which we measure as the ratio of total revenue to total assets(ROA).[11] MS is the market share of the firm, CR is a measure of the concentration of the market, and X is a vector of additional control variables specific to the firm and the market that prior studies have found to affect bank's

[10] I use Ordinary Least Squares (OLS). However, efficiency scores are not independent and identically-distributed. Therefore, we could use a two tage model as in Simar and Wilson (2005), which is a topic for future research.

[11] Although this is not an ideal measure of economic profits, I use it because of data limitations. For further discussion of the difficulty with measure economic profits, see Iwasaki et al. (2008) and Carlton and Perloff (2005).

profitability. These include barrier to entry, market demand, and the growth of market demand.

According to Smirlock's (1985), if β_1 is significantly greater than zero and β_2 is zero, the traditional collusion hypothesis holds. If, however, β_1 is zero and β_2 is significantly greater than zero the superior efficiency hypothesis holds. The implicit assumption in testing the superior efficiency hypothesis from the collusion hypothesis is that market share is a proxy variable for firm efficiency. Under this assumption the most efficient firms gain market share at the expense of the less efficient firms.

However, Sheperd (1986), Timme & Yang (1991) , Berger (1995) questioned Smirlock's (1985) use of market share as a proxy for firm efficiency. Shepherd (1986) points out a large market share may give a firm market power and is, therefore, a poor proxy for efficiency. Maudos (1998) addresses this problem by using a direct measure of efficiency by estimating the stochastic cost frontier. He adds an estimate of firm efficiency (EF) to get the following model:

$$\pi = \beta_0 + \beta_1 CR + \beta_2 MS + \beta_3 EF + \alpha' X, \qquad (3)$$

where EF is a direct estimate of efficiency obtained from the estimation of a stochastic cost frontier. He uses data from the Spanish banking industry. His results show that concentration has an insignificant effect and that market share and efficiency have a positive and significant effect on profitability. Of the other control variables, only asset size (ASSETS) and market size (MAKDEP) are statistically significant. His results are inconsistent with the traditional collusion hypothesis (i.e., β_1 is insignificant). They do support Shepherd's modified efficient structure

hypothesis, however, because market share has a positive effect of profitability, holding efficiency constant. This suggests that large firms have market power.

In my study, I will use Maudos' model to test these two hypotheses using the data from Chinese banking industry.[12] In my model, EF is measured by the Farrell Index of Technical Efficiency (F_i (y, x) = 1/ D_i (y, x)), ROA is measured as the ratio of total revenue to total assets. CR is measure by HHI as before, MS is the market share of each bank in each year. X includes several variables suggested by Maudos's (1998). These are total assets (ASSETS) of each bank, which measure the size of each bank, the ratio loans/assets (LOASS), which measures the risk assumed by banks. Maudos also includes market specific variables, including total industry deposits (MAKDEP), and the annual growth rate in total industry deposit (GMD). The results can be found in Table 5.

My results are somewhat different from those of Maudos. Like Maudos, concentration has an insignificant effect and efficiency has a positive and significant effect on profitability. Unlike Maudos, however, market has a negative and significant effect on profitability. Thus, there is no evidence of market power in Chinese banking and that large banks, especially the Big Four, are inefficiently large, a result that is likely to be rectified over time with continued competition in banking. Of the other bank specific variables, only the loan to assets ratio is significant (LOASS). Therefore, my results support the efficient structure hypothesis that the level of efficiency is driving bank profits in China.

[12] I use the same variables as Maudo. However, one could also use the ratio of revenue to cost to measure profitability.

6. Conclusion

This study estimates the efficiency of 17 Chinese banks over a 12 year period. I use DEA to estimate bank level efficiency. With these estimates, I analyze the causes of high efficiency and firm profitability. My results suggest that the traditional collusion hypothesis does not apply to Chinese banking. Instead, firm efficiency drives profitability.

There is an important reason why my results should be viewed with caution. Data from Chinese banking are limited. For example, we are only able to collect data on two outputs and two broadly measured inputs. This makes it more difficult to get accurate estimates of firm efficiency. Other variables are relatively accurate measured, however. Fortunately, the empirical results using the efficiency estimates have the expected signs and appear to accurately capture what is driving banking profits in China.

