# Efficiency Gains and Deregulation Policies: Evidence from Bank Level Data

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THESIS

Submitted to the University of Adelaide in

Partial Fulfilment of the Requirements for the Degree of

Doctor of Philosophy in Economics

October 2013

# Declaration

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# Abstract

This thesis uses bank level data from developing countries and emerging economies and the data envelopment analysis (DEA) approach to provide empirical evidence on the impact of deregulation policies in the banking industry on the banks' efficiency. Since the banking industry in China is the largest and most complex among the developing countries and in transition from a centrally planned to a market economy, its transition process and the development of the banking industry is analysed first in order to provide the background information for the following econometric analyses and the thesis.

To gather the empirical evidence from China's banking industry on the correlation between the World Trade Organization (WTO) accession and efficiency gains by commercial banks, this thesis evaluates the efficiency of Chinese banks over the period 2000–09 (this is referred to as the adapting phase of the WTO accession). During this period of time, the restrictions on the foreign banks were removed gradually. The evolution of banks' efficiency is computed by the DEA approach combined with the bootstrapping technique. All commercial banks are broken down into four groups: (1) all banks in China; (2) domestic banks; (3) private banks; and (4) city banks. Since the categories are mutually exclusive, the empirical results reveal that the efficiency of the banks in China's banking industry increased over this period. In terms of profit maximising, city banks were the least efficient banks and the catch-up effect was highly significant in this group, since their efficiency increased dramatically compared with other banks.

However, the empirical evidence from the Chinese banking industry cannot identify the efficiency effect from removing restrictions on banks in the market. In order to identify the efficiency impacts from different kind of deregulation policies, first, the impact of the deregulation policies to remove the restrictions on foreign banks and domestic banks are explored in six Asian banking industries over the period 1997–2006, namely China (data for mainland China and Taiwan presented separately), India, Indonesia, Malaysia, Pakistan and Thailand.

In the first stage of the two-stage DEA model, the output direction DEA is employed for the selected countries to compute the efficiency of the banks. In the second stage, the estimated DEA score is regressed on the indices of the restrictions in the market. The values of indices are taken from Dinh (2008). The main reason to select her indices is that these indices are used to estimate the restrictions on foreign banks and domestic banks in the given market. The expectation is that the deregulation policies to remove the restrictions on foreign or domestic banks will lead to efficiency gains in the markets.

In order to overcome the reverse causality issue between the dependent variable (the estimated DEA score) and the independent variable (restriction indices), the two-step first-difference regression model is used and bank efficiency in the previous period is included in the model as one of control variables. The main reason to use the first-difference model is to partial out unobservable time and country effects from the data panel. In the sensitivity analysis, a couple of different model specifications are utilised to confirm the baseline results. The regression results show that the deregulation policies related to the operation of foreign banks are positively correlated with efficiency gains of commercial banks, but the other key set of policies to

liberalise the domestic banks has not resulted in significant efficiency gains in the selected banking industries.

As alternative channels for increased competition in the market, the efficiency impacts of mergers and acquisitions (M&As) are explored. Theoretically, banks may be encouraged to enhance their efficiency due to the pressures that arise from the possibility of M&As. Most previous analyses use the case study methodology in this topic rather than the cross-country statistical methodology. In this thesis, the efficiency impacts are examined with a sample of banks from a range of emerging economies (China, India, Malaysia, Russia, Thailand and Vietnam) over the period 2002–09. All banks in the selected countries are divided into three groups, namely target banks, acquiring banks, and the banks not involved in the event (or incumbent banks).

To compare the differences in the impacts on efficiency between the banks involved in the event (target and acquiring banks) and the banks not involved in the event (incumbent banks), the two-stage DEA is employed. In the first stage, the efficiency of the banks is calculated in the DEA model. The results from the DEA show that the efficiency of the banks increased in most of the countries, except India, in which the bank efficiency is neutral over the sample period. In the second stage, two different matching methods was utilised in this thesis: the regression method and propensity score matching. The empirical results are robust across a number of sensitivity analyses and identification methods and reveal that the M&As reduce the efficiency of the acquiring banks and target banks in the selected emerging economies.

# Acknowledgments

First of all, I would like to express my heartfelt gratitude to Prof. Christopher Findlay, my principal supervisor. Over the past four years, he has been guiding me, both consciously and unconsciously, how to transform my interests into a good thesis. He has given me sufficient freedom to choose and decide my topic of interest, while providing suggestions and insightful comments on this thesis. I really appreciate all his contributions of time, ideas, and funding on my thesis.

Secondly, I would like to acknowledge my co-supervisors, Prof. Richard Pomfret, and Dr Nicholas Sim. I appreciate their huge time and patience they have shown whenever I want to discuss with them about my research. Prof. Pomfret has given me a lot of good suggestions when I choose the topic of my thesis, and Dr Sim has taught and supervised me to develop the method from an econometric point of view. The numerous conversation and electronic exchanges we had constantly improved and refined this thesis. I also very much appreciate Dr Nicola Chandler's enthusiasm, intensity, and willingness to do the editing work and the proof reading for my thesis.

My appreciation also goes to the other school staff including academic and professional staff for their help in the course work, PhD workshop, seminar and daily life in Adelaide. The names are (among many others), Fabrice Collard, Jacob Wang, Ralph Bayer, Dmitriy Kvasov, Tatyana Chesnokova, Duygu Yengin, Seungmoon Choi, Jiti Gao, Nadya Baryshnikova, Allison Stokes, Sandra Elborough, Sherry Dzonsons, John Snelling and Anne Arnold.

I also acknowledge my PhD colleagues in the same office –Xiaobo He, Chaohua

Dong, Jiang Lin, Yuan Di, Faqin Lin, Hang Wu, Yan Zhang, Kofi Otumawu, Sinad Treewanchai and many others for the time we spent together in Adelaide.

Finally, I thank my parents and my wife Sunny Liu for their unconditional support and sacrifices. This thesis is dedicated to them.

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# Abbreviation

| | |
|---|---|
| ABC | Agriculture Bank of China |
| ADBC | Agriculture Development Bank of China |
| ATT | Average Treatment Effect |
| Big Five | ABC, ICBC, BOC, CCB and BoCom |
| BOC | Bank of China |
| BOCom | Bank of Communications |
| CBRC | China Banking Regulatory Commission |
| CCB | China Construction Bank |
| CDB | China Development Bank |
| China EXIM | Export-Import Bank of China |
| CPI | Consumer Price Index |
| CRS | Constant returns to scale |
| DEA | Data Envelopment Analysis |
| EBRD | European Bank of Reconstruction and Development |
| EU | European Union |
| EVA | Economic Value Added |
| GDP | Gross Domestic Product |
| IAS/IFRS | International accounting or international financial reporting standards |
| ICBC | Industrial and Commercial Bank of China |
| IMF | International Monetary Fund |
| JSCBs | Joint-stock commercial banks |

| | |
|---|---|
| KMD | Kuo Min Dang Party (KMD) |
| LGAAP | Local generally accepted accounting principles |
| M&As | Mergers and acquisitions |
| NIM | Net Interest Margin |
| NPLs | Non-performing loans |
| OLS | Ordinary least squares |
| PBC | People's Bank of China |
| PCBC | People's Construction Bank of China |
| ROA | Return on assets |
| ROE | Return on equity |
| RMB | Renminbi (The official currency of China) |
| PRC | People's Republic of China |
| SOBs | State-owned commercial banks |
| SEZs | Special Economic Zones |
| SFA | Stochastic Frontier Analysis |
| SOEs | State-owned enterprises |
| WTO | World Trade Organization |
| VRS | Varied returns to scale |
| 2SLS | Two-step least squares |

# Chapter 1 Introduction

## 1.1 Background

In any economy, the financial sector takes a central and pivotal role – it allocates resources by accepting deposits from businesses and individuals and lending funds to the 'real' sector (i.e. the part of the economy with actually producing goods and services). This eases the exchange of goods and services in the market, enabling businesses (and individuals) to function on a day-to-day basis, to achieve productive potential, to invest, and so on, benefiting from the wide range of services that the financial sector can offer. Levine (2004) states that the financial sector could serve at least the following five functions:

1. Produce information ex ante on possible investments and allocate capital
2. Monitor investments and exert corporate governance after providing finance
3. Facilitate the trading, diversification, and management of risk
4. Mobilise and pool savings
5. Ease the exchange of goods and services

Being a critical component of the financial sector, the banking industry has unique advantages in funding and selecting the most promising firms in economic terms. The allocation of loan products in a well-functioning bank offers a professional and reliable signal to the market regarding the borrowers' financial situation. As the bank originates loans to borrowers, it always commences with the evaluation of the borrower's ability to meet payment obligations. Accordingly, to take out a loan from the bank is like a positive signal (i.e. a promising firm) and that signal could be used

by other lenders in the market. Without such signal from the bank, other lenders would have to use their own resources to duplicate the bank's evaluation. In this respect, an efficient banking industry saves financial costs for the whole economy.

Levine (2004) reviews the theoretical and empirical work on the relationship between the financial development and economic growth, and points out that a well-functioning financial sector could significantly enhance economic growth by encouraging an efficient allocation of capital in the real sector. Due to the relatively undeveloped stock market in developing countries, this advantage is more important to developing than developed countries. In developing countries, the banking industry can obtain the most accurate information available on the financial position of firms as they have a professional team that has access to the firms' financial data, which enables it to investigate the firms' financial situation and carries out in-depth analyses on firms' status.

It is important to understand that a poorly functioning financial sector would hinder economic growth. Furthermore, a number of financial crises have happened successively throughout history, and it seems impossible to avoid such crises in the future. Examples include 'bank panic' (people lose their confidence in the banks and withdraw their funds induced by panic) or sharp drops in the credit supply stemming from an accumulation of non-performing loans (NPLs). If financial risk is not eliminated, the probability of a banking crisis will increase. When these crises occur, it reminds how important the financial sector is to the functioning of the economy as a whole.

## 1.2 Research Questions

This thesis focuses on the banking industry, as a major subset of the financial sector. Serving as an intermediary between savers and borrowers, the banking industry provides a service in channelling capital flows for the domestic economy and also for the global economy. This channel is established by obtaining liquid financial assets from savers to fund illiquid and highly customised assets for specific borrowers and to generate high-yielding future cash flows. Poor performance by banks will limit this contribution and in some circumstances could shake the confidence of the general public and thereby lead to bank panic (i.e. customers withdrawing deposits due to fear or uncertainty about the security of their funds).

According to competition theory, a highly regulated market could have the effect of giving the banks in that market a kind of monopolistic status. One of the consequences of protecting the market status of the incumbent banks is that the monopolist's effort is devoted not to increasing their output but to restricting it in order to maximise their profits. Hicks (1935) claims that "the best all monopoly profits is a quiet life". The ideal situation for an economy is that all firms are treated equally and have the same opportunities in the market. The consequence is more likely to be a banking system that performs its functions, listed above, to a greater extent and in a more innovative manner. The policies should ensure that competition in the market is not restricted in a way that is harmful to the society.

For the purpose of improving bank performance, the governments in developing countries have been carrying out a set of reform policies to increase competition in the banking industry. This usually takes the form of removing the restrictions within the market. The reform policies were expected to help create robust local firms by

increasing the competition in the market and providing incentives for innovation and cost reduction. More open markets also provide channels for technological transfers from overseas. For example, domestic banks in developing countries could access the technology relating to business management and day-to-day operation from foreign banks that are based in developed countries. Two key examples are the 'open door' policy which opened up China's banking market to foreign banks; and the establishment of the Economic and Monetary Union in Europe. In order to provide the background information for this thesis, the main financial reform policies in China's banking industry between 1978 and 2006 are summarised as a case study in Chapter 2.

The research topic of this thesis is to evaluate the efficiency gains from the deregulation policies which remove the restrictions on foreign banks, domestic banks and banks' takeover activities (i.e. mergers and acquisitions). Going a step further than the existing analyses in the literature to date, the following three questions are answered in this thesis:

(1) Did Chinese bank efficiency increase after the World Trade Organization (WTO) accession?

Due to the accession, commercial banks in the market realised that their local market would no longer be protected by regulations and that greater potential competition was coming, which is like an exogenous shock to the market. In order to answer this question, the evolution of bank efficiency is constructed for banks in the Chinese banking industry over the period 2000–09 using data envelopment analysis (DEA) combined with the bootstrapping technique. All commercial banks are broken down into four groups: all banks in China's banking industry; domestic banks; private

banks (excludes state-owned commercial banks); and city banks. These groupings are motivated by specific features of banks that may result in them responding differently to banking deregulation.

(2) Do efficiency gains come from the deregulation policies which removes the restrictions on the operation of banks (foreign banks and domestic banks)?

In order to investigate the efficiency impacts from the deregulation policies for foreign banks and domestic banks, the indices from Dinh (2008) are employed as proxies of those policies. In her indices, the deregulation policies to remove unnecessary restrictions on the banks' daily operation and entry conditions are estimated. The values of her indices are calculated specifically for foreign banks and domestic banks. The index for the foreign banks indicates the level of deregulation of the activities of the foreign banks and the index for the domestic banks reflects the policy changes to liberalise the activities of the domestic banks. The two-stage DEA model is utilised and the DEA is employed to estimate the efficiency achieved by each of banks in the first stage of the estimation. The second stage of estimation uses the two-step least squares model (2SLS) to identify the effect of the deregulation policies on the DEA estimated efficiency gains.

Lehner and Schnitzer (2008) investigate the impact of foreign bank entry on the host country's market and point out that the impact of removing the restrictions on foreign banks is ambiguous as it depends on the mode of the foreign bank entry: Greenfield entry or acquiring entry, which have different consequences for competition. Following their suggestions, the third research question of this thesis is as follows:

(3) Do the mergers and acquisitions (M&As) in the banking industry lead to

similar efficiency gains for commercial banks from the deregulation policies studied in question 2?

Acting as a threat to the inefficient banks hanging over the market, M&As reduce the number of banks in the market, which differs from the deregulation policies of removing barriers to banks operating across national borders, since the deregulation policies directly increase the number of banks in the market. However, both of these changes introduce new sources of competition in the market. In this thesis, efficiency considerations are introduced into M&A appraisals and the two-stage DEA model is employed to investigate the efficiency impacts of the banks' takeover activities. In the first stage, the output-oriented efficiency of the banks is estimated and using which, the effect of the M&As on bank efficiency is tested using a truncated regression approach and propensity score matching.

## 1.3 Outline

The thesis is organised as follows. Since China's economic success is virtually unparalleled among developing countries, Chapter 2 describes the process of the financial reform in China's banking industry over the period 1987–2006. The transition path that the banking industry has followed could serve as a useful example to other countries, since this path has seen China's banking industry facilitate its economic growth. In this chapter, the transition process is summarised and the key players in the current banking market are analysed, and this provides the background for Chapters 4, 5 and 6.

Chapter 3 reviews the related literature on efficiency gains arising from the deregulation policies of removing the entry barriers to foreign banks and to M&As.

Since bank efficiency is the main topic of this thesis, the different methods in the literature to evaluate bank efficiency are discussed, such as the financial ratio, parametric and non-parametric analysis, and the reason to select the DEA as the main methodology of this thesis is presented together with the detail of the model.

As a key influence on the financial reform in China's banking industry, the WTO accession provides a good opportunity to investigate the efficiency gains from the deregulation policies of removing the restrictions on foreign banks. In Chapter 4, the evolution of bank efficiency in the adapting phase of the WTO accession is constructed using DEA with the bootstrapping technique over the period 2000–09. However, the empirical evidence from Chapter 4 does not look at the specific effect of the deregulation policies on the efficiency gains achieved by commercial banks. In order to overcome this weakness, cross-nation analysis is employed in Chapter 5 to investigate the impact of deregulation policies to remove the restrictions on foreign banks and domestic banks, looking at seven Asian developing countries.

As another mode to increase the competition in the market and thereby bring efficiency gains, the efficiency impacts of M&As are explored in Chapter 6. In this chapter, the relationship between the impacts of the M&As and the efficiency gains of the banks is studied in the dataset from six emerging economies.

Finally, Chapter 7 concludes the thesis and summarises the key findings of this thesis.

# Chapter 2 Financial Reform in China's Banking Industry

## 2.1 Introduction

In 1978, the government of China enacted a range of economic reforms entitled 'Socialism with Chinese Characteristics', which used the principle of a market-based economy to replace the central planning system. This reform began in the agricultural sector in 1978, and was subsequently applied to all areas of the economy, including the financial system from 1979. In the agricultural industry, the conventional central planning system was replaced by the household responsibility system in 1980, in which the farmers were able to keep their output after paying a share to the state. As one of the reform policies, the Chinese banking market was opened up to foreign banks (referred to as the 'open door' policy), and the whole economy shifted to encourage and support foreign trade and investments. Since the commencement of these economic reforms and the 'open door' policy, sustained rapid economic growth has characterised the Chinese economy, with China surpassing Japan as the world's second largest economy in 2010.[1]

However, the sustained rapid growth does not necessarily indicate that the banking industry can effectively support economic growth. The transition from a planned economy to a market economy not only provides opportunities, but also poses challenges to China's banking industry. For instance, the economists in the International Monetary Fund (IMF) warned that the rapidly growing demand for credit from China's real sector (i.e. the part of the economy producing goods and

[1] Bloomberg, 'China overtakes Japan as world's second-biggest economy', accessed on 6 April 2013.

services as opposed to the financial sector) may not be satisfied by the banking industry. This weakness might amplify potential problems in the economy and thereby stunt China's rapid economic growth.[2] For example, insufficient support from the banking industry forces the firms to look for support from outside the formal financial system, which disturbs the existing financial order and increases risk over all.

In order to meet the increasing demand for capital from the newly established market economy, a set of financial reforms were introduced from 1979 as part of the economic reforms. China's government expected that the financial reform policies would increase the efficiency of the banks and thereby the effectiveness in the use of financial resources in the banking industry to meet the demand for credit.

The main financial reforms between 1979 and 2006 are summarised and reviewed in this chapter, providing the background information for the efficiency analysis in Chapters 4 and 5. The financial reforms are separated into four sections. In Section 2.2 and 2.3, the financial reform policies for state-owned commercial banks (SOBs) are discussed. Section 2.2 discusses the first step of the financial reform in China's banking industry, whereby government appropriation was replaced by bank loans via establishing four specialised banks between 1979 and 1984. When the specialised banks were founded, the commercialisation of the banking industry got underway in about 1985, and this is discussed in Section 2.3. In Sections 2.4 and 2.5, the history of private banks and the adaptation phase following China's WTO accession are discussed. The current banking industry is described in Section 2.6 and Section 2.7 summarises the chapter.

[2] IMF Survey Magazine: Countries & Regions, 'Financial sector reform vital to rebalance, sustain China's growth', accessed on 6 April 2013.

## 2.2 Replacement of Government Appropriation by Bank Loans

In China, there was a civil war in 1945–49 between the communist party and the ruling Kuo Min Dang party (KMD) government. The communist party won and the KMD relocated to Taiwan. In 1949, the People's Republic of China (PRC) was created by the ruling communist party. The central bank of the communist party became the central bank of PRC with a network of commercial banks. The central bank was the People's Bank of China (PBC).

During the 1950s, several changes occurred in the banking industry. A network of rural credit cooperatives was created to serve farmers in the rural area, which were gradually merged with the PBC. In 1950, the Bank of China (BOC), which was founded in 1912, was consolidated with the PBC as its department for foreign exchange services. The Agriculture Bank of China (ABC) was created in 1951 to provide financial support to the agricultural sector. It was consolidated with the PBC in 1957. In 1954, the People's Construction Bank of China (PCBC) was founded as one of the subordinate units of the Ministry of Finance to manage the government appropriations and loans for capital construction. In the 1950s, nationalisation and consolidation of the country's banking industry received the highest priority.

From 1949 onwards, China practised central planning under the direction of the central government which directed all major sectors of the economy and formulated decisions about the use of economic inputs and the means of production. In the centrally planned economy of the 1960s and 1970s, the banking industry was the 'cashier' of the government; the PBC and the Ministry of Finance were directly under the leadership of the State Council – the chief administrative authority of the central government. The PBC carried out the functions of the central bank as well as that of

commercial banks. The whole financial system was integrated with the national credit allocation system, in which the long-term and non-interest funding came from the Ministry of Finance, while the PBC provided the short-term lending services.[3] As a kind of government appropriation, bank credit was allocated by the commands of the government.

The first step of the financial reforms in China, which started in 1979, was to separate the government's central banking functions from its commercial banking functions, and therefore using bank loans to replace government appropriation in commercial activities. Between 1979 and 1984, four specialised banks were re-established or established in order to provide support to specific sectors: the agricultural sector for ABC, international trade for BOC, national infrastructure for PCBC, and the manufacturing industry for Industrial and Commercial Bank of China (ICBC).

In 1979, the ABC was separated from the PBC as the first specialised bank in order to promote investment in the agricultural industry and countryside areas. There was another reason for the State Council to re-establish the ABC. Before its re-establishment in 1979, the rural credit cooperatives were part of the PBC but supervised by the local governments to offer financial support in the country areas. There was a lot of administrative work, and their daily operation became a big burden to the PBC. In 1979, the rural credit cooperatives were split from PBC together with ABC and worked as local branches of ABC.

In the same year (1979), the BOC was re-established to specialise in foreign exchange transactions and international trade finance. The PCBC was split from the

[3] History of People's Bank of China from website of the PBC (http://www.pbc.gov.cn/, accessed on 6 April 2013).

Ministry of Finance and specialised in medium to long-term credit for long-term specialised projects, such as infrastructure projects and the investment in urbanisation. In 1996, the PCBC changed its name to China Construction Bank (CCB). During the period 1979–84, ABC, BOC and PCBC were re-established, but the PBC still carried out some commercial banking functions, which seriously challenged its independent status as the central bank and the regulator of the market. In 1983, the State Council promulgated that the PBC would function only as the central bank of China and the regulator of the banking market. Accordingly, ICBC was established in 1984 to take over the remaining commercial functions of PBC. After that, the PBC would serve only as a central bank, and at the same time provide supervision to all four specialised banks.

Although the specialised banks had some freedom in allocating credit in the form of loans, there remained some limitations. They operated as monopolies in their own sub-sector, for example, the ABC was banned from providing loans to the manufacturing sector or the urban areas, which was the business field of ICBC. In addition, loan policies of the specialised banks were strongly influenced by the government's policies and strategies and the bank loans were allocated to unprofitable state-owned enterprises (SOEs) in order to encourage economic development.

## 2.3 Commercialisation in China's Banking Industry

From the late 1970s onwards, while the real economy was being transformed from a centrally planned to market-based economy, the country's financial system lagged behind. For example, specialised banks provided credit on the basis of patronage favours, instead of the risk-performance principle which commercial banks normally follow. With regards to the supervision and regulatory system of the banking industry,

prior to commercialisation, the headquarters of the specialised banks were under the leadership of the PBC, but their local branches were under the control of the local governments. Hence, their lending activities were strongly driven by the needs of regional policy-makers.

When the specialised banks were faced with the transition to a market economy, Bonin and Huang (2001) argue that specialised banks failed in facilitating the management and diversification of financial risk and the ratio of NPLs to total lending soared in each bank.[4] In order to stimulate the development of the banking industry and reduce the exposure of SOBs to NPLs, the State Council described the final aim of the financial reforms as being to set up "a unified, orderly competitive and strictly managed financial system" in the 'Seventh Five-Year Plan of National Economic and Social Development' in 1985.[5] In this plan, the specialised banks would become SOBs, and these SOBs were the main body of that financial system.

As a part of the arrangement to achieve the stated aim, the State Council set up three policy banks to serve the government-directed spending functions that had been operated by the ABC, BOC, PCCB and ICBC. The three policy banks were established in 1994: China Development Bank (CDB), Export-Import Bank of China (China EXIM), and Agriculture Development Bank of China (ADBC). They were directly under the leadership of the State Council and solely owned by the government. As with the specialised banks, the policy banks mainly focused on their specific field, such as the agricultural development projects in rural areas for ADBC. With regard to the 'bottleneck' infrastructure projects which could seriously constrain

[4] A non-performing loan is a loan that is in default or close to being in default.
[5] As another significant event for China's financial system, the Shanghai Stock Exchange and Shenzhen Stock Exchange were established in 1990.

economic growth, this became the focus for the CDB.[6] As an example of the government-directed spending functions being taken on by the policy banks, PCBC transferred its policy-related infrastructure lending business to the newly established CDB and the fiscal policy business to the Ministry of Finance in 1994.

If the funding is for investments related to the specific field of the policy banks, it would be easier in theory for firms or projects to get financial support from the policy banks than from commercial banks, because that is their focus. Furthermore, the loan interest rate would be likely to be much lower in the policy banks than the commercial banks, and sometimes, even zero, since the government wants to encourage the investments in these fields.

Initially, the policy banks were scheduled to be established in 1985, but they were not founded until 1994. There were two main reasons why the State Council had to postpone the arrangement of setting up the policy banks. The first reason was that the SOBs did not have the motivation to move government-directed transactions out to the policy banks, since these transactions could be used as an excuse for operating losses and to get allowances from the government. The initial funding requirement for the policy banks was the second reason. The establishment of policy banks could not bring any direct benefit to the PBC and Ministry of Finance, so they did not want to provide the funding. Ultimately, the start-up capital for the policy banks came mainly from financial bonds and direct lending from the central bank. Table 2.1 presents the main business and capital sources of policy banks.

[6] The bottleneck projects refer to the large infrastructure projects that act as bottlenecks to economic growth because commercial banks do not want to (or are not able to) support such large investments.

