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How Competitive and Stable is the Commercial Banking Industry in China after Bank Reforms?

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This paper examines market concentration and its effect on competition in the Chinese commercial banking market. This study also investigates how changes in competition have affected the financial stability of Chinese commercial banks. To test the competitive conditions, we obtained the H statistic of the Panzar-Rosse model from a revenue function equation. The degree of financial stability is estimated by the Z-score formula. The Chinese banking industry has become an increasingly less concentrated market with an increased number of banks. Along with a decreased market concentration, competition in the Chinese banking industry has improved moderately. However, its market structure is still far from a competitive market. An individual bank's ability to earn higher markup or charge a higher net interest margin contributes to its financial soundness, although a higher degree of market concentration may have negative effect on the financial stability of the entire banking system.

Key Word: Market concentration, Bank competition, Panzar-Rosse model, Bank stability, Chinese banks
JEL Code: G21, L10

I. Introduction

The last three decades have witnessed a surge in bank mergers. Although firm mergers have occurred for a long time, the mergers during the past twenty years, known collectively as the "fifth merger wave," have been the most remarkable. The banking industry did not escape the merger wave. Banking industries all over the world have experienced a fundamental change in their market structure through rapid consolidation. Financial deregulation and financial

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globalization triggered fierce competition among banks and necessitated consolidation to reduce risk through business diversification and to take advantage of economies of scale.

The Chinese banking system has undergone a different path of structural change, transforming from a mono-bank system to a "several-tiered" banking system over the last 30-plus years. Several measures of financial liberalization and restructuring have been established to improve competitiveness in the commercial banking industry since the 1990s. There have been many bank foreclosures, takeovers and mergers in China, as in many other countries. However, the number of new banks appearing in the Chinese banking market has far exceeded the number of banks which have disappeared.

Until 1978, there was one single bank, the People's Bank of China. Then, as part of its economic reforms, the Chinese government authorized four state-owned commercial banks between 1979 and 1984, with limited competition among them. Since then the Chinese government has allowed many joint-equity banks and private banks in order to mobilize the financial resources needed for economic development. Furthermore, it authorized several policy banks and local (or city) banks as well as joint-equity banks in the 1990s as a measure of financial liberalization in preparation for entry into the World Trade Organization. All of these developments have contributed to a continuous decrease in the degree of market concentration of the Chinese banking industry. It may be worthwhile to examine whether and how much the decreased market concentration in the Chinese banking industry has improved the competitiveness of the banking sector in China.

The purpose of this paper is empirically to investigate whether changes in the concentration of Chinese banks affected the competition and stability of the Chinese commercial banking market for the period of 1992-2008. The degree of competition is estimated by the H statistic of the Panzar-Rosse model, while financial stability is estimated by the Z score formula. This paper is organized as follows. The next section describes developments in the Chinese commercial banking market and analyzes the market concentration trends in the Chinese banking industry. This is followed by a section which reviews the literature on bank competition and financial stability. Section IV discusses the methodology used to assess the degree of competition in the empirical analysis. Section V describes the data and interprets the estimates of the model. Section 6 investigates the relationship between competition and financial stability. The last section provides a summary and conclusion.

II. Developments in the Chinese Banking Industry and Changes in Bank Concentration

Before Deng Xiao Ping's 1978 reforms, China had a single bank, the People's Bank of China, playing both the role of a central bank and those associated with commercial banking, in order to channel funds in accordance with the state plan. With the reforms, four specialized state banks were derived from the People's Bank of China between 1979 and 1984 to form a two-tier banking system in China, leaving the People's Bank of China (PBC) solely functioning as China's central

bank. The four state commercial banks which split from the People's Bank of China are the Bank of China (BOC), the Construction Bank of China (CBC), the Industrial and Commerce Bank of China (ICBC) and the Agricultural Bank of China (ABC). The intention of the creation of these specialized banks was to provide banking services to specific sectors of the economy. For example, the BOC is to specialize in foreign-exchange transactions and trade finance, the CBC is to specialize in medium- to long-term credit for long-term infrastructure projects and urban housing development, the ICBC acts as the major supplier of funds to China's urban areas and manufacturing sector, and the ABC is to specialize in providing financing to China's agricultural sector while also offering wholesale and retail banking services to farmers.

Despite the fact that restrictions on these specialized banks to do business in only their designated areas were removed in 1985, competition among them remained very limited until the mid-1990s. There was a boost to competition when the Chinese government authorized the establishment of three policy banks. These three banks are the China Development Bank (CDB), the Export Import Bank of China (EIBC), and the Agricultural and Development Bank of China (ADBC). The CDB was chartered to provide long-term lending to finance construction projects for infrastructure and leading industries. The EIBC was established to provide loans for the exports and imports of capital goods. The ADBC provides agricultural lending.

To enhance competition in the Chinese commercial banking market, the Chinese government launched a second round of bank reforms in the 1990s. A variety of new bank types were created, including joint-equity banks, local (or city) banks, and foreign banks. This time, 14 joint-equity banks were established, where shares were held by the government, cooperatives and the private sector. These banks are the Bank of Communication, China Merchants Bank, Shenzhen Development Bank, Guangdong Development Bank, Pudong Development Bank, China Everbright Bank, China Minsheng Banking Corporation, Hua Xia Bank, Fuijin Industrial Bank, Hainan Development Bank, China Investment Bank, Yantai Housing Saving Bank and Bengbu Housing Saving Bank. During the mid-1990s, the central government allowed local governments to establish local (or city) banks. The number of banks continuously increased each year. China, with four state-owned commercial megabanks, now runs four of the world's five largest banks as a consequence of the reduced market value of U.S. and other western banks due to the global financial crisis of 2007-2008.

