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The Analysis of Banking Efficiency in China: A Spatial Panel Data Approach

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Abstract: This paper explores whether increasing market competition in China under its current market system enables improving Chinese bank efficiency levels similar to those in capitalist countries. Spatial inequalityis considered in testing of bank efficiency. The empirical findings show that the Chinese government had to continually reform the banking industry in China to deal with foreign bank competition after China joined the WTO in 2001. Consequently, the cost and profit efficiency of the Chinese banking industry have progressed considerably. The extent of liberalization in a region enables cost reductions in finding foreign bank customers, thereby improving bank cost efficiency. The potential foreign customer sources generated by foreign investments and government expenditure in neighboring regions improve cost efficiency. The economic activities also generated by government fiscal expenditures improve bank profit efficiency. We further find that excessive competition caused by financial industry agglomeration generates a market-crowding effect, reducing both cost efficiency and profit efficiency.

Keywords: regional economic factors, government policies, cost and profit efficiency, China's banking industry, spatial econometric model

JEL Classification Nos: G210, O160, P340, R120

1. Introduction

The post-WTO beginning from the end of 2001 was a period of liberalization, in which the Chinese government allowed the foreign banks and financial institutions become shareholders of state-owned banks in China and open various business operations. In 2002, all of the territorial restrictions on foreign banks were lifted; foreign banks were allowed to establish operations branches in any city of China. In addition, restrictions on cities to undertake foreign exchange operations were successively lifted. By the end of 2006, promises to open the Chinese market following China's membership in the

WTO were fulfilled. Thus, all territorial and customer restrictions on the foreign exchange operations of foreign banks were lifted, enabling the banks to apply to establish locally incorporate foreign-owned banks.

Recently, He and Fu (2008),Xue (2010) and Heand Yeung (2011) have verified the 'follow-the-customer' strategies of foreign banks in various cities in China. Zhao et al. (2004) report that the more liberalized the economy of a region is, the higher the demand for financial services and the greater the agglomeration of multinational corporation headquarters and high-end financial services in the region. Beijing and Shanghai are the major international financial centers in China.

As the number of multinational banks in a region increases, a region is likely to become an international financial center. Such an external economy attracts more manufacturing companies to the region, effectively reducing the costs of financial institutions and facilitating information exchanges between the financial institutions and all industries. Thus, the existing networks and infrastructures can be utilized more effectively, thereby improving production efficiency (Park and Essayyad,1989).

Furthermore, foreign capital, economic reforms or market-opening policies initiated by government typically increase bank efficiency. The details of the related literature on China's banking efficiency will be reviewed in next section. However, the economic institutions of post-reform China partially introduced the concepts of market economies. Compared to those of capitalist countries, the Chinese economy does not provide a comprehensive exit mechanism for companies. Therefore, this study first aims to determine whether increasing market competition in China under its current market system enables improving Chinese bank efficiency levels similar to those in capitalist countries.

China with a vast expanse has different degree of economic development in each area or province. As shown in Table 1, based on the Gini-Hirschman indices, the geographical distribution of annual industrial and financial developments is unbalanced in China because of the substantial size of its territory. The six major regions of China exhibit a higher imbalance of resource distribution than that when divided into 31 provinces or municipalities. In addition to spatial inequality,the banks between the proximal regions might generate a spillover effect of bank efficiency through the mutual sharing of financial development, advantages in market size, superior knowledge and skills from foreign banks,or cross-regional competition.

In this study, we adopt two estimating stages. We estimate the efficiency of each bank in the first stage and then use the average efficient levels of provinces (or municipalities), for each year, to examine factors that affect the efficiency of provinces (or municipalities) by consideringthe

Table 1: China's Gini-Hirschman indices, 2002–2012

31 Provinces/Municipalities	*GDP*	*GDPBA*	*GDPMA*	*FDI*	*BAOPP*	*FB*	*IPO*
2002	0.2307	0.2569	0.2466	0.3390	0.2390	0.4359	0.6124
2003	0.2323	0.2592	0.2499	0.3299	0.2437	0.4339	0.6000
2004	0.2317	0.2591	0.2496	0.3311	0.2426	0.4267	0.6000
2005	0.2346	0.2651	0.2525	0.3306	0.2433	0.4209	0.5890
2006	0.2354	0.2664	0.2515	0.3265	0.2423	0.4052	0.6383
2007	0.2347	0.2784	0.2488	0.3140	0.2418	0.4052	0.5533
2008	0.2329	0.2771	0.2449	0.3126	0.2399	0.5742	0.5533
2009	0.2314	0.2574	0.2443	0.3115	0.2384	0.5742	0.5533
2010	0.2295	0.2563	0.2379	0.3179	0.2368	0.6168	0.5673
2011	0.2270	0.2517	0.2332	0.3175	0.2354	0.5658	0.5673
2012	0.2253	0.2433	0.2317	0.3156	0.2334	0.5745	0.5673
6 Major Regions							
2002	0.4941	0.5093	0.5122	0.5578	0.4781	0.5457	0.6124
2009	0.4950	0.5177	0.5062	0.5827	0.4887	0.6877	0.6308
2012	0.4871	0.5066	0.4913	0.5887	0.4861	0.6991	0.6197

Notes: The 6 major regions are North China, Northeast China, East China, South Central China, Southwest China, and Northwest China. For the six major regions, only the data in the first and last years of the sampling, along with that of 2009 (post-2008) are listed. Each Gini-Hirschman index is defined by $G_t = \sqrt{\sum_k (x_{kt}/X_t)^2}$, where x_{kt} represents the value x of the kth province (city, region) at year t and X_t represents the sum of the x's in all of the regions at year t. GDP, GDPBA, and GDPMA represent the gross domestic product, financial industry output, and industrial output of each region. FDI represents the amount of foreign direct investment in each region in China. BAOPP represents the summed amount of deposits and loans in the banks of each region; FB represents the number of foreign banks in each region; and IPO represents the number of listed banks on the market in each region.

Sources: China Statistical Yearbook (2002–2012); Almanac of China's Finance and Banking (2002–2012)

geographical proximity and spatial inequality between overall environment in the second stage. In other words, the bank efficiency of our research is focused on the individual side in the first stage, and then considered about overall side in the second stage.

This research contributes to the existing literature on China's bank efficiency in several realms. First, this study differs from previous studies on bank efficiency by exploring the factors affecting bank efficiency in each province of China through spatial distribution. Second, by considering the regional economic characteristics and industrial agglomeration in each region along with its neighboring regions, this study is the first to explore the effect of spatial proximity on changes in average regional bank efficiency in an insightful perspective.