Table 2.1. Main business and capital sources of policy banks

| Name and main business | Capital sources |
|---|---|
| **China Development Bank** | Policy financial bonds |
| Main business: Financial support to so-called 'bottleneck' projects which seriously constrained economic growth; the projects which directly enhance the strength of the national pillar industry;(1) high-technology application(2) in economic development; and important national projects. | |
| **Export-Import Bank of China** | Mainly from policy financial bonds<br>International finance market |
| Main business: Credit services for international trade of technical and electrical products and equipment, and related insurance and guarantee business. | |
| **Agriculture Development Bank of China** | Mainly lending from PBC and few policy financial bonds |
| Main business: Loans for national reserves and acquisition of grain, cotton, oil and other major agricultural products; financial support for poverty alleviation, comprehensive agricultural development and construction or technological transformations of agriculture, forestry, animal husbandry, and water conservation facilities. | |

Notes: 1. The national pillar industry means the sector of the economy which is of critical importance to the economy. 2. High-technology application means the projects which need huge investments in the stage of research and development, and the newly created or discovered knowledge about the scientific and technological topics could produce large profits, e.g. electronic information technology, biological and medical technology and new materials technology.
Source: Information obtained from respective bank homepages.

After the government-directed transactions were moved to policy banks, the four SOBs officially transformed to commercial banks and adopted lending practices based on asset-liability ratios and risk management. In 1995, the National People's Congress promulgated the 'Law of the People's Republic of China on Commercial Banks' to protect the lawful rights and interests of commercial banks, depositors and other clients and standardise the behaviour of commercial banks. Under this law, commercial banks conduct business operations without interference from any unit or individual, which removed any official link between the government and the

commercial banks.

In 1999, the government created four financial asset management companies (AMCs) to take over the RMB 1,400 billion NPLs from the ICBC, ABC, BOC and CCB. Moreover, in 1998, the government had already injected RMB 27 billion of capital into the four SOBs to improve their balance sheets.

## 2.4 Private Banks

There are two groups of private banks in the banking market. The first group of private banks is joint-stock commercial banks (JSCBs) which are national banks and city banks are the second group, and these operate locally. The JSCBs were newly established as enterprises after 1985. As a part of the 'Seventh Five-Year Plan of National Economic and Social Development' in 1985, the Bank of Communications (BOCom) was restructured, and later re-opened in 1987 as the first JSCB.[7] In the 10-year period from 1987 to 1996, 10 JSCBs were established, with three more between 2003 and 2006, the last one being the Bohai Bank in 2006. Table 2.2 shows the establishment dates of the 13 JSCBs.

[7] BOCom (Bank of Communications) is the fifth largest commercial bank in China and the biggest JSCB. Therefore, some researchers put ABC, BOC, CCB, ICBC and BOCom as a group ('Big Five'), rather than the 'Big Four' of ABC, BOC, CCB and ICBC.

Table 2.2. Establishment dates of JSCBs

| No. | Date | Name of Bank | Notes |
|---|---|---|---|
| 1 | 1987 | Bank of Communications (Listed in Shanghai 2007) | Top five leading commercial banks |
| 2 | 1987 | Merchants Bank (Listed in Shanghai 2000) | First entirely corporate owned |
| 3 | 1987 | CITIC Industrial Bank | |
| 4 | 1987 | Shenzhen Development Bank | China's first listed bank |
| 5 | 1988 | Industrial Bank | |
| 6 | 1988 | Guangdong Development Bank | |
| 7 | 1992 | China Everbright Bank | |
| 8 | 1992 | Shanghai Pudong Development Bank | |
| 9 | 1992 | Huaxia Bank | |
| 10 | 1996 | China Minsheng Bank | First bank invested in by private enterprises |
| 11 | 2003 | Prudential Bank | |
| 12 | 2004 | China Zheshang Bank | |
| 13 | 2006 | Bohai Bank | |

Source: Information from bank websites.

The second group of private banks are the city banks. These were founded on the basis of urban credit cooperatives in the local market, normally at the city or county level. The urban credit cooperatives were established from 1988 to support the regional economy by mobilising and pooling the savings of city dwellers and the medium and small-size enterprises. To encourage the development of the credit cooperatives, the capital requirement was RMB 500,000 for setting up an urban credit cooperative in 1988, which was much lower than the requirement for the commercial banks. Due to the low threshold, 4,800 cooperatives were established in the five years from 1988. Most of the urban credit cooperatives were very small and relatively unprofessional.

In order to combine the resources in these small credit cooperatives and minimise the risk related to lending, the State Council released the document of 'Circular of the State Council on Setting Up the City Cooperative Bank (city banks)' in 1995. According to this regulatory document, the existing cooperatives had to be merged with the city cooperative banks if they could not reach the new and much stricter regulations.

The first city bank to be established was Shenzhen City Cooperative Bank in 1995. By 2000, 2,300 cooperatives had been consolidated into 90 city banks. In 2012, there were 140 city banks in the market, based on information from the website of China Finance Net.[8]

The main differences between the JSCBs and city banks are the bank size and the operational region. The size of JSCBs is much larger than the city banks and JSCBs are nation-wide banks. Some city banks might have branches in more than one province, but their extension to other provinces is primarily to support their services in the local market.

## 2.5 Foreign Banks and WTO Accession

After the founding of the People's Republic of China in 1949, the Chinese government ordered the closure of all forms of private finance and foreign banks. There were only four foreign banks that were allowed to continue their business in Shanghai for their foreign clients. They were the branches of Hong Kong and Shanghai Banking Corporation Limited, Bank of East Asia, Bank of Overseas Chinese, and Standard Chartered Bank. The Japan Bank for International Cooperation

[8] http://www.zgjrw.com, accessed on 6 April 2013.

was the first foreign bank to set up an office in Beijing. However, it was a Japanese policy bank and its function was just to provide policy loans to the government of China on behalf of the Japanese government. Due to the different reasons, these five foreign banks were already operating in China before the financial reforms of 1979 onwards, but their business was fully restricted. In this period of time (before 1979 and even before 1984), the banking market was not officially opened to foreign banks.

In China's banking industry, the whole process of opening up to foreign banks may be summarised as follows: first, the foreign exchange market was opened up between 1984 and 1999 and the restrictions on the local currency market were removed gradually over the period 1996–2006, starting with the coastal areas and moving inland.

In the first wave of the opening-up process from 1984, i.e. relaxing rules relating to foreign bank entry, the main motivation for the State Council to open up the banking market to foreign banks was to facilitate the exchange of goods in the transaction-intensive areas. In 1985, the first regulations aimed at the foreign banks were issued — 'Regulations Governing Foreign Banks and Joint Chinese-Foreign Banks in Special Economic Zones (SEZs)', which was the first regulatory document from the government for the foreign banks.[9] As a part of the preferential policy to support the Pudong Development Zone in Shanghai in 1992, foreign banks were approached to set up branches in this zone to provide foreign exchange business. This was the first time that foreign banks were allowed to establish branches[10] outside of

[9] In special economic zones, the government gives them special and more market-oriented economic policies than other provinces' typical or national laws, such as more freedom on economic administration, special tax incentives for foreign investments, and greater independence on international trade activities.

[10] The branches were of the following banks: Bank of East Asia, Standard Chartered Bank, Hong Kong and Shanghai Banking Corporation (HSBC) and Overseas-Chinese Banking Corporation (OCBC).

the SEZs. In this wave, the foreign banks were mainly from target countries or regions for international trade, e.g. Hong Kong, Japan, and the US. Another feature for the liberalisation policies in this period of time (1984–92) is that the business of foreign banks was only allowed in the specific geographic area (SEZs and Pudong development zone).

The second wave of the opening-up process took place mainly during the 1990s. During this time, foreign direct investment increased dramatically in China, and international trade expanded significantly, which provided strong demand for the foreign exchange services of the banking industry. In order to meet the demand, the geographical restrictions affecting foreign banks were gradually removed. The restrictions in the SEZs and Shanghai were removed in 1984 and 1992, respectively. From 1992 onwards, the State Council extended the area for foreign banks to carry out foreign exchange business by adding the regions of Dalian, Tianjin, Qingdao, Nanjing, Ningbo, Fuzhou and Guangzhou, as summarised in Table 2.3. In 1994, that area was extended again by including inland cities: Beijing, Shenyang, Shijiazhuang, Xi'an, Chengdu, Chongqing, Wuhan, Hefei, Suzhou, Hangzhou and Kunming. From 1999 onwards, there were no restrictions to foreign banks on engaging in foreign exchange business in China.

Table 2.3. Removal of geographical restrictions on foreign banks

| Business | Year | Region |
|---|---|---|
| Foreign | Before 1992 | SEZs and Pudong area in Shanghai |
| Exchange | 1992 | Dalian, Tianjin, Qingdao, Nanjing, Ningbo, Fuzhou, Guangzhou |
| | 1994 | Beijing, Shenyang, Shijiazhuang, Xi'an, Chengdu, Chongqing, Wuhan, Hefei, Suzhou, Hangzhou, Kunming |
| | 1999 | No geographic restrictions |
| RMB | 1996 | Pudong area in Shanghai |
| Business | 1998 | Shengzhen |
| | 1999 | Shanghai (Jiangsu, Zhejiang); Shengzhen (Guangdong, Guangxi, Hunan) |
| | 2001 | Tianjin, Dalian |
| | 2002 | Guangzhou, Zhuhai, Qingdao, Nanjing, Wuhan |
| | 2003 | Jinan, Fuzhou, Chengdu, Chongqing |
| | 2004 | Kunming, Beijing, Xiamen, |
| | 2005 | Shantou, Ningbo, Shenyang, Xi'an |
| | 2006 | No geographic restrictions |

Sources: *People Daily*, 12 June 2001.

The third wave of opening up foreign bank entry was in the local currency (renminbi or RMB) business, which was the most important part of China's banking market. Before 1999, foreign banks were only allowed to provide foreign exchange business, with the exception of the Pudong area in Shanghai from 1996 and Shenzhen from 1998, where RMB business was also allowed (see Table 2.3). From 1999 onwards, foreign banks in Shanghai and Shenzhen were able to provide RMB business to customers in Jiangsu, Zhejiang, Guangdong, Guangxi and Hunan, but were not allowed to set up branches in that area. Their clients needed to visit the branches of foreign banks in Shanghai or Shenzhen to access the banking services. In 2001, Tianjin and Dalian were added to the region in which the foreign banks were

able to provide foreign exchange services and RMB business to the general public and enterprises. After one year, the State Council extended this region to Guangzhou, Zhuhai, Qingdao, Nanjing and Wuhan. To honour the WTO commitments, the government lifted all geographical restrictions on foreign banks in 2006.

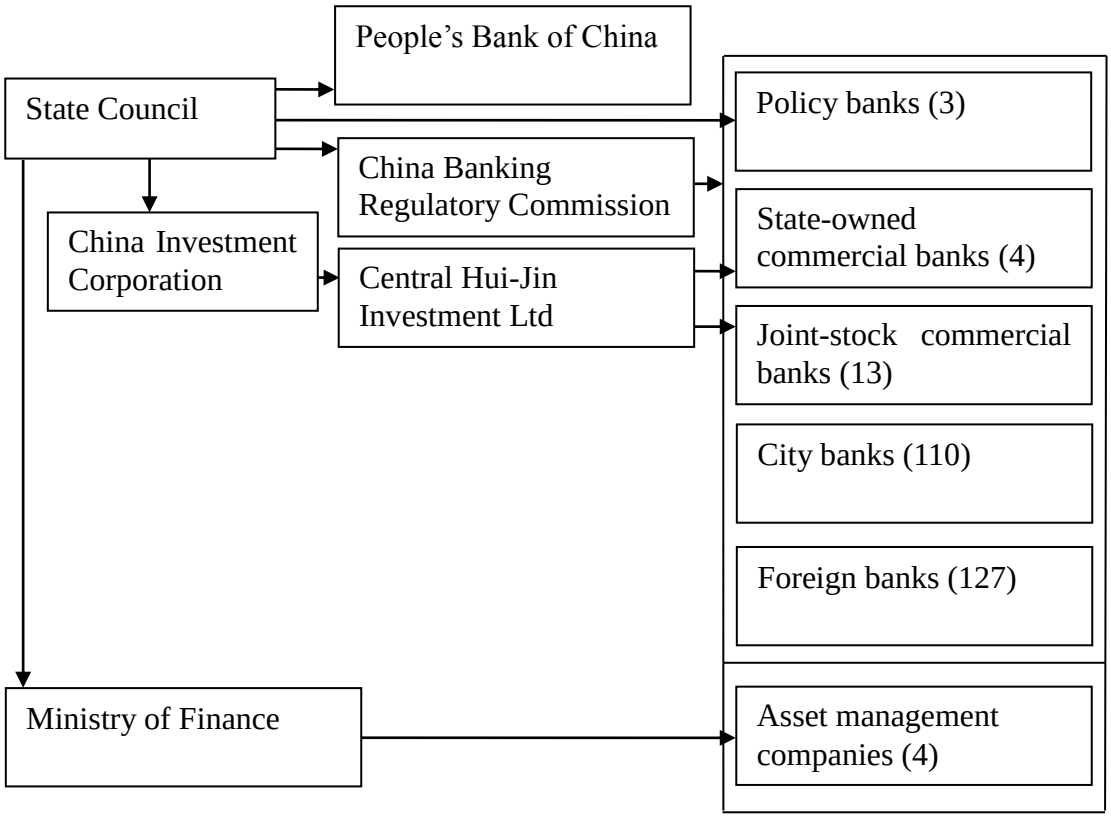
There are at least two reasons for the nature of the path of policy development. First, the Chinese economy developed in a very unbalanced manner in economic terms in the coastal areas compared to the inner areas. For example, using a field survey on 20 city banks from three provinces (Hubei, Zhejiang and Sichuan) at different levels of economic development over four years 2000–03, Ferri (2009) finds that the performance of the banks in China is systematically related to the level of economic development of their location. Compared with the banks in well developed areas, the domestic banks were relatively less efficient in the inner area. Chen and Liao (2011) investigate a sample of foreign banks in 70 countries over the period 1992–2006. They investigate the home- and host-country effects of banking market structure, macroeconomic conditions, governance, and bank supervision on the performance of the foreign banks. Their empirical evidence shows that the foreign banks competed for the profits of domestic banks. The Chinese government expects that the restrictions in the market could protect the less efficient banks from foreign competition.[11] Another reason is that the reform of domestic banks ended in 1999. For example, in 1999, the NPLs were transferred from SOBs to AMCs and most of the urban credit cooperatives were merged with city banks.

[11] Chen and Liao (2011) find that foreign banks are more profitable than domestic banks when they operate in a host country whose banking sector is less competitive than the home country of the foreign banks and when the parent bank in the home country is highly profitable, which is like the case in China.

## 2.6 Current Banking Industry in China

The market economy has created an almost entirely new banking industry in China. In response to rapid development in this sector, the China Banking Regulatory Commission (CBRC) was officially launched in 2003 as an agency of the State Council to take over the supervisory role of PBC.[12] Its mission is to maintain a stable and efficient banking system in China by taking responsibility for the regulation and supervision of financial entities, such as commercial banks, policy banks, and asset management companies. Figure 2.1 illustrates the current banking industry in China.

Figure 2.1. Structure of China's banking industry




Source: Summarising the information from the CBRC website.

[12] The banking markets in Hong Kong, Macau and Taiwan are not supervised by CBRC, since they are special administrative regions.

There are four departments in CBRC which supervise the banking institutions: No. 1 department for four SOBs; No. 2 department for private banks – JSCBs and city banks; No. 3 department for foreign banks; and No. 4 department for policy banks, the postal savings bank and asset management companies.[13] The main functions of the CBRC are: (1) to formulate supervisory rules and regulations governing the banking institutions; (2) to authorise the establishment, changes, termination and business scope of the banks; (3) to conduct on-site examinations and off-site surveillance of banking institutions, and take enforcement actions against rule-breaking behaviours. After the establishment of CBRC, PBC was no longer the regulator of the banking industry, and only responsible for monetary policy, including setting the interest rate, and allocating the credit quota for commercial banks.

In this system, however, the government still plays two roles as regulator of the sector via CBRC and PBC, and majority owner of four SOBs and some JSCBs via Central Hui-Jin Investment Ltd and China Investment Corporation. As illustrated in Figure 2.1, Central Hui-Jin Investment Ltd is the largest shareholder of the banks, and is a full holding company of China Investment Corporation, which manages some of the country's SOEs on behalf of the State Council. Due to this link, the leaders and senior managers in the SOBs are indirectly nominated by the State Council through China Investment Corporation and Central Hui-Jin Investment Ltd. In some cases, the senior managers of SOBs could continue their career in the government or other SOEs after their term in the bank.

According to the differences in the nature of ownership, size and origin, China's

[13] Originated from the postal savings system, the postal savings bank was founded in 2007 by the State Post Bureau and provided basic banking services at post offices. Asset management companies are not banking firms, which take over the NPLs from SOBs. Since their main function is to deal with these NPLs, they are supervised by the CBRC and Ministry of Finance.

banking industry consists of four tiers, with SOBs comprising the first tier, 13 nation-wide JSCBs as the second tier, and around 140 city banks as the third tier. The fourth tier is the foreign banks, which are the newcomers in the market. The banking industry has developed rapidly since 2006. As shown in Table 2.4, the growth rate of total assets was more than 17 per cent from 2006 to 2008, rising to 26.3 per cent in 2009. From 2006 to 2009, both the total assets and total liabilities nearly doubled.

Table 2.4. China's banking industry

| Year | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|
| Total assets (100 million RMB) | 439,499.7 | 525,982.5 | 623,912.9 | 787,690.5 |
| Growth rate over previous year (%) | 17.3% | 19.7% | 18.6% | 26.3% |
| Total liabilities (100 million RMB) | 417,105.9 | 495,675.4 | 586,015.6 | 743,348.6 |
| Growth rate over previous year (%) | 16.5% | 18.8% | 18.2% | 26.8% |

Note: The banking institutions include policy banks, SOBs, JSCBs, city banks, rural commercial banks, rural cooperative banks, urban credit cooperatives, rural credit cooperatives, postal savings bank, foreign banks and asset management companies.
Source: Summarising the data from website of CBRC, http://www.cbrc.gov.cn/chinese/home/docViewPage/110009.html, accessed on 6 April 2013.

The four SOBs are the biggest banks by almost any measure. Despite the rapid expansion of private banks (JSCBs and city banks) and foreign banks, the SOBs overwhelmingly continue to dominate the sector. As shown in column of percentage of banking industry in Table 2.5, their market share was more than half of the whole industry both in terms of total assets and liabilities throughout the period (2006–09).

However, there is no consensus view in the literature on the impact of bank size on the banks' productivity or efficiency. The large bank size of SOBs does not guarantee high profitability or productivity. The big banks could enjoy the economies of scale, but it is also possible to suffer the consequences of an irrational growth strategy. Yao et al. (2008) examine the performance of 15 banks in the Chinese

marking sector using the DEA approach in 2005 and find that CCB, BOC and ICBC dominated the market due to high profitability and efficiency. By contrast, Lin and Zhang (2009) investigate the performance of 60 banks over the period 1997–2004 and find that the four SOBs had worse asset quality than the rest of the banks and were less profitable and efficient.

Table 2.5. State-owned commercial banks

| Year | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|
| Total assets (100 million RMB) | 225,390.4 | 280,070.9 | 318,358.0 | 400,890.2 |
| Growth rate over previous year (%) | 14.7% | 15.6% | 13.7% | 25.9% |
| Percentage of the banking industry (%) | 51.3% | 53.2% | 51.0% | 50.9% |
| Total liabilities (100 million RMB) | 212,698.4 | 264,330.0 | 298,783.6 | 379,025.6 |
| Growth rate over previous year (%) | 13.3% | 15.5% | 13.0% | 26.9% |
| Percentage of the banking industry (%) | 51.0% | 53.3% | 51.0% | 51.0% |

Note: This group includes ICBC, ABC, BOC and CCB.
Source: Summarising the data from website of CBRC: http://www.cbrc.gov.cn/chinese/home/docViewPage/110009.html, accessed on 6 April 2013.

In order to improve the performance of SOBs, the State Council carried out a set of policies, such as the ‘open door’ policy, ownership reform and the policy to liberalise the domestic banks in their daily operation. In the ‘open door’ policy, foreign banks are allowed to enter the domestic banking market. Due to the requirements of the WTO accession, there have been no restrictions on the business of foreign banks in China since 2006. For the ownership reform, the critical element was to restructure the four SOBs and enable them to be listed on the stock exchange, subjecting them to monitoring and control by the market instead of the government. Accordingly, CCB was listed on the Hong Kong Stock Exchange in 2005. A year later, BOC and ICBC were listed on the Hong Kong and Shanghai stock exchanges. Finally, ABC was the last one to be listed in 2010.

In addition, the government gave more freedom to domestic banks in their daily operations. Most of the non-prudential restrictions in the sector were removed. From 2006, domestic banks had more freedom in choosing the composition of their asset portfolio in terms of the nature and quantity of loans, marketable securities and cash, and managing the net interest margin by setting up the loan and deposit interest rates. In the lending business, they were allowed to lend to any firm without any geographical restrictions, to design their loan agreements, and to set the prices of their loans. According to the empirical results from the cross-nation analysis in Chapter 5, the policy to liberalise the domestic banks has not significantly increased the banks' efficiency, although the 'open door' policy has been effective in this regard.

The 13 JSCBs are the second tier of the sector. The primary objective of setting up JSCBs is to enlarge the credit supply by bringing in investment from the private sector and to improve the efficiency of credit allocation by creating a new source of competition. After more than two decades of development from 1985 to the late 2000s, they had become the strongest competitors of SOBs. In Table 2.6, the total assets and liabilities of JSCBs are shown to be around one seventh of the whole banking industry and the growth rate was higher than for the SOBs and the whole banking industry, but lower than for the city banks, as shown in Table 2.7.

Table 2.6. Joint-stock commercial banks

| Year | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|
| Total assets (100 million RMB) | 71,419.0 | 72,494.0 | 88,130.6 | 117,849.8 |
| Growth rate over previous year (%) | 22.9% | 33.2% | 21.6% | 33.7% |
| Percentage of the banking industry (%) | 16.2% | 13.8% | 14.1% | 15.0% |
| Total liabilities (100 million RMB) | 68,667.3 | 69,107.5 | 83,683.9 | 112,215.3 |
| Growth rate over previous year (%) | 22.5% | 31.5% | 21.1% | 34.1% |
| Percentage of the banking industry (%) | 16.5% | 13.9% | 14.3% | 15.1% |

Note: This group of banks includes Bank of Communications, CITIC Bank, Everbright Bank, Huaxia Bank, Guangdong Development Bank, Shenzhen Development Bank, Merchants Bank, Shanghai Pudong Development Bank, Industrial Bank, Minsheng Bank, Prudential Bank, China Zheshang Bank and Bohai Bank.
Source: Summarising the data from website of CBRC: http://www.cbrc.gov.cn/chinese/home/docViewPage/110009.html, accessed on 6 April 2013.

The third tier consists of city banks. Unlike the SOBs and JSCBs, the city banks are local banks and their business focus is on their own region. Since most of them are small banks, their market share was only around 6 per cent in 2006, rising to 7.2 per cent in 2009, as shown in Table 2.7, which is much smaller than for the first and second tier. However, the growth rate of over 37 per cent in 2009 both for the share of total assets and liabilities is the highest of all the tiers. The total assets and liabilities of city banks more than doubled between 2006 and 2009. Chen et al. (2005) evaluate the efficiency of Chinese banks from 1993 to 2000 and find that SOBs and city banks were more efficient than other banks. The bank efficiency was increased after the deregulation policies to establish a competitive and modern banking industry in 1995.

Table 2.7. City banks

| Year | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|
| Total assets (100 million RMB) | 25,937.9 | 33,404.8 | 41,319.7 | 56,800.1 |
| Growth rate over previous year (%) | 27.4% | 28.8% | 23.7% | 37.5% |
| Percentage of the banking industry (%) | 5.9% | 6.4% | 6.6% | 7.2% |
| Total liabilities (100 million RMB) | 24,722.6 | 31,521.4 | 38,650.9 | 53,213.0 |
| Growth rate over previous year (%) | 26.5% | 27.5% | 22.6% | 37.7% |
| Percentage of the banking industry (%) | 5.9% | 6.4% | 6.6% | 7.2% |

Source: Summarising the data from website of CBRC: http://www.cbrc.gov.cn/chinese/home/docViewPage/110009.html, accessed on 6 April 2013.

Foreign banks are the fourth tier and the newcomers to the market. Unfortunately, CBRC did not provide their statistical information. In 2001, the government committed to full opening up of the banking industry to foreign competition after a five year transition period, which ushered in a new era for the banking market.

In 2006, the government released new regulation documents for the foreign banks, in which the authorities encouraged the foreign banks to be legal entities so as to cut off the direct link between the branches of foreign banks in China and their overseas parent company. As the legal entity, the foreign banks in China and their parent company are two companies in the eyes of the law, so it eases the supervision role of CBRC. In addition, this arrangement could reduce the possibility of a banking crisis in China, which may be triggered by negative shocks from other countries. If the foreign banks are the branches of their parent companies, the minimum threshold of their deposit business is more than 1 million RMB for each transaction and they are forbidden to do bank card business. Moreover, the initial capital requirement for setting up a branch is more than $US20 billion, which is twice that of establishing a fully foreign owned or joint stock bank for foreign banks.

## 2.7 Summary

This chapter has reviewed the main financial reform policies in China since 1979 and the history of the key players (i.e. SOBs, JSCBs, city banks and foreign banks) in the banking industry, and this provides the background information for the whole thesis. The current structure of the banking industry in China has its roots in the country's administrative hierarchy, which has been through major periods of change and has impacted on how banks are owned and operated. From 2007 onwards, a relatively open and competitive market has been established, comprising four SOBs as the core, complemented by the JSCBs, city banks and foreign banks.

The government expects that the threat of competition from foreign banks means that domestic banks, i.e. SOBs, JSCBs and city banks, have to be become more efficient in their operation in order to survive. Moreover, the WTO accession provides a unique opportunity to investigate the link between financial liberalisation in terms of removing entry barriers to foreign banks and efficiency gains in the domestic banking market. WTO accession could be considered as an exogenous shock to the domestic banks, since the accession agreement was made before the transition process and the adaptation requirements could not be changed during that process.

Has the expectation of the government been fulfilled and is the positive efficiency effect of the financial liberalisation supported by the empirical results from the China's banking industry? These questions are answered in Chapter 4 by modelling the evolution of bank efficiency over the period 2000–09.