Among the bank reforms in China, the most noteworthy is the joint-equity reform of the four large state-owned banks owing to its impact on the overall economy. A special treasury bond which amounted to US$32.61 billion was issued in 1998 to strengthen the capital requirements of the four banks, raising their equity ratio to 8%. Four asset management corporations were established to purchase the non-performing loans from the four banks, resulting in a reduction of their non-performing loan ratio by 10%. These four banks took measures to improve their operational efficiency by eliminating more than 55,000 branches and laying nearly 363,000 employees off. Over 2003-2005, the BOC, CBC and ICBC received capital injections from the Chinese government in an amount of $62 billion.

Along with the bank reforms, the Chinese government gradually introduced

market-determined interest rates guided by the central bank rate, and the central bank implemented the liberalization of interest rates. The gradual liberalization of interest rates took place in steps: liberalizing the foreign currency interest rate prior to the domestic currency interest rate, liberalizing the lending rate prior to the deposit rate, and liberalizing the large and long-term fund rates prior to the small and short-term fund rates. This type of the gradual interest rate deregulation provided incentives for banks to strengthen their asset and liability management practices and to earn more profits. A nationwide unified inter-bank market had been created by the end of the 1990s, and both the inter-bank lending rate and the inter-bank bond market rate had been liberalized, thus offering financial institutions more of an incentive to adjust the composition of their assets by reducing their excess reserves while increasing the amount of bonds they held as assets. Banks were also given more autonomy to improve their competitiveness by trading in stock markets and making foreign equity investments.

China's joining the WTO had a major impact on the operation of foreign banks in China and on their involvement in the ownership and management of domestic banks. According to China's commitment to the WTO, all restrictions imposed on the ownership and operation of foreign banks, including restrictions on licenses and the number of branches, had to be removed by 2006. Furthermore, foreign banks became entitled to treatment equal to that of Chinese domestic banks, and the Chinese government allowed foreign banks to own up to 25% of domestic banks. By 2008, foreign banks had equity investments in three state-owned commercial banks, nine joint-equity banks and many local (or city) banks.

There are a number of ways to measure the degree of market concentration. The most widely used index is the Herfindahl-Hirschman Index (HHI). This index is applied by the US Department of Justice in its effort to implement its antitrust policies. Another straightforward method is to calculate the share of the industry's output or assets that is owned by a few dominant firms. This top-k firm concentration ratio (CRk) is used by some governments to determine the degree of anti-competition of a proposed merger. Figure 1 presents the HHI and CR4 of the total assets of China. We obtained the HHI and CR4 of three variables, that is, total assets, total loans and total deposits, finding that the correlation coefficients of the HHI and CR4 among the three variables all exceed 0.99. Therefore, only the HHI and CR4 of total assets are shown in Figure 1.

The higher the CR4 and HHI, the more concentrated the market is. Both the CR4 and HHI show a moderately decreasing trend over time; CR4 decreased from 94% in 1992 to 61% in 2008, while the HHI decreased from 2743 in 1992 to 1642 in 2008. This clearly indicates that the market concentration of the Chinese banking market continually decreased for the period of 1992-2008. This change is mostly attributable to changes in banking policies made by the Chinese government, which allowed the establishment of more banks and promoted competition among them. In spite of several mergers of banks in recent years, the number of new banks created far exceeded the number of banks undergoing foreclosure and a merger. The Chinese banking industry, even with the gradual decrease in its market concentration, is still a highly concentrated market compared to those in other countries. Figure 2 shows the HHI of domestic deposits among a few selected countries. China is not included in this sample, but China would be at the high end

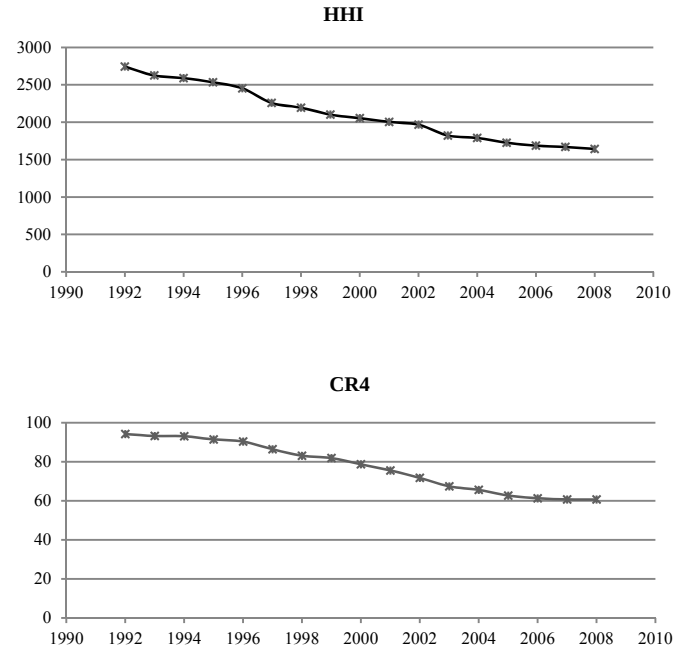

FIGURE 1

Source: 1) HHI is the Herfindahl-Hirschman index and CR_4 is the concentration ratio as measured by the market share of the largest four banks. 2) Total assets are used to calculate CR_4 and HHI. Total assets include assets in both banking accounts and trust accounts.