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Table 1 Means of the Farrell Input-Saving Measure of Technical Efficiency in Chinese Banking, 1996-2007

Year	All Firms	Big Four	Other Firms	Standard Deviation
1996	0.715183894	0.7290274	0.710977474	0.15906436
1997	0.714990382	0.788826685	0.693693241	0.118318488
1998	0.697892534	0.69942787	0.697420801	0.128561041
1999	0.679390244	0.673893924	0.681090421	0.10301342
2000	0.700873999	0.687413994	0.705068324	0.11675137
2001	0.72743193	0.729823253	0.726697716	0.105656213
2002	0.753975733	0.791199796	0.742878412	0.096012407
2003	0.811282475	0.834712184	0.80420651	0.100670546
2004	0.727229359	0.783036326	0.710871737	0.203805703
2005	0.776955285	0.724479941	0.793853814	0.109722243
2006	0.747780242	0.803469011	0.731434564	0.204117541
2007	0.766976037	0.836181525	0.746857175	0.214774163
Means	0.734120858	0.754859989	0.727854955	0.132444035

Table 2 HHI and standard deviation of MS in Chinese Banking Industry, 1996-2007

Year	HHI	MS Standard Deviation
1996	0.17198823	0.096360071
1997	0.15704024	0.091056051
1998	0.15194735	0.089483274
1999	0.15007477	0.087293013
2000	0.14812778	0.086003447
2001	0.14408719	0.084293765
2002	0.13496211	0.080370486
2003	0.119935062	0.075576131
2004	0.11079579	0.070297944
2005	0.10272007	0.066319189
2006	0.10714545	0.067944912
2007	0.11158623	0.069224302

Table 3 Correlation of HHI and means& standard deviation

	All Firms	Big Four	Other Firms	Standard Deviation
Correlation	-0.690405925	-0.535648927	-0.652685369	-0.411518113

Table 4 Regression results of Efficiency on GDP, Foreign Capital, and HHI

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.738664639
R Square	0.545625449
Adjusted R Square	0.375234992
Standard Error	0.029832834
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.008549872	0.00285	3.202207	0.08355125
Residual	8	0.007119984	0.00089		
Total	11	0.015669856			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.599763549	0.313902759	1.910667	0.092436	-0.12409751	1.323624608
GDP	1.48169E-06	1.41006E-06	1.050799	0.324054	-1.7699E-06	4.7333E-06
Foreign K	-2.2304E-05	2.02662E-05	-1.10058	0.303091	-6.9038E-05	2.44294E-05
HHI	-0.30262369	1.607200886	0.188292	0.855336	-3.4035882	4.008835572

Table 5 Regression results of Profit on Efficiency and other variables

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.661263
R Square	0.437269
Adjusted R Square	0.41265
Standard Error	0.259551
Observations	204

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	8.375582	1.196512	17.76112	2.53E-17
Residual	196	10.7787	0.067367		
Total	203	19.15429			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.904478	0.314135	2.879268	0.004532	0.284093	1.524864
MS	-0.03466	0.007456	-4.64795	6.97E-06	-0.04938	-0.01993
EF	0.499548	0.139456	3.582131	0.000452	0.224137	0.774959
ASS	-3.8E-06	1.01E-05	-0.37937	0.704913	-2.4E-05	1.62E-05
LOASS	-1.17394	0.256904	-4.56958	9.72E-06	-1.6813	-0.66658
GMD	-0.01175	0.066708	-0.1761	0.860441	-0.14349	0.119995
MAKDEP	1.76E-05	9.82E-06	1.793161	0.074836	-1.8E-06	3.7E-05
HHI	0.309942	1.418788	0.218456	0.827353	-2.49202	3.111909

Figure 1 Means of the Farrell Input-Saving Measure of Technical Efficiency in Chinese Banking, 1996-2007