# Chapter 3 Literature on Financial Deregulation and Bank Efficiency

## 3.1 Introduction

Since work as early as that of Schumpeter (1911), the contribution of the financial sector has been recognised as supporting technological innovation in all areas of the economy by providing funding which facilitates investment in the innovation, by which economic growth can be achieved. In this chapter, new empirical evidence in line with this piece of work is discussed first. Within the financial sector, the banking industry allocates resources by effectively transferring funds, and provides financial services to ease the exchange of goods and services. In order to increase the efficiency of the banking industry and thereby promote economic growth, financial liberalisation and deregulation policies have been carried out in many developing countries, such as the financial reform in China's banking industry, which is reviewed in Chapter 2.

This chapter provides the literature review that informs these subsequent chapters. After the new empirical evidence on financial development and economic growth are reviewed in Section 3.2, Section 3.3 discusses the motivation behind these kinds of liberalisation policies and the related literature on the liberalisation of banking industries through the removal of Greenfield entry barriers. These kinds of policies are expected to encourage competition in the market that may lead to efficiency gains in terms of how the commercial banks operate.

Section 3.4 discusses the related research on acquisition entries in banking markets.

The various approaches to estimating bank efficiency are reviewed in Section 3.5, i.e. the financial ratio, the parametric and non-parametric frontier analysis. Next, the advantages of the DEA model are discussed, which is used to estimate the inefficiency scores of banks in this thesis. The details of the DEA model are presented in Section 3.6. Section 3.7 summarises the key points of this chapter.

## 3.2 Financial Development and Economic Growth

In recent times, the hypothesis that development of the financial sector is a powerful impetus for economic growth has been strengthened by a growing body of empirical evidence. The most important subset of the financial sector is the banking industry. The key developments are mainly related to the functions of banks in evaluating and monitoring investments. The seminal work of Rajan and Zingales (1998) looks at 40 countries in the 1990s. They consider financial development in a country as the ratio of national market capitalisation over gross domestic product (GDP); the ratio of domestic credit to the private sector over GDP; and accounting standards in each country. Their empirical evidence shows that financial development provides a substantial supportive influence for economic growth. They find that financial development reduces the costs of funds that firms obtain from outside of the firm (external finance to firms), which is particularly important in the most financially dependent industries, such as the production of pharmaceuticals and plastics.

According to the corporate finance literature, firms are generally more dependent on

external financing in the beginning of their life cycle, so one hypothesis from the theory is that small firms operate more effectively in countries with greater financial development than countries with lower levels of financial development. Beck et al. (2008) search for evidence supporting this hypothesis in their dataset from 44 countries over the period 1980–90. They control for the variances in financial dependence on banks by taking into account the measure of the industry's dependence on external finance from Rajan and Zingales (1998) and find that small firms grow disproportionately faster in economies with well-developed financial systems and the industrial composition is significantly affected by the level of financial development. From their dataset, they find that in those countries with higher financial development, the manufacturing sectors have a larger proportion of small firms than in countries with lower levels of financial development.

The positive relationship between financial development and economic growth is not only evident in cross-country studies, but also in the case of China. For instance, using province-level data for the period 1986–2002, Hasan et al. (2009) find a positive association between the economic growth rate (i.e. the growth rate of real annual per capita GDP in the province) and the degree of development of financial markets. They use two proxies for the development of financial markets, that is, the ratio of total bank loans to GDP, which measures banking industry depth, and the ratio of equity and non-financial corporate debt (long-term and short-term) issuance to GDP, which is an indicator of capital market depth (non-banking financial market activity). Their findings show that only capital market depth has a strong influence on economic growth and they argue that the banks' poor lending

practices might hinder economic growth at provincial level, because of the continued bad lending practices and the huge amount of NPLs.

However, the province-level data may be a source of weakness in their analysis, since they are too aggregated and lose a lot of local information. To overcome this weakness, Zhang et al. (2012) use the relatively disaggregated city-level data, which is a lower level constitution than the province level, and focus on the period 2001–06 after China's accession to the WTO to investigate the effects of financial reforms during that time. By looking at the ratios of total loans, total deposits and total household savings to GDP; the ratio of corporate deposits to total deposits in the financial system; and the share of fixed asset investment financed by loans, they find that the development of the banking industry measured in these ways positively influenced economic growth.

Summarising the works reviewed above, the research focus has been on the relationship between financial development and economic growth. However, one pre-condition for the contribution to economic growth from financial development is the increased efficiency of banks.

## 3.3 Financial Deregulation and Efficiency Gains

It is generally the case that the primary objectives of deregulation policies in the banking industry are to improve the efficiency of banks and provide more types of services and service providers to consumers through increased competition. The main motivation behind these kinds of policies is to create a competitive environment which would force relatively

inefficient banks to look for ways to reorganise their processes, and this will result in producing the most efficient outcome both in terms of production/revenue and consumer welfare. For instance, Focarelli and Panetta (2003) look at banks in Italy over the period 1990–98, and find that in the short run removing the barriers to entry to foreign banks through acquiring domestic banks increased the market power of the consolidated banks. However, in the long run, those deregulation policies increased general bank efficiency and the efficiency effect was stronger than the market power effect. The efficiency effect was passed on to consumers via increasing the interest rates on deposits, so they benefited from increased returns.

This idea that there is a significant efficiency effect on banks due to competition in the banking market has a long tradition dating back to Hicks (1935), who famously claimed that "the best of all monopoly profits is a quiet life", as market power reduces the incentives for effort made by managers. If the survival of firms depends on how productive managers are, a competitive environment would then force managers to raise their efforts towards the promotion of profit, or reduction of cost (see Leibenstein, 1966).

However, in general, it is not always the case that a firm will use the most efficient production techniques available. In the literature, researchers have expended some effort in trying to understand the factors contributing to firm efficiency. With respect to a firm's environment, the impact of the competitiveness of that environment on the firm's efficiency is not at all clear cut. Using a theoretical analysis, this is shown by Schmidt (1997), who provides evidence that competition is not sufficient to guarantee an increase in firm

productivity. It is possible that competition will introduce a negative effect whereby managers lose motivation to increase profits or reduce costs. For instance, competition squeezes the profit margin created by managers from their efforts regarding cost reduction or profitability promotion.

Complementing these theoretical analyses is a large body of empirical literature, which this thesis is in line with. Many developing countries have carried out a set of financial reforms to promote the performance of the banking industry, which include the liberalisation of policies to remove the Greenfield entry restrictions, or deregulation of acquisition entry, for both domestic and foreign banks. These policies afford a good opportunity to provide the empirical evidence for the topic of the efficiency impact of increased competition in the market. Policy-makers and economists expect these types of policies to foster both competition and efficiency in the market and find that these types of policies are effective in some countries. For instance, with regard to the removal of entry barriers to Greenfield investments, Delis (2012) looks at 84 banking industries worldwide as far back as possible until 1987, and finds that the market power of banks in transition countries (e.g. Belarus, Hungary, Poland, Russia, and Vietnam) gradually declined from 1996, due to the ongoing financial liberalisation and the gradual penetration of foreign banks.

Focusing on the banking industry in the European Union (EU), Goddard et al. (2007) summarise the important policy changes that have resulted in reducing entry barriers for each member country since the late 1970s, which contributed towards the integration of European banking and financial markets, such as the 1985 White Paper on the Completion of the

Internal Market, the 1986 Single European Act, and the 1992 Maastricht Treaty. Goddard et al. (2007) suggest that the effects of deregulation, globalisation and technological change as the drivers of structural change in European banking and European banking are likely to provide fertile territory for economists.

In order to examine the efficiency impact from the deregulation policies in the banking market and the establishment of the Economic and Monetary Union, Casu and Girarbone (2006) look at the banks in the EU15 countries over the period 1997–2003.[14] Their empirical results show that deregulation increased bank efficiency (estimated DEA score in the input direction) through the subsequent rationalisation process and cost reductions in most selected countries. By including various definitions of bank efficiency, bank risk and bank capital in commercial banks in EU26 countries over the period 1995–2007, Fiordelisi et al. (2011) find that the decreased efficiency scores from the stochastic frontier analysis (SFA) model had a positive correlation with the NPLs to total loans ratio, which indicates that decreased bank efficiency increases the bank risk. Their results underline the importance of attaining long-term efficiency gains to support financial stability objectives.

Using the index of financial reform compiled by the European Bank of Reconstruction and Development (EBRD) with the primary purpose of assessing the progress of the banking industries of formerly centrally-planned economies, Brissimis et al. (2008) find a positive effect from the financial reforms on bank efficiency in the following countries: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and

[14] The EU15 countries are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the UK.

Slovenia. This conclusion is supported by Fries and Taci (2005) who find a similar result by using the same index from EBRD for 15 East European countries over the period 1994–2001.[15] Furthermore, they find that the relationship is non-linear between financial reform and bank efficiency. At the beginning of the financial reforms, the banks sharply reduced their costs in order to survive in the market, which increased the estimated bank efficiency, but the bank costs were pushed up at the more advanced stages, which decreased the bank efficiency. They argue that one possible reason for the increased costs in the more advanced stages is due to the investment from banks in innovation or promoting the service quality.

Unfortunately, the empirical evidence available for this topic is not always consistent in terms of the impact direction. The studies discussed above found that bank efficiency increases when financial markets are deregulated, whereas the following studies found no impact on efficiency. Pasiouras (2008) uses a 2003 dataset from 95 countries to investigate the impacts of the regulations and supervision on banks' efficiency using a two-stage DEA model (using DEA in the first stage and the Tobit regression model in the second stage). He finds that restrictions on banks activities and entry requirements did not have a significant impact on banks' efficiency. Using the data from 80 countries worldwide for the 1988–1995 period, Claessens et al. (2001) find that the entry of foreign banks (measured as the share of the number of banks that are foreign owned, and the share of foreign bank assets in total bank assets) reduces the profitability ratio (according to banks' income statements) and revenue

[15] They examine the cost efficiency of banks by SFA for a sample of 289 banks from the following countries: Bulgaria, Croatia, Czech Republic, Estonia, FYR Macedonia, Hungary, Kazakhstan, Latvia, Lithuania, Poland, Romania, Russia, Slovakia, Slovenia and Ukraine.

margin of domestic banks. The relaxation of restrictions on Greenfield entry makes the banking industry vulnerable, and this is particularly true in developing countries because the domestic banks in those countries tend to be relatively inefficient. Using a database which covers the regulation and supervision framework in 107 countries in 1999, Barth et al. (2004) find no compelling international evidence of favourable relationships between the removal of entry barriers and bank development, performance or financial stability.

In some cases the research can provide notably contrasting results for the same region. One example is the EU. Kasman and Yildirim (2006) investigate the evolution of bank efficiency over the period 1995–2002 in eight central and eastern European countries in order to provide empirical evidence from the newly acceded EU countries on the efficiency impact of setting up the integrated market discipline and of institutional changes.[16] They find that the evidence of efficiency gains from that period prior to, and in preparation for, joining the EU, is weak at best.

Similar to the integration policies of the EU, deregulation of financial markets through reducing/removing entry barriers is one of the striking features in the recent design of financial reform policies in Asian developing countries. However, the research and empirical evidence for this group of countries is very limited. Using the data from 10 emerging economies, i.e. Argentina, Brazil, Peru, Mexico, India, Indonesia, Korea, Pakistan, Thailand and the Philippines, Hermes and Hhung (2010) find a positive correlation between the aggregated country-level bank efficiency and the index of foreign liberalisation from Laeven

[16] The sample countries in their study are Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia, which became members of the EU in May 2004.

(2003). This index shows the extent to which a country has implemented financial liberalisation policies in six different areas: interest rates, entry barriers, reserve requirements, credit controls, privatisation and prudential regulation.

Previous studies on the efficiency impact of removing the entry barriers to banking markets, using data from EU countries or developing countries such as India, Indonesia, Korea and Thailand, do not directly focus on this impact. For example, the indices from EBRD and Laeven (2003) focus on changes in the policy environment, which is mixed up with unrelated information on this topic. These indices aggregate the different impacts of deregulation policies. For example, the index of Laeven (2003) focuses on six reform measures: interest rate deregulation, reduction of entry barriers, reduction of reserve requirements, reduction of credit controls, privatisation of state banks, and strengthening of prudential regulation, and this aggregated focus may create econometric problems that lead to biased estimators in empirical analyses. Claessens et al. (2001) argue that one difficulty in this topic is how to specifically measure the impacts from the barriers to entry for foreign banks in a banking market without other impacts being included.

In order to fill the gap in the literature, namely the lack of evidence from developing countries, this thesis looks at the banking industries of China, India, Indonesia, Malaysia, Pakistan, Thailand, Russia and Vietnam. For example, Chapter 4 investigates the efficiency impacts of WTO accession on the Chinese banking industry. In order to overcome the inherent problems of aggregate measures, and to apply the appropriate indices to estimate the effects of the deregulation policies in the banking market, the indices from Dinh (2008) are

used to investigate the effects of removing entry barriers using a cross-country dataset in Chapter 5. The results from these two chapters attempt to fill the gap in the literature by providing additional evidence on how liberalisation of the market influences bank efficiency.

## 3.4 Efficiency Gains from M&As

As another kind of liberalisation of the banking industry, the entry of a foreign bank through M&As creates a different kind of competitive environment to the Greenfield entry. M&As are viewed as a threat to inefficient banks in the market, because of the possibility to be acquired by, or merged with, the more efficient banks. Amel et al. (2004) list the possible ways in which M&As can improve bank performance, e.g. by accessing cost-saving technologies, distributing their fixed costs over a larger base, or allowing the consolidated institutions to enter new markets.

Due to the introduction of the EU's Third Generation Insurance Directives in 1994, which aimed to deregulate the financial markets in EU member countries and allow the banks' takeover activities, the market structure of the Spanish insurance industry in particular changed dramatically, especially in terms of the number of insurers decreasing and the size of the firm increasing in 1980s and 1990s. By analysing that change in the Spanish insurance industry between 1989 and 1998, Cummins and Rubio-Misas (2006) find that the small, inefficient, and financially underperforming firms were eliminated because of insolvency or having to go into liquidation and the productivity of surviving firms increased.

While there is some evidence showing that the M&As provide a mechanism by which

inefficient banks may be restructured and which may benefit the industry, the evidence of their impact on efficiency is not always consistent. Some analyses on M&As find efficiency gains, but some do not. Focusing on characteristics of target banks in M&As, Caiazza et al. (2012) look at 24,235 banks between 1992 and 2006, which were involved in 1,484 M&A deals, of which 1,156 were domestic and 328 were cross-border. Their empirical evidence shows that domestic and foreign investors target fairly similar banks in M&As, which are typically the less efficient banks which are considered to be the most likely to benefit from restructuring in terms of increasing their efficiency.

However, Harjoto et al. (2012) look at banks merging with non-banking firms in the US and find that the cost increases more than the revenue in the consolidated firms, so these kinds of M&As do not enhance bank revenue, although bank managers claimed that the M&As would enhance their revenue.[17] Focusing on the German banking industry over the period 1995–2000, Behr and Heid (2011) find that the effect of M&As on banks' profitability and cost efficiency was neutral and argue that the potential longer term benefits from the M&As might not be as much as generally expected.

Selecting different countries could be a reason to explain the different conclusions in the case studies, but the results in the cross-nation analysis are still mixed. For instance, DeYoung et al. (2009) point out some evidence in the post-2000 literature, which shows that M&As have generated substantial efficiency gains for banking industries in Europe and

[17] Harjoto et al. (2012) summarise the two key sources of motivation why banks engage in M&As: (1) the external competitive forces from deregulation and capital equity restriction; (2) the internal pressures to increase profit and to seek alternative sources of revenue beyond the traditional banking.

North America. When more countries are involved, however, their conclusion is challenged by Amel et al. (2004), who review the existing works in Japan, Australia, Canada, the US, and the EU in the 1990s, and conclude that consolidation is only beneficial for relatively small size banking firms, and there is little evidence to show that M&As could yield cost reductions by improving managerial efficiency.[18] Their conclusion is supported by Ayadi et al. (2013), who look at 42 M&A deals and 587 non-merging banks in the EU15 plus Norway between 1996 and 2003, and find that the M&As did not increase the productivity of the banks because the efficiency of consolidated banks was similar to that of the incumbent banks, which are defined as those banks not involved in M&As.[19]

Unfortunately, the research on M&As focuses on the developed countries in the literature, e.g. Germany, the EU or the US, and only very few researchers focus on the developing countries, especially on Asian developing countries which are almost absent in the literature. In Chapter 6 of this thesis, the efficiency impact of M&As is studied in Asian developing countries and the additive evidence is provided to fill the gap in the literature.

## 3.5 Methodology of Efficiency Analysis

The simplest method to measure bank efficiency could be to calculate the financial ratio, which is used as an indicator of bank performance. The financial ratio may be measured in a

[18] The main sector of the financial industry in their review includes commercial and investment banks, insurance and asset management companies and five major industrial countries, namely the US, Europe, Japan, Australia and Canada.

[19] The EU15 countries are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the UK.

number of ways. For example, Li et al. (2001) investigate the efficiency and performance of Chinese banks by using financial ratio analysis (the revenue-to-assets ratio and the expenses-to-assets ratio); and Geretto and Pauluzzo (2009) employ the returns to assets and returns to equity to be the proxies of banks' performance in China's banking market. Rhoades (1998) employs 16 financial ratios to examine the impact of M&As on banks' efficiency, profitability and balance sheet structure in the US banking industry, e.g. the ratio of various expenses to assets or operating revenue; the ratio of net income after taxes to average assets; the ratio of off-balance sheet items to total assets; and the net income-to-equity ratio.

However, changes in financial ratios do not fully reflect changes in bank efficiency. For example, an increase in the financial ratio relating to return on assets (ROA) could just represent an increase in the bank size rather than efficiency improvements. Rhoades (1998) points out that cost reductions and efficiency gains are not necessarily synonymous, since an improvement in efficiency requires that costs be reduced by more than any decline in assets or revenues, therefore it is very hard for this kind of financial ratio to fully reflect the bank efficiency. Avkiran (2011) uses frontier analysis and finds that the correlation is weak between financial ratios and efficiency scores in general. To examine the evaluation of bank efficiency in Greek commercial banks, Halkos and Salamouris (2004) argue that the comparative advantage of the frontier model in estimating efficiency, in comparison with the simple ratio analysis, is due to the fact that it forms a comprehensive analysis of bank efficiency, taking account of a variety of ratios simultaneously and combining them into a single measure of efficiency.

Across banks, technology and inputs are relatively consistent, which means that theoretically, differences in the performance of banks are due to the differences in efficiency. To get a better measure of bank efficiency, some researchers rely on the frontier analysis to benchmark the 'best practice' participant in the dataset. This kind of analysis may be classified into two main groups, parametric or non-parametric frontier analysis, due to the assumptions imposed on the functional form, the distribution of inefficiency and the error term. The common point of these two groups (DEA and SFA) is that both of them have a similar mechanism to identify bank efficiency: first, the frontier of observations is identified and second the inefficiency is estimated by different algorithms.

In most cases, the parametric analysis, e.g. SFA, specifies a functional form to estimate the frontier for cost or profit efficiency, which includes inputs, outputs and environmental factors. The logic is that the efficiency of banks cannot be negative, so the corresponding inefficiency term in the equation is assumed to follow a certain truncated distribution (e.g. the half normal distribution). Taking into account the measurement error and other random factors, the random error term is integrated in the equation which follows a symmetric distribution (e.g. the standard normal distribution). Both the inefficiencies and the errors are assumed to be orthogonal to other variables specified in the estimating equation and the estimated inefficiency is taken as the conditional mean (or mode) of the distribution of the inefficiency term, given the observation of the composed error term.

This method has been popular for the study of the efficiency of financial institutions. For instance, the SFA has been employed by Gardner and Grace (1993) to investigate the

efficiency of the US life insurance industry; by Fries and Taci (2005) to examine the cost efficiency of banks in post-communist countries; and by Lozano-Vivas and Pasiouras (2010) to examine the relevance of non-traditional activities in the estimation of bank efficiency levels.[20] In this kind of method, however, the first compulsory assumption is the appropriateness in the specification of the production function, which is still controversial in the literature. Santomero (1984) points out that there is no consensus on the form of the production function, but there is agreement that the banks aim to maximise their output. In that process of maximising output, the decision-maker deliberately chooses the best strategy to produce outputs by using minimum inputs.

In order to avoid having to make an assumption about the exact nature of the functional form, some researchers use non-parametric analysis, such as DEA. For example, Brissimis et al. (2008) investigate the relationship between banking industry reform and bank efficiency in 10 newly acceded EU countries over the period 1994–2005 using the DEA model. Matthews and Zhang (2010) employ the smooth bootstrapping method with DEA to estimate the Malmquist indices in China's banking industry from 1997 to 2007, and Delis et al. (2011) examine the relationship between the DEA estimated productivity growth of banks and the regulatory framework in 22 countries over the period 1999–2009.

Fethi and Pasiouras (2010) review a total of 196 studies in operational research and artificial intelligence techniques in the assessment of bank performance and find that 181

[20] In the analysis of Lozano-Vivas and Pasiouras (2010), other earning assets and non-interest income are used as the proxy of non-traditional activities of banks, such as loan origination, securitisation, standby letters of credit and derivative securities.

studies use DEA-like techniques to estimate various measures of bank efficiency and productivity growth, and this research covers almost all of the banking industries around the world. In order to review the DEA application in branch level analysis, Paradi and Zhu (2013) find 275 DEA applications in the banking market between 1985 and 2011. Moreover, there are several surveys or bibliographies in the literature (particularly Seiford, 1997; Gattoufi et al., 2004; and Emrouznejad, 2008) that list the DEA applications in other fields, e.g. education institutions, transport and logistics industry, agricultural sector, manufacturing industry, and so on.

With the DEA method, the frontier is created by enveloping the cloud of the observations in the dataset and the inefficiencies are represented by the distance from the frontier to specific observation points. Obviously, the first advantage of DEA is to avoid the artificial distortion from the undiscovered specification of the production function, which has general assumptions on the technology but does not use a functional form.

The second advantage of non-parametric analysis is that it can support the multi-output and multi-input production process and that is more realistic in the situation of evaluating bank efficiency. However, the parametric analysis, e.g. SFA, employs the regression approach which only allows one dependent variable in the equation and that is far different to the real production processes in banks, which use inputs, such as capital, labour and fixed assets, to produce financial products such as loans, foreign exchange services and credit cards. Because of the advantages discussed above, the DEA approach (detailed in the next section) is utilised in this thesis to estimate bank efficiency.

## 3.6 DEA Frontier Model

In microeconomics, the bank is assumed to choose how much output to supply to maximise profits. After that, the bank chooses its cost-minimising combination of inputs that can feasibly supply that output level for the given level of inputs. The meaning of technical efficiency in this thesis is borrowed from the concept of Debreu (1951) and Farrell (1957), which is defined as "one minus the maximum equi-proportionate reduction in all inputs that still allows continued production of given outputs". Based on their concept and the convexity assumption, Charnes et al. (1978; 1979), Deprins et al. (1984) and Färe et al. (1985) developed the DEA model to measure efficiency relative to a non-parametric, maximum likelihood estimate of an unobserved but true frontier.

The DEA efficiency score can be estimated in two directions, namely the input or output direction. The input direction measures the proportional reduction in input quantities without changing the output quantities produced. Alternatively, the output direction measures the proportional increase in the output quantities produced without altering the input quantities employed. Since maximising profit is the goal of commercial banks, which is achieved by providing more outputs, the output direction is adopted in this thesis.

To be precise, the empirical specification is given by the following frontier model (illustrated in the output direction). The first fundamental assumption is that all banks have access to the same production set, which is denoted as $\Psi$. Inputs $x$ in any bank can be freely obtained in the long run, e.g. during the entire time period. Production set $\Psi$ of physically attainable points $(x, y)$ is given by:

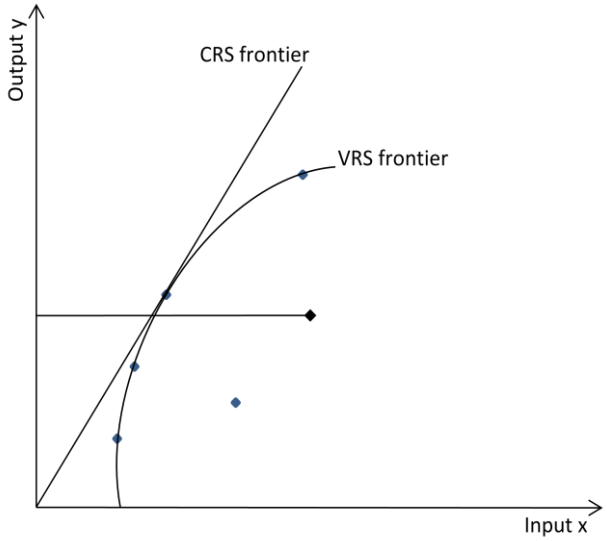
$$\Psi = \{(x, y) \in R_+^{p+q} | x \text{ can produce } y\} \quad (3.1)$$

Any possible input and output combination from the observations are included in this production set, which can be described by the corresponding output set.

$$Y(x) = \{y \in R_+^q | (x, y) \in \Psi\} \text{ defined } \forall x \in \Psi \quad (3.2)$$

This set means all possible output $y$ can be found in the production set $\Psi$ if any corresponding input $x$ ($x \in \Psi$) is given. The best practice participants in the dataset are observations on the boundary of that set. The one dimension input and output example shown in Figure 3.1 illustrates the technical efficiency and the difference between the assumption on the frontier, that is constant returns to scale (CRS) and the varied returns to scale (VRS). These two efficiency frontiers are created by the fully efficient banks. The right-hand section below the two efficiency frontiers is the production set, which includes all observations from the dataset selected. The straight line is the CRS frontier, which assumes that the banks are automatically scale efficient and the curved line is the VRS frontier, which assumes that the bank could be achieving increasing returns to scale at low output levels. The technical inefficiency ($\beta(x, y)$) is the horizontal distance from the observation inside the frontier and the CRS or VRS frontier.