Using a total of 1206 samples in one of the most dynamic economy, China, a stochastic frontier analysis (SFA) is conducted on Chinese bank efficiency. Moreover, a spatial econometric model is used to analyze the factors affecting changes in efficiency for the period 2004–2012. Our empirical findings suggest that the Chinese government had to continually reform the banking industry in China to deal with foreign bank competition after China joined the WTO in 2001. Consequently, the cost and profit efficiency of the Chinese banking industry have progressed considerably. An investigation of the factors affecting improvements in Chinese bank efficiency reveals that the extent of liberalization in a region enables cost reductions in finding foreign bank customers, thereby improving bank cost efficiency. However, because most foreign business companies are foreign banks' customers, no significant improvement in the profit or profit efficiency of the entire Chinese banking industry is observed. Because of excessive government intervention, the Chinese market lacks a comprehensive exit mechanism. An improvement in the degree of competition by an agglomeration of the financial industries (i.e. the market-crowding effect) reduces regional bank efficiency, which differs from capitalist countries in which an increase in competition improves bank efficiency.

The remainder of this paper is organized as follows. Following this introduction, the next section is literature review. Section 3 describes the model specification and data analysis. Section 4 describes estimation results of bank efficiency. Section 5 explains the empirical results of the spatial econometric model, and the final section presents the conclusions drawn from this study.

2. Literature Review

A plethora of studies have explored bank efficiency in China. Specifically, Yao et al. (2008), Berger et al. (2009) and Li and Huang (2015) have investigated the effect of introducing foreign capital to a market or partial privatization on bank efficiency. In similar studies, Fu and Heffernan (2009), Lin and Zhang (2009) and Wu and Chen (2010) have documented that both partial privatization and foreign capital increased bank efficiency. Yin et al. (2013) have found the improvement of Chinesebank efficiency is most prominent for the largest banks with substantial state ownership. Zha et al. (2015) have indicated that banks in China show both technical and scale inefficiency during 2008–2012, which results from the inefficiencies of both the productivity stage and profitability stage by using a dynamic two-stage data envelopment analysis (DEA) model. Ding et al. (2015) have found a positive influence on bank costefficiency by adjusting macro policies, andcity commercial banks appear to be the most efficient and foreign banks are the least efficient.

Wu et al. (2007) have examined the macroeconomic effect on Chinese bank efficiency. By analyzing total factor productivity, Chang et al. (2012) suggest that productivity growth in China's non-foreign bank was because of technological progress instead of efficiency improvements. Zhang et al.

(2015) have suggested there were a gradient difference in the regional financial efficiency of China.

Moreover, Berger and Hannan (1998), Jayaratne and Strahan (1998), DeYoung et al. (1998), and Koetter et al. (2012) have indicated that increasing the level of market competition improves the efficiency of bank industries. Hsiao et al. (2015) have found that the domestic banks in China have gradually caught up the cost advantage of foreign banks in amanner consistent with the increased competitive pressure. Furthermore, an increase in the number of companies for an industry or allowing foreign companies to enter a market enables improving average production efficiency because of an increase in the level of market competition (Melitz, 2003; Melitz and Ottaviano, 2008). Nevertheless, if the market providesfree entry and exit mechanism, average efficiency of enterprises increaseswhen market competition increases in the privatization process; conversely, when the market provides no exit mechanism, then average efficiency decreases (Wu et al., 2016).

3. Model specification and data analysis

3.1. Efficiency estimation models and bank input and output variables

According to data from BankScope and the *Almanac of China's Finance and Banking* for the period 2002–2012, we estimate the cost efficiency (ϕ^c, CEFF) and profit efficiency (ϕ^π, PEFF) of each bank. Generally, the efficiency estimation value is set between 0 and 1, where a value closer to 1 indicates a higher efficiency. We estimate efficiency levels by commonly-used translog functional form for the costand profit functions. The parameters of the stochastic frontier modelsare estimated using maximum likelihood. For convenience, we show only thetotal cost trans log function for bank b in year t:

$$\begin{aligned}
&\ln(\text{Total cost} / \bar{p}z)_{bt} \\
&= \alpha_0 + \sum_{q=1}^{3}\alpha_q \ln(y_q / z)_{bt} + \frac{1}{2}\sum_{q=1}^{3}\sum_{k=1}^{3}\alpha_{qk}\ln(y_q / z)_{bt}\ln(y_k / z)_{bt} \\
&\quad + \sum_{q=1}^{2}\beta_q \ln(p_q / \bar{p})_{bt} + \frac{1}{2}\sum_{q=1}^{2}\sum_{k=1}^{2}\beta_{qk}\ln(p_q / \bar{p})_{bt}\ln(p_k / \bar{p})_{bt} \\
&\quad + \sum_{q=1}^{3}\sum_{k=1}^{2}\tau_{qk}\ln(y_q / z)_{bt}\ln(p_k / \bar{p})_{bt} + v_{bt} + u_{bt} \\
&= \Omega + v_{bt} + u_{bt},
\end{aligned} \tag{1}$$

$$where \;\; u_{bt} = \zeta_0 + \zeta_Y year_t + \sum_{k=1}^{3}\zeta_k (D_k)_{bt} + \varepsilon_{bt},\; v_{bt} \sim N(0,\sigma_v^2),\; \varepsilon_{bt} \sim N(0,\sigma_\varepsilon^2), u_{bt} \geq 0.$$

There are $q(k)$ kinds of input prices (p) or outputs (y) in equation (1). In this equation, α, β, τ, and ζ are the regression coefficients of the model, and $\alpha_{qk} \equiv \alpha_{kq}$, $\beta_{qk} \equiv \beta_{kq}$; the term $(v_{bt} + u_{bt})$ is a composite error term, v_{bt} is a random error, and u_{bt} represents a bank's inefficiency level; y represents the output; p represents the input prices; and z represents the total earning asset (TEA), which belongs to the fixed input (z) of the bank. The normalization bythe price of capital ($\bar{p}$) ensures price homogeneity $\sum_{q=1}^{3}\beta_q = 1$, $\sum_{q=1}^{3}\beta_{qk} = 0$, $\sum_{k=1}^{3}\tau_{qk} = 0$. Following Berger et al. (2009), total cost (TC) was converted into pre-tax profit (PTP) for estimating profit efficiency (PEFF), and the positive u_{bt} was changed into negative, indicating that banks with lower profit efficiency (PEFF) yielded lower profits.