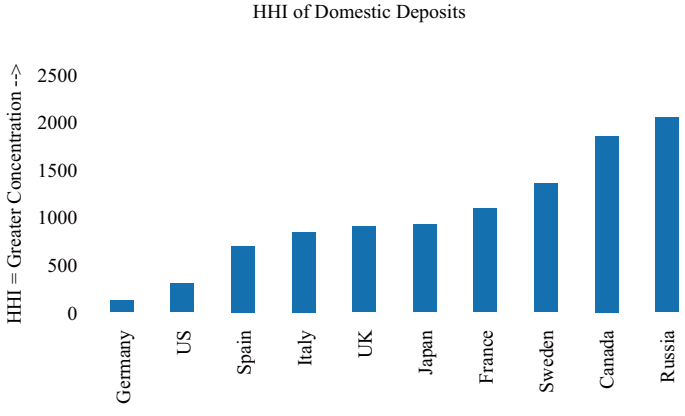

FIGURE 2

Source: Celent analysis, annual report, central banks

of this range, along with Russia and Canada, while Germany and the US are at the low end of the range.

III. Survey of the Literature

In this section, theoretical models and empirical findings pertaining to bank competition are briefly reviewed. Although many studies have been conducted in an effort to investigate the effect of bank consolidation on competition, there is little consensus on an appropriate theoretical framework, and the empirical findings are inconclusive. Gilbert (1984) provides a comprehensive survey of earlier studies and Berger and Humphrey (1992) do so for later studies. The concern about the effect of consolidation on competition arises from the structure-conduct-performance (SCP) paradigm, which dates back to Mason (1939). The SCP model suggests that increasing market concentration leads to less competitive conduct in terms of higher prices and less output and results in higher profits at the expense of lower consumer welfare. This paradigm is the basis of what is termed the "collusion" hypothesis.

Although there is a theoretical basis for these linkages, other equilibrium conditions can lead to different relationships between market concentration and conduct. As long as there are no sunk costs and hit-and-run entry is possible, then market contestability can yield competitive pricing regardless of the number of firms (Baumol *et al.* 1982). The efficient structure hypothesis advances that efficient banks obtain higher profitability and a greater market share due to their efficiency, which will lead to a more concentrated market. Therefore, the association between structure and performance may be spurious unless efficiency is controlled for in the model (Smirlock 1985). Adverse borrower selection may result in spurious empirical SCP linkages as well (Shaffer 2002).

Empirical results on the SCP paradigm are mixed. According to Gilbert (1984), many studies presented a mixed set of results in the aggregate and tended to display various methodological flaws. Weiss (1989) reported that only 21 out of 47 studies support the SCP model. More recent studies find that bank profitability is unrelated or even inversely related to concentration when controlling for efficiency and market share (Berger 1995). Conversely, collusive actions can be found even in non-concentrated markets (Calem and Carlino 1991; Shaffer 1999).

Two empirical methods have been developed to address the shortcomings of the SCP model by testing the conduct directly, without regard to the industry structure. The first of these is the Bresnahan (1982) and Lau (1982) model (B-L model), which estimates the price markup over the marginal cost as a measure of market power. Thus, this method is also termed the markup test. This model is based on two structural equations, an inverse demand equation and a supply equation derived from the first-order condition of profit maximization. The following studies apply the B-L model empirically. Shaffer (1989) rejects the collusive conduct hypothesis with a sample of US banks, and Shaffer (1993) finds that Canadian banks were competitive for the period 1965-1989, even with a relatively concentrated market. Berg and Kim (1994) show that Cournot behavior is rejected in the Norwegian banking system. Fuentes and Sartre (1998) find that bank consolidation in Spain did not weaken the competition level. Gruben and McComb (2003) find regarding Mexican banks before 1995 that marginal prices were set below marginal costs and conclude that the Mexican market is super-competitive.

Another means of overcoming the shortcomings of the SCP model is to use the

Panzar-Rosse (1977) model (P-R model). This model measures the extent to which a change in a vector of input prices is reflected in the gross revenue. Thus, the method is also called the revenue test. If the market is perfectly competitive, the change will then be fully reflected in the revenue. Shaffer (2004) compares and contrasts both methods in detail and discusses their advantages and disadvantages. Numerous studies apply the P-R model empirically, beginning with Shaffer (1983), who finds monopolistic competition with a sample of New York banks in 1979. Nathan and Neave (1989) reject the hypothesis of the monopoly power of Canadian banks. Country-specific empirical studies include Vesala (1995) for Finland, Molyneux *et al.* (1996) for Japan, Coccorese (1998) for Italy, Hondroyiannis (1999) for Greece, and Hempell (2002) for Germany. Molyneux *et al.* (1994) and Bikker and Groeneveld (2000) find monopolistic competition in several European countries. On the other hand, De Bandt and Davis (2000) find monopolistic competition for large banks and monopolies for small banks in Germany and France. Bikker and Haaf (2002) find that the banking industries in 23 OECD countries for the period 1998-1999 are generally characterized by monopolistic competition, with the exception of Australia and Greece. Gelos and Roldos (2002) compare eight European and Latin American countries and find that the bank consolidation process in its early stage does not lower competition.

