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CAN BANK SIZE INFLUENCE BANKS' MARKET EFFICIENCY? TWO-STAGE DEA ANALYSIS ON MAINLAND CHINA

Bank size can determine its market power and hence influence banks' market efficiency. In this paper, we estimate the market efficiency of Chinese listed commercial banks from 2007 to 2011 with Chen & Zhu's (2004) two-stage data envelopment analysis (DEA) method, and then study the impacts of bank size on their market efficiency by the beta-regression method. Our findings indicate that Chinese listed commercial banks have significant difference in their market efficiency, and that the differences in their size can influence their market efficiency.

Keywords: *listed commercial banks; market efficiency; beta regression; two-stage DEA.*

Тао Сюй

ЧИ ВПЛИВАЄ РОЗМІР БАНКУ НА ЙОГО РИНКОВУ ЕФЕКТИВНІСТЬ? ЗА ДАНИМИ ДВОФАЗНОГО АНАЛІЗУ СЕРЕДИ ФУНКЦІОНУВАННЯ НА СТАТИСТИЦІ МАТЕРИКОВОГО КИТАЮ

У статті показано, що розмір банку може визначати його ринкову частку і, отже, впливає на його ринкову ефективність. Оцінено ринкову ефективність китайських комерційних банків з 2007 по 2011 рр. за допомогою двофазного аналізу середи функціонування за Ченем і Чжу (2004), вивчено вплив розміру банку на його ринкову ефективність методом бета-регресії. Дані показали, що китайські комерційні банки значно розрізняються за своєю ринковою ефективністю і що відмінності в їх розмірах можуть впливати на їх ринкову ефективність.

Ключові слова: *комерційні банки, ефективність ринку, бета-регресія, двофазний аналіз середи функціонування.*

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Тао Сюй

ВЛИЯЕТ ЛИ РАЗМЕР БАНКА НА ЕГО РЫНОЧНУЮ ЭФФЕКТИВНОСТЬ? ПО ДАННЫМ ДВУХФАЗНОГО АНАЛИЗА СРЕДЫ ФУНКЦИОНИРОВАНИЯ НА СТАТИСТИКЕ МАТЕРИКОВОГО КИТАЯ

В статье показано, что размер банка может определять его рыночную долю и, следовательно, влияет на его рыночную эффективность. Оценена рыночная эффективность китайских коммерческих банков с 2007 по 2011 гг. с помощью двухфазного анализа среды функционирования по Чэню и Чжу (2004), изучено влияние размера банка на его рыночную эффективность методом бета-регрессии. Данные показали, что китайские коммерческие банки значительно различаются по своей рыночной эффективности и что различия в их размерах могут влиять на их рыночную эффективность.

Ключевые слова: *коммерческие банки, эффективность рынка, бета-регрессия, двухфазный анализ среды функционирования.*

I. Introduction.

Since the global financial crisis in 2008, Chinese commercial banks have become more and more striking with their rocketing profits. Among all Chinese commercial

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banks, larger banks have better profitability. Since the strict regulation in the banking sectors has confined banks to highly homogeneous businesses, better profitability of larger banks can be attributed to their ability to find better customers and projects. Namely, large banks must have higher market efficiency, so they can produce higher profits with given number of loans and deposits. A larger bank scale means a stronger market power, so it deserves further research whether bank size can enhance Chinese commercial banks' market efficiency? In this paper, we try to test whether larger size can contribute to higher market efficiency of Chinese listed commercial banks.

There is no agreement on the impact of bank size and their market power on banks' market efficiency. Structure-conduct-performance hypothesis (SCP) proposes that higher efficiency would exist in more concentrated markets as a result of competitive imperfections at these markets. On the contrary, the efficient structure hypothesis (Demsetz, 1973) explains the market power as a result of bank efficiency, not the opposite. If so, the positive relationship observed between concentration and profitability is spurious.

The impact of bank size on their market efficiency is of special interest in China. Since the state is the largest shareholder of most commercial banks, the government would sometimes prefer larger banks. With the help from the government, it's easier for banks to find better customers and projects, and hence to have higher market efficiency. If so, market efficiency would depend on bank size and hence their market power rather than on diligence, which is not good for the sustainable development of Chinese commercial banks.