Of studies using stochastic frontier analysis, namely Berger et al. (2009), Fang et al. (2011), Pasiouras et al. (2007), and Lensink and Meesters (2014) (hereafter as BFPL) were referenced regarding variable selection. The p input pricesinclude thecost of loanable funds (CLF) = total interest expense / deposits, the price of capital (PC, $\bar{p}$) = noninterest expense / fixed assets, and the price of labor (PL) = personnel expenses / total assets. The output y was divided into three items, and the first two items are total loans (LOAN) after excluding nonperforming loans and other earning assets (OEA).[1]

In addition to the interest spread, the net fee-based incomes of Chinese banks have increased annually and constituted the third major contributor to the income portfolio of banking in China. Therefore, unlike BFPL, this study also applies net fees and commissions income (FEE) to represent noninterest revenues, and this is the third output in this study. The aforementioned variables were in millions of RMB. The deflator used is the 2002 consumer price index of Chinese residents, which is set as the base and converted into real variables.

In this study, our efficiency estimation models *a la* Battese and Coelli (1995) and Coelli et al. (1999), which concerned the exogenous variables, are therefore adopted, and four exogenous variables, namely the three dummy variables on the reforms by the government (or ownership of each bank) (D) and the control year variable (*year*) for liberalizing and reforming the banking industry in China stage by stage, are also considered simultaneously. The Ω in equation (1) does not include the time-trend effects because we try to focus on 'the control year variable (*year*)'.

The three dummy variables (D) on the reforms by the government (or ownership of each bank) involved whether foreign capital is introduced

(D_1, the variable is 1 if the ownership structure in a particular year involves foreign capital or is a wholly-owned foreign or joint-venture bank itself), whether the bankis listed in the market (D_2, the variable is set as 1 starting from the year the bank was listed on the Chinese market), and whether a shareholding system is adopted (D_3, the variable is set as 1 starting from the first year a shareholding system was involved). The year variable (*year*) is defined as 1–11, corresponding sequentially to 2002–2012.

This sample data is so representative because the annual total assets and total deposits, on average, of the sample banks used for estimations in this study comprise an 84% of the entire Chinese banking industry. The loans of the sample banks comprise 93% of the entire industry. A total of 1206 samples are acquired for the period between 2002 and 2012. A total of 197 banks of various types, among which 111 are city commercial banks, 40 are joint-venture and foreign banks, and 26 are rural commercial banks, are sampled. However, if equation (1) considers the human resource input, the number of samples would be reduced from 1206 to 610, and the representativeness of the samples would be subsequently decreased. The human resource input is therefore not included in the second stage of empirical testing.

3.2. Spatial regression model and variables used

The local Moran's I statisticis the verification index used to measure the spatial correlation between an observed value of the variable in a specific region and that of neighboring regions.This study analyzes the relationship among the bank efficiencies of the Chinese provinces. Because each Chinese province exhibits adjacency relations with its neighboring provinces, the standardized first-order Queen-based contiguity is used to perform spatial weighting.

$$\text{Moran's I} = Z_i \sum_{j=1}^{n} w_{ij} Z_j \ . \qquad (2)$$

The correlation is defined in equation (2) (Anselin, 1995), in which the observed values ($Z_i$and Z_j) are in standardized formand w_{ij} represents the spatial weights, which indicates the geographical spatial correlation between areas.

Moreover, uneven regional financial development, economies of scale or disadvantages from cross-regional competition all led to spillover effects in bank efficiency. Therefore, this study appliesa spatial econometric model focused on the impact of spatial heterogeneity and dependency on the average efficiency in each province and municipality. Anselin et al. (1997)

have developed the spatial lag model (SLM) and spatial error model (SEM) for spatial econometrics. LeSage and Pace (2009) developed the spatial Durbin model, and this model extends the spatial lag model with spatial lags of the explanatory variables.

In addition, LeSage and Pace (2009) have developed the direct and indirect effects to test the hypothesis as to whether or not spatial spillovers exist. In the present study, balanced panel data are used for analysis. To identify the effects of unobserved variables in each region, as suggested by Elhorst (2003, 2014a), aspatial panel data model with fixed effects was used instead of one with random effects.

3.2.1. Spatial panel data model with fixed-effects

The spatial panel data regression analysis is conducted according to LeSage and Pace (2009) and Elhorst (2003, 2014a, b) and is detailed as follows:

$$\overline{\phi}_{it} = \mu_i + \kappa_t + \lambda \sum_j w_{ij} \overline{\phi}_{jt} + \sum_k \beta_k x_{kit} + \sum_k \sum_j \theta_k w_{ij} x_{kit} + \omega_{it},$$

$$\text{where } \omega_{it} = \rho \sum_j w_{ij} \eta_{jt} + \gamma_{it}, \tag{3}$$

where $\overline{\phi}_{it}$ is the province *i*'s cost or profit efficiency in time *t*; μ_i represents the region-specific fixed effect of the *i*th province; and κ_t represents the time-specific fixed effect in the *t* th year. Selecting the region-specific fixed effect in the model indicates that the effects of undetected unique variables in a specific region on the model are considered. If the time-specific fixed effectis observed in the model, it is indicative that annual policy changes regarding liberalization after China joined the WTO or the short-term impact of the financial crisis in 2008 and subsequent regulatory were considered.

The term w_{ij} represents the spatial weightings; *j* represents the region neighboring the *i*th province; and λ is a spatial auto regressive coefficient, which represents the degree of the impact of the average efficiency of the neighboring regions on the efficiency of the specific region and represents the spatial dependence. Similar to β, θ is a regression coefficient to be estimated, representing the degree of influence each other among the province *i*'s neighbors about the independent variable; ($w_{ij}\eta$) represents the interaction effects among the disturbance terms of different regions; ρ is a spatial auto correlation coefficient, which enables illustrating the degree of this interaction effects; γ is independent and identically distributed (*i.i.d.*) error term for *i* and *t* with zero mean and variance σ^2; ($w_{ij}\,\overline{\phi}_j$) and ($w_{ij}\,x_{ki}$) represent lag term of the explained and explanatory variables, respectively.

If $\theta = \lambda = 0$, and $\rho \neq 0$, equation (3) is a spatial lag model; if $\theta \neq 0$, $\lambda \neq 0$ and $\rho = 0$, equation (3) is a spatial error model; and if $\theta \neq 0$, $\lambda \neq 0$, and $\rho = 0$, equation (3) is aspatial Durbin model.