Molyneux *et al.* (1996) find that the Japanese banking market was under monopoly or conjectural variations of a short-run oligopoly in 1986, though the situation had improved with regard to the level of monopolistic competition by 1988. Uchida and Tsutsui (2005), from long-term Japanese panel data from 1974 to 2000, conclude that market competition improved during the 1970s and 1980s but has worsened since 1997. There are many studies on the efficiency and profitability of Korean banks, including that by Park and Weber (2006a, 2006b). However, very few researchers have studied competition with regard to Korean banks. Lee and Nagano (2008) report that market concentration brought about by bank mergers does not necessarily result in low competition in Japan and Korea. Park (2009) concludes that the Korean banking industry is monopolistically competitive, except during the Asian financial crisis period, from panel data of 1992-2004. Studies of bank competition in China are scant and mostly descriptive rather than analytical. Wong and Wong (2001) describe the trends of bank concentration ratios during the 90s, and Yuan (2006) examines the state of Chinese banking competition for 1996-2000. The present study applies the P-R model to the data of the Chinese banks.

Regarding the relationship between competition and financial stability, there are two opposing schools of thoughts. The competition-fragility school argues that competition drives banks to undertake more risk, while larger banks in concentrated banking systems can reduce their financial fragility by providing more robust capital buffers (Allen and Gale 2004; Boyd *et al.* 2006). The opposing school, believing in the competition-stability linkage, argues that competition leads to more stability. More credit rationing, more competitive lower loan rates and less managerial inefficiency in a less concentrated banking system reduce risk-taking behavior and decrease the probability of bank failure, though banks with more power may engage in more risk-taking behavior (Boyd and DeNicoló 2005; Beck *et al.* 2010; Turk-Ariss 2010). This study will test these opposing models with Chinese bank data.

IV. Model

The P-R model is used to assess the competitive nature of the Chinese banking industry because this model is robust to the extent that market- and bank-level data are available. Let a bank's revenue function be $R = R\ (x, y_1)$, where x is a vector of products and y_1 is a vector of exogenous variables shifting the revenue function, and let a bank's cost function be $C = C\ (x, w, y_2)$, where w is a vector of input prices and y_2 is a vector of exogenous variables shifting the cost function. y_1 and y_2 may have common variables.

Profit maximization by the bank requires that marginal revenue is equal to marginal cost, as $R'(x, y_1) = C'(x, w, y_2)$. Panzar and Rosse (1987) calculate the sum of the elasticities of revenue with respect to input prices from the reduced-form revenue equation and define it as the H-statistic.

$$H = \Sigma\left(\partial R / \partial w_i\right)\left(w_i / R\right) \tag{1}$$

Here, w_i is the i^{th} input price. Panzar and Rosse show from the profit maximization condition that the H-statistic is equal to unity (H=1) in a perfectly competitive market and is less than or equal to zero ($H \leq 0$) under a monopoly. Although the Panzar-Rosse article also shows that $0 < H < 1$ could be consistent with oligopolistic behavior, it is common to regard $0 < H < 1$ as a condition of Chamberlinian monopolistic competition. This interpretation is valid under the assumption that the observations are in long-run equilibrium (Nathan and Neave 1989).

Following Park (2009), we specify the reduced-form revenue equation of a bank as follows,

$$ln\left(R_{it}\right) = \alpha + \beta_1\ ln\left(w_{1,it}\right) + \beta_2\ ln\left(w_{2,it}\right) + \beta_3\ ln\left(w_{3,it}\right) + \gamma_k \Sigma z_k + \varepsilon_{it}, \tag{2}$$

where R_{it} is bank i's revenue at time t, w_1 is the input price of labor, w_2 is the input price of capital, w_3 is the input price of funds, and z_k is a vector of control variables affecting the bank's revenue function. The H-statistic is the sum of β_1, β_2 and β_3. In order to eliminate the manual calculation of $\beta_1 + \beta_2 + \beta_3$ and its standard error, equation (2) can be rearranged as follows.

$$\begin{aligned} ln\left(R_{it}\right) = \alpha &+ \beta_1\left[ln\left(w_{1,it}\right) - ln\left(w_{3,it}\right)\right] + \beta_2\left[ln\left(w_{2,it}\right) - ln\left(w_{3,it}\right)\right] \\ &+ \left(\beta_1 + \beta_2 + \beta_3\right) ln\left(w_{3,it}\right) + \gamma_k \Sigma z_k + \varepsilon_{it} \end{aligned} \tag{3}$$

The H-statistic is estimated by the coefficient of $ln(w_{3,it})$, and its standard error is used to test the significance of this estimate.

