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The effects of reform on China's bank structure and performance

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Abstract

This paper investigates the relationship between market structure and performance in China's banking system from 1985 to 2002, a period when this sector was subject to gradual but notable reform. Using panel data estimation techniques, both the market-power and efficient-structure hypotheses are tested. In addition, the model is extended to consider issues such as the impact of bank size/ownership and whether the big four banks enjoy a "quiet life". On average, X-efficiency declined significantly and most banks were operating below scale efficient levels. Estimation of the structure–performance models lends some support to the relative market-power hypothesis in the early period. The reforms had little impact on the structure of China's banking sector, though the "joint stock" banks became relatively more X-efficient. There was no evidence to support the quiet-life hypothesis, probably because strict interest rate controls prevented the state banks from earning monopoly profits. Thus the ongoing liberalisation of interest rates should be accompanied by reduced concentration. Overall, to improve competitive structure, new policies should be directed at encouraging market entry and increasing the market share of the most efficient banks.

JEL classification: G21; G28

Keywords: Market structure and performance; Reform of China's banking sector; X-efficiency; Scale efficiency

1. Introduction

An extensive literature reveals two major hypotheses on the structure–performance relationship in banking. Under the market-power hypothesis, firms in a concentrated market or with a large market share and well-differentiated products may exercise market power in pricing and earn supernormal profits. The efficient-structure hypothesis posits that low costs of production by relatively efficient firms enable them to compete more aggressively, capture a bigger market share and earn high profits. The implications for competition policy are in direct opposition: anti-trust regulation is supported by the market-power hypothesis but rejected if the efficient-structure hypothesis holds.

This paper contributes to the literature in a number of directions. First, it fills a void by developing a structure–performance model for China. Despite its status as a key tiger economy, to date, there has been no published work in this area. Second, in line with recent work, it expands beyond the narrow confines of concentration and competition/performance by incorporating issues related to bank reform, integrating China's unique banking structure, and testing the quiet-life hypothesis.

The model incorporates measures of concentration, market share, X-efficiency, scale efficiency, and an ownership dummy directly into the estimating equation, to test both the market-power and the efficient-structure hypotheses in China's banking sector, together with the impact of size/ownership over period 1985–2002, during two distinct phases of regulatory change. In the presence of panel data, the random effects (GLS) estimating procedure is employed, though the results using a traditional OLS

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method are also reported. The findings suggest that future policy should be directed at encouraging the development of joint-stock (i.e. shareholder owned) banks. These are found to be more efficient, so they could increase their market share and improve competition. Further improvements could be realised by deregulation of market entry and a continuation of the policy to liberalise interest rates. The paper is organised as follows. Section 2 provides a brief outline of the current Chinese banking system, followed by a literature review in Section 3. Section 4 discusses the methodology and the data used. Section 5 presents the results of the tests. Section 6 summarises and presents the implications of the results for China's banking sector in its new regulatory environment.

2. China's banking system

Until 1978, China operated an economic and financial system based on socialist principles. The People's Bank of China (PBC) not only issued currency, but also was the financial hub of each State Economic Plan. In 1978, China embarked on major economic reforms with the objective of increasing economic efficiency and improving resource allocation. In line with most sectors of the economy, the banking system was the focus of significant, albeit gradual, reforms.[1] To date, there have been two stages of reform, from 1979 to 1992, and from 1993 to present.[2] Stage one began with the creation of a "two tier" banking system, consisting of the People's Bank of China (the central bank) and four state owned banks: the Industrial and Commercial Bank of China (ICBC), the Agricultural Bank of China (ABC), the Bank of China (BOC),[3] and the China Construction Bank (CCB). Initially there was a high degree of functional segmentation between them. By 1985, they were allowed to accept deposits and make loans to households and corporates (mainly SOEs: state-owned enterprises) via nation-wide branches.[4] By 1986, most had expanded to universal banks, with trust, securities, and insurance affiliates.[5]

Between 1985 and 1992, to promote more competition, the government allowed new "small and medium sized" commercial banks to be established, which initially offered bank services to households and firms, mainly in the regions and cities.[6] This group included the Bank of Communications, the CITIC Industrial Bank, the Shenzhen and Guangdong Development banks, China Merchants Bank, China Everbright Bank and Hua Xia Bank. Many are joint-stock, i.e. shareholder owned.

In 1993, the State Council announced a second stage of bank reforms in the "Decision on Financial System Reform".[7] One objective was to create a competitive commercial banking sector where state banks co-existed along side other types of banking institutions.[8] Numerous reforms were implemented,[9] resulting in a banking system the key features of which are:

- The central bank, PBC: responsible for the implementation of monetary policy, though the State Council (China's equivalent of a cabinet) sets interest rates. The Governor of the PBC is on the committee that advises the State Council.
- The China Banking Regulatory Commission: established in 2003, it is the supervisory authority for banks. The PBC has a financial stability bureau to take decisions about liquidity support in the event of bank runs.
- Three policy banks: established in 1994 to finance major government projects (e.g. infrastructure); funded mainly through issues of state bonds and loans from the PBC.
- Four state-owned commercial banks (BOC, CCB, ICBC, ABC) which provide nationwide wholesale (to large and medium sized enterprises) and retail banking services. Overseas branches serve Chinese customers abroad. The average assets of these four banks over the period (1985–2002) were RMB 2400 billion (or $290 billion).
- Eleven[10] joint stock banks, with shares owned by the state, private sector, and some foreign concerns. The state and/or state-owned enterprises (SOEs) hold 60–70% of non-tradable shares – only four have a small proportion of their shares traded on the stock market.[11] These banks tend to focus on offering retail and

[1] China's gradual reforms are characterised by partial experimentation and a trial-and-error approach. The successes and failures of these experiments influence the decisions on the future direction of reform policy (Jin, 1994). There is a debate about the optimal pace and sequence of banking reforms. Some argue that China's gradual approach maintained market order, preserved a high savings rate for economic development, and contributed to superior economic performance (e.g. Murrell, 1995; Walder, 1996). While acknowledging the successful strategy, others note that China is quite unique and its approach is not suitable for other transition economies (e.g. Woo, 1994; Sachs and Woo, 1994). Lardy (1998) and Lo (2001), among others, note the substantial economic costs of bank reform, citing the growing problem of non-performing loans as evidence.

[2] For more detail on these reforms, see Wu (1998) and Xie and Jiao (2002).

[3] The Bank of China began operating as a private bank in 1912, but also had central bank responsibilities.

[4] At the end of 1992, each bank had an average of about 30,000 branches and sub-branches, though there were large variations. The ABC had over 56,000 and at the other extreme the BOC had 1352. The ICBC had just under 32,000.

[5] However, universal banking was short-lived. From 1993 onward, banks had to terminate their securities and insurance operations.

[6] Later, two of these banks expanded beyond their regions, with nationwide branches.

[7] Almanac of China's Finance and Banking (1994).

[8] Wu (1998).

[9] Space constraints prevent a review of them here. For more detail, see Fu (2004) and Wu (1998).

[10] In 2003, the Yantai House Savings Bank became a new joint stock bank, the China Evergrowing Bank.

[11] The Shenzhen Development Bank was the first to list a minority of its shares on the Shenzhen Stock Exchange in 1991. Three other banks followed between 1999 and 2002.

wholesale banking services in medium sized and large cities. Their average assets over the period were RMB 321 billion ($38.8 billion).

- City Commercial Banks (111) owned by local government, local enterprises, and households. They offer commercial banking services (intermediary, settlements, money transfers, etc.) to city-based small and medium sized enterprises and residents, though they are also trying to attract larger firms headquartered in their respective cities, which would normally do business with a state bank. There is some customer overlap with the 758 Urban Credit Cooperatives, though the coops offer basic banking services (taking deposits, making small loans) to residents and small local firms in urban areas.
- Rural Commercial Banks (3): like their urban counterparts but operate in rural areas.
- Rural Credit Coops (35,544): each coop supplies basic banking services to residents and local enterprises based in rural areas.
- In 2004, there were roughly 204 foreign bank subsidiaries, which are permitted to provide nation-wide foreign exchange facilities to foreigners and Chinese citizens. They provide Renminbi services in 20 cities (2005) as part of China's World Trade Organisation[12] commitment to give foreign banks completely open access to Chinese markets by the end of 2006. Some have acquired shareholdings in the joint stock banks. For example, Newbridge Financial now owns 15% of Shenzhen Development Bank, and Citicorp has a 5% share in Pudong Development Bank.