The estimation and tests of equation (3) are based on those of Elhorst (2014a). Because the (wx) term in spatial Durbin model had been affected by the spatial weights matrix, the estimation coefficients did not generate marginal effects as the non-spatial regression coefficients did. Consequently, the indirect effectsof impact measures proposed by LeSage and Pace (2009) is used to analyze spatials pillovers. In addition to the indirect effects, the impact measures include the direct and total effects.

3.2.2. Settings of the research variables in the spatial panel data model

The settings and selection of the variables in this study are detailed in Table 2. The factors affecting the efficiency changes in the banks of a region are divided into two types, namely regional economic factors and government policies. Regarding industrial agglomeration, the level of financial industry agglomerationis considered to correspond with the industrial agglomeration phenomenon during the forming of an international financial center, as reported by Park and Essayyad (1989). Baldwin et al. (2003) indicated that this type of agglomeration increases the degree of market competition, and then the excessive competition may result inmarket-crowding effect. Wu et al. (2016) have argued that if no exit mechanism is provided in a market, increasing market competition causes a decrease in the average industry efficiency. These findings indicate that the forming and agglomeration of a financial center may enable the positive externalities of scale economies, but the subsequently higher degree of competition may also generate negative externalities through over competition (i.e., too many firms). This agglomeration index is used to observe the impact of the trade-off between the positive and negative externalities of a financial center on the banking efficiency in a region.

Regarding the regional economies, four variables, namely the GDP in a region (GDP), bank opportunity represented by the total amount of deposits and loans in a region (BAOPP), amount of imports and exports in a region (TRD), and amount of investment by foreign companies in a region (FDI), are selected.

First, Liu and Wu (2008) have indicated that the distribution of bank assets is highly correlated with the GDP of each province. Therefore, GDP is used in this model to depict the size of the banking operations in a region and the economic performance, verifying the correlation between the varying level of financial system development in each region and the operational efficiency of the banks in the region. In addition, GDP represents

Table 2: Variables used in the regression model

Variable category	*Variable code*	*Variable name*	*Unit*	*Variable description and definition*
	Dependent variable ($\bar{\phi}$)			
Bank efficiency	CEFF	Cost efficiency	Efficiency value	Average efficiency of the head office of a bank in a province or municipality
	PEFF	Profit efficiency	Efficiency value	
	Independentvariable (x)			
Regional economic factor	AGGBA	Financial industry Agglomeration Level	Agglomeration level	(Proportion of financial output in total industrial output of province) /(Proportion of financial output in national GDP)
	GDP	Regional output	RMB 100 million	Total output in a region
	BAOPP	Bank opportunity	RMB 100 million	Sum of deposits and loans in the banks of a region
	FDI	Foreign direct investment	US$100 million	Total amount of investment by foreign companies in a region
	TRD	Total import and export trade volume	US$10,000	Sum of import and export amount in a region
Government policy	GOV	Fiscal expenditures	RMB 1 million	Total public finance expenditure in a region

Sources: China Statistical Yearbook (2004–2012); Almanac of China's Finance and Banking (2002–2012); BankScope (2002–2012).

the local market opportunity of banks through their strategies of 'follow-the-customer'.

Secondly, the higher the total amount of deposits and loans in a region (BAOPP) is, the more likely that banks will enter the region. This study explores whether bank preferences in location selection further improve the business efficiency of banks. This variable represents a 'follow-the-customer' strategy for banks. Thirdly, two variables, namely amount of imports and exports in a region (TRD), and amount of investment by foreign companies in a region (FDI) are used to illustrate the extent of liberalization of a region. Zhao et al. (2004) find out that the quality of financial service is higher in a more openness location. Therefore, we determined that although higher levels of financial services generate higher costs, they also generate more fees, thereby potentially reducing cost efficiency (CEFF) but expanding profit efficiency (PEFF). FDI also represents the market size for potential foreign firms and customers. The major market of credit of domestic banks usually comes from domestic firms or consumers before liberalizing, so an important potential market is developed gradually from the foreign firms and customers (i.e. FDI). Finally, regarding government policies, the total amount of public finance expenditures (GOV) in each region is used to illustrate the effect of the varying levels of government policies on each region.

Table 3 lists the correlation coefficients of the aforementioned explained variables. With the exception of the financial industry agglomeration level (AGGBA), all of the variables of the regional economies display significant and positive correlations to one another. However, the correlation between FDI and government policies (GOV) is relatively lower. To avoid generating muticollinearity in the model estimation, only financial industry agglomeration level (AGGBA), FDI, and government policies (GOV) are used in the following models.

Table 3: Correlation coefficients of the independent variables

	AGGBA	*GDP*	*BAOPP*	*FDI*	*TRD*
GDP	0.08				
	(0.18)				
BAOPP	0.45	0.90			
	(0.00)	(0.00)			
FDI	0.38	0.81	0.86		
	(0.00)	(0.00)	(0.00)		
TRD	0.50	0.81	0.91	0.96	
	(0.00)	(0.00)	(0.00)	(0.00)	
GOV	0.13	0.88	0.87	0.64	0.67
	(0.07)	(0.00)	(0.00)	(0.00)	(0.00)

Note: *p*-value in parentheses.

4. Estimation results of bank efficiency

The cost efficiency (CEFF) and profit efficiency (PEFF) of the banks are estimated using equation (1). As shown in the rankings between the periods in Table 4, the average cost efficiency (CEFF) of the Chinese banking industry has increased since 2002, whereas the foreign bank rankings decreased from the first to the fourth place because of the significant impact of the financial crisis. After the financial crisis in 2008, the China Banking Regulatory Commission (CBRC) executed the comprehensive and prudential regulations to control nonperforming loans; the allocation of expected loss (i.e., the proportion of the allowance for nonperforming loans in the total loans) was set at 2.5%,which might have caused an overestimation of expected credit losses of foreign banks. In 2009, to increase the risk regulatory measure regarding customer authentications, the CBRC specified that the representatives of new customers must arrive at the banks in person and the contracting processes must be recorded for evidence when banks conduct operations regarding new customers. Because foreign banks were restricted to fewer number of branches, following the regulatory measure increased operations costs for foreign banks (PwC, 2010).This decrease of foreign banks'cost efficiency after 2008 (financial crisis) was also showed in Ding et al. (2015).

Additionally, after the financial crisis, the Chinese people showed an increased distrust of foreign banks; consequently, foreign banks had to increase their costs to recover lost accounts. Jeon et al. (2013) have reported that foreign banks are affected the financial impact to their home countries. In processing the investment losses of their parent banks overseas, the cost efficiency (CEFF) of foreign banks in China is reduced significantly.