In addition, this topic is of universal interest for the following reasons. Firstly, the impact of bank size on market efficiency can influence banks' competitiveness, which is important for Chinese banks' competitors in the world. Secondly, whether Chinese commercial banks' market efficiency depends on their size and market power can determine the sustainability of Chinese financial model, which could be the example for many transitional economies.

In this paper, we try to test the relationship between banks' market power and their market efficiency. Our paper has two contributions. First, our paper is one of the first attempts to measure the market efficiency of Chinese listed commercial banks with the two-stage DEA approach. Some researches try to measure the market efficiency with an independent DEA model. But no banks would consider their market efficiency without their overall consideration. In this case, the two-stage DEA approach is more in accordance with the banks management strategy. Second, we have used beta regression to estimate the relationship between banks' scale and their market efficiency. The extant literature usually employs Tobit model for efficiency analysis. But Tobit model is a sort of censored data model, which assumes the dependent variable is the value in a presumed interval of a latent variable with normal distribution, which is not always applicable for efficiency. Beta regression doesn't need the normal distribution assumption, so it is better for the efficiency analysis.

Our paper includes 6 sections. Section I is the introduction. Section II is the literature review. In section III we summarize the two-stage DEA approach and beta regression method. Section IV explains the data. Section V presents the empirical findings, and section VI concludes.

II. Literature Review.

To our knowledge, there is no study on the relationship between bank size, market power and banks' market efficiency. Only a few studies have analyzed the relationship between bank size, market power and efficiency in banking, and the findings are diversified.

Some literature has found a positive relationship between bank efficiency and market concentration, and hence market power. This research includes: Berger and Hannan (1997) on the US banks, Lang (1996) on Western German banks, and Goldberg and Rai (1996) and Punt and Van Rooij (2003) on European banks. Berger and Hannan (1998) used the Herfindahl index to measure the degree of US banking market concentration to examine whether banks in more concentrated markets exhibit lower operating efficiency, and compared the efficiency cost of concentration with the loss measured by the welfare triangle. The results supported the quiet life hypotheses – a positive relationship between market power and inefficiency – and indicated that the efficiency costs estimated are much higher than the social cost occasioned by non-competitive pricing. Maudos & Fernandez de Guevara (2006) analysed the relationship between market power at the loan and deposit markets and efficiency in the EU15 countries over 1993–2002. Results indicated a positive relationship between market power and cost X-efficiency. Pruteanu-Podpiera, Weill and Schobert (2008) measured banks' competition with Lerner index at the loan market and estimated banks' efficiency with a distribution-free approach. The Granger causality analysis found the evidence that increased competition would reduce the cost efficiency of banks. So, the market power can help to improve banks' efficiency. Mensi & Zouari (2010) investigated the market structure-performance relationship within Tunisian banking system during 1990–2005, and found that market share has a positive impact on the efficiency.

Despite the above literature supporting a positive role of market power in banks' efficiency, there are also some researches with opposite findings. Delis & Tsinonas (2009) provided a methodology for the joint estimation of efficiency and market power of individual banks and found efficiency and market power presents a negative relationship.

So far, there is no research on the role of market power in market efficiency for banks. In this paper, we will use two-stage data envelopment analysis (DEA) to measure the market efficiency of Chinese listed commercial banks and estimate the impacts of market power on market efficiency with the beta regression method.

III. Methodology.

1. Measurement of bank market efficiency – Two-stage DEA. Data envelopment analysis (DEA) has been used widely in measuring efficiency of decision-making units (DMUs). In the recent decades, many variant DEA approaches have been put forward. One of them is the two-stage DEA method to measure the efficiencies of different stages of production. For example, a two-stage DEA method was adopted by Seiford and Zhu (1999) to measure the operational and market efficiencies of US commercial banks. Their approach has been modified by Chen &Zhu (2004). In two-stage DEA method, DMU operation has been divided into 2 stages. The first stage depicted the DMUs' effort in producing maximum intermediate outputs with given

inputs, so the efficiency in this stage is operational. The object of the second stage has been set differently according to the aim of the research. Most studies set the market value, return on equity or profits as their object respectively. In China, because the stock market cannot reflect true value, we set profits as the output of the second stage. The efficiency of the second stage is the market efficiency. The efficiencies of these two stages will be estimated with various DEA methods. In this paper, we will adopt Chen & Zhu (2004)'s two-stage DEA method.