The P-R model is constructed under the assumption that the market is in equilibrium. Consequently, following Panzar and Rosse (1977, 1987), Shaffer (1983), Molyneux *et al.* (1996), Claessens and Laeven (2004), and Park (2009), equation (4) is used to test the equilibrium conditions.

$$(4) \qquad ln\left(ROA_{it}\right) = \alpha + \beta_1\ ln\left(w_{1,it}\right) + \beta_2\ ln\left(w_{2,it}\right) + \beta_3\ ln\left(w_{3,it}\right) + \gamma_k\ \Sigma\ z_k + \varepsilon_{it}$$

In equilibrium, rates of return on assets should not be statistically correlated with factor prices (H=0), particularly if the market is perfectly competitive. On the other hand, if the market is in disequilibrium, an increase in factor prices would result in a temporary decline in the rates of return (H<0).

V. Empirical Analysis

Revenue (R_{it}) is typically measured as interest revenue or with its ratio to total assets, presuming that the main function of banks is financial intermediation. However, with the weakening of financial intermediation in recent years and the diversification of bank assets, total revenue or its ratio to total assets is used in some studies. We use both interest revenue (*IR*) and total revenue (*TR*) in this study. ROA is the ratio of net after-tax income to total assets in percentage. The unit labor cost ($w_{1,it}$) is measured by the ratio of personnel expenses to the number of employees, the unit capital cost ($w_{2,it}$) is measured by the ratio of the depreciation allowance and other maintenance costs to the total fixed assets, and the unit funding cost ($w_{3,it}$) is measured by the ratio of interest expenses to the sum of total deposits and borrowings. As personnel expenses are not available in more detail, it is not possible to have differing levels of human capital.

Several control variables are included in the model. Total assets (*ASSET*) are included to observe the size effect and the number of branches (*BRANCH*) is included to account for the effect of the bank network. The ratio of non-performing loans to total loans (*NPL*) is included to control for the credit risk effect. The equity ratio (*EQUITY*) is alternatively used as a control variable for credit market and operational risk. The ratio of non-interest revenue to total revenue (*NINT*) is included to reflect the effect of changing financial intermediation or diversification. The variable BRANCH, representing the bank network, was eventually deleted from the regression estimation due to its high correlation with ASSET. Bikker *et al.* (2006) state that the inclusion of a scale explanatory variable such as ASSET in the Panzar-Rosse model may lead to an overestimation of the level of competition and may distort the tests of monopoly and perfect competition. Therefore, we estimate competitive conditions in both ways, with and without the scale explanatory variable ASSET. However, the H values, regardless of the inclusion or exclusion of ASSET in the model, show similar test results with no indication that the inclusion of a scale explanatory variable causes an overestimation of the level of competition. Thus, in the sections below, we only report the estimation results with the inclusion of ASSET in the model. The fixed-effects model is used for the estimation to reflect bank-specific characteristics and to control for heterogeneity among the banks.

Data used for China are from Bank Scope, the Almanac of Chinese Banking and Finance, and from China Financial Yearbooks. Although China has many banks, only 15 major banks are included in the sample because data availability is limited. A similar sample size is used in Yuan (2006). This limitation of the data tends to

overstate the degree of market concentration. However, any overstatement of HHI would be of a small magnitude, as these 15 banks account for most of the total bank deposits in China, more than 90% in the earlier period and more than 80% in the later period. Furthermore, an overstatement of HHI has no effect on the H statistic, a measure of competition, which is our main concern here. The fifteen Chinese banks are the Bank of China, the China Construction Bank, the Industrial and Commercial Bank of China, the Agricultural Bank of China, the Agricultural Development Bank of China (ADBC), China Development Bank (CDB), the Bank of Communications, China CITIC Bank, China Everbright Bank, China Minsheng Bank, Guangdong Development Bank, Shenzhen Development Bank, China Merchants Bank, Shanghai Pudong Development Bank and Industrial Bank.

A. *Equilibrium Condition Test*

As the P-R model is constructed on the assumption of market equilibrium, the equilibrium condition test is done before the competition condition test. The second column in Table 1 gives the estimation results of equation (4) with the dependent variable, lnROA, for the full sample period. Because the rate of return on assets of some banks can be negative, the dependent variable is actually computed as ln (1+ROA), where ROA is the ratio of net after-tax income to total assets. Several troubled Chinese state and joint-equity banks in their earlier years had negative rates of return on assets. Adding 1 to the ROA before taking the logarithm is arbitrary, but it is a common method used to handle non-positive numbers in logarithmic transformations. Bos and Koetter (2006) point out that adding 1 affects the composition of total error but does not affect the coefficient estimates, which are our main concern.

TABLE 1—TEST OF EQUILIBRIUM CONDITION:
ESTIMATION RESULTS OF EQUATION (4) DEPENDENT VARIABLE: LNROA

	Full Sample Period	Pre-2000 Period	Post-2000 Period
$\ln W_1$	-0.009	0.014	0.002*
	(0.243)	(0.157)	(0.081)
$\ln W_2$	0.007	0.005	0.004
	(0.296)	(0.375)	(0.204)
$\ln W_3$	-0.058**	-0.041	0.008**
	(0.032)	(0.162)	(0.026)
lnASSET	0.022*	0.043**	0.014*
	(0.063)	(0.028)	(0.059)
NINT	0.004	0.002	0.007
	(0.457)	(0.597)	(0.287)
NPL	-0.012**	-0.006	-0.025**
	(0.046)	(0.147)	(0.019)
EQUITY	0.002	0.001	0.005
	(0.186)	(0.285)	(0.139)
ADJ. R^2	0.378	0.342	0.489
Wald test: H=0	5.712**	2.431	1.937
(ρ-value)	(0.017)	(0.121)	(0.194)
Eq. vs. Diseq.	Disequilibrium	Equilibrium	Equilibrium

Source: 1) Estimation results of the fixed-effects model. 2) The coefficients of the constant under the fixed-effects model are not reported here because there are as many as the number of banks. 3) ρ values are shown in parentheses. * and ** indicate significance at the 10% and 5% levels, respectively.