These bullet points illustrate that segmentation remains a feature of China's banking system following the second stage of reforms. The State Council only recently (late 2003) accepted the principle of private ownership, which explains why China's private equity markets remain underdeveloped, and means the banking system plays a critical role in the supply of finance. Table 1 shows that in 2002, the combined market share of the state-owned and joint stock commercial banks was about 80% of deposits and 70% of loans. Since 1992, the joint stocks have increased their share of loans and deposits to over 10% though the big four state banks continue to dominate, with market shares well in excess of 50%.

This study focuses on the state-owned and joint stock commercial banks. It is reasonable to assume a single national banking market for the purposes of calculating measures of concentration and market share, because these are the only banks allowed to operate nation-wide, with branches throughout the country. For example, in 2004, the Agricultural Bank of China, one of the big four, had over 30,000 branches nation-wide. Their dominance of the deposit and loan markets (Table 1) has been largely unchanged for nearly two decades. Furthermore, (state-controlled) deposit and loan rates apply across the country. For example, rates quoted by the CCB will apply in all its branches. A plan to liberalise rates was announced in 2002. Thus, certain features of China's national banking system are not unlike those found in Canada, Australia and most European countries including, among others, France, the UK, and Spain.[13]

Table 1
Chinese banks: shares of deposits and loans: 1992 and 2002

Banks	Deposits – 1992	Deposits – 2002	Loans – 1992	Loans – 2002
Policy banks	NA	0	NA	13%
State-owned commercial banks	78%	66%	84%	59%
Joint stock commercial banks	6%	13%	4%	11%
City commercial banks	NA	7%	NA	6%
Urban credit cooperatives	3%	1%	2%	0.005%
Rural credit cooperatives	13%	12%	9%	10%
Foreign banks	0.004%	1%	1%	1%
Total	RMB 2742 bn	RMB 16,861 bn	RMB 2759 bn	RMB 13,528 bn

Sources: Fu (2004) and Almanac of China's Finance and Banking (1993, 2003).

Some financial institutions are excluded from the study because either their operations are regional (e.g. city/rural commercial banks) or they focus on a certain group of members (e.g. cooperatives). Hence, their inclusion could create a heterogeneous sample. Given their average market share is less than 25% over the sample period, their exclusion should not materially alter the results.

Some readers might question whether it is appropriate to assess structure and performance in the China's banking market using the market power/efficient structure hypotheses. The answer is in the affirmative, for a number of reasons. First, when the state-owned commercial banks were created, they were expected to minimise costs. Invoking duality theory, there is no reason why these tests should not be employed. Second, the Commercial Banking Law (1995) required the state-owned banks to maximise profit; and it has been the objective function of the joint stocks since they were established. Third, even though some banks have been subject to government interference, this is really no different from banks in other countries, which must satisfy a host of regulations in order to operate, and are often called upon by regulators to, for example, participate in the

[12] China became a member of the World Trade Organisation in 2001.

[13] If anything, the US is somewhat unique with its "local" banking markets, and limited nation-wide banking. This is largely due to regulations on inter (even intra) state branching. Nation-wide branching was made possible (from 1997) after the Riegle Neal Interstate Banking and Branch Efficiency Act was passed in 1994. The effects of these changes are beginning to be felt, with the Bank of America able to claim nation-wide banking status. Even so, its expansion is limited because of the rule that no bank can control more than 10% of US deposits.

life boat rescue of another failing bank. Finally, to date, the Chinese government was unwilling to let their big banks fail. Again, regulators in most countries have a policy of protecting banks considered too big to fail, and many intervene to safeguard smaller banks too. Japan is a recent example, where the whole system was shielded for well over a decade. Even in the United States, where regulators have been required by law to take prompt corrective action and adopt a least cost approach to failing banks, the Federal Reserve can, under certain conditions, engineer the rescue of any bank which poses a "systemic risk".

Given that the state is a major shareholder of joint stock banks, another legitimate question is whether there is any difference between the two types of bank. Even though the newly created policy banks were supposed to fund major projects[14] (to fill the gap caused by the absence of private capital), the state-owned banks continued to assist in fulfilling social welfare objectives. By contrast, the joint-stock banks were established to facilitate the development of an efficient banking system, and so are less likely to be involved with the implementation of state policy. Nonetheless, their ownership structure makes them vulnerable to named lending. Introducing an ownership dummy in the estimating equation (see below) makes it is possible to assess whether these different types of bank had any significant influence on structure and performance over the period.

3. Literature review and hypotheses

The early empirical literature focused on the structure-conduct-performance (SCP) and the relative efficiency (RE) hypotheses. SCP says a change in the market structure or concentration of banking firms affects the way banks behave and perform. The more concentrated the market, the more market power banks have, which means they can be inefficient (i.e. avoid minimising costs) without being forced out of the market. All else equal, SCP predicts that the more concentrated the market, the more profitable the banks, earned from higher loan rates and lower deposit rates. RE posits that the more efficient firms earn supernormal profits. A consequence of greater efficiency could be higher output. Like SCP, the relative efficiency hypothesis predicts a positive profits–concentration relationship. The empirical evidence is mixed. For example, Gilbert (1984) reviewed 44 studies which employed US data published between 1964 and 1982. Just over half supported the SCP hypothesis and the rest reported evidence consistent with the relative efficiency hypothesis. Lloyd-Willians and Molyneux (1994) and Molyneux and Forbes (1995) found evidence in favour of the traditional SCP paradigm for Spanish banking (1986–1988) and European banking (1986–1989).[15]

These ideas evolved into two market-power hypotheses, consisting of the traditional SCP model and the relative market-power (RMP) hypothesis: banks with a higher market share and well-differentiated products exert more market power and earn higher profits, independent of how concentrated the market is (Shepherd, 1982). Two efficient-structure propositions also emerged. The relative X-efficiency (ESX) hypothesis states that more X-efficient banks (due to better management and/or better technology) have lower costs, higher profits, and bigger market shares, which may result in greater concentration (Demsetz, 1973, 1974; Peltzman, 1977). Under the relative scale-efficiency (ESS) hypothesis, banks have similar management skills and production technology but different scale economies.[16] Banks operating at optimal economies of scale will have lower costs, and consequently, higher profits, which may lead to a larger market share and/or greater concentration (Lambson, 1987).

The hypotheses have directly opposing policy implications. If high profits are created by market power, then anti-trust enforcement may be socially beneficial, moving prices toward competitive levels and allocating resources more effectively. By contrast, if greater efficiency is the explanation for high profits, then either breaking up efficient firms or forbidding them to acquire other firms may raise costs and lead to less favourable prices for consumers.

Using 1980s data on US banks, Berger (1995) developed a series of tests which included direct measures of both market structure and efficiency in one model. He reported limited support for both the RMP and ESX hypotheses. Employing data on banks across 11 European countries over the period 1988–1991, Goldberg and Rai (1996) found evidence favouring the RMP hypothesis for all banks except for those located in countries with low concentration ratios, where the evidence supported the ESX hypothesis. Berger and Hannan (1997) employed US bank data (1985) and found more support for the structure-conduct-performance paradigm than for the relative market-power or efficient-structure hypotheses.

Berger and Hannan (1997) also tested the 'quiet life' hypothesis, based on the observation made by Hicks:

> "The best of all monopoly profits is a quiet life." (Hicks, 1935, p. 8).

It is posited that firms with greater market power opt for a more relaxed environment in which less effort is put into the rigours of maximising cost efficiency, at the expense of somewhat lower profits. As a result of this slack management, banks with greater market power are inefficient. Their findings supported the quiet-life hypothesis.

[14] E.G.: The development of the infrastructure, assisting state-owned enterprises with mergers or bankruptcy liquidation, subsidising student education, programs for finding unemployed workers new jobs, and other social undertakings.