Among the state-owned banks, the 12 major national joint-stock commercial banks exhibit the highest cost efficiency (CEFF), which might be ascribed to the banks being the earliest to adopt a shareholding system.[2] The rankings (Table 4) show that the efficiency of the five major state-owned banks improved annually; the rankings exhibit significant improvements after the financial crisis,which might be attributed to greater government support and the market shares received by the banks after the crisis.[3]

Table 4: Rankingsof the average efficiency and efficiency level by bank type

	Five major state-owned banks	*Three major policy banks*	*12 major national joint-stock banks*	*City banks*	*Foreign banks*	*Rural banks*	*Periods*
Cost efficiency (CEFF)							
2002~2012	0.822 (2)	0.721 (6)	0.868 (1)	0.772 (5)	0.813 (3)	0.791 (4)	
2002~2005	0.711 (5)	0.650 (6)	0.811 (1)	0.714 (4)	0.751 (2)	0.747 (3)	**0.734 (3)**
2006~2008	0.866 (3)	0.725 (6)	0.883 (2)	0.795 (5)	0.884 (1)	0.800 (4)	**0.820 (2)**
2009~2012	0.900 (2)	0.788 (6)	0.914 (1)	0.812 (5)	0.821 (4)	0.827 (3)	**0.827 (1)**
Profit efficiency (PEFF)							
2002~2012	0.787 (3)	0.716 (6)	0.807 (2)	0.737 (4)	0.833 (1)	0.725 (5)	
2002~2005	0.478 (3)	0.424 (5)	0.563 (2)	0.443 (4)	0.613 (1)	0.420 (6)	**0.483 (3)**
2006~2008	0.926 (1)	0.776 (6)	0.895 (3)	0.815 (4)	0.923 (2)	0.804 (5)	**0.839 (2)**
2009~2012	0.991 (1)	0.963 (6)	0.985 (3)	0.973 (4)	0.986 (2)	0.970 (5)	**0.977 (1)**

Notes: The values in parentheses are ranking. The entire sampling period is divided into three subintervals. The final column of the table lists the overall efficiency rankings of all banks combined for each of the subintervals, which are used to explore the trend of overall bank efficiency performance.

The rankings (Table 4) indicate that the overall profit efficiency (PEFF) of the Chinese banking industry has improved over the years. However, the profit efficiency (PEFF) of the five major state-owned banks out performed that of foreign banks around 2008. This is consistent with the fact that the state-owned banks of China have reached top rankings worldwide for assets and profits. The government's implicit guarantee on deposits in 2008 and continual regulation of and restrictions on cross-industry operations also contributed to the aforementioned effects.

The efficiency regression estimation results (Table 5) show that the exogenous variables of the governmental reforms (or ownership of each bank) improve the cost efficiency (CEFF) and profit efficiency (PEFF) of each individual bank. Listings the banks on the market resulted in larger improvement incost efficiency (CEFF) than by introducing foreign capital. However, introducing foreign capital yielded significantly higher improvement in profit efficiency (PEFF) than that by other exogenous variables, which might be ascribed to foreign banks being more capable of introducing or developing more new high added-value financial products to improve their profit performance. The coefficients of year control variable are significant and negative, indicating that cost efficiency (CEFF) and profit efficiency (PEFF) have improved over years.

Table 5: Estimation results of the exogenous variables by stochastic frontier analysis (SFA)

	Cost inefficiency			*Profit inefficiency*		
Intercept	-0.350	(-1.22)		1.328	(8.75)	***
Year control variable	-0.183	(-4.65)	***	-0.185	(-11.51)	***
Foreign capital dummy	-1.160	(-4.38)	***	-0.364	(-1.96)	*
Listed on the market dummy	-2.372	(-3.45)	***	-0.209	(-0.61)	
Shareholding dummy	-0.486	(-3.21)	***	-0.025	(-0.16)	

Notes: These are the inefficiency estimation results obtained using equation (1). The values in parentheses are t values. *, **, and *** are significant at 10%, 5%, and 1% significance levels, respectively.

5. Empirical results of the spatial regression model

The Moran's I values of cost efficiency (CEFF) and profit efficiency (PEFF), on average,were 0.2048 and 0.2489, respectively. They exhibit spatial heterogeneity and dependence. Therefore, spatial econometric model is used.This study covers the period 2004–2012, during which continuous bank efficiency data was obtained for 16 regions.[4] Fourteen of the 16 regions (with the exception of Jiangxi and Hunan) are among the top 16 in national rankings for regional financial production and financial industry agglomeration level (AGGBA). Therefore, these samples are regarded as the Chinese provinces with relatively higher levels of financial development.

First, as shown in Tables 6 and 7, the results of the joint Likelihood ratio (LR) test on the region-specific and time-specific fixed-effects indicate that both the cost efficiency (CEFF) and profit efficiency (PEFF) estimation models reject significantly the null hypotheses, namely H_0: $\mu_i = 0$ (no region-specific fixed-effect) and H_0: $\kappa_t = 0$ (no time-specific fixed-effect). Therefore, an estimation model that exhibit both region-specific and time-specific fixed-effects is applied to perform a spatial analysis on the factors affecting the efficiency changes in each Chinese province.Regarding spatial interaction effects, the estimation models for the two efficiencies underwent the Lagrange multiplier (LM) test or the robust LM test and mostly yielded favorable results.Under 1%–10% level of significance, the two models reject the null hypotheses H_0: $\lambda = 0$ (no spatial lag effect)and H_0: $\rho = 0$ (no spatial error effect). Therefore, these LM test results suggest that the spatial econometric models are more appropriate specification than non-spatial models.