The hypothesis that the market is in equilibrium, that is, H = 0, is rejected for the full sample period at the 2% level of significance. The continuous influx of banks over time and the rapid changes in the structure of the Chinese commercial banking industry may have resulted in a disequilibrium condition. Shaffer (2004) stated that this restriction of the equilibrium condition, that is, H = 0, is necessary only for a case of perfect competition, whereas it is not necessarily required for a case of monopolistic competition. The finding of a disequilibrium condition is not a critical issue, as this paper does not claim that the commercial banking industry in China is perfectly competitive. However, the cause of and solution for the disequilibrium condition are investigated further below.

The Chinese government has introduced many reforms in its financial sectors since year 2000 in an effort to join the WTO (World Trade Organization) and China finally succeeded in joining WTO in December of 2001. Due to several bank reforms and major restructuring in the financial sector during this period, there exist different bank competitive conditions between the pre-2000 period and the post-2000 period. The Chow breakpoint test is used to determine whether there is no significant difference in the estimated equation (4) between the two sub-sample periods, that is, the pre-2000 period and the post-2000 period. The null hypothesis of no structural change is rejected with an F-statistic of 21.38 for the Chow breakpoint test. Therefore, equation (4) is re-estimated for each sub-sample period and its results are reported in the third and fourth columns of Table 1. The hypothesis that the market is in equilibrium, i.e., H = 0, cannot be rejected for each sub-sample period.

B. *Competition Condition Test*

Table 2 presents the estimation results of equation (2) with the dependent variables of lnIR and lnTR along with the H-statistic, which is sum of β_1, β_2 and β_3. According to the Wald test, which is a test for a competition condition, the hypothesis of a monopolistic market structure (H=0) and the hypothesis of a perfectly competitive market structure (H=1) are rejected at the 1% level. We re-estimate equation (2) for each sub-sample period. For the pre-2000 period, the hypothesis of H=1 is rejected, but the hypothesis of H=0 cannot be rejected at the 1% level. For the post-2000 period, both H=0 and H=1 are rejected at the 1% level. These results indicate that there has been a dramatic change in the competition level of the Chinese banking industry over time.

The values of the H statistic for the Chinese banking industry with the full sample are very small regardless of which revenue (lnIR or lnTR) is used as a dependent variable. This result indicates that the Chinese banking market is still far from being a competitive market. It is rather characterized as having an oligopolistic market structure in the earlier period and a monopolistic market structure in the later period. Relatively high adjusted R^2 values indicate the goodness of fit for all of the regressions in Table 2. All coefficients of the input costs, that is, the unit labor cost ($w_{1,it}$), the unit capital cost ($w_{2,it}$) and the unit funding cost ($w_{3,it}$), have positive signs, as expected. However, their coefficient size is small and some coefficients are not statistically significant.

TABLE 2—TEST OF COMPETITION CONDITION: ESTIMATION RESULTS OF EQUATION (2)

	Sample Period		Pre-2000 Period		Post-2000 Period	
	lnIR	lnTR	lnIR	lnTR	lnIR	lnTR
lnW_1	0.116**	0.131**	0.108**	0.112**	0.219**	0.204**
	(0.021)	(0.034)	(0.027)	(0.041)	(0.018)	(0.022)
lnW_2	0.023	0.035	0.029	0.022	0.036*	0.069
	(0.132)	(0.142)	(0.153)	(0.126)	(0.071)	(0.113)
lnW_3	0.078**	0.081**	0.064**	0.072*	0.097**	0.109**
	(0.033)	(0.028)	(0.042)	(0.058)	(0.018)	(0.019)
lnASSET	1.066***	1.009***	1.253***	1.357***	0.938***	0.825***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
NINT	-0.027	0.094	-0.012	0.062	-0.049	0.109
	(0.193)	(0.176)	(0.139)	(0.155)	(0.261)	(0.229)
NPL	-0.004***	-0.006***	-0.002***	-0.004***	-0.005***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
EQUITY	0.013	0.014	0.009	0.008	0.019	0.021
	(0.127)	(0.116)	(0.139)	(0.124)	(0.143)	(0.119)
ADJ. R^2	0.592	0.623	0.504	0.572	0.721	0.698
H statistic	0.233***	0.245***	0.199***	0.208***	0.369***	0.385***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Wald test: H=0,	23.92***	29.32***	3.22*	3.57*	35.33***	39.17***
ρ-value	(0.000)	(0.000)	(0.071)	(0.062)	(0.000)	(0.000)
Wald test: H=1	512.93***	575.62***	714.73***	693.09***	447.28***	419.26***
ρ-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Source: 1) lnIR is the natural logarithm of interest revenue while lnTR is the natural logarithm of total revenue. 2) The coefficients of the constant under the fixed-effects model are not reported here because there are as many as the number of banks. 3) ρ values are shown in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. 4) H statistic and its ρ value are obtained by estimating Equation 3.