[15] Other studies using US or European data include: Brozen (1982), Smirlock (1985), Evanoff and Fortier (1988), Molyneux et al. (1996).

[16] Banks producing at output levels closer to the minimum average cost point may achieve greater scale efficiencies.

Using Spanish banking data from 1990 to 1993, Maudos (1998) found support for both the X-efficiency and relative market-power hypotheses. Goddard et al. (2001) reported evidence favouring the SCP, ESX, and ESS hypotheses for banks from 15 European countries over the period 1989–1996. Based on Portuguese banking data during the nineties, Mendes and Rebelo (2003) showed that both the SCP and the ESX hypotheses held in the first half of the nineties but after 1994, there was more evidence for the RMP and ESX hypotheses.

Berger et al. (2004), summarising the new research avenues in the area of competition and concentration, stressed the importance of future investigations using a broad framework, incorporating, where possible, bank regulation and institutional structure. The methodology outlined below shows how this study fulfills some of these objectives by extending the traditional approach to address the effects of reform, ownership structure, and other issues.

4. Methodology and data

4.1. Methodology

Following Berger (1995) and Goldberg and Rai (1996), Eq. (1) is used to test the validity of the four hypotheses:

$$P_{i,t} = \alpha_0 + \beta_1 \mathrm{CONC}_t + \beta_2 \mathrm{MS}_{i,t} + \beta_3 \mathrm{XEFF}_{i,t} + \beta_4 \mathrm{SEFF}_{i,t} + \beta_5 \mathrm{CONTROL}_{i,t} + e_{i,t} \quad (1)$$

where $P_{i,t}$: a measure of profitability, such as return on equity (ROE) or return on assets (ROA), of bank i at time t; CONC_t: a measure of market concentration, such as four-bank concentration ratio (CR4) or Herfindahl–Hirschman index (HERF) of concentration at time t; $\mathrm{MS}_{i,t}$: market share (in terms of deposits) of bank i at time t; $\mathrm{XEFF}_{i,t}$: a measure of X-efficiency, reflecting the ability of banks to produce a given bundle of output at minimum cost through superior management and/or technology; $\mathrm{SEFF}_{i,t}$: a measure of scale-efficiency, reflecting the ability of banks to produce at optimal output levels (economies of scale), given similar production and management technology; $\mathrm{CONTROL}_{i,t}$: a vector of control variables, including average income per person (AIP_t), a dummy variable for different ownership (OWN_i), a time trend variable (TT_t), the ratio of loans to assets ($\mathrm{LA}_{i,t}$), and the ratio of equity to assets ($\mathrm{KA}_{i,t}$); and $e_{i,t}$: an error variable for each bank i at time t.

Under the efficient-structure (ES) hypotheses, causation is assumed to run from efficiency to profits, and to market structure. More efficient banks should have higher profits, so the signs of the coefficients on XEFF and SEFF should be significantly positive, that is, $\beta_3 > 0$, $\beta_4 > 0$. Under the market-power hypotheses, a positive and significant β_1 confirms the structure-conduct-performance; β_2 should be positive if the relative market-power hypothesis holds.

It is possible that the measures of concentration (CONC) and market share (MS) are endogenous in the ES model. However, Berger (1995) argued they can be included as independent variables, since they are correlated with profitability only because they reflect the influences of XEFF and/or SEFF and the control variables in Eq. (1).[17] Furthermore, in theory, such endogeneity arises under conditions of free entry with fixed costs, but in China, the state has, to date, placed strict controls on bank entry.

To ensure the absence of a spurious relationship between profitability and market structure, both profits and the market structure variables must be positively related to efficiency. Thus, a necessary condition for the efficient-structure hypothesis to hold is that efficiency has a positive effect on market structure. To establish its presence, two additional equations are estimated:

$$\mathrm{CONC}_t = \alpha + \beta_1 \mathrm{XEFF}_{i,t} + \beta_2 \mathrm{SEFF}_{i,t} + \beta_3 \mathrm{CONTROL}_{i,t} + e_{i,t} \quad (2)$$

$$\mathrm{MS}_{i,t} = \alpha + \beta_1 \mathrm{XEFF}_{i,t} + \beta_2 \mathrm{SEFF}_{i,t} + \beta_3 \mathrm{CONTROL}_{i,t} + e_{i,t} \quad (3)$$

The necessary condition is satisfied if the signs on the coefficients XEFF and SEFF are significantly positive in Eqs. (2) and (3). Therefore, the efficient-market hypothesis is strictly valid only if more efficient banks are more profitable, with larger market shares and/or higher levels of market concentration.

Like Berger and Hannan (1997), Eqs. (4) and (5) are used to test Hicks' (1935) 'quiet life' hypothesis.

$$\mathrm{XEFF}_{i,t} = \alpha + \beta_1 \mathrm{CONC}_t + \beta_2 \mathrm{MS}_{i,t} + \beta_3 \mathrm{CONTROL}_{i,t} + e_{i,t} \quad (4)$$

$$\mathrm{SEFF}_{i,t} = \alpha + \beta_1 \mathrm{CONC}_t + \beta_2 \mathrm{MS}_{i,t} + \beta_3 \mathrm{CONTROL}_{i,t} + e_{i,t} \quad (5)$$

According to the 'quiet life' hypothesis, the signs on the coefficients on CONC and/or MS should be significantly negative in Eqs. (4) and (5). Thus, banks with greater market power are less efficient due to a relaxed environment and slack management. Note the direction of causation is reversed between Eqs. (2)/(3) and (4)/(5). If both sets of relations are found to hold, then OLS estimation causes simultaneous equation bias (Berger and Hannan, 1997), which is usually resolved by using a two-stage least squares (2SLS) procedure. As will be seen (Section 5), the results for China make this unnecessary.

All the equations are first estimated using both the fixed and random effects (GLS) approaches for panel data. As indicated by Greene (2003), the fundamental advantage of a panel data set over a cross-section or time-series is that the researcher can allow for differences in behaviour across individuals and/or time periods. A

[17] The prerequisite of this argument is that the model is block-recursive – that other factors affecting market structure do not affect profitability. That is, the error terms in the recursive structural model are mutually uncorrelated (Berger, 1995; Berger and Hannan, 1997).

Hausmann test is used to identify the optimal model.[18] These results are compared with those from an OLS estimation on the pooled sample.

4.2. Data

Most of the data used in this study come from various editions of *the Almanac of China's Finance and Banking*, which reports annual results from the balance sheet and income statements of all banks operating in China. The number of employees, the average wages of employees, and the average income per person are obtained from the China Statistical Yearbook (2003). Data are collected for the four state-owned commercial banks and the ten joint-stock commercial banks. The full sample runs from 1985 to 2002 with 187 observations, but the data are split into two sub-samples, covering, respectively, the reforms in stage I (1985–1992), and stage II (1993–2002). The variables are described below.

4.2.1. Measures of profitability and concentration

Two popular measures of profitability, ROA and ROE, are employed here. ROA is defined as the ratio of pre-tax net income to total assets, and ROE: the ratio of pre-tax net income to total equity.[19] In addition, two common measures of concentration, the four-bank concentration ratio, CR4, and the Herfindahl–Hirschman Index (HERF), are used. CR4 is defined as the ratio of the total deposits of the four largest banks to the total deposits of all the banks in a given year. CR4 should be close to 0 for a perfectly competitive market and 100 for a monopoly. However, the CR4 measure is limited because it excludes the joint stocks' market share, though it is well known that their market share is quite small and did not vary much over the period.

HERF is defined as the sum of squared market shares of deposits of the sample of banks in a given year. The index is slightly greater than 0 for a perfectly competitive market and 100 for a monopoly. Generally, the more banks there are in a market, the lower is the value of HERF, ceteris paribus. HERF takes into account both the number of banks and the inequality of market shares. For example, HERF will increase as the market shares of a given number of banks become less equal. Use of the Herfindahl index appeals because Cowling and Waterson (1976), among others, showed its link with a firm's mark-up implicit in the Cournot model of oligopoly.[20] However, it is not without its critics: Hannah and Kay (1977) pointed out that HERF uses a particular weighting between the inequality of the firms' market shares and the number of firms. Nonetheless, HERF (and CR_4) are the most common measures used in virtually all the published studies in this area. In this study, market share (MS) is defined as the ratio of an individual bank's total deposits to the total deposits of all banks in a given year.