Secondly, as suggested by LeSage and Pace (2009), the spatial Durbin model and its corresponding explained variables and impact measures are estimated, the results of which are listed in Table 8. To further test which spatial model specification is appropriate, we conduct both the Wald test and LR test to test the hypothesis whether the spatial Durbin model (SDM) could be simplified to the spatial lag model (SLM) or spatial error model (SEM). Based on the result of Wald test and LR test in a bottom area in Table 8, the null hypothesis that the SDM could reduce to the SLM ($H_0^{(L)}$: $\theta = 0$) is rejected at a 1% significance level. Similarly, the null hypothesis that the SDM could reduce to a SEM($H_0^{(E)}$: $\theta + \lambda\beta = 0$) is also rejected at least 10% significance level.These empirical results indicate that both the SLM and SEM are rejected in favor of the SDM.We, then, find the higher the operation performance (W*dep.var.) of the banks in the neighboring regions is, the lower the local cost efficiency (CEFF) and profit efficiency (PEFF) of a region,which is attributed to financial development in China being focused on a small number of regions.The locations with concentrated financial resources subsequently received an optimal business environment andconditions, thereby improving operation efficiency. Conversely, the neighboring regions exhibited a decrease in business efficiency because of insufficient resources. Regarding the other types of effect, financial industry agglomeration affected costefficiency (CEFF) and profit efficiency (PEFF) in each region, and the extent of liberalization and market sizes also generated unique effects on bank efficiency. Government policy was also a decisive factor. Unlike conventional non-spatial regression coefficient, the estimation coefficients of the spatial regression model do not have the feature of marginal effect. Accordingly, impact measures (Table 8) is used to explore the impact of regional economic factors and government policies on the average bank efficiency of each region. Using an increased number of explanatory variables, Model 2 repeats the robustness test of Model 1.

Table 6: Estimation results of cost efficiency (CEFF) using panel data models without spatial interaction effects

CEFF	*Pooled OLS*			*Spatial fixed effects*			*Time-period fixed effects*			*Spatial & Time-period fixed effects*		
lnAGGBA	0.024	(2.11)	**	-0.094	(-3.69)	***	0.026	(2.73)	***	-0.074	(-3.08)	***
lnFDI	-0.008	(-1.42)		0.108	(3.25)	***	0.007	(1.13)		0.061	(1.90)	*
lnGOV	0.053	(5.17)	***	-0.001	(-0.03)		-0.023	(-1.33)		0.069	(1.43)	
intercept	0.223	(2.15)	**									
Observation	144			144			144			144		
sigma^2	0.0039			0.0020			0.0027			0.0016		
R-squared	0.2172			0.4799			0.0808			0.1340		
log-lik.	197.64			246.22			222.64			262.28		
LM spatial lag		1.935			1.628			3.438	*		6.643	***
robust LM spatial lag		25.229	***		0.861			4.932	**		0.193	
LM spatial error		0.062			1.048			5.139	**		6.485	**
robust LM spatial error		23.357	***		0.281			6.633	***		0.035	

		LR-value	*degrees of freedom*	*p-value*	
Tests for the joint significance of spatial and/or time-period fixed effects	Spatial fixed effects	79.2721	16	0.0000	***
	Time-period fixed effects	32.1233	9	0.0002	***

Notes: The values in parentheses are t values. *, **, and *** are significant at 10%, 5%, and 1% significance levels, respectively. The studied periodis 2004–2012. The spatial weights matrix is a standardized, first-order Queen-based contiguity matrix. A total of 16 regions are analyzed.

Table 7: Estimation results of profit efficiency (PEFF) using panel data models without spatial interaction effects

PEFF	*Pooled OLS*			*Spatial fixed effects*			*Time-period fixed effects*			*Spatial & Time-period fixed effects*		
lnAGGBA	-1.961	(-10.21)	***	-0.157	(-4.05)	***	0.035	(5.16)	***	-0.032	(-1.98)	**
lnFDI	0.029	(1.37)		0.046	(0.92)		0.013	(3.09)	***	-0.064	(-2.97)	***
lnGOV	-0.045	(-4.19)	***	0.266	(7.91)	***	-0.035	(-2.86)	***	0.217	(6.7)	***
intercept	0.254	(13.46)	***									
Observation	144			144			144			144		
sigma^2	0.0133			0.0045			0.0014			0.0007		
R-squared	0.609			0.8624			0.279			0.2615		
log-lik.	108.92			186.14			272.86			320.20		
LM spatial lag		87.253	***		122.260	***		3.680	*		6.39	**
robust LM spatial lag		68.726	***		26.640	***		0.202			7.43	***
LM spatial error		28.296	***		95.726	***		4.928	**		12.47	***
robust LM spatial error		9.769	***		0.105			1.450			13.51	***

		LR-value	*degrees of freedom*	*p-value*	
Tests for the joint significance of spatial and/or time-period fixed effects	Spatial fixed effects	94.6742	16	0.0000	***
	Time-period fixed effects	268.1203	9	0.0000	***

Notes: The values in parentheses are t values. *, **, and *** are significant at 10%, 5%, and 1% significance levels, respectively. The studied periodis 2004–2012. The spatial weights matrix is a standardized, first-order Queen-based contiguity matrix. A total of 16 regions are analyzed.

Table 8: Estimation results of the cost efficiency (CEFF) and profit efficiency (PEFF) with spatial interaction effects–spatial Durbin model

	CEFF						*PEFF*					
	Model 1			*Model 2*			*Model 1*			*Model 2*		
lnAGGBA	-0.063	(-2.76)	***	-0.069	(-3.04)	***	-0.050	(-3.41)	***	-0.049	(-3.28)	***
lnFDI	0.029	(0.99)		0.027	(0.87)		-0.066	(-3.51)	***	-0.075	(-3.67)	***
lnGOV	0.112	(2.45)	**	0.049	(0.87)		0.201	(6.88)	***	0.198	(5.34)	***
lnAGGMA				0.110	(2.20)	**				0.025	(0.76)	
W*lnAGGBA	0.007	(0.14)		-0.009	(-0.20)		-0.101	(-3.26)	***	-0.107	(-3.41)	***
W*lnFDI	-0.240	(-4.06)	***	-0.209	(-3.51)	***	-0.081	(-2.11)	**	-0.074	(-1.85)	*
W* lnGOV	0.465	(4.47)	***	0.383	(2.95)	***	0.258	(3.72)	***	0.284	(3.25)	***
W*lnAGGMA				0.048	(0.41)					-0.067	(-0.86)	
W*dep.var.	-0.325	(-3.39)	***	-0.339	(-3.53)	***	-0.497	(-5.50)	***	-0.483	(-5.30)	***
Direct effect												
lnAGGBA	-0.065	(-2.83)	***	-0.071	(-3.12)	***	-0.038	(-2.41)	**	-0.037	(-2.31)	**
lnFDI	0.054	(1.79)	*	0.049	(1.51)		-0.059	(-2.71)	**	-0.069	(-2.99)	***
lnGOV	0.068	(1.38)		0.013	(0.24)		0.176	(5.06)	***	0.168	(4.53)	***
lnAGGMA				0.108	(2.19)	**				0.038	(1.09)	
Indirect effect												
lnAGGBA	0.024	(0.60)		0.011	(0.28)		-0.062	(-2.48)	**	-0.070	(-2.73)	**
lnFDI	-0.214	(-4.13)	***	-0.186	(-3.67)	***	-0.041	(-1.27)		-0.031	(-0.89)	
lnGOV	0.368	(3.95)	***	0.310	(2.84)	**	0.131	(2.30)	**	0.156	(2.27)	**
lnAGGMA				0.013	(0.14)					-0.066	(-1.07)	
Total effect												
lnAGGBA	-0.041	(-0.90)		-0.060	(-1.38)		-0.100	(-3.81)	***	-0.107	(-3.97)	***
lnFDI	-0.160	(-3.08)	***	-0.137	(-2.73)	**	-0.099	(-3.45)	***	-0.100	(-3.29)	***
lnGOV	0.436	(5.05)	***	0.324	(2.75)	**	0.307	(6.30)	***	0.325	(4.70)	***
lnAGGMA				0.121	(1.16)					-0.028	(-0.45)	