Figure 3.1. Theoretical frontier with production set (Ψ)




Source: Coelli et al. (2005)

The basic idea of DEA is to estimate the attainable set $\Psi$ by its subset $\hat{\Psi}$ ($\hat{\Psi} \in \Psi$) that envelops all observations. The boundary enveloping all observations is called the Farrell efficiency boundary, defined as $\partial Y(x)$, since it meets all requirements of the concept of technical efficiency mentioned above.

$$\partial Y(x) = \{y | y \in Y(x), \beta y \notin Y(x) \; \forall \beta > 1\} \tag{3.3}$$

In the mathematical expression, the Farrell efficiency boundary is a subset of the production set. The main feature of this subset is that $\beta$ cannot be larger than one, and the intuition is that any value over one (for $\beta$) will increase the size of the output value and make it outside of the production set. In other words, given the input $x$, the output $y$ is already the

maximum level. Any deviation in other observations under that boundary is due to the Farrell technical inefficiency, as:

$$\beta(x, y) = \sup\{\beta > 0 | \beta y \in Y(x)\} \quad (3.4)$$

Given the direction and corresponding maximum output, all other observations from each bank in each year will be marked by that distance ($\beta$) from the boundary ($\partial Y(x)$). Under most circumstances, the Farrell technical inefficiency ($\beta(x, y)$) is transformed to the Shephard distance function so as to be readily interpreted and dealt with, such as

$$\delta_{Output}(x, y) = (\beta(x, y))^{-1} = inf\{\delta > 0 | \frac{y}{\delta} \in Y(x)\} \quad (3.5)$$

$\delta_{Output}(x, y) = 1$ means that the observation is on the frontier, or $(x, y) \in \partial Y(x)$. Otherwise, $\delta_{Output}(x, y) > 1$ is interpreted as the maximum feasible proportionate augmentation of outputs for that observation $(x, y) \in \Psi$.

The Shephard distance function and the model mentioned above is the theoretical model used in this thesis. In order to evaluate the parameter in the model, the following requirement set is calculated by the linear programming technique.

$$\hat{\Psi} = \{(x, y) \in R^{p+q} | y \leq \sum_{i=1}^{n} \gamma_i y_i, x \geq \sum_{i=1}^{n} \gamma_i x_i, \quad (3.6)$$
$$\sum_{i=1}^{n} \gamma_i = 1, \gamma_i \geq 0, i = 1,2, \dots n\}$$

In this estimated set, all observations are enveloped by the observations on the boundary. Thus, $\hat{\Psi}$ is the smallest convex free-disposal hull that fits all observed data, and its upper

boundary is a piece-wise linear estimate of the theoretical frontier in Figure 3.1. The constraint of VRS is ensured by $\sum_{i=1}^{n}\gamma_i = 1$. $\gamma_i$ is a $n \times 1$ vector of radial constants of the input and output vector, and that constraint is modified in the CRS assumption. The projected point $(x, y)$ is a linear combination of other observations on the frontier, and the efficiency score is estimated by the following linear programming algorithm:

$$(\hat{\delta}_{Output}(x,y))^{-1} = \max\{\beta \mid \beta y \leq \sum_{i=1}^{n}\gamma_i y_i, x \geq \sum_{i=1}^{n}\gamma_i x_i, \sum_{i=1}^{n}\gamma_i = 1, \quad (3.7)$$

$$\gamma_i \geq 0, \beta > 0, i = 1, \dots n\}$$

The output direction efficiency $\hat{\delta}_{Output}(x,y)$ is evaluated for the specific observation $k$, denoted as $\widehat{TE_k}$ $(k \in N)$, and it is employed as the proxy of bank efficiency in this thesis. Moreover, $\widehat{TE_k}$ is used as the dependent variable in the two-stage DEA model in Chapter 5 and Chapter 6. The detail of the two-stage models is discussed in the methodology sections of these two chapters.

## 3.7 Summary

This chapter has reviewed the literature on the topic of the relationship between efficiency gains and financial deregulation policies from two directions: the deregulation policies of removing the restrictions on the daily operation of banks and of the M&A activities in the banking industry. In addition, the link between financial development and economic growth and the methodologies in the literature to estimate the efficiency of banks are discussed. The DEA model is selected to estimate bank efficiency in developing countries and the detail of the DEA model is provided.

The recent empirical evidence from China and other countries shows that there is a positive link between financial development and economic growth. Although most research to date shows that there is a large potential impact from the financial liberalisation policies on bank efficiency, most of the existing analyses have focused on developed countries. The research on developing countries is sparse. In this thesis, the gap is filled by providing the additive evidence on the efficiency impact of financial liberalisation from the banking industries in a range of developing countries or emerging economies.

In terms of empirical works on the topic of the efficiency impact from the liberalisation policies, the existing literature did not consider the issue of the reverse causal effect. The policy of financial deregulation usually increases bank efficiency, and bank efficiency might be one of the drivers of change in the policy environment. In order to overcome this issue, the empirical evidence on the efficiency impact of the WTO accession on China's commercial banks is provided by modelling the evolution of bank efficiency in the adapting phase of the WTO accession. The successive changes in the banking industry in the adapting phase were finalised before the WTO accession and thereafter could not be modified, and therefore acted as an exogenous shock to the Chinese banking market.

In order to directly test the impact of the deregulation policies on bank efficiency, some existing works employ an index of financial reform as the proxy of the policies. However, the indices employed in the existing works do not distinguish between the deregulation policies for foreign banks and for domestic banks. In order to overcome this weakness, the restriction indices from Dinh (2008) are employed in this thesis, since the value of the indices were

calculated separately for domestic banks and foreign banks.

For the research on the efficiency gains from the M&As, most of the existing analyses use the case study methodology rather than the cross-country statistical methodology and focus on the developed countries, such as the US banking industry and EU banking industry. This suggests that the empirical evidence from the cross-country statistical methodology is required to better understand the efficiency impact of the M&As. In order to fill this gap, a dataset from the emerging economies is utilised in this thesis and the impact of M&As is investigated using the two-stage DEA model.

# Chapter 4 WTO Accession and Efficiency Gains in China's Banking industry

## 4.1. Introduction

Going back to Schumpeter (1911), a long series of empirical evidence in the literature has shown that the development of a country's financial system stimulates innovation and helps to increase the growth rate of small and medium enterprises, thereby contributing to economic growth. It is therefore important to examine what practical measures a country may take to promote the efficiency of banks.[21] As part of its WTO commitments, China promised to open up its banking industry to foreign banks during a five-year adaptation phase from 2001 to 2006, and this adaptation process acts as an exogenous influence on the banks in the market. The key question of interest in this chapter is: Did the efficiency of the banks in the Chinese banking industry increase after the WTO accession?

To answer this question, this chapter estimates the evolution of bias-corrected DEA efficiency in the Chinese banking industry by using a dataset from the period 2000–09. As the contribution to the literature of efficiency analysis on Chinese banks, the bootstrapping technique proposed by Simar and Wilson (1998; 2000) is utilised to provide the statistical underpinning for the DEA scores, e.g. the standard deviation and the confidence interval of the DEA efficiency. By focusing on the case of the Chinese banking industry, this chapter explores how deregulation of the banking industry through the removal of entry barriers to

[21] See the literature review in Chapter 3 and recent research on the relationship between the economic growth and financial development from Rajan and Zingales (1998), Beck et al. (2007), and Beck et al. (2008).

foreign banks resulting from WTO accession has affected the evolution of bank efficiency for domestic banks.[22] In particular, it looks specifically at China's accession into the WTO that has brought about a series of deregulations to the Chinese banking industry. The impact of this event is also exogenous to any increase in bank efficiency, since the agreement was made before the WTO accession in 2001 and cannot be modified. Based on this event, i.e. the liberalisation of the Chinese banking industry as a result of WTO commitments, a similar study by Lin (2011) explores the impact of foreign bank entry into the domestic Chinese banking industry over the period 2001–05, and finds that the deregulation policies for foreign bank lending helped to alleviate financial constraints on domestic firms, especially those that are less connected to the government.[23]

The rest of this chapter is structured as follows. Section 4.2 reviews relevant literature; Section 4.3 provides the data sources and the discussion on the selected input and output specification. Section 4.4 presents the methodology and algorithm of the bootstrapping technique. Section 4.5 reports the empirical results in detail and Section 4.6 shows the sensitivity analyses. Concluding remarks and suggestions for policy-makers are contained in Section 4.7.

[22] The bank efficiency is evaluated by using a dataset from 145 commercial banks and Chapter 2 provides the background of Chinese banking market. Since this analysis focuses on the commercial banks in the urban area, the observations from policy banks and rural commercial banks are removed.

[23] In China, the commercial banks discriminate against the firms without the government backing for bank lending, since they hardly receive the support from the government when they are in financial difficulties.

## 4.2. Literature on Efficiency Analysis of Chinese Banks

The transition process of the Chinese banking industry following China's accession to the WTO may be separated into three stages according to the restriction levels in that sector: before the WTO accession (pre-2001); during the transition process from 2001 to 2006; and after the adaptation phase (post 2006). Table 4.1 lists the deregulation policies of geographical and product restrictions in the transition process. Immediately upon WTO accession in 2001, foreign banks were allowed to conduct foreign exchange business without any restriction in the already opened areas, e.g. Shanghai, Shenzhen, Tianjin and Dalian, and these areas were extended gradually in the adapting phase. After 2006, foreign banks were granted right of entry to the whole Chinese market without any restriction.

Table 4.1. Deregulation of foreign banks from 2001 to 2006

| | The opened area | RMB business in the area (Local currency business) |
|---|---|---|
| Before WTO (2001) | Shanghai; Shenzhen; Tianjin; Dalian | Before 2001, no RMB business |
| 2002 | Guangzhou; Zhuhai; Qingdao; Nanjing; Wuhan | After 2003, RMB business to local enterprises |
| 2003 | Jinan; Fuzhou; Chengdu; Chongqing | |
| 2004 | Kunming; Beijing; Xiamen | After 2006, RMB business to any customer |
| 2005 | Shantou; Ningbo; Shenyang; Xi'an | |
| 2006 | No restrictions | |

Source: Summarised from the website of WTO.

Unfortunately, the literature on this subject only focuses on the first and second stages – before and during the transition process. For instance, Li et al. (2001) investigate the performance of 15 Chinese commercial banks in 1998 by using different financial ratios, e.g. return on assets (pre-tax net income/total assets), return on equity (pre-tax net income/total equity capital), net profit margin (pre-tax net income/total revenue), and so on. The empirical evidence in their analysis shows that the profitability of four SOBs is lower than other banks (the 11 JSCBs), due to the much lower profit margin in SOBs, which decreases their level of ROA and return on equity (ROE). Their findings are supported by Lin and Zhang (2009), who use four performance measures, including the ROA and ROE as in Li et al. (2001), to look at 60 banks over the period 1997–2004, including policy banks.[24] In their study, Lin and Zhang (2009) find that the SOBs are less profitable (using ROA and ROE) and efficient (using the cost to income ratio) than policy banks, JSCBs, and city banks. Using the same sample period (1997–2004) to investigate the key determinants of the low profitability of Chinese banks, Garcia-Herrero et al. (2009) employ annual data for 87 Chinese banks, and find that the SOBs have been the least profitable (using the profit which excludes provision of NPLs and ROA) and have therefore reduced the average profitability for the whole sector.

In order to assess the effect of the type of bank ownership on bank efficiency, Berger et al. (2009) use a panel of 38 Chinese banks over the period 1994–2003, and find that the SOBs are the least efficient type of bank in their sample period. Their empirical evidence reveals improvement in performance when reducing state ownership of banks and increasing foreign

[24] The policy banks in China were established in 1994. These banks implemented the policy-related business taking the place of SOBs who performed these roles prior to this. Since they are not commercial banks, the policy banks are not included in this analysis.

ownership. Another study supporting the conclusion that the SOBs are the least efficient banks in the market is Ariff and Can (2008). They use the non-parametric DEA-based technique in order to investigate the efficiency of four SOBs, nine JSCBs and 15 city banks over the period 1995 to 2004, and find that JSCBs are the most efficient banks in the Chinese banking market.

Focusing on the period before 2006, most of the analyses find that the SOBs are the least efficient banks in the market. However, this finding is far from conclusive and challenged by some empirical evidence that implies the opposite. Yao et al. (2008) measure profitability in the ratio of pre-tax profit to total assets and use DEA to estimate technical efficiency in order to assess whether Chinese banks have reacted successfully to the reforms in the 15 largest banks (four SOBs and 11 JSCBs) over the period 1998–2005. Their empirical evidence shows that three large SOBs, namely CCB, BOC and ICBC, dominate the market since they have high technical efficiency and profitability.

Using the annual data (1999–2006) from 76 banks – the four SOBs, 13 national JSCBs, 51 city banks, and eight rural commercial banks, Heffernan and Fu (2010) investigate the bank performance by the Net Interest Margin (NIM) and Economic Value Added (EVA), and both methods find that the efficiency gains are not significant. In their analysis, Heffernan and Fu (2010) argue that the benefits from WTO accession are not likely to have materialised yet, since the effect is relatively recent for their sample period 1999–2006. Their argument is supported by the findings from the Indian banking industry over the period 1988–2004. Gormley (2010) investigates the effect of foreign bank entry on domestic credit access of

domestic firms following India's 1994 commitment to the WTO, and finds the observed effect of foreign bank entry occurs after one to two years and appears to persist for the duration of the following time period.

In order to fill the gap in the literature looking at efficiency since 2006, a more comprehensive and recent dataset is employed in this analysis to capture the efficiency dynamics over the period of 2000–09, which is almost the largest dataset for commercial banks in this literature and consists of financial information from 145 commercial banks. Another challenge that arises in the literature is how to measure bank efficiency. As a sort of linear programming technique, DEA creates the efficiency frontier by enveloping all observations in the dataset, with the assumption that there is no measurement error in the dataset. However, this assumption is frequently questioned and argued in the literature. For example, Berger and Humphrey (1997) survey 130 studies that apply frontier efficiency analysis to financial institutions in 21 countries, and suggest that it would be very useful to prove the model's reliability and acceptance by providing statistical inference or confidence intervals for the estimated efficiency scores, since it is a common weakness for the papers they reviewed.

Following their suggestion, the re-sampling technique, i.e. the bootstrapping technique conceived by Simar and Wilson (1998; 2000), is employed to overcome this drawback by computing the bias-corrected efficiency frontier. For bias-corrected DEA (BC-DEA), the intuition is that the observation point is fixed, but it faces many random frontiers created in the bootstrapping process. The number of bootstrapping frontiers is huge and it is enough to

form an empirical distribution of the estimated frontier for statistical inference and tolerate the possible measurement errors, and finally to provide conservative estimates of bank efficiency.

The same bootstrapping technique is also employed by Matthews and Zhang (2010), who investigate the productivity growth of four SOBs, 10 JSCBs and 47 city banks in the Chinese banking market over the period 1997–2007. As the proxy of the productivity growth of the banks, the Malmquist index of total factor productivity is estimated by the DEA model with the same bootstrapping technique in their analysis. The findings in the analysis by Matthews and Zhang (2010) show that the average productivity growth has been positive for the city banks but neutral for the SOBs and JSCBs over the period 2003–07, which is the second part of their sample period. In addition, Halko and Tzeremes (2013) predict the efficiency change of 18 Greek banks in 45 potential M&As by the DEA-based procedure with bootstrapping techniques over the period 2007–11, and find that the majority of the potential bank M&As under examination are unable to generate short-run operating efficiency gains.

## 4.3. Data

The data are obtained from the Bankscope database maintained by Bureau van Dijk, which includes financial information for 154 Chinese banks. Hong Kong, Macau and Taiwan are not included in this analysis due to the different institutional systems in these three regions. Since this analysis focuses on commercial banks, eight rural credit cooperatives and one policy bank are removed from the dataset. As a result, there are 145 banks in the dataset, including

four SOBs, 13 JSCBs, 36 foreign banks, and 92 city banks.

To be consistent with the literature, all data are downloaded in US$ millions and adjusted by the Consumer Price Index (CPI) to eliminate the impact of inflation. The Bankscope database provides two kinds of financial statement – consolidated and unconsolidated. The consolidated statement aggregates the information from all branches of the bank, e.g. the financial leasing company or insurance company, which are not related to the bank's main business. Hence, the unconsolidated statement is selected unless the consolidated statement is the only option available. Ultimately, it was only necessary to rely on consolidated statements for nine banks.

As an event study to assess the impact of removing the barriers on the Chinese banking industry, the event window is from 2000 to 2009, which is carefully selected based on the following reasons.[25] Firstly, the efficiency frontier is created by enveloping all observations. In other words, a production set for all observations from that 10-year period, which results in a strong assumption that the technology is constant throughout the sample period. That assumption will be challenged when the sample period is extended.

The financial reform in the market is another reason to get rid of the data before 2000. As one of the important components in the market, most of the city banks were established after 1999 by merging the urban credit unions in local markets. Therefore, it is impossible to find their data before 2000. In addition, the Chinese government injected US$4.3 billion (RMB 27 billion) of capital into four SOBs to improve their balance sheets in 1998 and there was

[25] The original dataset could be traced back to 1995, so the data before 2000 are removed.

US$224.2 billion (RMB 1,400 billion) of NPLs which were transferred to asset management companies from these four SOBs in 1999, which would have significantly influenced the performance of the SOBs after this change.[26] However, these transfers are not related to the research topic of this analysis.

For the event window, the time period could be separated into three stages, from 2000 to 2002; 2003 to 2006; and 2006 to 2009. In the first stage, the main market, i.e. the local currency market, is almost fully closed to foreign banks through tight restrictions. In the second stage, this market is gradually opened up to foreign banks and finally there are no restrictions for foreign banks in the last stage.

The analysis focuses on efficiency changes in the banking industry as a whole and in different groups of banks namely, domestic banks, private banks and city banks. The first group comprises of all banks operating in China (145 banks which includes 36 foreign banks) and the second group is a subset of the first (109 domestic banks), with the 36 foreign banks removed. The private banks are the third group, which is the subset of the second group and includes observations from JSCBs and city banks (104 banks).[27] In this group, the five biggest banks in the market are removed ('Big Five'), which is ABC, ICBC, BOC, CCB and BoCom. The last group is just the 88 local city banks. Each group is expected to respond differently to the event of the WTO accession. For example, if the trend in bank efficiency is different between the group of all banks and the group of domestic banks, it will be due to the

[26] http://www.forbes.com/2009/03/30/loans-banks-china-business-oxford.html, accessed on 6 April 2013.

[27] Since its market share and bank size is significantly bigger than other JSCBs, the Bank of Communications (BoCom) is not included with the private banks and it is included in the Big Five group.

observations from foreign banks, because they are the only difference between these two groups. The number of banks in each group is listed in Table 4.2 and the distribution of the observations is in the Appendix (Table A4.1).

Table 4.2. Number of banks in each group

| Groups | Bank no. | Foreign banks | Big Five | National JSCBs | City banks |
|---|---|---|---|---|---|
| All banks | 145 | 36 | 5 | 16 | 88 |
| Domestic banks | 109 | | 5 | 16 | 88 |
| Private banks | 104 | | | 16 | 88 |
| City banks | 88 | | | | 88 |

Note: The Big Five is ABC, ICBC, BOC, CCB and BoCom.
Source: Author's calculations.

Another challenge in creating the efficiency frontier is the specification of input and output variables, since commercial banks have diverse functions in the economy including financial intermediation, financial product provision and profit maximisation. To date, there is no uniformly accepted specification that can be used in the literature. Focusing on the Japanese banking industry, Drake et al. (2009) find that DEA results depend strongly on the choice of input and output variables. This study considers bank operation from three different standpoints: intermediation approach, profit-revenue based approach and production approach. The input-output variables considered under each approach are given in Table 4.3.

Since the loan loss provision reflects the capability of banks to withstand risks, Laeven and Majnoni (2003) argue that it should be considered as a kind of cost. Following their

suggestion, the variable of total provisions is included in all three specifications to represent the ability of commercial banks to deal with risk. The loan loss provision is like a pool to cover the potential loss from assets, so it could be a negative number if assets have shrunk compared with the previous period.

Table 4.3. Input and output variables in three specifications

| Specification | Input | Output |
|---|---|---|
| **Intermediation** | Total deposits | Total loans |
| | Operating expenses | Total other earning assets |
| | Total provisions | Net commission and fees |
| | | Total other operating income |
| **Profit/Revenue** | Non-interest operating expenses | Net interest income |
| | Other operating expenses | Net commission and fees |
| | Total provisions | Other operating income |
| **Product** | Total non-interest expenses | Total loans |
| | Other operating expenses | Total other earning assets |
| | Total provisions | Net commission and fees |
| | | Total other operating income |
| | | Total deposits |

Source: Drake et al. (2009).

The results of the profit/revenue specification are discussed in Section 4.5, and the results of the intermediation and product specifications are presented in Section 4.6. There are two reasons for doing this. The first reason is that the restrictions on foreign banks were gradually removed during the adapting phase between 2001 and 2006. Under the restrictions during

2001 to 2006, the managers in foreign banks were limited in the financial products that they were permitted to provide. Thus, intermediation and the production are not the ideal approaches to measure foreign bank performance. Nevertheless, the results obtained under these two approaches are discussed as robustness check in Section 4.6.

The second reason to avoid using the intermediation and product specifications is the mix of the input and output variables (see Table 4.3). As the output variables, the total loans and total deposits are asset or liability variables, but the net commissions and fees as well as total other operating income are revenue variables. It is not rational to put these variables together. In the profit/revenue specification, all output variables are revenue variables, e.g. net interest income, net commissions and fees, and total other operating income, which is more reasonable.

The summary statistics are presented in Table 4.4a for input variables, Table 4.4b for output variables and Table 4.4c for total assets. The banks' total assets are used as a weight to balance the effect of bank size. The correlation matrices are presented in the Appendix of this thesis (Table A4.2, A4.3 and A4.4). As one of the stock variables, the value of the deposits in Table 4.4a is larger in absolute terms than the expense variables (non-interest operating expenses and other operating expenses) and loan loss provisions. For example, the minimum value of the deposit in foreign banks is US$2,693.91m, which is much bigger than the value of non-interest operating expenses (US$44.77m) and other operating expenses (US$28.95m) in this group of banks.

Table 4.4a. Summary statistics of input variables (US$ million)

| Groups | All banks | Domestic banks | Private banks | City banks | Foreign banks | Big Five |
|---|---|---|---|---|---|---|
| | | | Deposits | | | |
| Mean | 31,730.66 | 38,973.96 | 15,423.58 | 5,363.59 | 2,693.91 | 399,799.48 |
| S.D. | 106,165.80 | 117,565.40 | 30,250.03 | 8,336.63 | 4,000.61 | 274,038.53 |
| Min. | 17.88 | 164.84 | 164.84 | 164.84 | 17.88 | 42,942.70 |
| Max. | 1,075,395 | 1,075,395 | 213,525 | 62,602 | 18,243 | 1,075,394 |
| | | | Non-interest operating expenses | | | |
| Mean | 366.86 | 447.20 | 170.92 | 55.53 | 44.77 | 4,680.23 |
| S.D. | 1,277.82 | 1,416.77 | 343.46 | 70.61 | 74.74 | 3,497.86 |
| Min. | 0.54 | 3.01 | 3.01 | 3.01 | 0.54 | 780.88 |
| Max. | 12,560 | 12,560 | 2,581 | 488 | 409 | 12,560 |
| | | | Other operating expenses | | | |
| Mean | 248.94 | 303.82 | 114.01 | 42.94 | 28.95 | 3,211.88 |
| S.D. | 821.32 | 909.75 | 203.59 | 48.33 | 42.45 | 1,994.64 |
| Min. | 0.32 | 3.01 | 3.01 | 3.01 | 0.32 | 780.88 |
| Max. | 8,092 | 8,092 | 1,735 | 421 | 203 | 8,092 |
| | | | Loan loss provisions | | | |
| Mean | 126.44 | 157.01 | 65.13 | 24.62 | 3.89 | 1,564.77 |
| S.D. | 456.01 | 505.19 | 125.39 | 34.89 | 10.11 | 1,368.14 |
| Min. | -34.24 | -14.95 | -14.95 | -8.87 | -34.24 | 31.21 |
| Max. | 5,805 | 5,805 | 906 | 250 | 42 | 5,805 |

Source: Author's calculations.

Compared with the values in other groups, all mean values in the Big Five group are bigger than other banks by at least 10 times. The Big Five figures represent huge expenses, e.g. the non-interest operating expenses (US$4,680.23m), other operating expenses

(US$3,211.88m), and loan loss provisions (US$1,564.77m). Thus, a larger size of banking operation does not always result in scale efficiency, but can result in huge losses in operating efficiency, which could be a reason for the relative inefficiency of the Big Five in the intermediation specification.

The mean value of loan loss provisions is US$3.89m for foreign banks, which is significantly lower than for other banks. One possible reason for the small value of loan loss provisions could be the restrictions, which impede the development of foreign banks in China and thereby their loan size. The loan size in the foreign banks is also a lot smaller than for other banks.

In Table 4.4b, the other operating income is the revenue from the other operating business minus the related expenses (e.g. gold trading business), and the commission and fees are mainly from the charges minus the related costs which are mainly associated with investment banking, corporate financial management, and asset custody and cash management. These two variables could be negative if the expenses are bigger than the income.