4.2.2. X-efficiency

X-efficiency measures the efficiency with which banks employ their inputs to produce a given bundle of outputs, and is derived from the following cost function:

$$\ln C = f(w_i, y_i, \varepsilon_i) \tag{6}$$

where C: total costs; w_i: the input prices; y_i: the output quantities; $\varepsilon_i = u_i + v_i$; u_i: an X-inefficiency factor that may raise costs above the best-practice level; and v_i: the random error that incorporates measurement error and chance that may give banks high or low costs occasionally.

Eq. (6) is estimated using a translog specification with four output quantities (total loans, total deposits, total investments, non-interest income) and prices for three inputs (borrowed funds, labour, physical capital). The X-inefficiency factor u_i incorporates both technical inefficiencies from using too much of the inputs to produce the same outputs, y_i, and allocative inefficiencies from failing to react optimally to relative prices of inputs, w_i. The standard assumption is that the X-inefficiency and random error terms can be multiplicatively separated from the remainder of the cost function.

X-efficiency is defined as the ratio of the predicted minimum costs that would be used if the bank were as efficient as the best-practice bank in the sample facing the same exogenous variables (w, y) to the predicted actual costs, adjusted for random error. According to Berger and Mester (1997), a bank-specific measure of X-efficiency is calculated as follows:

$$X - \mathrm{EFF}^i = \frac{\widehat{C}^{\min}}{\widehat{C}^i} = \frac{\exp[\hat{f}(w_i, y_i)] \times \exp(\ln \hat{u}^{\min})}{\exp[\hat{f}(w_i, y_i)] \times \exp(\ln \hat{u}_i)} = \frac{\hat{u}^{\min}}{\hat{u}_i} \tag{7}$$

where $\widehat{C}^{\min}$: the predicted minimum costs as used by the best-practice bank; $\widehat{C}_i$: the predicted actual costs; $\hat{u}^{\min}$: the minimum of the $\hat{u}_i$ across all banks in the sample; and $\hat{u}_i$: the predicted actual cost inefficiency of a specific bank.

[18] Since the ownership dummy is time invariant, the results of all the Hausmann tests shown in Tables 4–6 suggest that the random effects model is the optimal one.

[19] Pre-tax net income is used to calculate ROA and ROE instead of after-tax net income because of missing corporate tax figures. Total equity (net worth) of the four state-owned banks refers to the paid-in capital, which corresponds closely to Tier 1 capital in the Basel Accord, plus retained profits and other surpluses to paid-in capital. Thus, it is roughly comparable to the sum of Tier 1 and Tier 2 capital (Lardy, 1999).

[20] Thanks to an anonymous referee for raising this point. According to Cowling and Waterson (1976), a Cournot oligopoly with a given number of firms and identical horizontal average costs is $M = H/e$, where M is the sum of individual firms' profit margins, weighted by their market shares, H is the Herfindahl index and e the elasticity of demand. Singh and Vives (1984) and Cheng (1985) show that Cournot equilibrium prevails if firms produce substitutes.

X-efficiency is the proportion of costs or resources that are used efficiently, so that an X-EFF ratio of 0.80 would indicate that the bank is 20% less efficient in terms of costs relative to the best-practice bank operating under the same conditions. X-efficiency theoretically falls in the interval $(0,1]$, and equals one for a best-practice bank within the observed data. The limitation of this definition is that the estimated X-efficiency is only a *relative* measure against the best practice bank within the sample, the best practice bank itself may not be efficient when compared to banks outside the sample.

To measure the X-efficiency of Chinese banks, this paper adopts the widely used parametric technique – the Stochastic Frontier Approach (SFA). Under the SFA, bank-specific estimates of X-inefficiency, u_i, can be obtained by using the distribution of the X-inefficiency term conditional on the estimate of the entire composite error term, as proposed by Jondrow et al. (1982). The mean of the conditional distribution for the half-normal model is:

$$E(u_i|\varepsilon_i) = \frac{\sigma\lambda}{1+\lambda^2}\left[\frac{\phi(\varepsilon_i\lambda/\sigma)}{1-\Phi(\varepsilon_i\lambda/\sigma)} + \frac{\varepsilon_i\lambda}{\sigma}\right] \quad (8)$$

where $\lambda = \sigma_u/\sigma_v$; $\sigma^2 = \sigma_u^2 + \sigma_v^2$; $\phi(\cdot)$ = the standard normal density function; and $\Phi(\cdot)$ = the cumulative standard normal density function.

According to Goldberg and Rai (1996), this empirical test substitutes XINEFF for the X-efficiency variables (XEFF), in Eqs. (1)–(4). The estimate of XINEFF represents an inefficiency measure for each bank in the sample. Hence, the coefficients on XINEFF in will have the opposite sign to the XEFF variable in these equations.

4.2.3. Scale efficiency

Scale efficiency indicates whether banks with similar management and production technology are operating at optimal economies of scale. Following Goldberg and Rai (1996), scale efficiency is calculated from the same translog cost function. Overall scale economies (SCALE) are said to exist if an equi-proportionate increase in all outputs is accompanied by a less than equi-proportionate increase in cost. Overall scale economies are given by:

$$\text{SCALE}(Y) = \sum_p \partial \ln C(Y)/\partial \ln y_p \quad (9)$$

where $C(Y)$: a multiple-output cost function; Y: a vector of outputs, $=[y_1 \cdots y_p]'$; and p: indices of different products.

Given that both SCALE > 1 and SCALE < 1 imply scale inefficiencies,[21] the method to estimate scale inefficiency is described below:

$$\text{SINEFF} = \text{SCALE} - 1 \quad \text{if SCALE} > 1$$
$$\text{SINEFF} = 1 - \text{SCALE} \quad \text{if SCALE} < 1$$

A bank is at the scale efficiency point if its SCALE = 1, thus SINEFF = 0. As with XINEFF, the sign of the coefficient will be opposite to that estimated in Eq. (1), (2), (3) and (5). For example, the predicted relationship between ROA (ROE) and SINEFF is negative, i.e., the less scale efficient a bank, the lower the profitability. Appendix 2 reports the complete set of estimated coefficients of both XINEFF and SINEFF regressions.

4.2.4. Control variables

Additional control variables include:

- Ownership dummy (OWN): to test whether the key state-owned and joint stock commercial banks affected structure and performance, equal to 0 if state-owned, 1 for joint stock.
- Average income per person (AIP): to control for factors affecting the supply of funds to banks. Its coefficient may have either sign in an imperfectly competitive market, because it may reflect either a greater or lesser elasticity of deposit supply.
- Time trend (TT): to assess whether there is a significant trend in the movement of the dependent variable[22] over the period 1985–2002.
- The ratio of loans to assets (LA) as a measure of liquidity risk.
- The ratio of equities to assets (unweighted for risk), (KA) to capture solvency risk.[23]

5. Empirical results

5.1. X-inefficiency and efficient bank scale

Table 2 provides summary data for the variables used in the analysis. It shows that the mean XINEFF was significantly higher (26%) in stage 2 than stage 1. Thus, there was a decline in efficiency between stages one and two, and the state banks are the main reason for it – their X-efficiency fell by a significant 48% between the first and second stages. The joint stocks experienced a smaller, albeit significant drop (20%) in X-efficiency.[24]

[21] SCALE > 1 means that banks are operating below optimal scale levels and have the ability to lower costs by increasing output further. SCALE < 1 means that banks are operating over optimal scale levels and are required to downsize in order to achieve optimal input combinations.

[22] The time trend variable could also pick up trends in omitted variables.

[23] We are grateful to an anonymous referee for suggesting the additions of proxies for risk taking, as reflected in the banks' liquidity and solvency measures. Unfortunately, the data to measure credit risk are either unreliable or unavailable. For example, there are no reliable data on net loan charge offs. The ratio of non-performing loans to total loans reflects past risks. In addition, it is well known that the official data on NPLs are underestimates. There is also a problem with data availability. Official NPL data exist for the state banks covering the second stage of reforms. For the joint stocks, NPL:TL is only reported from 1999 onward, i.e. 4 of the 10 years in the second stage.