contd. table 8

	CEFF		*PEFF*	
	Model 1	*Model 2*	*Model 1*	*Model 2*
sigma^2	0.001	0.001	0.001	0.001
R-squared	0.745	0.754	0.984	0.984
corr-squared	0.241	0.262	0.308	0.316
log-likelihood	275.73	278.05	333.49	271.62
Observation	144	144	144	144
Wald_spatial_lag	21.58 ***	16.37 ***	21.07 ***	21.03 ***
LR_spatial_lag	19.68 ***	15.06 ***	17.71 ***	18.22 ***
Wald_spatial_error	20.76 ***	14.81 ***	9.81 **	10.94 **
LR_spatial_error	19.46 ***	14.33 ***	8.41 **	9.43 *

Notes: The values in parentheses are t values. *, **, and *** are significant at 10%, 5%, and 1% significance levels, respectively. The studied periodis 2004–2012. The spatial weights matrix is a standardized, first-order Queen-based contiguity matrix.A total of 16 regions are analyzed. The spatial and time period fixed-effects model is adopted. The robustness test in Model 2 contains a higher number of explanatory variables than Model 1.

Because the estimation result reveals that Model 2 does not affect the analysis results of Model 1, the following analyses are performed primarily using Model 1.

First, if a bank is situated in a region with high financial industry agglomeration level (AGGBA), its cost efficiency (CEFF) and profit efficiency (PEFF) would both decrease. Excessive government intervention prevented the Chinese market from providing a comprehensive exit mechanism. The degree of over competition generated by financial industry agglomeration level (AGGBA) reduces bank efficiency in the region. The indirect effect revealed that a region with high financial industry agglomeration level (AGGBA) is typically a regional financial center and afinancial policy center. Consequently, financial industry agglomeration in the neighboring regions generates positive effects such as demonstration with financial business or spillovers about policy informationto bank businesses. However, these effects are not statistically significant. Finally, a decrease in market efficiency caused by excessive government intervention also generates spillovers, reducing the profit efficiency (PEFF) of the neighboring regions.

Regarding the impact of the degree of liberalization or market sizes of one specific region on the average efficiency of other regions, Model 1 in Table 8 depicts that the higher the foreign direct investment (FDI) of a region is, the more foreign companies are found in the region. Consequently, the cost of searching for potential foreign customers could be reduced, and cost efficiency (CEFF) could be improved. Furthermore, foreign companies typically prefer to contact foreign banks, rendering low profit generation for state-owned banks. However, foreign banks exhibit an insubstantial share of the Chinese market. Therefore, FDI does not positively affect the overall profit of the Chinese banking industry.

Total effect is the sum of the direct and indirect effects. The directions of the three total effects in the profit efficiency (PEFF) model are consistent with the direct and indirect effects. However, the total effect of lnFDI in the cost efficiency (CEFF) model reveals that the negative indirect effect dominate the positive direct effect, which can be attributed to most of the service recipients of the various state-owned banks in China being state-owned enterprises, and the proportion of loan lending to foreign companies from state-owned banks being low. Moreover, the quality of high-end financial services companies from state-owned banksmay not necessarily satisfy the requirements of foreign enterprises. Therefore, a higher extent of market liberalization causes a decrease in cost efficiency (CEFF).

Regarding government policies, increasing government public finance expenditures improves the economic development of a local region, thereby improving economic activities, expanding interest income and fees, and promoting profit efficiency (PEFF). The indirect effects indicate that government public finance expenditures also stimulate the economic development of neighboring regions, thereby improving these cost efficiency (CEFF) and profit efficiency (PEFF) with positive spillover effects.

The robustness test in Model 2reveals that the direct effect of industrial agglomeration (AGGMA) improves the cost efficiency (CEFF) of the local regional banks. The higher the financial industrial agglomeration (AGGMA) in a regionis, the higher the number of companies requiring capital for development or expansion. Thus, the cost of searching for loan customers for banks could be reduced, improving cost efficiency (CEFF). The other results of impact measures are generally consistent with the results of Model 1, with the exception of the direct effect of ln FDI, which is statistically insignificant.

The remainder of this section describes the robust and extended analyses of the other samples (excluding the Big 5 and foreign banks), which explore the efficiency reform strategies of the government regarding without Big 5 and observe the impacts of the potentially varying business models of foreign banks on Chinese banking efficiency.

To assess the robustness of our findings, the robustness test is conducted using the selection of the bank types in the samples. The large state-owned banks exhibit enormous assets and market shares, exceeding those of the other bank types. The operation models of and actual restrictions on foreign banks might also be different from those of Chinese banks. Therefore, the efficiency values are recalculated without five major state-owned banks or foreign banks. As shown in Table 9, the direct effect of ln FDI in the cost efficiency (CEFF) model without the five large state-owned banks become insignificant compared to that of Model 1 (Table 8) with all of the sample banks. The other results of the model are consistent with those of Model 1 in Table 8,which indicate that the optimization of cost efficiency (CEFF) generated by foreign enterprises primarily affects the five large state-owned banks. With the exception of foreign banks, the only other bank type that foreign enterprises tended to contact are five large state-owned banks.