Table 4.4b. Summary statistics of output variables (US$ million)

| Groups | All banks | Domestic banks | Private banks | City banks | Foreign banks | Big Five |
|---|---|---|---|---|---|---|
| | | | Net loans | | | |
| Mean | 18,421.90 | 22,569.92 | 9,198.82 | 2,913.64 | 1,793.40 | 227,434.30 |
| S.D. | 58,985.86 | 65,278.88 | 18,607.91 | 4,386.40 | 2,429.23 | 141,830.40 |
| Min. | 17.20 | 81.74 | 81.74 | 81.74 | 17.20 | 36,763.81 |
| Max. | 563,376 | 563,376 | 137,699 | 35,057 | 11,095 | 563,376 |
| | | | Other earning assets | | | |
| Mean | 14,662.92 | 18,003.42 | 6,849.61 | 2,623.87 | 1,271.61 | 188,895.60 |
| S.D. | 52,653.72 | 58,382.19 | 13,498.82 | 4,545.80 | 2,031.13 | 149,714.70 |
| Min. | 5.50 | 60.74 | 60.74 | 60.74 | 5.50 | 28,409.95 |
| Max. | 605,943 | 605,943 | 91,604 | 33,812 | 10,432 | 605,943 |
| | | | Net interest income | | | |
| Mean | 722.84 | 889.74 | 387.08 | 134.60 | 53.77 | 8,591.22 |
| S.D. | 2,476.22 | 2,742.84 | 795.74 | 205.48 | 80.24 | 7,176.08 |
| Min. | 0.41 | 3.87 | 3.87 | 3.87 | 0.41 | 1,069.46 |
| Max. | 25,207 | 25,207 | 6,055 | 1,442 | 408 | 25,207 |
| | | | Other operating income | | | |
| Mean | 7.57 | 6.98 | 5.71 | 1.51 | 9.96 | 26.44 |
| S.D. | 187.40 | 209.04 | 13.94 | 3.18 | 28.41 | 857.03 |
| Min. | -3,337.52 | -3,337.52 | -7.17 | -7.17 | -50.39 | -3,337.52 |
| Max. | 896 | 896 | 149 | 16 | 142 | 896 |
| | | | Commission and fees | | | |
| Mean | 130.63 | 158.98 | 39.98 | 15.12 | 16.99 | 1,982.17 |
| S.D. | 644.07 | 717.03 | 102.84 | 20.62 | 38.19 | 2,200.75 |
| Min. | -497.90 | -497.90 | -10.75 | -9.76 | -4.43 | -497.90 |
| Max. | 8,629 | 8,629 | 962 | 145 | 265 | 8,629 |

Source: Author’s calculations.

The first feature in the output variables is also the huge difference between asset or liability variables (net loans and other earning assets) and revenue variables (net interest income, other operating income, and commission and fees). For example, the average value of loans is US$22,569.92m in domestic banks, but the value of other operating income is US$6.98m.

As the most notable feature in the output variables in Table 4.4b, the average value of the net interest income is much bigger than the rest of the income variables in all groups, even in the group of foreign banks. It indicates that loan business is still the main source of funds for banks in the Chinese market. For example, the average value of the net interest income is US$53.77m in foreign banks, which is more than three times of the mean value of the commission and fees (US$16.99m). For the non-interest incomes of the banks, the commission and fees are the main source for this part, since its mean value is bigger than the other operating incomes in all of the groups. The most extreme case is in the group of Big Five. The value of the commission and fees is US$1,982.17m in this group, but the value of other operating income is only US$26.44m.

In order to handle the huge differences between asset or liability variables and income variables in the intermediation and product specification, all input and output variables are standardised before the frontier evaluation by the following formula:

$$x_{kj} = \frac{x_{kj} - \min\limits_{1 \le i \le n} x_{ij}}{\max\limits_{1 \le i \le n} x_{ij} - \min\limits_{1 \le i \le n} x_{ij}} \tag{4.1}$$

$$k = 1,2,\dots,n; j = 1,2,\dots,p \text{ in input or } \; j = 1,2,\dots,q \text{ in output}$$

$x_{kj}$ is the observations in variable $j$ from bank $k$. $\max_{1\leq i\leq n} x_{ij}$ is the maximum value of that variable, and $\min_{1\leq i\leq n} x_{ij}$ is the minimum value of that variable. The minimum and maximum values resulting from this formula are standardised to the value range from 0 to 1.

Table 4.4c presents the summary statistics of total assets. As shown in Table 4.4a and Table 4.4b, the variable values in the group of Big Five are not in the same magnitude compared with other groups; the mean value of the Big Five's total assets (US$440,805.3m) is more than 10 times as much as for the rest of the domestic banks (US$42,825.01m), and the mean value from the private banks is only half the value of other domestic banks.

Table 4.4c. Summary statistics of total assets (US$ million)

| Groups | All banks | Domestic banks | Private banks | City banks | Foreign banks | Big Five |
|---|---|---|---|---|---|---|
| | | | Total assets | | | |
| Mean | 34,925.43 | 42,825.01 | 16,849.60 | 5,879.69 | 3,257.84 | 440,805.30 |
| S.D. | 115,654.20 | 128,067.90 | 33,260.50 | 9,120.10 | 4,605.14 | 290,671.00 |
| Min. | 46.09 | 178.79 | 178.79 | 178.79 | 46.09 | 69,677.94 |
| Max. | 1,164,349 | 1,164,349 | 232,838 | 69,928 | 21,242 | 1,164,349 |

Source: Author's calculations.

## 4.4. Methodology

The conventional DEA is used as the main methodology of this analysis and the detail is discussed in Chapter 3. Following the suggestions from Berger and Humphrey (1997), the statistical foundation of DEA is provided, e.g. the standard deviation and confidence intervals,

by adopting the bootstrapping technique proposed by Simar and Wilson (1998; 2000), which is also employed to get the bias-corrected estimate of the efficiency frontier.

Borrowing the mathematic expression from Simar and Zelenyuk (2007), the dataset is generated from a true but unobservable data generating process, where $\wp = \wp(P(x), g(TE, \eta, x))$. $g(.)$ is the production process and $x$ is the input selected by the bank and the $P(x)$ is its output, which is based on the parameter of technology ($TE$) and another parameter $\eta$. All observations in each year is separated to $l$ groups. If the bootstrapping is consistent, the relationship between the bootstrapping estimate ($\overline{\widehat{TE}}^{*,l}$) and the original estimate ($\overline{\widehat{TE}}^{l}$) will mimic the relationship between the original estimate ($\overline{\widehat{TE}}^{l}$) and the true but unobserved efficiency score ($\overline{TE}^{l}$), so that:

$$\overline{\widehat{TE}}^{*,l} - \overline{\widehat{TE}}^{l} | \widehat{\wp} \; \widetilde{asy}. \; \overline{\widehat{TE}}^{l} - \overline{TE}^{l} | \wp \tag{4.2}$$

The limited observations ($N$) from the real world are used as the population in the bootstrapping world. In each loop of bootstrapping, some of the observations are randomly chosen from the so-called population ($N$) with replacement, and these observations make up the 'pseudo' subsample for one of the bootstrapping frontiers.[28] Following Simar and Zelenyuk (2007), 70 per cent of observations in each year (subsample size) are randomly chosen in each iteration, which they consider to be a reasonable percentage for precision purposes. That 'pseudo' subsample is calculated by the DEA method and aggregated to get the efficiency score for each year. To get a consistent estimate in the bootstrapping stage, the

[28] The observations are chosen with replacement means that the observations in the dataset could be chosen more than once in the bootstrapping process. After each loop, the selected observations are put back to the dataset before the next loop.

efficiency frontier is estimated 1,000 times ($B = 1{,}000$).

The detailed algorithm of the bootstrapping can be found from Simar and Wilson (2000). The bootstrapping technique selected in this thesis is briefly summarised as follows:

**Step 1.** Apply DEA to the original sample $S_n \coloneqq \{(x_i, y_i): i = 1, \dots N\}$ to obtain the estimate $\{\widehat{TE}_i: i = 1, \dots n, \dots N\}$ of the true (but unobservable) efficiency scores $\{TE(x_i, y_i): i = 1, \dots N\}$.

Separate the original sample into distinct groups for each year, $S_n^l \coloneqq \{(x_i, y_i): i = 1, \dots, n\}$, and corresponding estimates $\{\widehat{TE}_i^l: i = 1, \dots, n\}$ representing the efficiency score in each specific year. Obtain estimates of the aggregate efficiency score ($\widehat{TE}^l$) for the year $l \in \{1, \dots, 10\}$.

**Step 2.** Generate $b^{th}$ bootstrapping samples by drawing $s_i^l$ out of $S_n^l$ observations randomly and independently and $S_n^l$, is part of original sample set $S_n$. Denote these samples as $S_b^{*,l} \coloneqq \{(x_{b,i}^{*,l}, y_{b,i}^{*,l}): i = 1, \dots, s^l\}, l = 1, \dots 10$ and denote the pooled sample as $S_b^* \coloneqq \{(x_{b,i}^*, y_{b,i}^*): i = 1, \dots, s\}$, $s = s^1 + \dots + s^{10}$.

**Step 3.** Use DEA for the pooled bootstrapping sample $S_b^* \coloneqq \{(x_{b,i}^*, y_{b,i}^*): i = 1, \dots, s\}$ to obtain the bootstrapping-estimated frontier and compute efficiency scores to this frontier, denote them as $\left\{\widehat{TE}_{b,i}^*: i \in \{1, \dots, s\}\right\}$, which will be used to obtain bootstrapping estimates of the aggregate score, denoting them as $\widehat{\widehat{TE}}_b^{*,l}$, for the year $l \in \{1, \dots, 10\}$.

**Step 4.** Repeat steps 2-3 *B* times to obtain and save $\widehat{\widehat{TE}}_b^{*,l}$ from all bootstrapping

iteration to infer about the relationship $\overline{\widehat{TE}}^{*,l} - \overline{\widehat{TE}}^{l}|\widehat{\wp}$ and $\overline{\widehat{TE}}^{l} - \overline{TE}^{l}|\wp$ and to calculate the relative parameters, such as the expected value of $\overline{\widehat{TE}}^{*,l} = \frac{1}{B}\sum_{b=1}^{B} \overline{\widehat{TE}}_{b}^{*,l}$ or the standard deviation, $\frac{1}{B-1}\left[\sum_{b=1}^{B}\left(\overline{\widehat{TE}}_{b}^{*,l} - \frac{1}{B}\sum_{b=1}^{B}\overline{\widehat{TE}}_{b}^{*,l}\right)^{2}\right]^{½}$.

Another issue need to be settled is how to aggregate the individual score of each bank in each year. The most common methodology is to simply average the score in each year. However, the example in the paper of Simar and Zelenyuk (2007) shows that a simple average might ignore the importance of the observations in the group. In order to overcome this weakness, the Fare-Zelenyuk weighting method from Färe and Zelenyuk (2003) is employed to aggregate the efficiency score of each year.

First, all observations in the dataset, $N$, are separated into $l$ groups by year, so there are $n$ observations in each year $l$. The value $l$ is from 1 to 10 representing each year from 2000 to 2009. The basic idea of their approach is that the total maximal revenue is the sum of its observations' maximal revenues. The set of observations in each year is denoted as $n^l$. The specific observation $k$ $(k \in n^l \in N)$ needs $p$ inputs, $x = (x_1, \dots, x_p)' \in R_+^p$, to produce $q$ outputs, $y = (y_1, \dots, y_q)' \in R_+^q$. Since the prices of outputs and inputs are absent, the price independent weighting algorithms are used in this analysis.

$$w^k = y_{k1}\frac{\sum_{i=1}^{N} y_{i1}}{w} + y_{k2}\frac{\sum_{i=1}^{N} y_{i2}}{w} + y_{k3}\frac{\sum_{i=1}^{N} y_{i3}}{w} + \dots + y_{kq}\frac{\sum_{i=1}^{N} y_{iq}}{w} \quad (4.3)$$

$$w = \frac{1}{q}\left(\sum_{m=1}^{q}\frac{\sum_{i=1}^{n^l} y_{im}^l}{\sum_{i=1}^{N} y_{im}}\right) \quad (4.4)$$

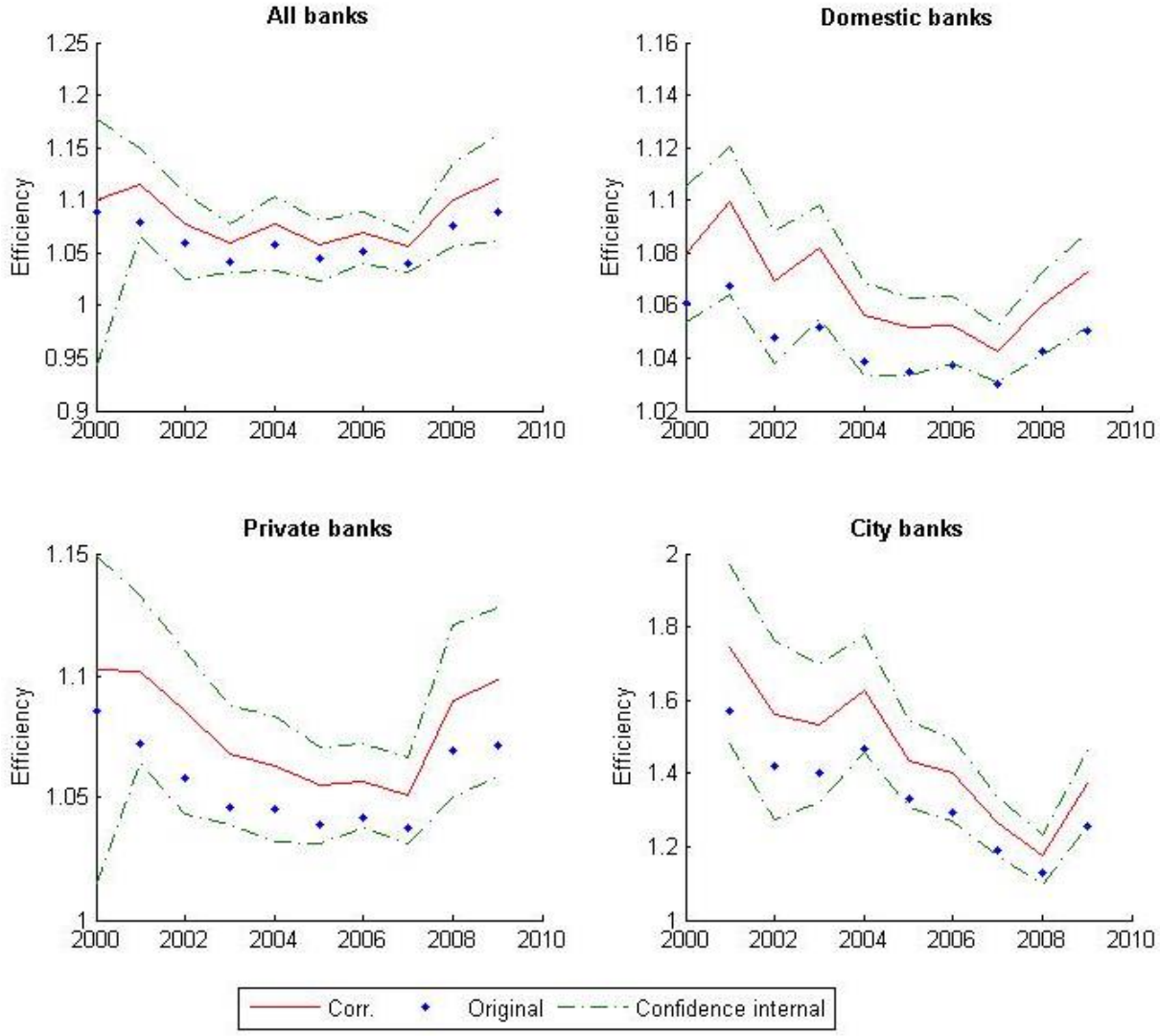
$w^k$ is the weight for the efficiency score from the specific observation $k$ in year $l$, which depends on the weight of that year, $w$. The weight in the output direction is according

to the output ($y$), in each observation. The weight in the weighted average is the shares of the total revenue from $q$ outputs in all observations. For example, the weight of the observation $k$ is the weighted average over all output shares of this observation in each year.

## 4.5. Empirical Results

Figure 4.1 shows the estimated trend of four sub-category groups, i.e. all banks, domestic banks, private banks and city banks, which are represented by the blue dots which are the original DEA scores, together with the 95 per cent confidence interval around the bias-corrected efficiency scores. Since most of the city banks were established in 2000, the efficiency estimation for this group is from 2001 to 2009. During this sample period, the efficiency of city banks increased until 2008, and this trend is roughly consistent with the efficiency trends in the groups of domestic banks and private banks, which increased until 2007. Unfortunately, the upward trend is not clear when foreign banks are added, i.e. the group of all banks in the top left corner of Figure 4.1. From 2001 onwards, the Chinese banking market opened up gradually to the foreign banks and the geographical and product restrictions were removed. These results reveal that the efficiency of the domestic banks increased in the adapting phase of the WTO accession, but the trend in the efficiency of foreign banks is unclear.

Figure 4.1. Efficiency evolution in profit/revenue specification (2000–09)




Source: Author's calculations.

The findings in Figure 4.1 are consistent with the evidence from Xu (2011) over a similar sample period (1999–2006), who demonstrates that the entry of foreign banks (using the index created by the author) promoted the performance of 114 commercial banks in China, measured by a range of indicators, such as the net interest margins, non-interest incomes and operating costs. Using the two-stage DEA model, moreover, Hermes and Nhung (2010) find

that financial deregulation had a positive impact on the efficiency of banks over the period 1991–2000 in Argentina, Brazil, Peru, Mexico, India, Indonesia, Korea, Pakistan, Thailand and the Philippines.

Table 4.5 presents the estimated DEA scores, where a value of one means that a bank is fully efficient. The score of 1.0896 in 2009 for the group of all banks shows that inputs used could produce 1.0896 times the output that they are actually producing. As discussed in the previous section, the absolute value of bias-corrected DEA scores (Corr. in Table 4.5) is bigger than the original scores due to the downward bias. For example, the value of 0.0605 for all banks in 2000 (S.D. in Table 4.5). The first reason for the positive bias is that the observations on the frontier are due to the fact that they are the relative ‘best practice’ in the dataset, and it is possible for the banks to increase their efficiency. Moreover, another reason could be the measurement errors in the dataset. The observations with measurement errors are seldom selected in the bootstrapping process, which makes the frontier different to the original one, since the values are higher.

Table 4.5. DEA scores in profit/revenue specification (2000–09)

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| **All banks** | | | | | | | | | | |
| Original | 1.0885 | 1.0785 | 1.0587 | 1.0417 | 1.0582 | 1.0448 | 1.0512 | 1.0403 | 1.0765 | 1.0896 |
| Corr. | 1.1004 | 1.1145 | 1.0768 | 1.0588 | 1.0778 | 1.0572 | 1.0693 | 1.0563 | 1.1000 | 1.1202 |
| S.D. | 0.0605 | 0.0208 | 0.0213 | 0.0120 | 0.0190 | 0.0145 | 0.0128 | 0.0104 | 0.0208 | 0.0265 |
| Lower | 0.9407 | 1.0654 | 1.0254 | 1.0316 | 1.0335 | 1.0241 | 1.0392 | 1.0318 | 1.0569 | 1.0607 |
| Upper | 1.1771 | 1.1488 | 1.1075 | 1.0772 | 1.1040 | 1.0800 | 1.0892 | 1.0717 | 1.1353 | 1.1632 |
| **Domestic banks** | | | | | | | | | | |
| Original | 1.061 | 1.0672 | 1.0479 | 1.0519 | 1.0385 | 1.0349 | 1.0375 | 1.0304 | 1.0428 | 1.0505 |
| Corr. | 1.0797 | 1.0995 | 1.0692 | 1.0820 | 1.0566 | 1.0517 | 1.0524 | 1.0428 | 1.0600 | 1.0725 |
| S.D. | 0.0129 | 0.0143 | 0.0140 | 0.0112 | 0.0086 | 0.0073 | 0.0064 | 0.0056 | 0.0078 | 0.0092 |
| Lower | 1.0533 | 1.0644 | 1.0377 | 1.0549 | 1.0333 | 1.0336 | 1.0382 | 1.0307 | 1.0414 | 1.0519 |
| Upper | 1.1050 | 1.1207 | 1.0884 | 1.0981 | 1.0689 | 1.0629 | 1.0635 | 1.0523 | 1.0727 | 1.0880 |
| **Private banks** | | | | | | | | | | |
| Original | 1.0855 | 1.0724 | 1.0583 | 1.0461 | 1.0452 | 1.039 | 1.0417 | 1.0376 | 1.0697 | 1.0712 |
| Corr. | 1.1022 | 1.1021 | 1.0858 | 1.068 | 1.0631 | 1.0553 | 1.0567 | 1.0510 | 1.0897 | 1.0984 |
| S.D. | 0.0351 | 0.0175 | 0.0175 | 0.0133 | 0.0138 | 0.0105 | 0.0091 | 0.0089 | 0.0180 | 0.0180 |
| Lower | 1.0140 | 1.0642 | 1.0431 | 1.0393 | 1.0319 | 1.0314 | 1.0376 | 1.0313 | 1.0505 | 1.0585 |
| Upper | 1.1493 | 1.1325 | 1.1101 | 1.0874 | 1.0832 | 1.0706 | 1.0722 | 1.0662 | 1.1206 | 1.1280 |
| **City banks** | | | | | | | | | | |
| Original | | 1.5695 | 1.4217 | 1.4020 | 1.4667 | 1.3321 | 1.2944 | 1.1914 | 1.1292 | 1.2580 |
| Corr. | | 1.7421 | 1.5626 | 1.5338 | 1.6290 | 1.4363 | 1.4015 | 1.2641 | 1.1765 | 1.3730 |
| S.D. | | 0.1218 | 0.1253 | 0.0974 | 0.0822 | 0.0607 | 0.0548 | 0.0409 | 0.0351 | 0.0516 |
| Lower | | 1.4792 | 1.2741 | 1.3232 | 1.4594 | 1.3073 | 1.2678 | 1.1781 | 1.0984 | 1.2582 |
| Upper | | 1.9714 | 1.7634 | 1.6974 | 1.7781 | 1.5430 | 1.4968 | 1.3368 | 1.2341 | 1.4622 |

Notes: 1. The 95 per cent confidence interval (lower and upper bound) is provided for the bias-corrected DEA score (Corr.) based on 1,000 replications in the stage of bootstrapping. 2. Original means the DEA score without bootstrapping. 3. S.D. means the standard deviation of the bias-corrected DEA score. 4. The code of the evaluation is programmed and shared by Ass. Prof. Zelenyuk (University of Queensland). Source: Author's calculations.

Another general trend in all four groups is the decrease in the efficiency of banks in 2008 and 2009. As shown in Figure 4.1, the bank efficiency (Corr.) decreased in 2008 and 2009. That efficiency change could be due to macroeconomic reasons, such as the global financial crisis which started in 2007, and it is possible that the impacts from such crises could lag two or three years. Yu (2010) argues that the Chinese commercial banks' losses were significantly larger from early 2008, since their moderate amount of investments in mortgage-backed securities and collateralised debt obligations in global capital market were turning bad. Dirk (2009) states that the profitability of Chinese banks could be reduced due to the huge loss of their Western partners (e.g. Bank of America, The Royal Bank of Scotland and the UBS). One direct consequence of the financial crisis on Chinese banks is to worsen the banks' financial report. In this chapter, the data used in the DEA model are from financial reports of the banks and thereby decrease the efficiency of the banks in Figure 4.1. The trends in Figure 4.1 are consistent with the general expectation on performance of the Chinese banks during the financial crisis.

In addition, Yu (2010) points out that the direct impact of the financial crisis on the Chinese economy has been on international trade. The export growth rate fell from 20 per cent in October 2008 to -2.2 per cent in the following month. Dirk (2009) claims that even the official statistics reveal that 10 million migrant workers had to return to their home province since the thousands of firms have gone bust due to the financial crisis.

The impacts from financial crises on international trade could transfer to the performance of commercial banks since the risks associated with loans to the firms which rely on

international trade are higher.

As shown in Figure 4.1, the efficiency increased from 2002 to 2003 in the group of domestic banks, and decreased in 2004. Similar evidence from Matthews and Zhang (2010) implies that the productivity growth was almost neutral over the period 2003–07, the second part of their 1997–2007 sample period, and they argue that there are two factors that could explain their findings. First, the foreign banks only command a small share of the banking market in China, so their impact is still weak in their sample period. Second, the competition in the market is already severe among SOBs, JSCBs and city banks. An increase in the intensity of competition therefore does not result in increasing the efficiency of the banks.

The highest rate of efficiency increase before 2008 was in the group of city banks, which indicates that the efficiency of city banks increased faster than for other groups. The best performance (1.1765) in that group across the whole period was in 2008, and the worst performance was in 2001 (1.7421). As the least efficient group in the dataset, this phenomenon is consistent with the literature which looks at growth convergence and with the 'quiet life' hypothesis from Hicks (1935). This hypothesis states that the managers of the least competitive banks in the market have the greatest pressure on them to increase efficiency. When the cost of the banks is higher than the industry average, Schmidt (1997) finds that the possibility of going bankrupt will push managers to put in a great deal of effort to save their banks and their positions (i.e. their jobs).

When the Big Five and JSCBs are removed from the dataset, the efficiency of city banks

decreases to more than 1.2, and this value is one of the worst performances of the groups of domestic banks and private banks. Therefore, the city banks are the most inefficient banks in the selected dataset. This evidence is partially supported by the findings from Ariff and Can (2008), who show that city banks were inefficient compared to JSCBs over the period 1995–2004, due to the limited operating area (not permitted to operate in other geographic regions) which restricts their profit sources. However, the results in this analysis are different to the findings from Li et al. (2001), Lin and Zhang (2009) and Berger et al. (2009), who show that SOBs are by far the least efficient in their analyses.

There are at least three reasons for the different conclusions. First, the sample periods are different. For example, García-Herrero et al. (2009) find that SOBs are the least efficient banks in their sample period (1997–2004) due to the poor capital structure and the huge NPLs. One important financial reform in the Chinese banking industry has been to establish the Asset Management Companies, which took over the NPLs from four SOBs in 1999. In this analysis, the effect of the NPLs is removed by focusing on the period 2000 to 2009.

The second reason is the difference in datasets. For instance, only 16 banks of 113 city banks are selected in the analysis by Berger et al. (2009) and 15 banks in the analysis by Ariff and Can (2008), which accounts for less than one eighth of the actual number of city banks. That limited dataset cannot fully reflect the efficiency of all city banks.