Presently, most Chinese commercial banks depend heavily on their deposit and loan business to make profits. Even their services income is highly related to their loan business. So, in our paper, the inputs of the first stage include net assets, assets and the employees. The outputs of the first stage are deposits, loans, gross income and interest income, which are the inputs for the second stage too. Net interest income, net service income and net income are the output of the second stage. Figure 1 describes Chinese commercial banks' production process adapted from Seiford & Zhu (1999).

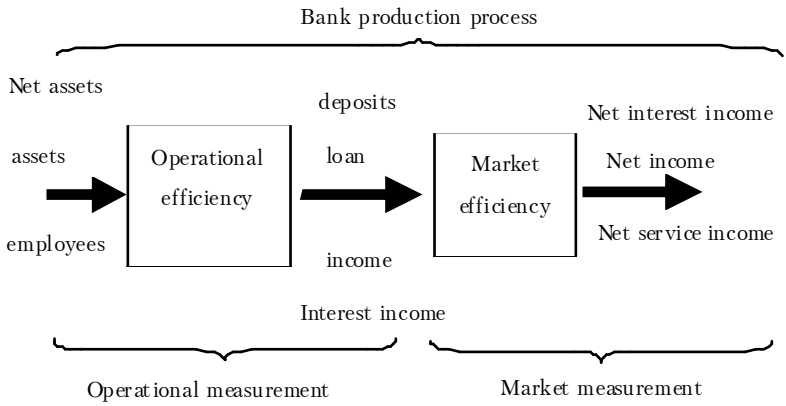

Figure 1. **Two-stage production process for Chinese banks**

We assume that the 2 stages are equally important for Chinese listed commercial banks in their profits earning. If there are n listed commercial banks, m kinds of inputs, D kinds of intermediate measures and s kinds of outputs, we can establish the following linear programming problem:

$$\min_{\alpha,\beta,\lambda_j,\mu_j,\tilde{z}} \alpha-\beta.$$

Subject to

(stage 1)

$$\sum_{j=1}^{n}\lambda_j x_{ij} \le \alpha x_{ij_0}, i=1,2,\ldots,m.$$

$$\sum_{j=1}^{n}\lambda_j z_{dj} \ge \tilde{z}_{dj_0},\ d=1,2,\ldots,D.$$

$$\sum_{j=1}^{n}\lambda_j = 1.$$

$$\lambda_j \ge 0.$$

(stage 2)

$$\sum_{j=1}^{n}\mu_j z_{dj} \le \tilde{z}_{dj_0}, d=1,2,\ldots,D.$$

$$\sum_{j=1}^{n}\mu_j y_{rj} \ge \beta y_{rj_0}, r=1,2,\ldots,s.$$

$$\sum_{j=1}^{n}\mu_j = 1.$$

$$\mu_j \ge 0,$$

where the symbol "~"reflects the unknown decision variables.

According to Chen &Zhu (2004), if $\alpha < 1$, a bank is inefficient in the first stage. It cannot provide enough intermediate measures with given inputs. If $\beta > 1$, a bank is inefficient in the second stage, which indicates that it can only achieve enough outputs with more intermediate measures. Here, market efficiency lies in the interval [1, $+\infty$), and smaller value indicates higher market efficiency. To avoid misunderstanding, we convert market efficiency into its inverse value, so in our paper market efficiency lies in the interval (0, 1].

2. Beta regression. Since our market efficiency is between 0 and 1, the ordinary least square (OLS) method is not applicable. Ferrari and Cribari-Neto (2004) first introduced the beta regression, which is more effective for modeling continuous variables y that assume values in the open standard unit interval (0,1). The beta regression model is based on the alternative parameterization of the beta density in terms of the variate mean and a precision parameter. The beta density is usually expressed as:

$$f(y;p,q)=\frac{\Gamma(p+q)}{\Gamma(p)\Gamma(q)}y^{p-1}(1-y)^{q-1}, 0<y<1, \quad (1)$$

where $p, q > 0$ and $\Gamma(\cdot)$ is the gamma function. Ferrari and Cribari-Neto (2004) set $\mu = p/(p + q)$ and $\phi = p + q$, so

$$f(y;\mu,\phi)=\frac{\Gamma(\phi)}{\Gamma(\mu\phi)\Gamma((1-\mu)\phi)}y^{\mu\phi-1}(1-y)^{(1-\mu)\phi-1}, \ 0<y<1, \quad (2)$$

where $0 < \mu < 1$ and $\phi > 0$. Hence $y \sim B(\mu,\phi)$. Here $E(y) = \mu$ and $var(y) = \mu(1-\mu)/(1+\phi)$. The parameter ϕ is the precision parameter. For fixed μ, the larger ϕ, the smaller the variance of y; ϕ^{-1} is the dispersion parameter.