The significant and positive sign of ASSET indicates the strong presence of a size effect. NINT (the ratio of non-interest revenue to total revenue) has no significant effect on either interest revenue or total revenue. The dominant source of Chinese banks' revenue is still interest revenue, indicating no sign of weakening of the financial intermediary function of banks in China, in contrast to the trend of the weakening financial intermediary function of banks in Japan and Korea. Only recently have certain Chinese banks expanded their business into non-loan-related activities. While NPL has a significant negative effect on lnIR or lnTR, as expected, equity ratio does not have a significant positive effect on them. According to the signal theory (Berger 1995), banks that expect to have better performance in terms of profitability credibly transmit this information through a higher equity ratio. There appears to be no strong signaling effect of the equity ratio on profitability in China. In other words, higher profit probability of Chinese banks has not been signaled through a higher equity ratio.

C. *Trend of the H Value over Time*

To determine how the values of the H static changed over time, this statistic is estimated for moving three-year time periods, that is, 1992-1994, 1993-1995, 1994-1996 and so on. The estimation results of the H statistic are reported together with HHI in Table 3.

Market concentration as measured by HHI declined continuously from 2743 in

TABLE 3—MARKET CONCENTRATION AND COMPETITION LEVEL OVER TIME

Year	HHI - Total Assets	H-statistic with lnIR	H-statistic with lnTR
1992-1994	2652	0.136	0.149
1993-1995	2583	0.164	0.174
1994-1996	2525	0.182	0.192
1995-1997	2415	0.207	0.228
1996-1998	2301	0.215	0.247
1997-1999	2184	0.233	0.269
1998-2000	2116	0.259	0.278
1999-2001	2053	0.271	0.299
2000-2002	2008	0.298	0.321
2001-2003	1931	0.302	0.343
2002-2004	1859	0.342	0.338
2003-2005	1779	0.365	0.376
2004-2006	1734	0.389	0.402
2005-2007	1694	0.405	0.427
2006-2008	1666	0.426	0.449

1992 to 1642 in 2008. The H statistic with both lnIR and lnTR increased gradually over the same time period, from less than .15 in the earlier period to more than .4 in the later period. Hence, these two variables exhibit a high negative correlation. The correlation coefficient between HHI and the H statistic with lnIR is -0.974, while the correlation coefficient between HHI and the H statistic with lnTR is -0.976. The decrease in the market concentration of the Chinese banking sector unquestionably contributed to an improvement in the banking competition level in China, although the effect may be mild.

D. *Comparison between Korea and China*

Contrary to the increasing trend of market concentration in the Korean banking industry, the Chinese banking system has experienced a continually decreasing market concentration. According to Park (2009), the Korean banking industry experienced an increase in the HHI of assets from 876 in 1992 to 1325 in 2004. This study finds that the HHI of assets in China decreased from 2743 in 1994 to 1642 in 2008. Bank merger activities and the creation of a few megabanks in Korea contributed to the increasing trend of banking market concentration. On the other hand, the financial liberalization policy of the Chinese government has increased the creation of new banks year after year, contributing to the decreasing trend of banking market concentration.

The H-statistic sheds light on the differences in the market structures between Korea and China. Park (2009), in his study on Korean banking, reports that the H-statistic value for either interest revenue or total revenue ranges from .511 to .659 during the stable period, which excludes the Asian financial crisis period. This indicates that the Korean banking market is monopolistically competitive. On the other hand, this study finds that the H-statistic value for either interest revenue or total revenue ranges from .211 to .385, implying a market structure closer to an oligopoly in the Chinese commercial banking market.

VI. Effect on Financial Stability

In this section, we investigate how bank competition affects the financial stability of Chinese banks. While competition among banks influences bank stability, bank competition may also be affected by the degree of financial stability, as banks may utilize a different competition strategy depending on the stability condition, causing the endogeneity problem of competition variables. Following Boyd *et al.* (2006) and Beck *et al.* (2010), we deployed lagged variables of the explanatory variables in the following estimation equation to address this endogeneity problem.

$$Z_{it} = \alpha + \beta_k \ \Sigma \ C_{k,i\ t-1} + \gamma_k \ \Sigma \ X_{k,i\ t-1} + \delta_k \ \Sigma \ Y_{k,t-1} + \varepsilon_{it} \tag{5}$$

In this equation, Z_{it} represents the Z score of bank i at time t; $C_{k,i\ t-1}$ are variables indicating the competitiveness of bank i at time $t-1$, such as the net interest margin and the Lerner index; $X_{k,i\ t-1}$ are bank-specific variables of bank i at time $t-1$, such as the equity ratio, the share of non-performing loans and the number of branches; and $Y_{k,t-1}$ are macroeconomic variables such as the economic growth rate, the inflation rate at time $t-1$ and two dummy variables, one representing the crisis period and another representing the post-2000 period. The Z score is calculated as the sum of a bank's asset returns and the capital-to-assets ratio divided by the standard deviation of asset returns. Therefore, the Z score can be interpreted as the number of standard deviations that a bank's return on assets has to drop below its expected value before equity is depleted and the bank becomes insolvent. A higher Z score indicates that a bank is more stable and thus has less probability of failing.