[24] Mean comparison t-tests were employed to check whether there was a significant difference in the mean X-efficiency scores, and produced t-statistics of: −3.58 (p-value: 0.0004) for all the banks, −4.42 (p-value: 0.000) for the state owned banks, and −1.91 (p-value: 0.0612) for the joint stocks.

Table 2
Variables used to estimate the structure–performance relationship

Variable	Mean (SD)	Maximum	Minimum	Number of observations
1985–1992				
ROA	0.011 (0.008)	0.034	0.002	54
ROE	0.139 (0.086)	0.327	0.02	54
CR4	0.981 (0.021)	1	0.939	54
HERF	0.284 (0.018)	0.300	0.249	54
MS	0.148 (0.145)	0.424	0.0003	54
XINEFF	0.077 (0.025)	0.126	0.031	54
SINEFF	0.067 (0.053)	0.184	0.0002	54
LA	0.595 (0.188)	0.903	0.322	54
KA	0.099 (0.093)	0.586	0.029	54
AIP (1000's)	0.546 (0.043)	0.619	0.491	54
1993–2002				
ROA	0.009 (0.008)	0.031	−0.0005	133
ROE	0.162 (0.116)	0.566	−0.007	133
CR4	0.889 (0.023)	0.932	0.844	133
HERF	0.217 (0.013)	0.241	0.193	133
MS	0.075 (0.104)	0.339	0.0007	133
XINEFF	0.097 (0.051)	0.299	0.030	133
SINEFF	0.068 (0.033)	0.145	0.0002	133
LA	0.517 (0.079)	0.699	0.238	133
KA	0.054 (0.024)	0.163	0.017	133
AIP (1000's)	0.981 (0.210)	1.367	0.665	133

Sources: Almanac of China's Finance and Banking (1986–2003); China Statistical Yearbook (2003).
Notes. (1) ROA: return on assets; ROE: return on equity; CR4: four-bank concentration ratio; HERF: Herfindahl–Hirschman index; MS: market share; XINEFF: X-inefficiency; SINEFF: scale inefficiency; LA: loan to asset ratio; KA: equity to asset ratio; AIP: average income per person. (2) Standard deviations are in parentheses. (3) All the figures are based on the mean value for the respective sample period, and all the original data are deflated by the CPI, using 1985 as the base year.

This decline could be a consequence of ineffective reforms. Though the objectives of the second phase of reforms were to encourage greater competition and efficiency, state lending policies and a lack of clarity about bankruptcy procedures contributed to rising amounts of bad debt. Despite the establishment of the three policy banks in 1994, the state banks were pressured to renew and/or extend loans to state-owned enterprises, the losses of which were mounting – for the most part, they had been profitable during stage 1. The problem was more pronounced among the state-owned banks but the joint stocks did not escape completely. Government (local, provincial, and national) and/or or state-owned enterprises hold the majority of (non-traded) shares. They used their considerable influence to ensure bank loans were made to a select group of firms, suggesting named, as opposed to analytical, lending was common.

Under these conditions, it is not surprising China is facing a serious problem with bad debt. Official estimates[25] put the state banks' non-performing loans as a percentage of total loans at 25% in 2002, falling to 15.6% at the end of 2004. The equivalent figures for the joint stocks, are, respectively, 12.4% and 4.9%. However, Whalley (2003) and some private analysts claim the figure is as high as 50–60% for the big four. The World Bank (2002) reports that restoring the banking system to financial health will require an increase in the stock of government debt from 20% to 75% of GDP.

Furthermore, X-inefficiency is normally associated with agency problems, and moral hazard exacerbates the difficulties. Confident the state would bail out any problem bank, there were no runs by depositors during the sample period. Borrowers lack the motivation to make their firms profitable and repay loans. Banks think loans to loss making SOEs are "safe" because the state will bail them out. Under these circumstances, managers have few incentives to practice good risk management techniques.

Evidence of the poor quality of management comes from a highly critical report by China's Banking Regulatory Commission (CBRC, 2005).[26] They inspected 11 banks (state owned and joint stock) in October, 2005 and found evidence of consistent under reporting of bad loans, breaching rules related to loan decisions, a failure to monitor outstanding loans, and a tendency to ignore regulations. The CBRC also cited a number of unsound accounting practices such as the unreliable reporting of profits and losses, "unreasonable" expenditures, and weak management of assets. Though the CBRC is committed to penalising banks (and senior management) that do not comply with regulations, they too are deficient in well-trained staff. Furthermore, as long as the Communist Party appoints senior managers, it will be difficult to enforce sanctions and/or remove poor managers from office.

To the extent that a combination of the above problems contributed to reduced cost X-efficiency, recent reforms may help to alleviate them. In 2005/2006, shares of two of the state-owned banks were sold on the Hong Kong stock exchange, with similar plans afoot for the other two state banks. Their partial privatisation appears to mark a third phase of bank reform. However, it is worth stressing that state-owned enterprises hold a majority of the shares in the recently privatised banks. For example, the Central Huijin Investment Company owns 62.59%[27] of the China Construction Bank, the first state bank to be listed in October, 2005. Their continued dominance is a source of concern in terms of improving X-efficiency. On the other hand, the minority holdings by foreign banks could help to improve efficiency if they can apply their expertise in areas such as risk management. There is potential for even bigger

[25] China Banking Regulatory Commission, www.cbrc.gov.cn.

[26] China Banking Regulatory Commission, 2005, www.cbrc.gov.cn.

[27] Others include one of Central Huijin's wholly owned subsidiaries (China Jianyin Investment Ltd.), the State Grid, the Shanghai Bao Steel Group, the China Yangtze Power Co., and other institutional/individual investors.

improvements if China fulfills its World Trade Organisation (WTO) commitment and lifts the current 25% ceiling on foreign bank ownership, provided overseas banks are willing to take controlling shares in what are effectively insolvent banks, and can make X-efficiency gains that have eluded the incumbent banks.

The mean scale inefficiency for the whole sample period is 0.068, giving an efficient bank scale of about RMB467 bn ($56.4 bn[28]). Two of the state-owned commercial banks were below this threshold in stage I. The exceptions, Bank A (RMB507 bn,) and Bank B (RMB470 bn) just exceeded it. By stage II, rapid growth brought the big four state banks well above the efficient bank scale. Again, size varied widely, ranging from RMB593 bn to RMB1093 bn ($132 bn). The joint stocks also grew quickly but operated below scale efficiency, with average assets of RMB151 bn ($18 bn) for the largest – one third of the scale efficient size. Thus, neither group is scale efficient though two state-owned banks come close in stage I. This issue is discussed in more detail in the next section.

5.2. Tests on structure and performance

Prior to estimating the equations, tests were conducted for the presence of multicollinearity between the market structure and efficiency variables, and concentration and market share, since both measures are based on the ratio of bank's deposits to total deposits. Table 3 reports the condition numbers, which range from 1.04 to 1.79 in both samples. Thus, multicollinearity is not a concern.[29] Nonetheless, to ensure the effects of possible multicollinearity are removed, Eq. (1) is tested in four components following Goldberg and Rai (1996) and as described in Appendix 1. It produced results similar to those reported in Table 4.[30]

Eqs. (1)–(5) are estimated using random effects. The results obtained from the estimating Eq. (1) appear in Table 4, where ROA and ROE are the dependent variables and the concentration measure is the Herfindahl index. Table 5 reports the outcomes from estimating (2) and (3), employing CONC and MS as the dependent variables. Coefficients from estimating Eqs. (4) and (5) appear in Table 6. Substituting CR4 for HERF produced similar results when Eqs. (1), (2), (4) and (5) were re-estimated. To conserve space, they have not been reported.[31]

Chow's Breakpoint test was used to check for data poolability. The test statistic was 3.069, with a *p*-value of 0.003, confirming the presence of a structural change in 1993, the year the second reform phase came into

Table 3
Condition numbers – testing for multicollinearity

	CR4	HERF	MS	SINEFF
1985–1992				
MS	1.251	1.251		
SINEFF	1.465	1.479	1.515	
XINEFF	1.372	1.303	1.169	1.041
1993–2002				
MS	1.048	1.056		
SINEFF	1.673	1.744	1.796	
XINEFF	1.082	1.040	1.201	1.049

Notes. (1) The condition number is the condition index with the largest value; it equals the square root of the largest eigenvalue divided by the smallest eigenvalue. In the absence of multicollinearity, the condition number will equal one. If the condition number is greater than 20, multicollinearity is a concern (Greene, 2003). (2) CR4: four-bank concentration ratio, HERF: Herfindahl–Hirschman index, MS: market share, XINEFF: X-inefficiency, SINEFF: scale inefficiency.