In our paper, banks' market efficiency series $y = (y_1, \ldots, y_n)^T$ can be expressed as a random sample so that $y_i \sim B(\mu_i, \phi)$, $i = 1, \ldots, n$.

Our beta regression model is defined as:

$$g(\mu_i)=x_i^T\beta=\eta_i, \quad (3)$$

where $\beta = (\beta_1, \ldots, \beta_k)^T$ is the $k*1$ vector of unknown regression parameter ($k < n$), $x_i = (x_{i1},\ldots, x_{ik})^T$ is the vector of k determinants of the banks' market efficiency. η_i is the linear predictor. And $g(\cdot):(0,1)\to IR$ is the link function, which is strictly increasing and twice differentiable.

The log-likelihood function is $\ell(\beta,\phi)=\sum_{i=1}^{n}\ell_i(\mu_i,\phi)$, where

$\ell_i(\mu_i,\phi) = \log\Gamma(\phi) - \log\Gamma(\mu_i\phi) - \log\Gamma((1-\mu_i)\phi) + (\mu_i\phi - 1)\log y_i +$
$+ ((1-\mu_i)\phi - 1)\log(1-y_i)$ notice that $\mu_i = g^{-1}(x_i^T\beta)$ is the function of β, the vector of regression parameters. Parameter estimation will be performed by maximum likelihood (ML).

In this paper, the market efficiency could be 1. So we follow Smithson and Verkuilen's (2006) technique to do a conversion with the market efficiency data as follows:

$$y^* = \frac{y \cdot (n-1) + 0.5}{n}, \quad (4)$$

where y^* is the adjusted data for banks' market efficiency, n is the sample size.

According to Demsetz (1973), market scale and hence market power may be the result of high market efficiency. So, there may exist the endogeneity problem in our beta regression. Besides, market power may influence market efficiency with a time lag. Regression without lagged terms cannot explore the true relationship. To solve this problem, we further run the beta regression on the lagged term of market power and other variables.

Besides the market power variables, we have included some control variables in our beta regression. According to the corporate governance literature (Jensen and Meckling, 1976; Demsetz, 1983; Shleifer and Vishny, 1986; Ianotta et al., 2007; Laeven and Levine, 2009), ownership would be one of the most important determinants of efficiency, so we have included the ownership proxies in our beta regression. Macroeconomic factors can influence bank efficiency (Chan & Karim, 2010), hence our independent variables include two macroeconomic factors: real GDP growth rate and CPI of China.

IV. Data.

The Lerner index and Herfindahl-Hirschman index (HHI) are 2 frequently used measurements for market power. In calculating Lerner index, price and marginal costs are needed, which has increased the hardship and inaccuracy of calculation. On the other hand, HHI can only measure the degree of concentration of the market as a whole, and cannot measure the market position of an individual bank. So, in this paper we will use individual banks' weight of loans, deposits and assets in the total of Chinese banking sector to measure banks' market power. Generally speaking, the higher the weight is the larger market position the bank has.

According to Charnes et al. (1994), the application of DEA method would depend on the number of observations. DEA is feasible if the number of observations is greater than 3 times the sum of inputs and outputs. An identical object in different years can be treated as an individual DMU (Charnes et al., 1978). Accordingly, for our panel data with 16 Chinese listed commercial banks and 5 years from 2007 through 2011, the observation is 80, while the sum of inputs and outputs is 9, so the condition has been satisfied.

Some of these 16 banks were listed later than 2007, but their annual reports have provided the data dated back for 3 years. So we can luckily get all the data needed for our analysis. The sample commercial banks are: China Construction Bank (CCB), Agricultural Bank of China (ABC), Industrial and Commercial Bank of China (ICBC), Bank of China (BOC), China Minsheng Banking Co., Ltd (CMBC), China Merchants Bank Ltd (CMB), Industrial Bank Co., Ltd (CIB), Bank of Beijing

(BOB), Bank of Communications (BCM), China Everbright Bank (CEB), China CITIC Bank, Shanghai Pudong Development Bank (SPDB), Shenzhen Development Bank (SDB), China Industrial Bank (CIB), Huaxia Bank (HB), Bank of Nanjing (BON), Zheshang Bank (ZSB), Bank of Ningbo (NBCB). Among these banks, the so-called Big Four (ICBC, CCB, BOC and ABC) are by far much larger than the other banks. SDB is the first listed bank and ABC went public in 2010 only.