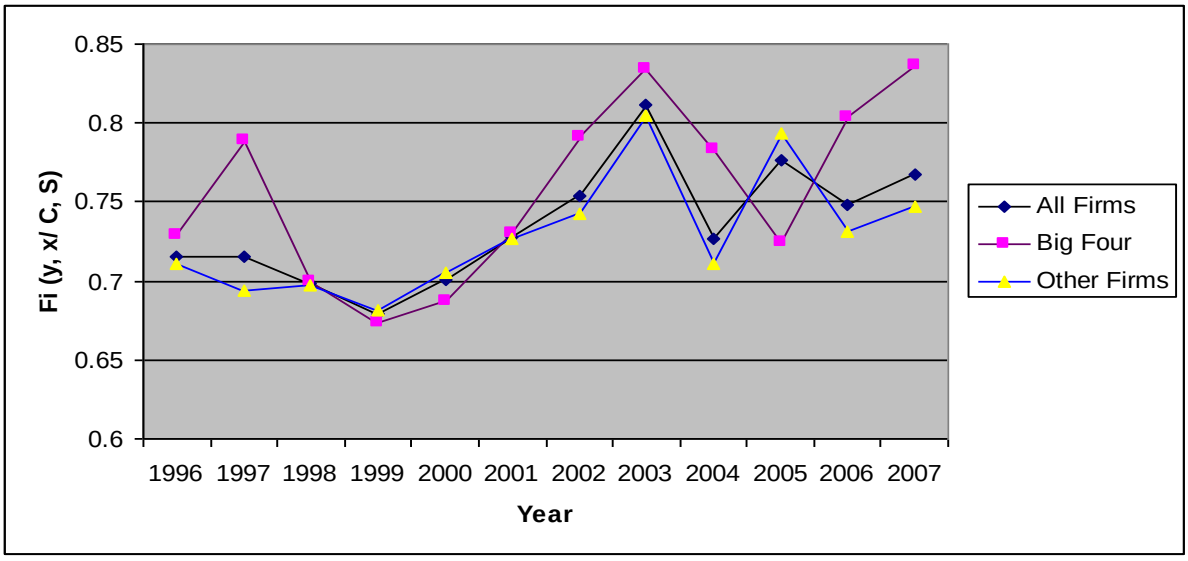

Figure 2 Standard Deviation of Farrell Input-Saving Measure of Technical Efficiency in Chinese Banking, 1996-2007

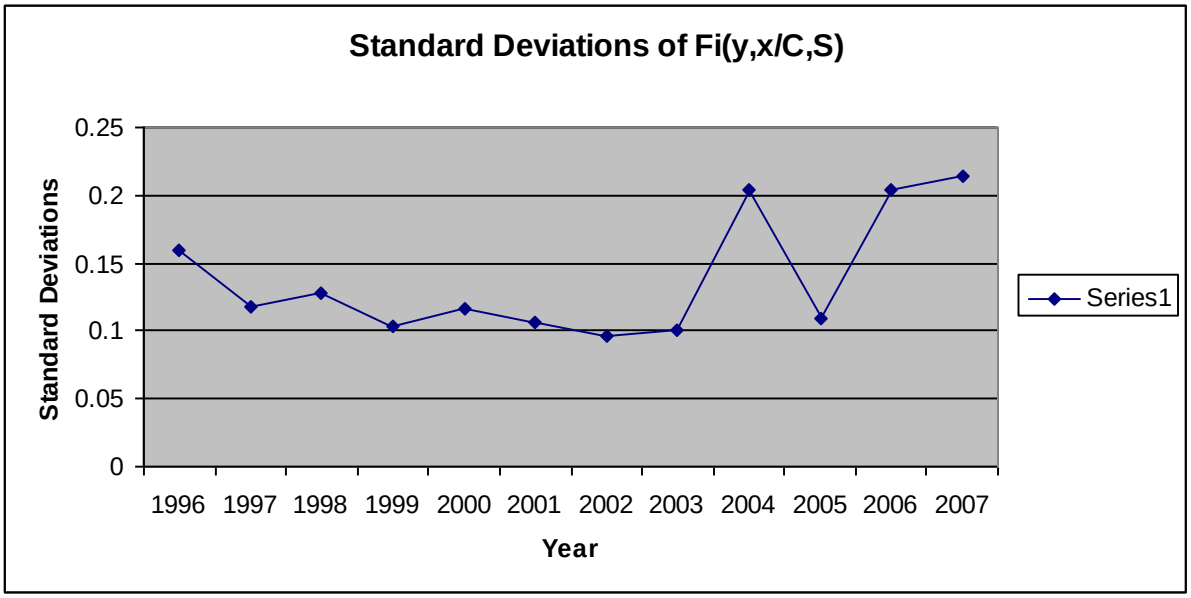

Figure 3 The Herfindahl-Hirschman Index（HHI）in Chinese Banking, 1996-2007