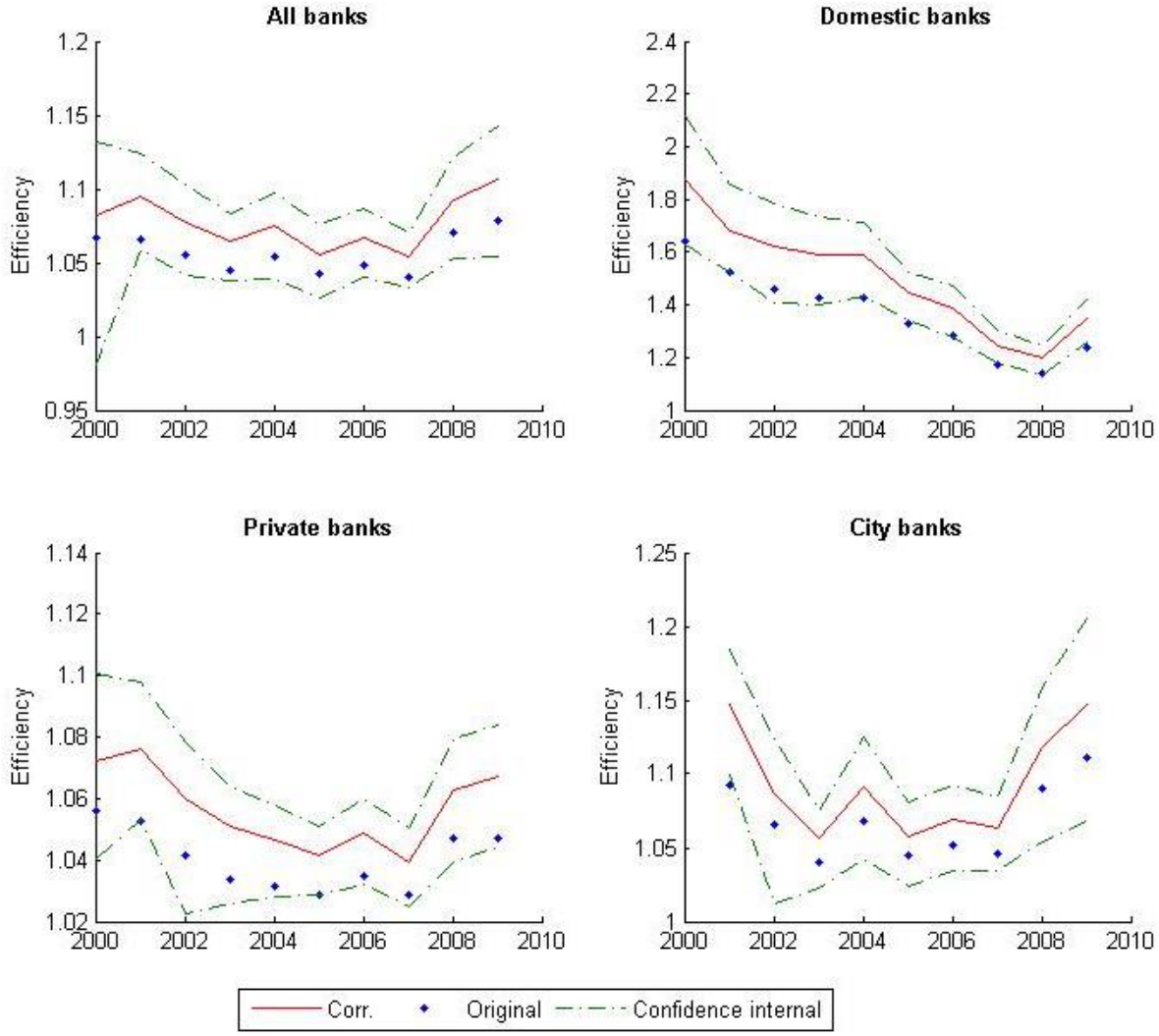
The results in this section show that the average efficiency of the city banks is relatively lower than for other banks and it is has been improved by China's WTO accession. The

methodology of this analysis is different to the papers reviewed above, which employ the financial ratio as the performance indicator or rely on parametric analysis as the main methodology. The disadvantages of the financial ratio and the parametric analysis are discussed in Chapter 3, which might bias the conclusions in the literature noted above.

## 4.6. Sensitivity Analyses

Since the DEA results are strongly influenced by the input and output specifications adopted, as shown in the paper by Drake et al. (2009), the same four sub-category groups are estimated in two other specifications – the intermediation (in Table 4.6 and Figure 4.3) and product specification (in Table 4.7 and Figure 4.4). The main findings in Section 4.5 are robust in all three specifications, although the input and output variables differ across the specifications.

Figure 4.2. Efficiency evolution in intermediation specification (2000–09)



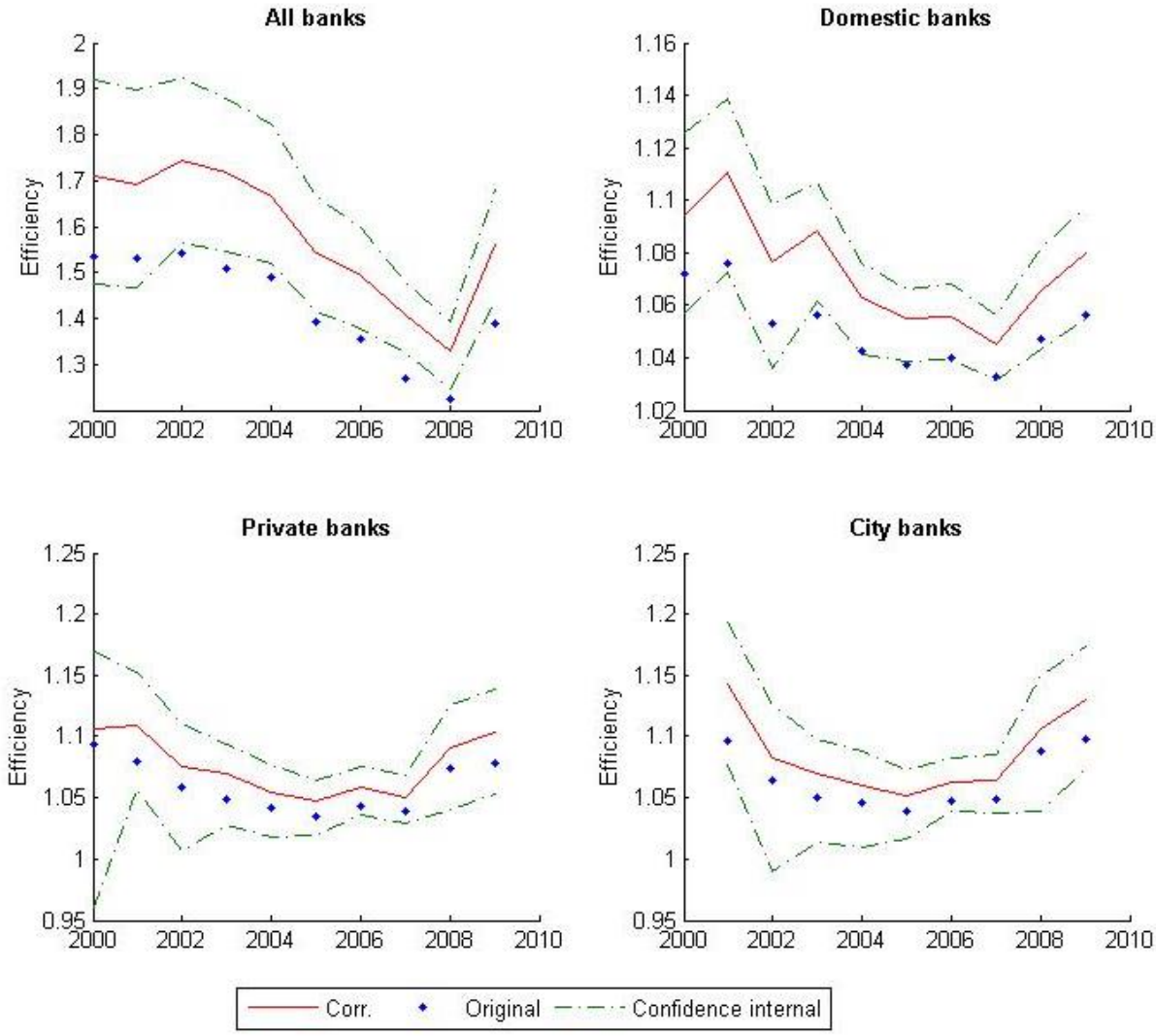

Source: Author's calculations.

Table 4.6. DEA scores in intermediation specification (2000–09)

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| **All banks** | | | | | | | | | | |
| Original | 1.0663 | 1.0661 | 1.0555 | 1.0442 | 1.0539 | 1.0428 | 1.0487 | 1.0396 | 1.0703 | 1.0781 |
| Corr. | 1.0813 | 1.0948 | 1.0779 | 1.064 | 1.0748 | 1.0556 | 1.0666 | 1.0541 | 1.0920 | 1.1069 |
| S.D. | 0.0416 | 0.0163 | 0.0156 | 0.0115 | 0.0151 | 0.0129 | 0.0117 | 0.0097 | 0.0175 | 0.0222 |
| Lower | 0.9790 | 1.059 | 1.0411 | 1.0374 | 1.0388 | 1.0260 | 1.0406 | 1.0326 | 1.0531 | 1.0542 |
| Upper | 1.1327 | 1.1234 | 1.1024 | 1.0826 | 1.0972 | 1.0761 | 1.0862 | 1.0702 | 1.1210 | 1.1419 |
| **Domestic banks** | | | | | | | | | | |
| Original | 1.6446 | 1.5248 | 1.4595 | 1.4296 | 1.4288 | 1.3256 | 1.2849 | 1.1745 | 1.1392 | 1.2399 |
| Corr. | 1.8793 | 1.6827 | 1.6199 | 1.5875 | 1.5888 | 1.4428 | 1.3895 | 1.2465 | 1.1977 | 1.3470 |
| S.D. | 0.1245 | 0.0830 | 0.0992 | 0.0845 | 0.0700 | 0.0482 | 0.0494 | 0.0328 | 0.0290 | 0.0415 |
| Lower | 1.6336 | 1.5271 | 1.4064 | 1.4036 | 1.4329 | 1.3400 | 1.2757 | 1.1772 | 1.1316 | 1.2564 |
| Upper | 2.1245 | 1.8539 | 1.7840 | 1.7297 | 1.7109 | 1.5267 | 1.4753 | 1.3032 | 1.2467 | 1.4189 |
| **Private banks** | | | | | | | | | | |
| Original | 1.0558 | 1.0525 | 1.0414 | 1.0335 | 1.0315 | 1.0284 | 1.0350 | 1.0286 | 1.0470 | 1.047 |
| Corr. | 1.0722 | 1.0761 | 1.0600 | 1.0509 | 1.0465 | 1.0417 | 1.0489 | 1.0394 | 1.0628 | 1.0670 |
| S.D. | 0.0151 | 0.0121 | 0.0144 | 0.0098 | 0.0079 | 0.0058 | 0.0070 | 0.0068 | 0.0101 | 0.0105 |
| Lower | 1.0404 | 1.0531 | 1.0225 | 1.0259 | 1.0280 | 1.0286 | 1.0322 | 1.0246 | 1.0393 | 1.0443 |
| Upper | 1.1005 | 1.0979 | 1.0782 | 1.0640 | 1.0576 | 1.0509 | 1.0599 | 1.0503 | 1.0795 | 1.0841 |
| **City banks** | | | | | | | | | | |
| Original | | 1.0920 | 1.0653 | 1.0398 | 1.0677 | 1.0453 | 1.0517 | 1.0462 | 1.0896 | 1.1113 |
| Corr. | | 1.1471 | 1.0863 | 1.0561 | 1.0915 | 1.0581 | 1.0695 | 1.0635 | 1.1178 | 1.1476 |
| S.D. | | 0.0226 | 0.0298 | 0.0134 | 0.0220 | 0.0147 | 0.0157 | 0.0131 | 0.0270 | 0.0367 |
| Lower | | 1.0997 | 1.0125 | 1.0226 | 1.0419 | 1.0244 | 1.0342 | 1.0345 | 1.0535 | 1.0681 |
| Upper | | 1.1839 | 1.1233 | 1.0754 | 1.1247 | 1.0808 | 1.0928 | 1.0841 | 1.1585 | 1.2054 |

Notes: 1. The 95 per cent of confidence interval (lower and upper bound) is provided for the bias-corrected DEA score (Corr.) based on 1,000 replications in the stage of bootstrapping. 2. Original means the DEA score without bootstrapping. 3. S.D. means the standard deviation of the bias-corrected DEA score.
Source: Author's calculations.

Figure 4.3 Evolution of efficiency in product specification (2000–09)




Source: Author's calculations.

Table 4.7 DEA scores in product specification (2000–09)

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| **All banks** | | | | | | | | | | |
| Original | 1.5352 | 1.5306 | 1.5429 | 1.5097 | 1.4889 | 1.3921 | 1.3539 | 1.2674 | 1.2237 | 1.3871 |
| Corr. | 1.7089 | 1.6934 | 1.7442 | 1.7182 | 1.6662 | 1.5433 | 1.4934 | 1.4063 | 1.3272 | 1.5594 |
| S.D. | 0.1180 | 0.1114 | 0.0953 | 0.0876 | 0.0810 | 0.0664 | 0.0589 | 0.0395 | 0.0376 | 0.0626 |
| Lower | 1.4736 | 1.4662 | 1.5657 | 1.5442 | 1.5196 | 1.4149 | 1.3773 | 1.3263 | 1.2482 | 1.4356 |
| Upper | 1.9199 | 1.8969 | 1.9252 | 1.8781 | 1.8231 | 1.6653 | 1.6000 | 1.4771 | 1.3937 | 1.6787 |
| **Domestic banks** | | | | | | | | | | |
| Original | 1.0723 | 1.0759 | 1.0532 | 1.0565 | 1.0428 | 1.0371 | 1.0398 | 1.0326 | 1.0472 | 1.0563 |
| Corr. | 1.0942 | 1.1103 | 1.0764 | 1.0883 | 1.0626 | 1.0547 | 1.0555 | 1.0451 | 1.0652 | 1.0800 |
| S.D. | 0.0174 | 0.0165 | 0.0160 | 0.0126 | 0.0093 | 0.0074 | 0.0074 | 0.0066 | 0.0094 | 0.0108 |
| Lower | 1.0566 | 1.0724 | 1.036 | 1.0613 | 1.0411 | 1.0385 | 1.0391 | 1.0314 | 1.0431 | 1.0549 |
| Upper | 1.1256 | 1.1385 | 1.0982 | 1.1067 | 1.0759 | 1.0663 | 1.0682 | 1.0561 | 1.0816 | 1.0975 |
| **Private banks** | | | | | | | | | | |
| Original | 1.094 | 1.0793 | 1.0586 | 1.0493 | 1.0422 | 1.0353 | 1.0438 | 1.0392 | 1.0743 | 1.0784 |
| Corr. | 1.1063 | 1.1086 | 1.0761 | 1.0704 | 1.0544 | 1.0472 | 1.0591 | 1.0507 | 1.0915 | 1.1033 |
| S.D. | 0.0567 | 0.0239 | 0.0280 | 0.0178 | 0.0157 | 0.0114 | 0.0102 | 0.0098 | 0.0217 | 0.0225 |
| Lower | 0.9580 | 1.0570 | 1.0074 | 1.0284 | 1.0179 | 1.0196 | 1.0364 | 1.0299 | 1.0409 | 1.0531 |
| Upper | 1.1697 | 1.1524 | 1.1101 | 1.0939 | 1.0766 | 1.0641 | 1.0761 | 1.0684 | 1.1262 | 1.1389 |
| **City banks** | | | | | | | | | | |
| Original | | 1.0969 | 1.0648 | 1.0504 | 1.0466 | 1.0396 | 1.047 | 1.0488 | 1.0876 | 1.0974 |
| Corr. | | 1.1424 | 1.0819 | 1.0699 | 1.0605 | 1.0520 | 1.0631 | 1.0647 | 1.1063 | 1.1299 |
| S.D. | | 0.0300 | 0.0393 | 0.0218 | 0.0203 | 0.0146 | 0.0112 | 0.0123 | 0.0287 | 0.0269 |
| Lower | | 1.0773 | 0.9899 | 1.0131 | 1.0098 | 1.0169 | 1.0385 | 1.0380 | 1.0395 | 1.0734 |
| Upper | | 1.1938 | 1.1261 | 1.0978 | 1.0880 | 1.0730 | 1.0823 | 1.0854 | 1.1501 | 1.1738 |

Notes: 1. The 95 per cent of confidence interval (lower and upper bound) is provided for the bias-corrected DEA score (Corr.) based on 1,000 replications in the stage of bootstrapping. 2. Original means the DEA score without bootstrapping. 3. S.D. means the standard deviation of the bias-corrected DEA score.
Source: Author's calculations.

Since the composition of the input and output variables differs across the specifications, the least efficient groups also vary. In the intermediation specification, the domestic banks at the upper right corner of Figure 4.2 are the least efficient group in the whole sample period. The main distinction between the groups of domestic banks and private banks is the inclusion of the Big Five in the domestic bank group, so the Big Five are the least efficient banks in the intermediation specification. This result is consistent with some findings in the literature, e.g. Lin and Zhang (2009) and Berger et al. (2009). They find that large bank size does not always result in a more efficient bank.

In the product specification, the least efficient group is the group of all banks, as shown in the upper left corner of Figure 4.3. Since the inclusion of foreign banks is the main distinction between the groups of all banks and domestic banks, foreign banks are the least efficient banks in this specification and decrease the efficiency of the group of all banks. During the adaptation phase, the restrictions are removed gradually, which could be the reason for the lower efficiency of foreign banks in the product specification, since the restrictions limit their performance in providing financial products or services.

The different composition of the input and output variables in the intermediation and product specifications also makes the bank efficiency decrease one year earlier than in the profit/revenue specification. For example, the efficiency of city banks decreased from 2007 onwards in the intermediation and product specifications but decreased from 2008 in the profit/revenue specification. The efficiency of domestic banks decreased from 2007 onwards

in the profit/revenue specification and product specification, but it decreased from 2008 in the intermediation specification. However, these differences do not challenge the main results of Section 4.5, i.e. that the efficiency of the banks increased after the WTO accession, especially between 2001 and 2007.

Finally, the annual DEA scores are aggregated in two weighting methods in this analysis: (1) the simple average and (2) Fare-Zelenyuk weighting method. The results of the simple average are presented in Section 4.5. Since the general trend is almost the same using these two methods, the results of the Fare-Zelenyuk weighting method are presented in the Appendix of this thesis (See Table A.4.5, Table A.4.6 and Table A.4.7). The only difference is that the aggregated score based on the simple averaging method is slightly lower than the score from the Fare-Zelenyuk weighting method.

## 4.7. Concluding Remarks

In the adapting phase of the WTO accession, the gradual removal of restrictions on foreign banks offers a unique setting for exploring the relationship between foreign bank entry and bank efficiency. By considering the WTO accession as an exogenous event, this chapter calculates the annual change of the efficiency of commercial banks using the observations of 145 Chinese commercial banks in the period from 2000 (from 2001 for city banks) to 2009.

As the contribution to the literature, DEA with bootstrapping technique is employed to overcome the two key drawbacks of the conventional DEA model. These drawbacks are: the strong assumption that there are no measurement errors in the data collection and the

assumption that there are no random errors. This chapter aggregates the annual change of efficiency scores for individual banks using two different methods – the simple average and Fare-Zelenyuk weighting method from Färe and Zelenyuk (2003), which provides a new way to aggregate the firm-level DEA score to the group-level. It is well known that the DEA is sensitive to the specification of input and output variables, so three different input and output specifications, i.e. the profit/revenue, product and intermediation specifications, are selected to evaluate bank efficiency and they cover almost all bank functions. The empirical evidence in this chapter shows that the efficiency of banks increased between 2000 and 2007, but decreased around 2008, in all three specifications (profit/revenue, intermediation and product). The bank efficiency decreased in 2008 could be due to the subprime crisis. For example, the export growth rate in China fell from 20 per cent to -2.2 per cent in 2008 (Yu, 2010). The bad macroeconomic situation deteriorates the banks' financial report from 2008.

In terms of profit maximising, city banks tend to be the least efficient among all banks during 2000–09 but not the SOBs as is suggested previously in the literature. One reason to support this finding is that the four SOBs could have benefitted from financial reforms before 2000, such as the setting up of asset management companies to take over the NPLs and the moving of policy-oriented businesses to policy banks. Nonetheless, the catch-up effect is strong among city banks, since their efficiency as a group has increased dramatically compared to other banks.

In this chapter, the empirical evidence from the Chinese banking industry speaks of a positive association between deregulation in the form of removing restrictions on foreign

banks and bank efficiency. However, this chapter is meant to provide descriptive analysis of the relationship between efficiency gains and deregulation using China as a case study. The positive association between deregulation of the banking industry and bank efficiency as suggested in this chapter merits further investigation on the effect of specific deregulation policies on bank efficiency. This issue is examined more closely using cross-country econometric analysis in Chapters 5 and 6.

# Chapter 5 Evidence from Asian Banking Industries of Efficiency Gains from Deregulation

## 5.1 Introduction

The importance of a well-functioning banking industry for economic development cannot be understated. Bank loans, for example, are the most important source of external finance for firms (Beck, 2008). Since banks function as intermediaries between savers and borrowers by channelling credit to where the best economic opportunities are, it is not surprising that in recent times, policy makers especially in developing countries have been concerned about the efficiency of their banking systems. One of the most common and direct strategies to raise efficiency is deregulation of the banking industry, where presumably, such deregulation would increase competition among banks and thus encourage them to operate more efficiently or face their demise (Delis, 2011).[29]

In this chapter, the effect of deregulation of the banking industry on the efficiency of banks is studied and a dataset is assembled, which covers the banking industries from 1996 to 2007 for six Asian developing countries, namely China (mainland China and Taiwan are not merged with China since they have different regulation and institutional systems), India, Indonesia, Malaysia, Pakistan and Thailand.[30] The methodology employed here is two-stage DEA and the efficiency scores are estimated in the first stage. After obtaining the efficiency

[29] Some country-specific research: Leightner and Lovell (1998) on Thailand banks, Halkos and Salamouris (2004) on Greek banks, Drake et al. (2006) on Hong Kong banks and Das and Ghosh (2009) on Indian banks.

[30] For brevity, the China in this chapter means the China mainland and Taiwan means the Taiwan province.

estimate for each bank, or DEA scores, the effect that deregulation policies have on the efficiency on banks is studied by the 2SLS model.

In general, deregulation policies may be classified as two types. The first type of policies is the deregulation of domestic banks to allow these banks to carry out business more freely. The second type of policies is the deregulation of the domestic banking market to allow for the presence of foreign banks. Based on the empirical results of this chapter, the deregulation on operation of foreign banks, such as the type of 'open door' policy in China, has been effective in terms of efficiency gains. However, the effect of liberalisation of domestic banks on their efficiency gain appears to be weaker compared to that due to 'open door' policy. This finding is especially relevant to developing countries where behind the impressive growth trajectory is a thirst for capital from firms. In developing countries such as China, India and Indonesia, the firms often struggle to obtain enough financial support from their relatively underdeveloped and inefficient financial sectors, but this problem could be at least partly countered by the increased efficiency of the banks.

The rest of this chapter is organised as follows. The related literature on financial deregulation is reviewed in Section 5.2. Sections 5.3 and 5.4 introduce the data sources, selected variables, and methodology. Section 5.5 discusses the empirical results from the DEA and regression analysis and the sensitivity analyses are presented in Section 5.6. Section 5.7 concludes.

## 5.2 Literature on Efficiency Impact of Financial Deregulation

The regulation and supervision activities by the government may be broken up into two different groups according to their purposes – whether they are prudential regulation or non-prudential restriction. According to the concept of the prudential regulation from Acharya (2009), the aim of prudential regulations is to ensure the financial stability of the whole system, not only banks individually but also as a part of the overall system. The most famous international standard for prudential regulations is from the Basel Accords, the current version being number III.

Any other extra requirements or restrictions are considered to be non-prudential restrictions. Dinh (2008) argues that the non-prudential restrictions are designed to protect the franchise profits of the incumbent banks, and expected to assist the fragile domestic banks to become stronger, e.g. the five-year transitional arrangements in the Chinese banking market after the country's accession to the WTO. The restrictions imposed on foreign banks were not removed immediately after the WTO accession; they were gradually lifted over the first five years.[31] The Chinese government believed that this arrangement would give their banking industry more time to meet the competition from the foreign banks. However, most economists argue that the non-prudential restrictions cannot boost the efficiency of the banks and one important focus of the Basel Accords is to maintain sufficient consistency of regulations so that any inconsistency does not become a source of competitive advantage for foreign banks.

[31] The details of the restrictions are discussed in section 2.5 of Chapter 2.

In order to test the efficiency impact from changes in environmental conditions, Dietsch and Lozano-Vivas (2000) look at banks in France and Spain over the period 1988–92. They add several environmental variables into a model of Distribution Free Approach, which is a kind of parametric frontier analysis. In the regression equation, the environmental variables are added with input and output variables. The environmental variables include population density, the Herfindhal index of bank concentration, and average capital ratio. They find that the changes in the environmental variables contribute significantly to the difference in the efficiency scores of the banks both in France and Spain. Adding similar environmental variables into the DEA model, e.g. per capita income, the salary per capita, and population density, Lozano-Vivas et al. (2002) extend their research across 10 European countries: Belgium, Denmark, France, Germany, Italy, Luxembourg, Netherlands, Portugal, Spain and the UK. They find that the country-specific environmental conditions exercised a strong influence over the behaviour of each country's banking industry in 1993. Unfortunately, their research does not identify the individual effect of each environmental variable.