The major variables in our analysis include the data for DEA, the data for beta regression and the bank size. The DEA data include the number of employees, assets, net assets, deposits, loans, income, interest income, net interest income, net services income, profits. The measurement of bank size includes the share of deposits, the share of loans and the share of bank assets. The independent variables of our beta regression include the weight of shares held by the top 5 shareholders, the weight of shares held by the foreign strategic shareholders, the real GDP and the CPI. We use the real GDP and the CPI from 2007 to 2011 as the independent variables because Chinese commercial banks' profitability is significantly influenced by economic fluctuations. Table 1 has the descriptive statistics.

Table 1. **Descriptive Statistics**

DEA Data	mean	median	standard deviation	max	min
Employee (I_{11})	105053.6	25109.5	149130.2	452464	1629
Asset (I_{12})	33863.28	15278.74	39647.95	154768.7	755.1077
Net asset (I_{13})	2152.374	1036.755	2619.647	11124.63	84.3582
Deposit (O_{11}, I_{21})	26504.52	11270.54	31959.71	113646.6	509.3153
Loan (O_{12}, I_{22})	16831.47	8643.505	19040.63	73298.82	306.2924
Income (O_{13}, I_{23})	980.7247	408.795	1186.129	4752.14	19.25679
Interest income (O_{14}, I_{24})	1302.187	595.2902	1470.213	5895.8	31.20573
Net interest income (O_{21})	792.9604	349.405	928.8426	3627.64	19.56237
Net services income (O_{22})	157.2865	45.625	229.951	1015.5	0.657082
Profit (O_{23})	355.2142	139.375	462.0643	2084.45	6.14035
Bank Size Data					
Share of deposits (%)	4.479392	1.988666	5.272356	17.71681	0.130805
Share of loans (%)	4.228832	2.203246	4.566032	15.56503	0.117044
Share of bank assets (%)	4.235771	1.964981	4.78901	16.5106	0.143561
Beta Regression Data					
Weight of top 5 shareholders (%)	60.71099	47.0825	26.44107	100	21.29
Weight of foreign shares (%)	16.46125	16.73	11.58427	40.56	0
Real GDP growth (%)	10.66	9.8	2.3191	14.6	8.9
CPI change (%)	3.74	4.8	2.6670	5.9	-0.7

Note: Assets, income and profits are in 100 mln. yuan RMB, while the employment is measured by persons.

Table 1 indicates that the listed banks vary a lot in their size, though the listed banks are relatively larger compared with those not listed. So, even the listed commercial banks have provided an effective sample to study the impact of market power on market efficiency.

V. Empirical Analysis.

Before market efficiency estimation, we have to do the isotonicity test to verify that the banks' outputs should grow if banks increase their inputs. This can be done by doing the correlation tests for all the inputs, the intermediates and the outputs. Table 2 has presented the results. They indicate there are strong positive correlations between all the inputs and outputs. So, the inclusion of the inputs and intermediate inputs is reasonable.

Table 2. **Pearson correlation tests**

	I_{11}	I_{12}	I_{13}	O_{11},I_{21}	O_{12},I_{22}	O_{13},I_{23}	O_{14},I_{24}	O_{21}	O_{22}	O_{23}
I_{11}	1									
I_{12}	0.927**	1								
I_{13}	0.867**	0.982**	1							
O_{11},I_{21}	0.947**	0.996**	0.971**	1						
O_{12},I_{22}	0.908**	0.996**	0.978**	0.991**	1					
O_{13},I_{23}	0.930**	0.993**	0.984**	0.992**	0.987**	1				
O_{14},I_{24}	0.939**	0.987**	0.973**	0.987**	0.977**	0.995**	1			
O_{21}	0.945**	0.985**	0.972**	0.988**	0.974**	0.995**	0.997**	1		
O_{22}	0.871**	0.977**	0.986**	0.969**	0.975**	0.984**	0.968**	0.968**	1	
O_{23}	0.862**	0.980**	0.988**	0.970**	0.977**	0.982**	0.973**	0.971**	0.991**	1

Note: *, ** and *** refer to the significance at 10%, 5% and 1% levels.