Table 4
Market-power vs. efficient-structure: estimation of Eq. (1)

	Dependent variable = ROA		Dependent variable = ROE	
	1 stage	2nd stage	1st stage	2nd stage
No. of observations	54	133	54	133
INT	−0.019	**0.072**	−0.049	**1.558**
	(−0.38)	(3.90)	(0.12)	(4.96)
HERF	0.010	**−0.229**	−0.371	**−4.680**
	(0.10)	(−3.52)	(0.626)	(−4.21)
MS	**0.062**	−0.007	**0.938**	0.032
	(4.82)	(−0.39)	(9.02)	(0.10)
XINEFF	−0.038	**−0.030**	−0.224	**−0.325**
	(−1.06)	(−3.59)	(−0.79)	(−2.25)
SINEFF	**0.058**	0.021	0.310	0.426
	(2.04)	(0.96)	(1.35)	(1.12)
AIP	0.023	−0.015	0.197	−0.351
	(0.45)	(−1.19)	(0.48)	(−1.59)
OWN	**0.022**	0.006	**0.278**	**0.159**
	(5.04)	(1.48)	(8.09)	(1.98)
TT	−0.0003	−0.001	−0.004	−0.014
	(0.35)	(−1.45)	(−0.60)	(−0.96)
LA	−0.012	**0.018**	**−0.196**	0.156
	(−1.58)	(2.63)	(−3.09)	(1.29)
KA	0.014	**0.106**	**−0.353**	**−0.972**
	(1.37)	(6.44)	(−4.37)	(−3.44)
LM-statistic	**32.62**	**24.09**	**2.72**	**51.36**

Notes. (1) 1st stage: estimation based on the sample of banks during the first stage of banking reform (1985–1992); 2nd stage: estimation based on the second reform phase (1993–2002); ROA: return on assets; ROE: return on equity; INT: intercept; HERF: Herfindahl–Hirschman index; MS: market share; XINEFF: X-inefficiency; SINEFF: scale inefficiency; AIP: average income per person; OWN: an ownership dummy variable, which is 0 if wholly state-owned, 1 for joint-stock; TT: a time trend variable; LA: loan to asset ratio; KA: equity to asset ratio. (2) Coefficients are in bold if they are statistically significant at 10% or less. *Z*-statistics are in parentheses. (3) LM (Lagrange multiplier) test: used to test for the random effects model based on the OLS residuals. The null hypothesis is that the classic OLS regression with a single constant term is appropriate. The alternative hypothesis favours the panel data model.

[28] The exchange rate at the end of 2002 was RMB 8.2772 = US$ 1.00.

[29] We are grateful to an anonymous referee for recommending this procedure as a test for multicollinearity. See the note below Table 3 for detail. Provided the condition number is less than 20, multicollinearity is not a concern (Greene, 2003). The more conventional computation of correlation coefficients ranged from 0.02 to 0.40. None was significant in the 1st stage sample and there was only one significant coefficient (between MS and SINEFF, at 0.22) in the 2nd stage sample.

[30] The results remain unchanged when an alternative measure of profitability (ROA/ROE) or concentration (CR4/HERF) is used.

[31] These results can be obtained from Email: maggiefu@umac.mo.

Table 5
Necessary condition: estimation of Eqs. (2) and (3)

	Dependent variable = HERF		Dependent variable = MS	
	1st stage	2nd stage	1st stage	2nd stage
No. of observations	54	133	54	133
INT	**0.477**	**0.272**	**0.160**	**0.192**
	(14.97)	(64.22)	(2.19)	(7.80)
XINEFF	−0.039	0.003	0.135	0.030
	(−0.71)	(0.30)	(1.21)	(0.88)
SINEFF	−0.014	0.005	−0.042	0.167
	(−0.35)	(0.19)	(−0.46)	(0.61)
AIP	**−0.341**	**−0.089**	0.033	−0.028
	(−5.50)	(−5.79)	(0.27)	(−0.61)
OWN	−0.001	−0.0003	**−0.237**	**−0.207**
	(−0.15)	(−0.21)	(−6.97)	(−8.69)
TT	−0.001	**0.002**	0.001	0.001
	(−0.74)	(2.14)	(−0.37)	(−0.16)
LA	0.002	0.004	**0.111**	**0.108**
	(0.25)	(0.50)	(2.73)	(3.94)
KA	0.002	0.008	0.002	**−0.146**
	(0.13)	(0.38)	(0.04)	(−2.23)
LM-statistic	**4.34**	**6.68**	**103.26**	**340.41**

Notes. (1) Table 5 shows the results for the test of the necessary condition, which is satisfied if the signs on the coefficients XEFF and SEFF are significantly positive in Eqs. (2) and (3). INT: intercept; HERF: Herfindahl–Hirschman index; MS: market share; XINEFF: X-inefficiency; SINEFF: scale inefficiency; AIP: average income per person; OWN: an ownership dummy variable, which is 0 if wholly state-owned, 1 for joint-stock; TT: a time trend variable; LA: loan to asset ratio; KA: equity to asset ratio. (2) Coefficients are in bold if they are statistically significant at 10% or less. *Z*-statistics are in parentheses. (3) LM (Lagrange multiplier) test: used to test for the random effects model based on the OLS residuals.

Table 6
The quiet life hypothesis-estimation of Eqs. (4) and (5)

	Dependent variable = XINEFF		Dependent variable = SINEFF	
	1st stage	2nd stage	1st stage	2nd stage
No. of observations	54	133	54	133
INT	0.320	0.072	0.031	−0.031
	(1.60)	(0.34)	(0.13)	(−0.37)
HERF	−0.267	0.396	−0.172	0.124
	(−0.68)	(0.52)	(−0.36)	(0.42)
MS	0.058	−0.098	−0.090	0.121
	(1.21)	(−0.60)	(−0.30)	(0.548)
AIP	−0.300	−0.192	0.119	**0.143**
	(−1.44)	(−1.34)	(0.46)	(2.56)
OWN	0.012	**−0.057**	**−0.088**	**0.054**
	(0.87)	(−2.56)	(−5.03)	(4.56)
TT	−0.0001	**0.017**	**−0.010**	−0.002
	(−0.00)	(1.77)	(−2.59)	(−0.66)
LA	−0.030	−0.082	**0.207**	**−0.169**
	(−1.42)	(−1.28)	(7.93)	(−7.13)
KA	0.013	0.033	0.025	0.070
	(0.30)	(0.17)	(0.49)	(0.97)
LM-statistic	0.78	**27.18**	1.26	**22.11**

Notes. (1) This table shows the results of the test for the quiet life hypothesis. To satisfy the hypothesis, the signs on the coefficients on CONC and/or MS should be significantly negative in the estimation of Eqs. (4) and (5). INT: intercept; HERF: Herfindahl–Hirschman index; MS: market share; XINEFF: X-inefficiency; SINEFF: scale inefficiency; AIP: average income per person; OWN: an ownership dummy variable, which is 0 if wholly state-owned, 1 for joint-stock; TT: a time trend variable; LA: loan to asset ratio; KA: equity to asset ratio. (2) Coefficients are in bold if they are statistically significant at 10% or less. *Z*-statistics are in parentheses. (3) LM (Lagrange multiplier) test: is used to test for the random effects model based on the OLS residuals.

effect. For this reason, the analysis focuses on the two sub-samples. Table 4 shows that during phase one of the reforms (1985–1992), the coefficient on MS is positive and significant when either ROA or ROE is used as the dependent variable. Thus, the relative market-power (RMP) hypothesis appears to hold: banks with a higher market share were more profitable, independent of market concentration. The coefficients on HERF and XINEFF are insignificant but the SINEFF coefficient is positive and significant when ROA is the dependent variable. This suggests that during the first phase of reform, the more scale efficient the bank, the lower the ROA, which appears to be counter-intuitive. However, recall that during stage I, only two banks came close to scale efficiency, indicating the result may be a statistical anomaly. Or it may reflect the fact that the relatively large state banks (measured by assets) actually earned a lower return for the reasons mentioned earlier – government interference in lending decisions, poor management, and moral hazard.