The regulation framework in the Basel Accord has three 'pillars' which must be followed. These are: (1) minimum capital requirements (addressing risk), (2) supervisory review and (3) market discipline. Delis et al. (2011) employ the two-stage DEA model using a dataset from 22 transition countries over the period 1999–2009. They examine the relationship between the productivity of banks and the regulatory and supervision frameworks in each country, and find that the first two pillars of Basel II enhance banks' productivity, since the first pillar enhances the banks' security in terms of capital assets, and the second pillar improves and

increases supervisory oversight of the system. In order to provide international evidence on the impact of the regulation and supervision approach on bank efficiency, Pasiouras (2008) employs the two-stage DEA (using the Tobit model in the regression stage) to a dataset covering 95 countries. Pasiouras (2008) found that there was no impact on bank efficiency from the imposition of entry requirements, i.e. whether there are specific legal submissions required to obtain a bank licence, and restrictions on banks activities in the field of securities, insurance, and real estate.

In order to identify the impacts of the financial reforms, some research relies on indices. For example, Laeven (2003) creates an index of financial reform to measure the impacts of financial reforms on financial constraints of firms in a regression including data from 13 developing countries: Argentina, Brazil, Chile, India, Indonesia, Malaysia, Mexico, Pakistan, Peru, Republic of Korea, Taiwan, Thailand, and the Philippines. The value of the index varies between zero and six, where zero means no restriction and six means full restriction. The data for the index are collected on the tools applied in the implementation of reform packages related to different measures, such as interest rate deregulation, reduction of entry barriers, and reduction of credit. Using the index as the independent variable in the regression, he finds that over the period 1988–98, liberalisation of banking markets resulted in more relaxed external financing constraints for small firms, but increased financing constraints for large firms.

Changing the index of Laeven (2003) to dummy variables, Hermes and Hhung (2010) employ the two-stage DEA model (using fixed effect estimation in the second stage) for 10

emerging economies, namely Argentina, Brazil, India, Indonesia, Republic of Korea, Mexico, Pakistan, Peru, Thailand and the Philippines, over the period 1991–2000. They find strong support for the positive effect from financial liberalisation on the efficiency of banks, which is estimated using the country-level aggregated DEA scores (estimated at the bank level in the first stage).

In a similar study, Fries and Taci (2005) use the index taken from the EBRD (*Transition Reports*), for 15 European countries over the period 1994–2001. The countries studied are Bulgaria, Croatia, Czech Republic, Estonia, Republic of Macedonia, Hungary, Kazakhstan, Latvia, Lithuania, Poland, Romania, Russia, Slovak Republic, Slovenia and Ukraine. They find that the SFA-estimated bank efficiency, calculated based on the cost reductions, is increased as a result of the greater macroeconomic stability and competition brought about by foreign entry.

One drawback common to the above analyses is that the prudential regulations and non-prudential restrictions are not distinguished, which renders their conclusions and policy suggestions weak and over-generalised. To overcome this shortcoming, the indices from Dinh (2008) are employed in this analysis, which focuses purely on the non-prudential restrictions. The final indices are composed of two parts – restrictions on foreign banks and domestic banks. The restriction indices for foreign banks measure the restrictions on the services provided by foreign banks and the indices for domestic banks measure the restrictions on the domestic banks in the same market.

In order to identify the impact of the deregulation policies, the two-stage DEA model is employed by some research, such as Berger and Hannan (1998), Hermes and Nhung (2010), Pasiouras (2008), and this analysis.[32] The reverse causality issue in the regression stage is another drawback in using this model – the promotion of bank efficiency could encourage changes in the policy environment, and there is also a reverse causality whereby banking deregulation impacts on efficiency gains. In order to deal with this issue, the 2SLS model is utilised in this analysis and the bank efficiency in the previous period is included as the control variable. A similar 2SLS method is also employed by Gonzalez (2009) and Delis et al. (2011).

In the literature, some researchers consider the DEA scores to be the same as 'censored' data, and then do their modelling using the Tobit model or the Probit model. In the set of censored data, some of the observations are not used in the dataset since they are lower or higher than the threshold values. The observations are censored, which results in either knowing the exact value of an observation or in knowing that the value lies within an interval. However, DEA scores are very different from 'censored' data, so it is not appropriate to use DEA scores in a Tobit or the Probit model. For DEA scores, an inefficient observation is defined as any observation where the efficiency score is more than one (i.e. the minimum value and the left bound). It is defined as inefficient compared to the fully efficient observations in the dataset, which have an efficiency score exactly equal to one. Since the DEA score is not generated from the censoring process, McDonald (2009) argues that use of

[32] In two-stage DEA, efficiency scores of banks are evaluated in the first stage and these are used as the dependent variables in the second stage regression.

Tobit or Probit estimators is inappropriate in gaining insights in the application of DEA. Following his suggestion, the method of least squares is employed in the second stage analysis, rather than the Tobit model or Probit model.

## 5.3 Data

One particular assumption inherent in the DEA approach has created a specific issue for the dataset used in this kind of analysis. Deregulation is normally a country-level policy, but the DEA has to assume that the same technology is accessed by all banks in the dataset. Hence, the inclusion of several countries would make the assumption less reasonable, so seven countries and regions in Asia are selected – China, Taiwan, India, Indonesia, Malaysia, Pakistan and Thailand. The first motivation to choose these countries is their common characteristics – they are all developing countries in Asia. For a similar reason, the technology is assumed unchanged in the selected time period from 1997 to 2006.[33]

The data for efficiency evaluation are taken from financial statements provided by the Bankscope database of Bureau van Dijk, which is a leading publisher of company specific information and business intelligence. The original dataset consists of all financial institutions in the selected countries that appeared to have records, such as commercial banks, finance companies, securities firms, investment and trust corporations and group finance companies. The index from Dinh (2008) only includes data relating to the services provided by

[33] The dataset is also restricted by the availability of the restriction indices, which is available from 1996 to 2007. The deregulation process in these seven regions is another motivation to select them, since the indices in these seven countries change dramatically over the selected time span, which eases the identification in the second stage of the analysis.

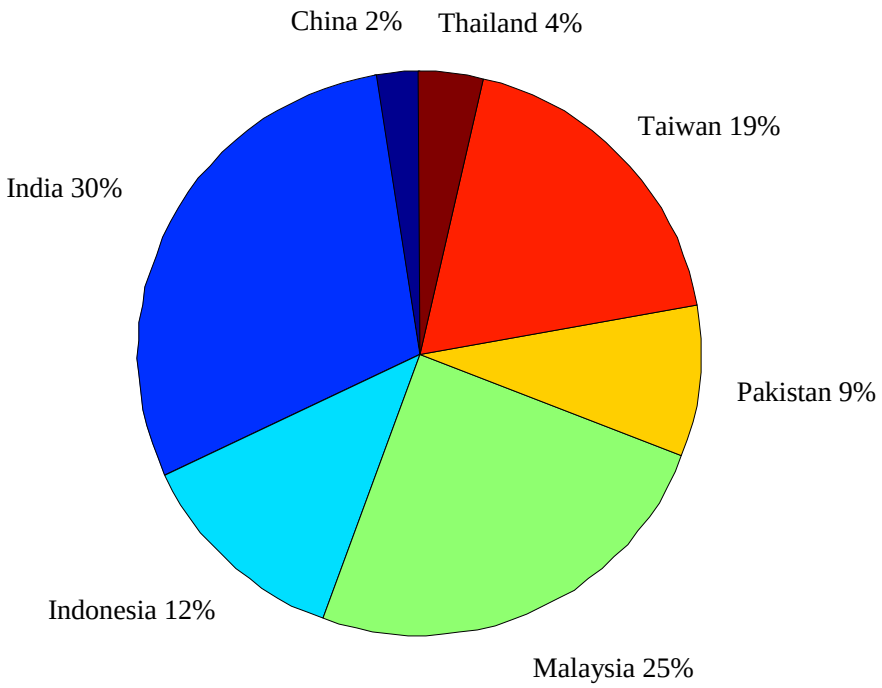
commercial banks, so in this chapter only data from commercial banks in the Bankscope database is considered. This provides a relatively homogeneous dataset in terms of financial products provided, and consequently a standardised set of inputs and outputs, thereby enhancing further the comparability among countries. Ultimately, the balanced dataset includes 810 observations from 81 banks from 1997 to 2006.

An observation is removed from the dataset if the sum of input or output variables is negative or missing. The individual variable, i.e. any of the three variables in the inputs and two variables in the outputs, is allowed to be zero or negative, for example, there could be negative income in a specific year. The observation is also removed if there are missing values in the case of the country-specific control variables.

There are two kinds of datasets used in this type of research – consolidated and unconsolidated. The data from consolidated financial statements include the combined information from banks and their subsidiaries, such as their insurance companies or financial companies, which sometimes are not directly related to the banks' main business. Therefore, in this analysis, unconsolidated data is used, since this additional information that is not required is not included. All data are converted to millions of US dollars and the unconsolidated data (the most common type in this dataset) is used but where it is not available, consolidated data is chosen instead. Following previous research (Pasiouras et al., 2008; Delis et al., 2011), the data are deflated by the CPI of each country. The financial statements prepared under international accounting or international financial reporting standards (IAS/IFRS) have been used wherever possible, but the dataset also includes those

prepared under local generally accepted accounting principles (LGAAP) where these are the only ones available. Figure 5.1 illustrates the distribution of the observations in each country.

Figure 5.1. Percentage of the observations from each country




Source: Author's calculations.

One unanswered issue in the DEA model is that of input and output variable specification. Drake et al. (2009) demonstrate that the estimated efficiency score is highly dependent on the input and output variables utilised. In this analysis, the profit/revenue-based specification of the input and output variables is adopted, instead of the conventional production and intermediation specification. There are at least three reasons to select the profit/revenue-based

specification, as follows.

Firstly, restrictions due to the policy environment could bias the results of the analysis since they strongly impair the number and range of products the specific group of banks could provide, so this supports the use of the profit/revenue-based specification. Berger and Mester (2003) focus on the productivity change in the US banking industry over the period 1991–97, looking specifically at the changes in best practice and changes in efficiency. They find that the application of profit maximisation is superior to cost minimisation for studying bank performance, since it better reflects the economic goals of managers and owners, who take revenues into account as well as costs. For example, foreign banks face restrictions in providing financial products or services in the restricted business field even if they wish to do so. In terms of the profit specification, managers in the bank have a relatively high level of freedom to adjust their internal management strategy in order to achieve higher revenue.

Secondly, the ideal raw data for the conventional product and intermediation specification are the number of the financial products or services provided by the management team in the banks, e.g. the number of the bank accounts or the loans originated by each manager in each time period. For this analysis, unfortunately, it is not possible to retrieve this kind of information from the financial reports of the banks.

Thirdly, the selected output variables in the profit/revenue specification are a more rational choice than in the product or intermediation specification, since the proxies of the output are all income type variables, i.e. the other operating income and net interest income, which derive purely from the profit function (Berger et al., 1993). However, the variable type

is mixed in both the intermediation and product specifications, with both income and quantity variables included in the estimation.

For the above three reasons, it is not appropriate to use the traditional product or intermediation specification.

In the profit/revenue-based specification, the inputs are non-interest operating expenses for the daily operating costs and other operating expenses are the proxy for the rest of the cost. The total provisions are also included to reflect the risk-taking behaviour of the banks. In Chapter 4, the variable of net commission and fees are selected as the output variable, but it is not included in this analysis, since the definition of this variable is not consistent across countries, and this could bias the final result of the analysis. For outputs, the net interest income is the proxy of the revenue that banks earned from the traditional business and other operating income which is used to reflect the income from other business, such as intermediary or off balance sheet business. The summary statistics of input and output variables are shown in Table 5.1.

Table 5.1. Summary statistics of input and output variables

| Type | Variables | Mean | S.D. | Min. | Max. |
|---|---|---|---|---|---|
| **Input** (US$ million) | Non-interest operating expenses | 135.58 | 168.61 | 0 | 1,099.90 |
| | Total provisions | 156.57 | 159.65 | 0 | 1,910.58 |
| | Other operating expenses | 78.10 | 116.92 | 0 | 948.16 |
| **Output** (US$ million) | Other operating income | 57.92 | 45.48 | 0 | 637.83 |
| | Net interest income | 218.12 | 285.57 | 0 | 2,110.84 |

Source: Author's calculations.

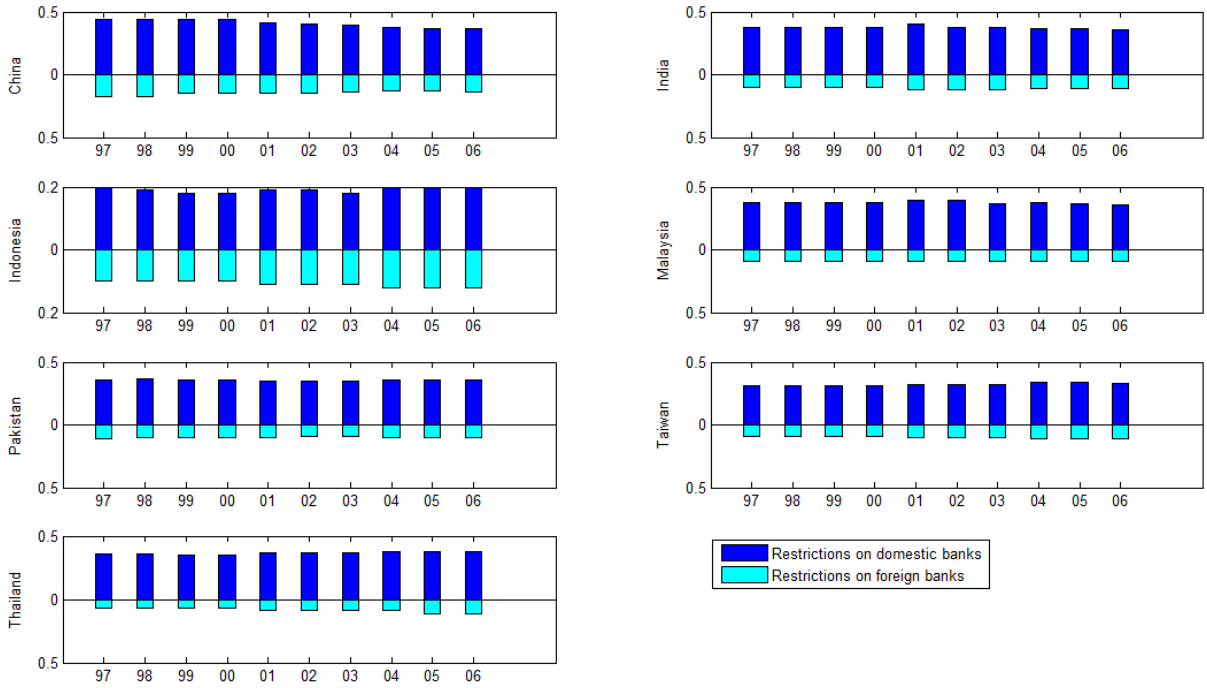
As a new attempt to investigate the efficiency impact from removing the non-prudential restrictions on the banking industry, the indices from Dinh (2008) are selected in this analysis, since they cover most possible restrictions affecting banking services in the banking industry across countries in this study. Dinh's (2008) indices are based on the concepts defined by the General Agreement on Trade in Services of the WTO in modes of financial service supply – cross-border supply (Mode 1), consumption abroad (Mode 2), commercial presence (Mode 3) and presence of natural persons (Mode 4), which are the different ways for customers to get the financial services from banks.

First, the policy documents are downloaded from the websites of each country, and each mode is given a mark between zero and one according to the information in these documents, where one indicates that the banks' activities are fully restrictive and zero means no restrictions. Then, the principal component analysis is used to obtain the weight of each mode

for the index of foreign or domestic banks. The higher the index value the greater the restrictions on the market. Alternatively, change in index reflects change in policy. A similar methodology is employed by Barth et al. (2004) to construct indices of regulation and supervisory activities in 107 countries, using survey data in their analysis, which is the main difference from the index from Dinh (2008).

For the indices from Dinh (2008), the restrictions are calculated for foreign banks and domestic banks separately. The indices for foreign banks measure the policy change which liberalises the daily operation of foreign banks and the indices for domestic banks measures the policy liberalising domestic banks. For example, restrictions include those on the maximum percentage of the foreign equity ownership on domestic banks or the restriction on the loan and deposit interest rates charged by banks (Dinh, 2008). For presentation purposes, the overall index is demonstrated as the sum of the foreign (blue bar) and domestic (red bar) summary indices, as illustrated in Figure 5.2. The value of the indices is presented in the Appendix of this thesis (Table A.5.1).

Figure 5.2. Restriction indices of foreign and domestic banks




Source: Dinh (2008).

Since the restriction indices are the main explanatory variables of interest, other impacts from the industry and country level are controlled in the regression. In a competitive market, each individual bank does not have enough power to exert their influence. However, the 'too big to fail' hypothesis states that large banks in the monopolistic markets could be powerful enough to affect the policy decision, since the authorities are afraid of the bankruptcy of those big banks. The first controlled impact is that of the potential bargaining power of the whole banking industry on the policy decision. Furthermore, the relatively undeveloped stock market could magnify the power from the big banks (Levine, 2002). Thus, the variable of bank concentration is added in the robustness test with the proxy of the development of the stock market. The number of publicly listed companies per 10,000 people is selected as the proxy of the developing stage of the stock market, which is taken from the database on

Financial Development and Structure (Beck et al., 2000). Since the stable financial environment could influence the efficiency of the banks, the Z-score for each country is added from the same database, which is estimated as the financial risk the banks faced. A larger value of the Z-score indicates a higher bank market stability and lower systemic risk for the country.

At the country level, the natural logarithm of population size and GDP level are included due to the potentially positive relationship with the efficiency gains in the banking industry. Using the dataset for 84 banking systems worldwide over the period 1987–2005, Delis (2012) finds that institutional development is the precondition for the success of financial reforms aimed at enhancing the efficiency of banking markets. He suggests that the weak legal system and poor institutional infrastructure impede the industry development and consequently decrease the efficiency of banks. Following his suggestion, the index of laws and orders from the International Country Risk Guide is included as the control variable.[34] Table 5.2 presents the summary statistics of the regression variables.

[34] The International Country Risk Guide is published by Political Risk Services Group, which rates financial, political and economic risk. The index of law and order measures the integrity of the legal system. Their website is: http://www.prsgroup.com, accessed on 6 April 2013.

Table 5.2. Summary statistics of regression variables

| Variable | Mean | S.D. | Min. | Max. |
|---|---|---|---|---|
| Restrictions on foreign banks | 0.34 | 0.06 | 0.18 | 0.44 |
| Restrictions on domestic banks | 0.10 | 0.01 | 0.07 | 0.17 |
| Bank concentration (index) | 0.40 | 0.11 | 0.25 | 0.82 |
| No. of list companies (per 10,000 people) | 0.16 | 0.15 | 0.01 | 0.53 |
| Law and order (index) | 2.41 | 0.72 | 1 | 4 |
| Z score (index) | 8.71 | 3.98 | 1.13 | 48.96 |
| Population (1,000 people) | 392,946 | 462,044 | 21,407 | 1,304,262 |
| GDP growth (US$ million) | 8,154.13 | 7,957.89 | 1,678.92 | 28,031.01 |

Source: Author's calculations.

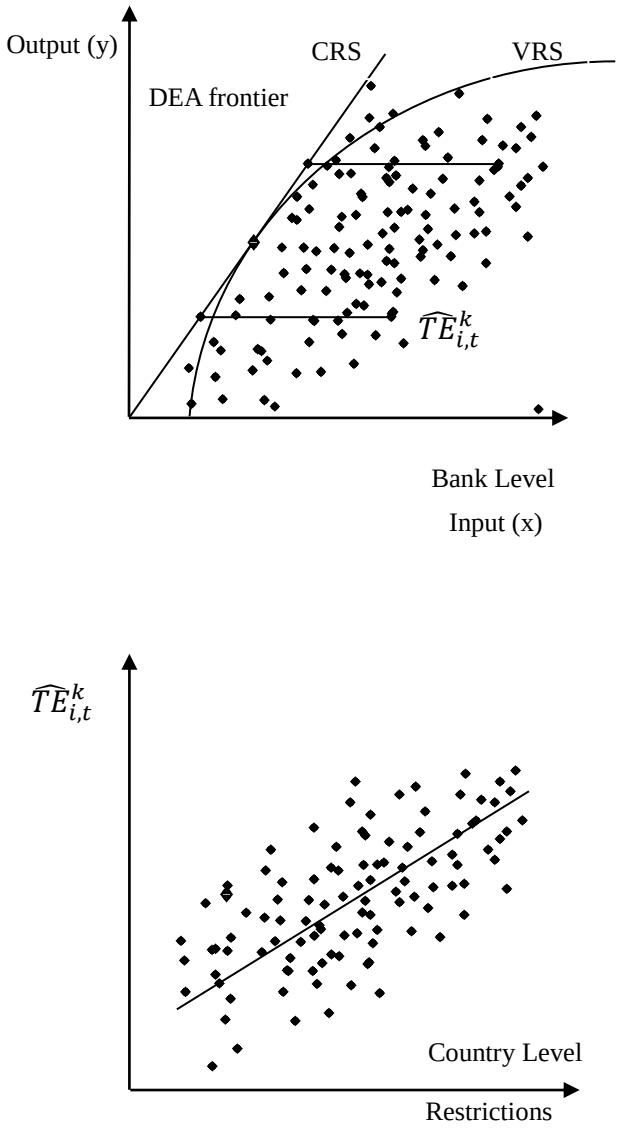
## 5.4 Methodology

To be consistent with the theory, the banks are assumed to maximise their profits by effectively using their inputs. Thus, the output direction DEA model is employed to evaluate the efficiency score of each bank in each year. In the output direction DEA, the frontier of the maximum outputs is created first, as per the assumption in the theory. Any value that is not located on the frontier will represent inefficiency, and the further the distance from the frontier infers less efficiency.

The two-stage DEA is illustrated in Figure 5.3. In the first graph of Figure 5.3, there are two different frontiers that could be utilised to evaluate the efficiency scores, that is, the CRS frontier, i.e. the straight line in the graph, and the VRS frontier, i.e. the convex curve. Chapter 3 discusses the details relating to these two frontiers. Since the CRS frontier could reflect the potential efficiency gains from the economies of scale, it is adopted in this analysis. The deregulation policy is expected to change the product line and foster the development of banks to achieve the optimal size.

The estimated DEA scores ($\widehat{TE}$) are used as the dependent variable in the regression equation in the second stage where the restriction indices are included among the independent variables (the second part of Figure 5.3 shows the expected relationship). One caveat of the conventional DEA approach is the resulting downward bias that applies to the estimates of bank efficiency, i.e. the distance between the true frontiers and the estimated frontier, which is discussed in Chapter 3. However, the qualitative results of this chapter will hold as long as the downward bias does not change the relative rankings of the DEA scores.

Figure 5.3. Illustration of two-stage DEA




In the analysis by Delis et al. (2011), the productivity scores (i.e. the output-direction Malmquist indices) are estimated using separate frontiers for 22 transition countries, which indicates that the technology is varied across countries. Consequently, the productivity scores from different countries cannot be compared directly in their research. In this analysis, the

grand frontier is created based on all observations from each country over the period 1997–2006, and all banks from different countries are assumed to have access to the same technology, or the same production set, which allows the DEA scores to be compared among different countries in the second stage of the analysis.

To identify the effect of non-prudential restrictions on bank efficiency ($\widehat{TE}_{i,t}^{k}$), the following linear model is assumed:

$$\Delta\widehat{TE}_{i,t}^{k} = \alpha_0 + \beta_1 \Delta Res_{i,t} + \beta_2 \Delta\overline{\widehat{TE}}_{i,t-1} + \beta_3 \Delta Control\ Var._{i,t} + \Delta\epsilon_{i,t}^{k} \quad (5.1)$$

$$k = 1, \dots, n \text{ banks in country } i = 1, \dots 7; \text{ and } t = 1, \dots, 10$$

where $\Delta Res_{i,t}$, a vector of restrictions on foreign or domestic banks in country $i$ at time $t$, is assumed to exert an impact on the efficiency score ($\Delta\widehat{TE}_{i,t}^{k}$) of each bank $k$ in country $i$ at time $t$ via the estimated parameter $\beta_1$ and $\Delta\epsilon_{i,t}^{k}$ are the random errors. The $\Delta Control\ Var._{i,t}$ is the vector of control variables to partial out the impact from the industry and country level and $\alpha_0$ is the constant term.

In order to eliminate the unobserved time and bank level effect, the first difference model is employed, and the country level average efficiency in the previous period ($\Delta\overline{\widehat{TE}}_{i,t-1}$) is included as independent variables to control for the average efficiency level of each country in previous period. Following the suggestion from Anderson and Hsiao (1981), the 2SLS estimator is utilised and the average of the penultimate efficiency level is used as the instrumental variable for that variable ($\Delta\overline{\widehat{TE}}_{i,t-1}$).

## 5.5 Empirical Results

Relying on the input and output variables selected, the DEA score is estimated in a grand frontier created by the data in the time span. The four most inefficient observations are removed since they are more than four times outside the so-called cloud of the dataset, as shown in Table 5.3. For instance, the DEA score of 12.152 from one of the banks in Thailand in 1998 shows that this particular bank is very ('super') inefficient. The main reason to remove the outliers is that they make the first-stage analysis misleading. The focus of this chapter is the distribution of the distance between the frontier and each observation, and it is assumed to be impacted by the different deregulation policies.