We have also done the Spearman correlation in case the variables are not normally distributed. The results are similar to those of the Pearson correlation analysis: the outputs and the inputs of both stages are positively correlated. Hence, those variables can be used for market efficiency estimation.

Table 3 presents the adjusted values (inverse) of the market efficiency estimated with the two-stage DEA approach. Among all the banks, ICBC, CCB and ABC have the highest market efficiency. BOC has the worst market efficiency among Big Four. For the non Big Four, NBCB, CMBC, BCM, CMB and BON have the highest market efficiency. The average market efficiency for Big Four is 0.9531 in the 5 years, which is much higher than 0.8613 for smaller banks. Obviously, large banks have higher average market efficiency.

To find out the impact of bank size on the market efficiency of Chinese listed banks, we will further run beta regressions. In case high correlation between the independent variables would lead to the collinearity problem, we first do the correlation analysis before the regression analysis. The results of the Pearson correlation are reported in Table 4.

Table 3. **Estimates of Market Efficiency**

Firm Code	Banks	2007	2008	2009	2010	2011
601169	BOB	0.7362	0.9906	0.8165	0.8903	1.0000
601166	CIB	0.8911	0.8572	0.7234	0.7364	0.8217
002142	NBCB	1.0000	1.0000	0.8606	0.6920	0.8970
000001	SDB	0.9345	0.8778	0.9276	0.7819	0.9574
601988	BOC	0.9213	0.8707	0.7041	0.8440	1.0000
601818	CEB	0.9394	0.8744	0.5581	0.7053	0.7856
600016	CMBC	0.8185	1.0000	0.7613	0.8631	1.0000
600000	SPDB	0.9226	0.9150	0.7473	0.8092	1.0000
601288	ABC	0.9796	1.0000	0.9587	1.0000	1.0000
601998	CITIC	0.8875	0.9241	0.7456	0.8205	1.0000
601328	BCM	0.8420	0.8262	0.7005	1.0000	1.0000
601939	CCB	1.0000	1.0000	0.8900	1.0000	1.0000
600015	HB	0.9150	0.7985	0.6820	0.7366	0.8278
600036	CMB	0.8847	1.0000	0.6703	0.8231	1.0000
601398	ICBC	1.0000	1.0000	0.8944	1.0000	1.0000
601009	BON	1.0000	1.0000	0.8377	0.8142	0.8487

Table 4: **Pearson Correlation of Independent Variables**

	Top5	FS	State	FD	depr	loanr	assr	meff	RGDP	CPI
Top5	1									
FS	0.354**	1								
State	0.532**	-0.1298	1							
FD	-0.0906	0.303**	-0.1828	1						
depr	0.673**	0.407**	0.2074	-0.1961	1					
loanr	0.675**	0.455**	0.2048	-0.1472	0.991**	1				
assr	0.674**	0.441**	0.2152	-0.1572	0.992**	0.991**	1			
meff	-0.1964	-0.1553	-0.0224	0.1439	-0.303**	-0.272*	-0.2690*	1		
RGDP	-0.0488	-0.0251	0.0212	-0.0544	-0.0157	-0.0406	-0.0264	-0.1788	1	
CPI	0.0029	-0.0029	0.0212	-0.0181	-0.0034	-0.0161	-0.0126	-0.512**	0.200	1

Note: *, ** and *** refer to the significance at 10%, 5% and 1% levels.

Definition of the symbols: Top 5: the weight of the shares held by the top five shareholders; FS: the shares held by foreign strategic institutional investors; State: dummy variable for the state as the largest shareholder; FD: dummy variable for the

existence of foreign strategic investors; depr: the weight of the deposit in all the banking sector; loanr: the weight of loans in all the banking sector; assr: the weight of assets in all the banking sector; meff: market efficiency; RGDP: real GDP growth rate of China; CPI: consumers' price index in China.

For all the correlation coefficients, only those between 3 bank size proxies are higher than 0.7, the commonly accepted threshold for high correlation. For all the other variables, there only exists low or medium correlations. Similarly, the Spearman correlation analysis has been done and the conclusion is the same: there is no high correlation between the independent variables except 3 market power proxies. Hence, if we add the market power proxies into the regression model one by one, the collinearity problem can be eliminated.