Turning to the second period of reform (1993–2002), Table 4 shows a significantly negative sign on the XINEFF coefficient, when either ROA or ROE is employed as the dependent variable. The coefficient on the market concentration measure HERF is significant but wrong signed, and both the MS and SINEFF coefficients are insignificant. These results indicate preliminary support for the relative X-efficiency (ESX) hypothesis, that is, more X-efficient banks have higher profits. However, recall that for the efficient structure hypothesis to hold, a necessary condition must also be satisfied: the more X-efficient banks must have bigger market shares and/or lead to higher levels of market concentration. Table 5 reports the results of estimating Eqs. (2) and (3). When MS is the dependent variable, the coefficients on both XINEFF and SINEFF (scale efficiency) are insignificant. Neither is significant when concentration (HERF) is the dependent variable. Thus, the necessary condition has not been met. It means that during the second phase of reform, even though the more X-efficient banks grew more profitable they had no impact on market structure in terms of market shares or increased concentration.

Based on these results, the effects of the reforms can be interpreted as follows. During the first phase of reform the larger banks exercised market power by providing differentiated products. At the time, neither concentration nor efficiency significantly influenced the level of profitability. This finding is consistent with the fact that the "big four" were state-owned specialised banks, subsidised by government to make loans to designated sectors/firms, via loans from

the central bank.[32] During the second reform phase, subsidies were cut (by 48%, on average) and attempts were made to encourage the state banks to behave like "private" commercial banks. The effects associated with relative market power diminished, which allowed the relatively more X-efficient joint stock banks to earn higher profits. Their market share also rose by 7%[33] during the second reform stage, but this was not enough to significantly improve market structure. No doubt this was largely due to the strict regulatory regime. For example, banks had to seek permission to open new branches and were subject to the tight controls on interest rates, which remained in place throughout the period.

The coefficient on the ownership dummy lends support to this interpretation of events. Table 4 shows the joint stocks were significantly more profitable than state banks. In Table 5, the significantly negative relationship between the joint stocks and market share confirms that the market share of the state banks continued to be significantly higher. In Table 6 the coefficient on OWN is significantly negative when SINEFF is the dependent variable meaning the joint stocks enjoyed more scale efficiency than the state-owned banks. But by phase two, the reverse is true. Furthermore, the OWN coefficient is significantly negative (positive) when XINEFFis the dependent variable. Together, these results suggest that, on average, the joint stock banks grew more X-efficient and profitable than the state banks, despite becoming less scale efficient with a smaller market share. It follows that policy should be directed at improving the opportunities for the joint-stock banks to enable them to expand their scale of operations and market share.

The other control variables do not provide much insight into the questions being addressed in this study. The sign of the coefficient on average income per person (AIP) varies. It is not significant in Table 4, significantly negative at both stages of reform when HERF is the dependent variable (Table 5), and significantly positive during the second reform period when the dependent variable is scale inefficiency (SINEFF) (Table 6). The result is probably spurious: liberalisation was accompanied by both a rise in China's average incomes over the period, and simultaneously, banking reforms reduced concentration and scale efficiency. The TT (time trend) coefficient is not significant in either reform period in Table 4. Though significant in Tables 5 and 6, the coefficients are close to zero and the sign changes, suggesting the influence of time on efficiency is ambiguous and very small.

Though the ratios of loan to assets (LA) and capital to unweighted assets (KA) have statistically significant coefficients in Tables 4–6, they tend to change sign. For example, less liquid and high KA banks have a significant, positive effect on ROA in stage 2 but the opposite is true if ROE is the performance measure. The results suggest these measures are poor proxies for liquidity and solvency risk. It is notable that the R^2 improves by less than 10% when these "risk" variables are added to the estimating equation. Ideally, a measure of credit risk would be useful, but as noted earlier, the data either do not exist or are unreliable.

Turning to Table 6, the quiet-life hypothesis is not rejected if the sign on either of the concentration variables (HERF or MS) is significantly positive. Though correctly signed for one of the two reform stages, neither the HERF nor MS coefficient is significant. Thus, even though the big four state banks had a higher market share and were more profitable during the first stage of reform, there is no evidence to suggest management eased up or were less efficient at the expense of profit. Nor is there any support for the quiet-life hypothesis during the second period of reform. The state control of prices is the most likely explanation for this finding. Unable to exploit their dominant position by charging higher loan rates and paying lower deposit rates, the state banks had no opportunity to enjoy monopoly profits. This does not mean the state banks were efficient or cost effective, merely that, in the absence of monopoly profits, the option of a "quiet life" (in the Hicks sense of the term) did not present itself. However, managerial behaviour could be adversely affected if these banks continue to operate in highly concentrated markets with fewer restrictions on interest rates – a policy which began in 2002.[34] Thus, unless reforms to improve competitive structure are introduced alongside the ongoing policy of interest rate liberalisation, "quiet life" effects may emerge.

To compare the results with other studies that employ standard OLS on pooled data, all the equations were re-estimated using OLS.[35] In addition to supporting the relative market-power (RMP) hypothesis for banks during stage I, the results also confirmed the relative X-efficiency

[32] Banks borrowed from the PBC to support loans to designated sectors/firms. In March 1998, a special Treasury bond (amounting to RMB270 bn, or $32.61 bn) was issued to strengthen the capital bases of the state-owned commercial banks and to raise their capital adequacy ratio to 8%. The bonds were purchased by these four banks with funds freed after the required reserve ratio was lowered from 13% to 8% (Xie, 1999). The re-capitalisation plan raised the capital of the state-owned banks to RMB478 bn (or $57.74 bn) from RMB208 bn (or $25.12 bn) without changing the size of their aggregate balance sheets. After 1998, there were no state capital injections until the announcement of new capital for the Bank of China and the China Construction Bank, on 30 December 2003 – outside the estimation period for this paper.

[33] Measured in terms of either total deposits or total loans (see Table 1).

[34] In stage I, interest rates were controlled with a view to promoting economic growth and social welfare objectives, such as directing funds to "priority"state owned enterprises, and encouraging more savings. In stage II, the goal of introducing market-driven rates was adopted. Banks have always had some discretion over certain loan rates. For example, from 1999, small business loans could carry a premium of up to 30% (50% for the rural credit coops) over the central bank rate. In 2002, the State Council announced a policy of liberalising all interest rates. Since 2003, banks and customers have been able to negotiate foreign currency deposit rates. However, Renminbi deposit rates continue to be controlled by the government. (3) LM (Lagrange multiplier test) is used to test for the random effects model based on the OLS residuals.

[35] The results are not shown here due to space constraints but are available upon request. Email: maggiefu@umac.mo.

(ESX) hypothesis in the second period of reform. This finding is in line with other published papers using data from other countries (e.g. Goldberg and Rai, 1996; Maudos, 1998). However, almost all of the Lagrange Multiplier (LM) tests showed the random effects estimation to be superior to the classic regression model for these data. This exercise illustrates how the use of OLS on pooled data could produce misleading results.

6. Conclusions

This paper carried out the first econometric study of market structure and bank performance in China from 1985 to 2002. In the context of bank reforms initiated during this period, the objectives were to identify which model, if any, best describes the competitive structure of China's banking sector and to assess the impact of bank size/ownership.

Following Berger (1995) and Goldberg and Rai (1996), this study tested two market-power hypotheses: structure-conduct-performance and relative market-power, together with the X-efficiency and scale efficiency versions of the efficient-structure hypothesis. X-efficiency and scale efficiency were regressed against concentration and market share to establish whether the higher order condition for the efficient-structure hypothesis is satisfied. There was also a test to assess whether state banks enjoyed a 'quiet life'.