We use two variables, the Lerner index and the net interest margin, as our measure of bank competition, with HHI as a measure of market concentration. While the H statistic shows the degree of competition for the entire banking industry, it does not show individual banks' levels of competitiveness. Accordingly, the Leaner index and the net interest margin instead of the H statistic are used to determine how individual banks' competitiveness levels affect bank stability. The Lerner index, which measures the mark-up of prices over marginal costs, indicates the degree of market power. It is calculated as

$$L_{it} = \left(P_{it} - MC_{it} \right) / P_{it},$$

where P_{it} is the price of total assets of bank i at time t, measured by the ratio of total revenues to total assets; MC_{it} is the marginal cost of bank i at time t. Following Turk-Ariss (2010), the marginal cost of bank i at time t is calculated as follows,

$$MC = TC / Q\left[\alpha + \beta \ ln \ Q + \Sigma \varphi_k \ ln \ W_k + \delta \ T \right], \tag{6}$$

where TC denotes total expenses, Q is total assets, and W_k represents the three input prices of labor, fixed capital and funding. T (Trend) is used to capture technical

TABLE 4—ESTIMATION RESULTS OF EQUATION (5), DEPENDENT VARIABLE: LN Z SCORE

Category	Variable	Model 1	Model 2
Competition Variables	Lerner Index	1.031**	
		(0.001)	
	Net Interest Margin		0.121**
			(0.003)
Concentration Variable	HHI (Assets)	-0.238*	-0.306*
		(0.046)	(0.049)
Bank-Specific Variables	Loans/ Assets	-0.137*	-0.148*
		(0.046)	(0.038)
	ln Branch	0.264*	0.314*
		(0.037)	(0.032)
	NPL	-0.061**	-0.053**
		(0.007)	(0.008)
Macroeconomic Variables	GDP Growth Rate	0.069	0.125
		(0.144)	(0.123)
	Inflation Rate	-0.102	-0.088
		(0.197)	(0.156)
Dummy Variables	CRISIS	-0.057	-0.062
		(0.115)	(0.157)
	Post-2000	0.129*	0.152*
		(0.032)	(0.040)
Adj. R^2		0.842	0.827

Source: 1) Estimation results of fixed-effects model. The coefficients of the constant under the fixed-effects model are not reported here. 2) ρ values are shown in parentheses. * and ** indicate significance at the 5% and 1% levels, respectively.

changes in the cost function over time. Equation (6) is scaled by the unit labor cost (*ln W3*) to account for heteroscedasticity.

Table 4 reports the estimation results of equation (5) for Chinese commercial banks. All independent and control variables are lagged by one year. The Lerner index and the net interest margin are highly correlated such that they enter the regression model separately in model 1 and model 2. HHI is negatively related to financial soundness, while both the Lerner index and net interest margin have positive and significant effects on the Z score. Our interpretation of the results is that while the higher degree of market concentration may have a negative effect on the financial stability of the entire banking system, an individual bank's ability to earn higher markups or charge a higher net interest margin contributes to its financial soundness.

Among the bank-specific variables, the loan-to-asset ratio has a negative effect on the Z-score, whereas larger banks or banks with more branches tend to be financially more stable than smaller banks. The ratio of non-performing loans to total loans (NPL) is negatively and significantly linked to the degree of financial stability. None of the macroeconomic variables are statistically significant. The GDP growth rate has a positive effect, while the inflation rate has a negative effect on the Z score, though neither is statistically significant. A dummy variable, CRISIS, has a negative but insignificant effect on the Z-score, which indicates that Chinese banks were not affected as much by the Asian financial crisis of 1997-1998 as the banks of many other Asian countries. The second dummy variable, Post-2000, distinguishing the pre-2000 period and the post-2000 period, is positive and significant.

VII. Summary and Conclusion

Worldwide financial liberalization and financial globalization caused fierce competition among banks all over the world. This necessitated bank mergers and consolidation within a country and across countries to achieve scale efficiency so as to take advantage of diversification or simply to survive. The bank merger wave began in the U.S.A. and spread to Europe, Japan and Korea. However, this wave has not yet hit the Chinese banking market owing to its restricted financial openness and the stringent government regulations on banking. Bank mergers in China were typically initiated by the government rather than originating in the market.

In this study, we examined the effect of market concentration on bank competition in China. The competitive conditions of the Chinese banking industry have definitely improved over time. The Chinese banking system progressed from a one-bank system to a four-bank system of state banks in the 1980s, transforming to a system with more than 20 banks, including joint-equity commercial banks, in the 1990s to a system with several hundred banks at the present time. This study finds that in spite of a drastic decrease in market concentration of the Chinese banking industry, its competition conditions are far from those of a competitive market, as evidenced by the small H statistic values. It appears that bank reforms have a small effect on the competitiveness of Chinese commercial banking. The sheer number of banks does not guarantee a competitive market. Lowering entry barriers for private banks and foreign banks would further facilitate competition. Institutional changes and lifting government regulations on banking are also necessary to speed up competitive behaviors in the Chinese banking market.

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