Next we run beta regressions to estimate the impact of bank size on market efficiency of Chinese listed commercial banks. We first run regressions without the lagged term and then with lagged terms.

(1) Without lagged terms. Table 5 presents the results of beta regression without the lagged independent variable. 3 bank size proxies have been put into the model one by one and so we have got 3 models. The pseudo R^2 of the 3 models are all bigger than 0.4, which indicates the models can explain nearly half of the change in bank size.

Table 5. **Beta regression without lagged independent variables**

	Model 1	Model 2	Model 3
Intercept	1.648116***	1.555987***	1.587098***
Top 5	-0.008143	-0.006128	-0.006834
FS	0.009294	0.006534	0.007891
depr	0.100329***	/	/
loanr	/	0.103495***	/
assr	/	/	0.102099***
rgdp	-0.044438	-0.042001	-0.042861
cpi	0.241432***	0.238553***	0.241061***
Pseudo R^2	0.4425	0.4203	0.4234

Note: *, ** and *** refer to the significance at 10%, 5% and 1% levels.

The 3 market power proxies are all positive and significant at 1% in the corresponding models. It indicates that the increase of the market share for Chinese listed commercial banks is beneficial for their market efficiency. The greater market power a banks has, the higher the market efficiency will be.

Among the control variables, CPI is significant in all 3 models, which indicates that the macroeconomic situation can affect banks' market efficiency. Moderately higher CPI is the sign of the economic boom and it would be easier for banks to find more profitable projects.

(2) With lagged terms. We then substitute the independent variables with the one-year lagged terms and run the beta regression again. The results are reported in Table 6.

Table 6: **Beta regression with lagged independent variables**

	Model 4	Model 5	Model 6
Intercept	-1.875528	-2.192416*	-2.100988*
Top5 (-1)	-0.009685	-0.008171	-0.008659
FS (-1)	0.015789*	0.012945	0.014790
depr (-1)	0.093242***	/	/
loanr (-1)	/	0.094657**	/
assr (-1)	/	/	0.093002**
market efficiency(-1)	1.666611	2.021894*	1.893155
Rgdp (-1)	0.265609***	0.265340***	0.267004***
CPI (-1)	-0.151759***	-0.160680***	-0.157033***
Pseudo R^2	0.3738	0.3638	0.3617

-1 in the bracket indicates one-year lagged term.
*, ** and *** refer to the significance at 10%, 5% and 1% levels.

The pseudo R^2 of the models are little lower than those of Models 1, 2 and 3, but are still higher than 0.35. The market power proxies are all positive and significant at the 5% level in the corresponding models too. The estimated coefficients of the market power proxies are similar to those estimated in Models 1, 2 and 3. It indicates that bank size can influence their market efficiency. Larger bank size can contribute to market efficiency. In China, most commercial banks were formerly owned by the state. Banks and the government deeply rooted relationship. Senior managers can usually be promoted to government officials. In the economy intervened frequently by government, a good relationship with government can provide a lot of business opportunities. For example, when Chinese government launched its 4 bln. yuan plan in 2008, the banks with a good government relation could get the best business loans for government-guaranteed projects. Hence, larger banks usually have higher market efficiency.

Real GDP and CPI are significant but with different impacts. It reflects the fact that real GDP and CPI can influence public expectation in a rather complicated way. If there is real GDP growth, the public would expect further growth. So they would be more optimistic in doing business and banks' market efficiency would be better. On the contrary, if there is a CPI increase, it is reasonable for the public to have inflationary expectations in the coming year, so they would be more cautious to do business and banks' market efficiency would drop.

VI. Conclusion.

Our beta regression results indicate that Chinese listed commercial banks' market efficiency is positively influenced by their size. The larger the bank is, the larger the market efficiency will be.

According to our results, Chinese listed banks' market efficiency is achieved in part for their size, not with their management improvement. Hence, it has presented a serious problem for banks: if they are at the world market and lose their market power, their market efficiency would drop dramatically. In this case, what Chinese commercial banks should do now is to learn from their foreign competitors and to

enhance their ability in market analysis and project analysis. Chinese government should reduce intervention in the banking sector gradually to cultivate commercial banks' market efficiency.

Our contribution in this paper is to estimate the role of bank size and hence market power in Chinese listed commercial banks' market efficiency with the two-stage DEA method and beta regression. Further study can be done with better bank size proxies to reflect banks' market power.

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