The results of a Lagrange multiplier test confirmed the superiority of the random effects estimation over standard OLS. Several key findings emerge from the GLS estimation of Eqs. (1)–(5). First, the relative market-power hypothesis best describes the Chinese banking sector during the first reform stage. In the second phase, although the results supported the X-efficiency version of the efficient-structure hypothesis, there was no evidence that efficiency had a positive effect on market structure, a necessary condition for this hypothesis to be accepted. Second, compared to the state banks, the joint stock banks enjoyed improved X-efficiency and profitability during the second stage of reform. Third, for the four state-owned banks, there was no evidence of a significant negative relationship between concentration and efficiency.

The reforms are associated with the joint stock banks becoming relatively more X-efficient, but there were no dramatic changes in market structure. This outcome is likely due to rigid regulatory rules governing their activities (e.g. branch expansion) and strict control over interest rates, which also prevented state banks from enjoying monopoly profits, thereby ruling out any opportunity to opt for a 'quiet life'. The competitive structure of the Chinese banking system should improve under policies that allow joint stocks to expand (in view of the finding that they are more efficient than the state banks), increased market entry to reduce concentration (provided the new entrants, e.g. foreign banks, can improve cost X-efficiency) and continued interest rate liberalisation.

The prospects for further research in this area are exciting. In this paper, the market-power and efficient-structure models were extended to include tests on the impact of ownership/size differences in an era of China's phased banking reforms. Data permitting, new regulatory changes will make it possible to expand the models employed here using interest margins, foreign bank entry, and the ongoing changes in bank ownership/structure. In addition, it is hoped that more accurate measures of risk taking might yield greater insight into its effects on bank performance and structure.

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Appendix 1. Further tests to remove any possible effects from multicollinearity

Though the condition numbers (Table 3) produced little evidence of multicollinearity, a technique developed by Goldberg and Rai (1996) is used here. Eq. (1) is tested in four components to remove the effects of possible multicollinearity.[36] As before, the random effects model for panel data approach was used in the estimation of Eqs. (1a)–(1d) below:

$$P_{i,t} = \alpha + \beta_1 \mathrm{XEFF}_{i,t} + \beta_2 \mathrm{SEFF}_{i,t} + \beta_3 \mathrm{CONTROL}_{i,t} + e_{i,t} \quad (1a)$$

$$P_{i,t} = \alpha + \beta_1 \mathrm{CONC}_{t} + \beta_2 \mathrm{MS}_{i,t} + \beta_3 \mathrm{CONTROL}_{i,t} + e_{i,t} \quad (1b)$$

$$P_{i,t} = \alpha + \beta_1 \mathrm{CONC}_{t} + \beta_2 \mathrm{XEFF}_{i,t} + \beta_3 \mathrm{SEFF}_{i,t} + \beta_4 \mathrm{CONTROL}_{i,t} + e_{i,t} \quad (1c)$$

$$P_{i,t} = \alpha + \beta_1 \mathrm{MS}_{i,t} + \beta_2 \mathrm{XEFF}_{i,t} + \beta_3 \mathrm{SEFF}_{i,t} + \beta_4 \mathrm{CONTROL}_{i,t} + e_{i,t} \quad (1d)$$

The empirical results obtained from estimating Eqs. (1a)–(1d) are similar to those of Eq. (1), independent of the measure of profitability or concentration is used.[37] Again, there is conclusive evidence of the relevant market-power hypothesis for the banks in the first reform stage. Likewise, in the second phase of reform, the X-efficiency version of the efficient-structure hypothesis is supported by the initial test but fails to meet the necessary condition (see Table 5). This result is largely consistent with the available literature on the topic (e.g. Berger and Hannan, 1997).

[36] Dropping variables suspected of causing multicollinearity is the standard method for dealing with the problem.

[37] To conserve space, the results are not reported. They can be obtained from Email: maggiefur@umac.mo.

Appendix 2

Parameter estimates of both XINEFF and SINEFF regressions

Independent variable	Description	XINEFF regression		SINEFF regression	
		Coefficients	*p*-Values (SE)	Coefficients	*p*-Values (SE)
C	Constant	**2.025**	0.005 (0.721)	0.966	0.432 (1.231)
Lny1	Total deposits	0.489	0.344 (0.516)	0.891	0.377 (1.008)
Lny2	Total loans	0.577	0.338 (0.601)	−0.111	0.898 (0.836)
Lny3	Total investments	**0.149**	0.037 (0.072)	0.053	0.590 (0.099)
Lny4	Non-interest income	0.109	0.291 (0.103)	−0.012	0.945 (0.171)
Lnw1	Price of funds	**1.152**	0.000 (0.154)	0.247	0.382 (0.282)
Lnw2	Price of fixed assets	**−0.447**	0.097 (0.269)	0.491	0.212 (0.393)
Lny1lny1/2	Total deposits ∗ total deposits/2	**−0.974**	0.011 (0.383)	−0.092	0.842 (0.463)
Lny1lny2	Total deposits ∗ total loans	0.270	0.428 (0.340)	0.078	0.841 (0.387)
Lny1lny3	Total deposits ∗ total investments	−0.012	0.899 (0.091)	−0.052	0.506 (0.078)
Lny1lny4	Total deposits ∗ non-interest income	−0.021	0.630 (0.044)	0.080	0.251 (0.070)
Lny2lny2/2	Total loans ∗ total loans/2	**0.918**	0.052 (0.473)	−0.021	0.950 (0.339)
Lny2lny3	Total loans ∗ total investments	0.032	0.733 (0.093)	0.041	0.598 (0.078)
Lny2lny4	Total loans ∗ non-interest income	−0.035	0.389 (0.041)	−0.095	0.148 (0.066)
Lny3lny3/2	Total investments ∗ total investments/2	0.010	0.110 (0.006)	**0.013**	0.013 (0.005)
Lny3lny4	Total investments ∗ non-interest income	−0.006	0.416 (0.008)	0.003	0.667 (0.007)
Lny4lny4/2	Non-interest income ∗ non-interest income/2	**0.010**	0.064 (0.005)	0.001	0.899 (0.009)
Lnw1lnw1/2	Price of funds ∗ price of funds/2	**0.131**	0.000 (0.028)	0.029	0.433 (0.037)
Lnw1lnw2	Price of funds ∗ price of fixed assets	**−0.087**	0.047 (0.044)	0.076	0.170 (0.055)
Lnw2lnw2/2	Price of fixed assets ∗ price of fixed assets/2	0.082	0.261 (0.073)	−0.088	0.302 (0.085)
Lny1lnw1	Total deposits ∗ price of funds	−0.099	0.301 (0.095)	−0.012	0.909 (0.104)
Lny2lnw1	Total loans ∗ price of funds	0.012	0.914 (0.107)	0.036	0.719 (0.100)
Lny3lnw1	Total investments ∗ price of funds	0.008	0.738 (0.023)	−0.011	0.600 (0.022)
Lny4lnw1	Non-interest income ∗ price of funds	0.021	0.157 (0.015)	0.018	0.426 (0.023)
Lny1lnw2	Total deposits ∗ price of fixed assets	−0.115	0.432 (0.146)	−0.050	0.746 (0.155)
Lny2lnw2	Total loans ∗ price of fixed assets	0.065	0.642 (0.140)	0.006	0.965 (0.136)
Lny3lnw2	Total investments ∗ price of fixed assets	−0.020	0.231 (0.017)	0.017	0.475 (0.023)
Lny4lnw2	Non-interest income ∗ price of fixed assets	−0.025	0.287 (0.024)	0.024	0.456 (0.033)
Adjusted R^2		0.98		0.99	

Notes. (1) To estimate both regressions, the standard symmetry restrictions are applied. Meanwhile, the cost and input price terms are normalised by the price of employees to impose linear homogeneity restrictions. (2) The cost and output terms are expressed as a ratio of total assets to control for any potential bias arising from differences in scale when estimating XINEFF. (3) Bold typeface for values indicates significantly different from zero at the 10% level.

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