6. Conclusions

Post-WTO banking data were used to analyze the liberalization effect of the Chinese market on bank efficiency in each region of China. In addition, industrial agglomeration and government reform policies are discussed. The efficiency analysis revealed that, since joining the WTO, the Chinese government has executed continual reforms in the banking industry in response to competition from foreign banks. Consequently, both cost efficiency (CEFF) and profit efficiency (PEFF) have exhibited continual

Table 9: Estimation results of spatial Durbin model without foreign banks or five large state-owned banks

	Without the five largestate-owned banks						*Without foreign banks*					
	CEFF			*PEFF*			*CEFF*			*PEFF*		
lnAGGBA	-0.064	(-2.78)	***	-0.049	(-3.37)	***	-0.063	(-2.79)	***	-0.046	(-3.15)	***
lnFDI	0.028	(0.93)		-0.065	(-3.50)	***	0.042	(1.42)		-0.088	(-4.67)	***
lnGOV	0.116	(2.51)	**	0.197	(6.86)	***	0.070	(1.55)		0.225	(7.71)	***
W*lnAGGBA	-0.001	(-0.01)		-0.101	(-3.30)	***	0.019	(0.41)		-0.087	(-2.79)	***
W*lnFDI	-0.253	(-4.20)	***	-0.065	(-1.71)	*	-0.235	(-3.97)	***	-0.113	(-2.92)	***
W*lnGOV	0.488	(4.61)	***	0.233	(3.40)	***	0.420	(4.04)	***	0.280	(4.04)	***
W*dep.var.	-0.334	(-3.50)	***	-0.485	(-5.32)	***	-0.309	(-3.20)	***	-0.528	(-5.98)	***
Direct effect												
lnAGGBA	-0.065	(-2.82)	***	-0.037	(-2.39)	**	-0.067	(-3.15)	**	-0.036	(-2.34)	**
lnFDI	0.055	(1.78)		-0.060	(-2.83)	***	0.066	(2.23)	**	-0.077	(-3.61)	***
lnGOV	0.070	(1.38)		0.176	(5.17)	***	0.033	(0.69)		0.195	(5.58)	***
Indirect effect												
lnAGGBA	0.018	(0.46)		-0.063	(-2.55)	**	0.035	(0.91)		-0.052	(-2.07)	*
lnFDI	-0.225	(-4.26)	***	-0.029	(-0.90)		-0.214	(-4.01)	***	-0.056	(-1.77)	*
lnGOV	0.384	(4.06)	***	0.114	(2.03)	*	0.343	(3.67)	***	0.139	(2.41)	**
Total effect												
lnAGGBA	-0.047	(-1.03)		-0.100	(-3.84)	***	-0.032	(-0.74)		-0.087	(-3.45)	***
lnFDI	-0.170	(-3.22)	***	-0.089	(-3.10)	***	-0.149	(-2.80)	**	-0.133	(-4.81)	***
lnGOV	0.454	(5.19)	***	0.290	(6.01)	***	0.376	(4.25)	***	0.334	(7.32)	***
sigma^2	0.001			0.001			0.001			0.001		
R-squared	0.740			0.985			0.755			0.985		
corr-squared	0.242			0.306			0.218			0.324		
log-likelihood	273.05			335.86			275.68			332.94		
Observation	144			144			144			144		
Wald_spatial_lag		22.77	***		19.74	***		18.99	***		20.57	***
LR_spatial_lag		20.71	***		16.83	***		17.57	***		16.91	***
Wald_spatial_error		21.72	***		9.42	**		20.02	***		8.31	**
LR_spatial_error		20.34	***		8.03	**		18.55	***		6.84	*

Notes: The values in parentheses are t values. *, **, and *** are significant at 10%, 5%, and 1% significance levels, respectively. The studied periodis 2004–2012. The spatial weights matrix is a standardized, first-order Queen-based contiguity matrix. A total of 16 regions are analyzed. The spatial and time period fixed-effects model is adopted.

increases. Regarding cost efficiency, in response to the financial crisis, Chinese banks have operated to outperform foreign banks. Subsequently, the large state-owned banks also began to outperform foreign banks regarding profit efficiency. Being listed in the stock exchange market also affects the efficiency of the large state-owned banks significantly. During the period 2005–2006, with the exception of the Agricultural Bank of China, the other four large state-owned banks were listed in the market. Thus, the average profit efficiency of the five large state-owned banks outperformed that of other types of commercial banks, and outperformed that of foreign banks following the financial crisis. However, no significant effect on cost efficiency is observed.

Uneven resource distribution in the regions of China is considered in the present study in determining the factors affecting efficiency changes in each Chinese province. Therefore, spatial econometric model with spatial heterogeneity is used. We have found that the potential foreign customer sources generated by foreign investments and government expenditures in neighboring regions improve cost efficiency. The economic activities generated by government fiscal expenditures improve bank profit efficiency. Excessive competition caused by financial industry agglomeration generates a market-crowding effect, reducing both cost efficiency and profit efficiency.

The empirical evidence we have documented may have some important policy implications for promoting China's bank efficiency. First, economic reforms to introduce non-state investments into the Chinese market must continue to be promoted.Second, Chinese banks must be encouraged to improve their shareholding systems through the introduction of foreign capital, thereby promoting operation efficiency. Third, the processes for foreign banks to apply for various operations must be accelerated.

With the support of the congenital advantage of market size, the Chinese banking industry can undergo continual reforms and make adjustments to its overall financial structures and corporate governance systems, and receive foreign strategic partners through shareholding systems. As a result, the Chinese banking industry will be more capable of facing the challenges of future market competition.

Notes

1. Three outputs in this study are including the total loans (LOAN) after excluding nonperforming loans, the other earning assets (OEA) and the net fees and commissions income (FEE).
2. The 12 major national joint-stock commercial banks are including China Merchants Bank, China CITIC Bank, Shanghai Pudong Development Bank, China Minsheng Bank, Industrial Bank, China Everbright Bank, Ping An Bank,Hua Xia Bank, China Guangfa Bank, Evergrowing Bank, China Bohai Bank, and China Zheshang Bank.

3. The five major state-owned banks are including Industrial and Commercial Bank of China, China Construction Bank, Bank of China, Agricultural Bank of China, and Bank of Communications. The three major policy banks are including China Development Bank, Agricultural Development Bank of China, and Export-Import Bank of China.
4. The starting year is not set as 2002, the year after China joined the WTO. Otherwise, the number of analyzable regions would have decreased to 13. The 13 provinces and municipalities were Beijing, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Jiangxi, Shandong, Hubei, Hunan, Guangdong, Chongqing, and Sichuan. Setting the starting year as 2004 enables analyzing three additional provinces, namely Hebei, Anhui, and Guizhou, thereby expanding the number of analyzable regions to 16 and increasing the spatial comprehensiveness of the analysis.

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