Table 5.3. Super inefficient observations in the dataset

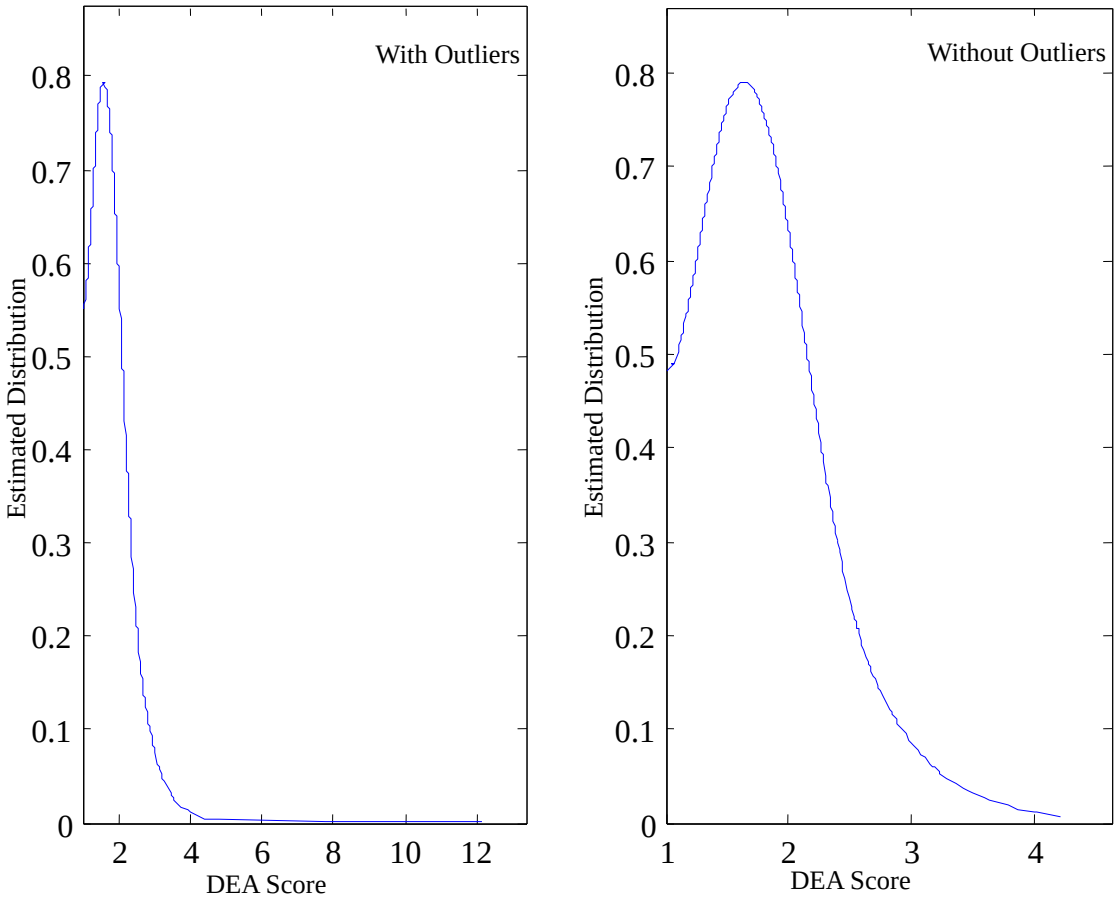
| Year | Country | $\Delta\widehat{TE}_{i,t}^{k}$ | Non-interest expenses | Loan provision | Interest expenses | Interest income | Non-interest income |
|---|---|---|---|---|---|---|---|
| 1997 | Pakistan | 7.752 | 267.59 | 237.73 | 193.85 | 21.77 | -13.07 |
| 1998 | Thailand | 12.152 | 662.34 | 1,322.34 | 405.65 | 23.24 | 246.54 |
| 2000 | Thailand | 4.796 | 546.06 | 829.98 | 356.10 | 27.25 | 552.40 |
| 2006 | Taiwan | 4.416 | 139.18 | 509.29 | 77.44 | 9.66 | 197.42 |

Note: $\Delta\widehat{TE}_{i,t}^{k}$ is the DEA score for the banks, one indicates full efficiency and a value of more than one means inefficiency.
Source: Author's calculations.

Figure 5.4 presents the efficiency distribution with and without the very inefficient observations. The only difference between the two distributions is the long right tail in the chart on the left hand side, which is due to the included outliers. To double check whether the

distribution is distorted or not by excluding the super inefficient observations from the cloud of the dataset, the adapted Li test (1,000 times in bootstrapping) from Simar and Zelenyuk (2006) is employed. The calculated *t* statistic is 1.0496 and the *p*-value is 0.1170, which supports the null hypothesis, i.e. that the two distributions are the same.

Figure 5.4. Distribution of DEA score with or without outliers




Source: Author's calculations.

The aggregated DEA scores in each country in each year and corresponding observation numbers are shown in Table 5.4. The average DEA score is 1.8041 for observations without the four most inefficient observations, which implies that the profit could be increased at least

1.8041 times on average compared with the fully efficient observations on the frontier.

Table 5.4. The average DEA score in each country

| Name | Obs. | 1997/98 | 1999/2000 | 2001/02 | 2003/04 | 2005/06 | Ave. eff. |
|---|---|---|---|---|---|---|---|
| China | 20 | 1.4383 | 1.8849 | 1.7105 | 1.4942 | 1.2676 | 1.5591 |
| Taiwan | 150 | 2.1285 | 2.2644 | 2.5440 | 2.1186 | 2.6773 | 2.3443 |
| India | 240 | 1.6904 | 1.6905 | 1.7618 | 1.7425 | 1.6572 | 1.7085 |
| Indonesia | 100 | 1.2677 | 1.3331 | 1.3916 | 1.4830 | 1.6304 | 1.4211 |
| Malaysia | 200 | 1.5907 | 1.7358 | 1.8780 | 1.7031 | 1.6887 | 1.7193 |
| Pakistan | 70 | 1.7435 | 1.7917 | 1.8082 | 1.5899 | 1.5111 | 1.6881 |
| Thailand | 30 | 2.4697 | 2.4575 | 2.3015 | 1.9895 | 1.7949 | 2.1840 |
| Period Average | | 1.7171 | 1.8018 | 1.9124 | 1.7602 | 1.8282 | 1.8041 |

Source: Author's calculations.

As shown in Table 5.4, the most efficient banks are from Indonesia, followed by mainland China. The worst performance is by the Taiwanese banks, specifically in 2005 and 2006. Pasiouras (2008) finds that in the 2003 sample of 95 countries, the average bank could improve its overall technical efficiency by 33.20 per cent in the cross-section DEA. The figure of interest in this chapter, 1.8041, is lower than the finding from Pasiouras (2008). The difference between these two results, i.e. the DEA score of 1.8041 (or 55 per cent) and 33.20 per cent, indicates that the banks in the selected Asian countries are less efficient than the banks, on average, in the 95 countries.

To directly analyse the efficiency impact of restrictions, density estimation techniques are utilised and the dataset is separated into three groups by the degree of deregulation, both for foreign and domestic banks, after sorting the indices from minimum to maximum (0–0.5).

The first group is the group with the toughest restrictions or the least deregulation, referred to as the 'tough restriction' group. On the other hand, the group with the least restrictions includes the observations from the relatively deregulated market, referred to as the 'least restriction' group. The group called 'average restriction' contains the observations from the group with an average degree of deregulation. The efficiency of these groups are presented in Table 5.5 for the restrictions on foreign banks and Table 5.6 for the restrictions on domestic banks.

Table 5.5. DEA efficiency of restriction groups of foreign banks (1997–2006)

| Groups | Mean | Median | S.D. | Max. |
|---|---|---|---|---|
| Least restriction | 1.9512 | 1.8877 | 0.6445 | 4.1991 |
| Average restriction | 1.7529 | 1.6713 | 0.4919 | 4.0076 |
| Tough restriction | 1.7079 | 1.7045 | 0.3817 | 3.5892 |

Note: The minimum value (i.e. one) is not shown in the table, since it is the frontier boundary.
Source: Author's calculations.

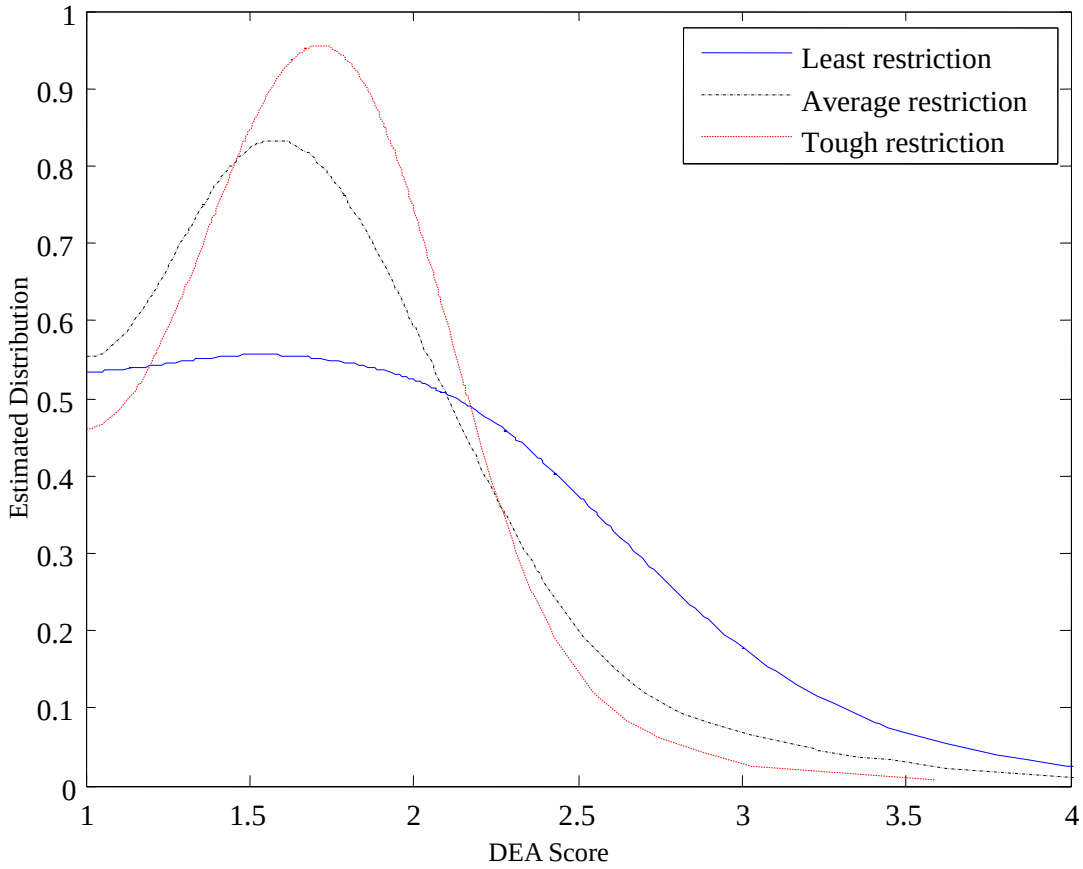
The results in Table 5.5 show that the mean from the group of banks in the tough restriction environment (1.7079) is smaller than the one of average restriction (1.7529) and the group of banks in the least restriction environment (1.9512). The maximum value of these three groups is also different from the expectation – the value in the least restriction group (4.1991) is bigger than that in the average restriction group (4.0076), which is bigger than the value (3.5892) in the tough restriction group. However, the median of these three groups gives us a slightly different story. The group with average restriction has the lowest median value (1.6713). Figure 5.5 shows the efficiency distribution of foreign banks by level of

deregulation.[35]

It is worth noting that the distribution of the group of least restriction is relatively flat. The standard deviation in the least restriction group is almost twice that of the tough restriction group. This regulation policy renders the efficiency of the banks more concentrated about the mean, but the deregulation activities result in the efficiency levels being much more spread. Part of the banks in the least restricted group are very efficient, and few of them are relatively inefficient, which could indicate that in the long term it is likely that the very inefficient banks will leave the market. This process is addressed in Chapter 6.

[35] Taking up the suggestion from Simar and Zelenyuk (2006), the issue of the boundary in the DEA score is solved by the Silverman reflection method and the bandwidth is selected by the Sheather and Jones (1991) method in Gaussian kernel. A similar analysis can be found in the paper by Valverde et al. (2007).

Figure 5.5. Distribution of restriction groups of foreign banks (1997–2006)




Source: Author's calculations.

Table 5.6 and Figure 5.6 present the summary statistics and distribution of the efficiency of domestic banks by level of deregulation. The distributions of these groups are shown to be very similar. For instance, the mean of these groups are all around 1.80 and the standard deviation is about 0.5, as shown in Table 5.6.

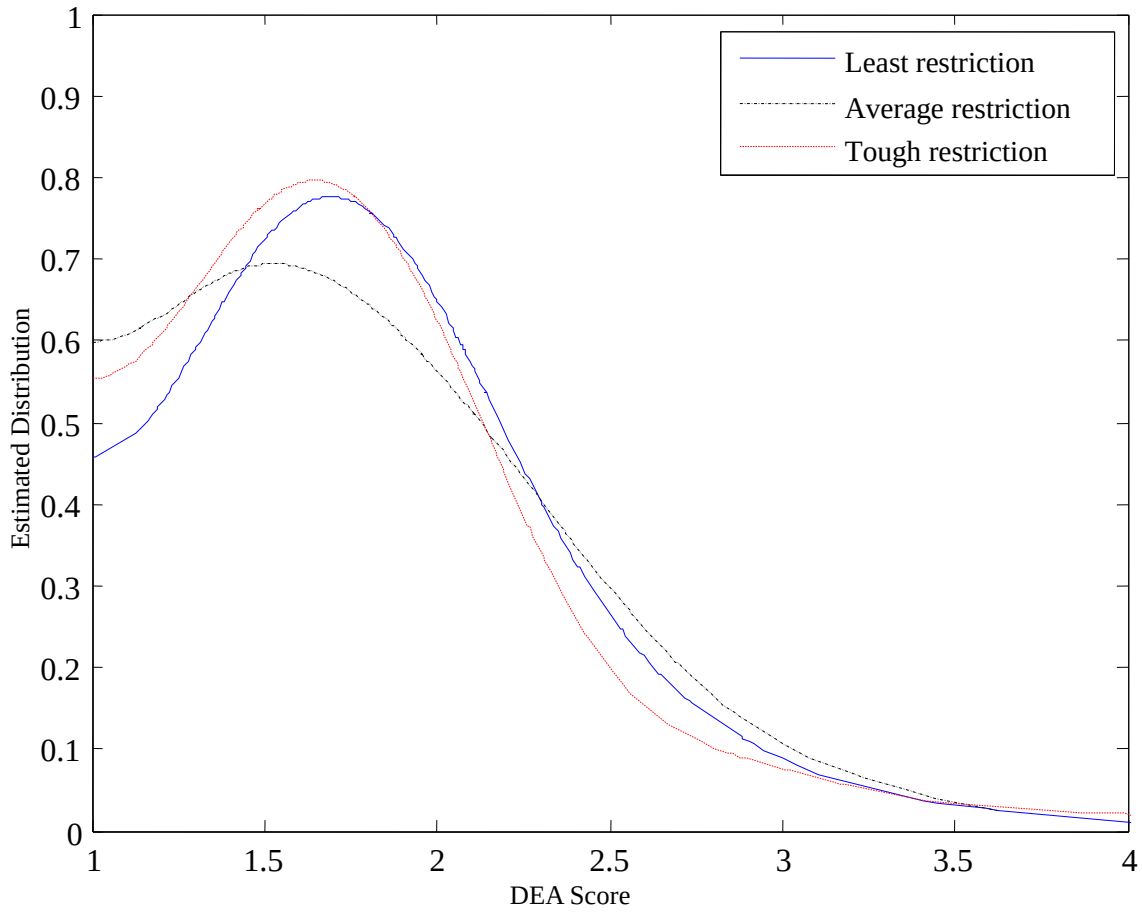
Table 5.6. DEA Efficiency of restriction groups of domestic banks (1997–2006)

| Groups | Mean | Median | S.D. | Max. |
|---|---|---|---|---|
| Least restriction | 1.8271 | 1.7567 | 0.5059 | 4.0076 |
| Average restriction | 1.8097 | 1.7449 | 0.5361 | 3.6253 |
| Tough restriction | 1.7755 | 1.7071 | 0.5407 | 4.1991 |

Note: The minimum value, i.e. one, is not shown in the table, since it is the frontier boundary.
Source: Author's calculations.

Figure 5.6 shows that the distribution of the groups of least and tough restriction are very similar to each other. In these three groups, the efficient and inefficient banks are not concentrated in any particular group, which indicates that the impact of deregulation on bank efficiency is relatively weak.

Figure 5.6. Distribution of restriction groups of domestic banks (1997–2006)




Source: Author's calculations.

In order to examine whether these three distributions are similar, the adapted Li (1996) test by Simar and Zelenyuk (2007) is used to compare the distribution of each of the groups and the results are shown in Table 5.7. The null hypothesis of the test is that two distributions are the same, which is rejected across all groups, except for the test on the group of least versus tough regulation of domestic banks. The *p*-value of the test on this group is 0.078 and the *t* statistic is 1.1769, which implies that it is not possible to say with confidence that the two distributions are significantly different.

Table 5.7. Adapted Li test of restrictions on efficiency distribution (1997–2006)

| Groups | Foreign banks | Domestic banks |
|---|---|---|
| Least/Average | Reject $H_0$ | Reject $H_0$ |
| | 13.0813 | 3.4200 |
| | (*p*-value: 0.0000) | (*p*-value: 0.0040) |
| Average/Tough | Reject $H_0$ | Reject $H_0$ |
| | 3.8408 | 3.2423 |
| | (*p*-value: 0.0000) | (*p*-value: 0.0040) |
| Least/Tough | Reject $H_0$ | Retain $H_0$ |
| | 23.4829 | 1.1769 |
| | (*p*-value: 0.0000) | (*p*-value: 0.0780) |

Notes: 1. $H_0$ is that two distributions are identical. 2. The grand frontier is estimated using all observations. 3. The result is based on 1,000 replications in the stage of bootstrapping.
Source: Author's calculations.

In microeconomic theory, banks are viewed as the firm that attempts to maximise an objective function for their profit. In modelling banking firms, Santomero (1984) argues that the market environment and degree of regulation constrain the opportunity set of banks by restricting the domain of the solution for their assets or liabilities. In the first-stage analysis, the DEA model is employed to estimate the capability of each bank in each year to demonstrate their best performance with respect to the 'opportunity set', or the production set in the DEA model. This set comprises all possible combinations of the assets and liabilities that banks could attain. After that, the efficiency score of bank *k* in year $t$ is assumed to be dependent upon the environment in the second-stage analysis, e.g. the non-prudential

restriction, the industry structure and the economic endowment of each country.

A negative correlation is expected between the efficiency gain and the restriction indices calculated by Dinh (2008), that is, the deregulation policies of removing the restrictions on the market leads to increased efficiency of the banks. Since the dependent variable is the efficiency score ($\widehat{TE}_{i,t}^{k}$), the sign of the restriction indices is expected to be positive. The model is regressed as follows: the pooled OLS model is used in columns (1) and (2) of Tables 5.8 and 5.9 and the first difference model is employed in columns (3) and (4). Results of the benchmark regression are reported in Table 5.8 for foreign banks and Table 5.9 for domestic banks.

Table 5.8. Benchmark regression on restrictions on foreign banks

| Dependent variables | $\widehat{TE}_{i,t}^{k}$ | $\widehat{TE}_{i,t}^{k}$ | $\Delta\widehat{TE}_{i,t}^{k}$ | $\Delta\widehat{TE}_{i,t}^{k}$ |
|---|---|---|---|---|
| Model | Pooled OLS | Pooled OLS | First difference | 2SLS |
| | (1) | (2) | (3) | (4) |
| *Restrictions on foreign banks* | 0.635 | 0.046 | 2.878** | 3.063** |
| | (0.617) | (0.500) | (1.455) | (1.494) |
| $\overline{\widehat{TE}}_{i,t-1}$ | | 0.635*** | -0.034 | 0.449 |
| | | (0.075) | (0.090) | (0.361) |
| *Constant* | 1.584*** | 0.659*** | 0.008 | 0.001 |
| | (0.216) | (0.209) | (0.014) | (0.015) |
| *Observations (No. of banks)* | 803 (81) | 719 (81) | 638 (81) | 638 (81) |

Notes: 1. The first difference model is employed in columns (3) and (4); 2. Standard errors in parentheses and *** p<0.01, ** p<0.05, * p<0.10

Source: Author's calculations.

Table 5.8 shows the results for the regression of the non-prudential restrictions on foreign banks. The coefficient value on restrictions fluctuates from 0.635 in the pooled OLS in column (1) to 0.046 in column (2) and 2.878 from the first difference model in column (3). Without controlling for the unobserved differences between banks and over the years, i.e. the characteristics of each bank and the time trend, the results from the pooled model in columns

(1) and (2) are biased.[36] To address the issue of bias, the first difference model is employed in column (3) and column (4), which has the same function as the fixed effect model in the panel data analysis, i.e. the variations are removed due to time and differences between banks.

In the first difference model in column (3) and column (4) of Table 5.8, the coefficient of restrictions is significantly positive and stable. Since the high correlation between the efficiency score in the current period ($\widehat{TE}_{i,t}^{k}$) and in the previous period ($\widehat{TE}_{i,t-1}^{k}$), the sign of the country level average efficiency level in the previous period ($\overline{\widehat{TE}}_{i,t-1}$) is far from the general expectation in column (3). To overcome this weakness, the 2SLS estimator is employed in column (4) and the average of the two period lag efficiency level ($\Delta\overline{\widehat{TE}}_{i,t-2}$) is used as the instrument for the endogenous variable ($\overline{\widehat{TE}}_{i,t-1}$). In column (4) of Table 5.8, the sign of coefficient is the same as the general expectation.

In Table 5.9 for the non-prudential restrictions on domestic banks, the only significant coefficient is in column (1) of the pooled OLS model. The negative sign indicates that the bank efficiency is reduced by removing the restrictions on domestic banks, which is in the opposite direction to the expectation and is not considered to be consistent. For the reasons discussed above, variations between banks and across years need to be removed before identifying the impact from the deregulation policies. Thus, the first difference model is employed in column (3) and column (4) of Table 5.9 to control the variations between time and bank factors, and the sign changes to positive in column (3), which implies that the

[36] For example, banks follow different risk management strategies or asset-liability management systems, which are constant to the individual bank, but different in each bank in the dataset.

policy change for domestic banks increases the efficiency of the banks, but the effect is not statistically significant. The 2SLS estimator is also employed in column (4), and the value of the results is between 1.540 in column (3) and 2.836 in column (4), but still not significant.

Table 5.9. Results of basic regression on restrictions on domestic banks

| Dependent variable | $\widehat{TE}_{i,t}^{k}$ | $\widehat{TE}_{i,t}^{k}$ | $\Delta\widehat{TE}_{i,t}^{k}$ | $\Delta\widehat{TE}_{i,t}^{k}$ |
|---|---|---|---|---|
| Model | Pooled OLS | Pooled OLS | First difference | 2SLS |
| | (1) | (2) | (3) | (4) |
| *Restrictions on* | -4.083*** | -0.601 | 1.540 | 2.836 |
| *domestic banks* | (1.471) | (1.532) | (2.430) | (2.627) |
| $\overline{\widehat{TE}}_{i,t-1}$ | | 0.627*** | -0.034 | 0.546 |
| | | (0.077) | (0.091) | (0.363) |
| *Constant* | 2.217*** | 0.750*** | 0.010 | 0.003 |
| | (0.156) | (0.236) | (0.014) | (0.015) |
| *Observations* | 803 | 719 | 638 | 638 |
| *(No. of banks)* | (81) | (81) | (81) | (81) |

Notes: 1. The first difference model is employed in columns (3) and (4). 2. Standard errors in parentheses and *** p<0.01, ** p<0.05, * p<0.10

Source: Author's calculations.

## 5.6 Sensitivity Analyses

The empirical results in the baseline model are highly robust in a battery of sensitivity tests

that attempt to separate out important factors from industry and country characteristics.[37] Table 5.10 and Table 5.11 show the results in the different model specifications. In column (1), the bank concentration and the average efficiency level of the previous period are controlled to diminish the impacts from the market structure and the efficiency level. In column (2), the second model specification includes the macroeconomic environment, i.e. the size of population and GDP level, which is a common specification in the literature, such as in Kravtsova (2008).

In an attempt to control the impacts of the differences in industry structure and country characteristics on bank efficiency, six variables are gradually included in the model in columns (1) to (6). The industry structure variables are bank concentration, the number of listed companies per 10,000 people, the index of the law and institution for each country and Z scores. The country characteristic variables are population and GDP. The full model in column (6) contains all control variables and the deregulation policies to remove the restrictions on foreign banks is still significant and stable with a value from 3.084 to 3.557, as shown in Table 5.10. Zelenyuk (2009) points out that it is usual for this kind of model to yield relatively low significance of coefficients, which indicates the effect could be very large in reality if the results are significant, as they are shown to be in Table 5.10.

[37] The three-period lag efficiency levels are used as the instrument in the 2SLS model. The results are available on request.

Table 5.10. Efficiency gains from removing restrictions on foreign banks

| Dependent variable | $\Delta\widehat{TE}_{i,t}^{k}$ | $\Delta\widehat{TE}_{i,t}^{k}$ | $\Delta\widehat{TE}_{i,t}^{k}$ | $\Delta\widehat{TE}_{i,t}^{k}$ | $\Delta\widehat{TE}_{i,t}^{k}$ | $\Delta\widehat{TE}_{i,t}^{k}$ |
|---|---|---|---|---|---|---|
| 2SLS model | (1) | (2) | (3) | (4) | (5) | (6) |
| *Restrictions on* | 3.087** | 3.084* | 3.139** | 3.248** | 3.340** | 3.557** |
| *foreign banks* | (1.557) | (1.678) | (1.573) | (1.563) | (1.532) | (1.619) |
| $\Delta\overline{\widehat{TE}}_{i,t-1}$ | 0.446 | 0.859* | 0.531** | 0.467* | 0.448 | 0.815** |
| | (0.375) | (0.455) | (0.263) | (0.268) | (0.273) | (0.395) |
| *Bank concentation*$_{t-1}$ | 0.019 | -0.142 | -0.006 | -0.018 | 0.028 | -0.108 |
| | (0.362) | (0.410) | (0.355) | (0.352) | (0.343) | (0.375) |
| *Stock no* $_{t-1}$ | | | 0.455 | 0.622 | 0.652 | -0.468 |
| | | | (0.734) | (0.745) | (0.749) | (1.100) |
| *Law & order* $_{t-1}$ | | | | -0.051 | -0.063* | -0.100** |
| | | | | (0.035) | (0.035) | (0.040) |
| *Z score* $_{t-1}$ | | | | | -0.003 | -0.003 |
| | | | | | (0.004) | (0.005) |
| *log Population* $_{t-1}$ | | -2.328 | | | | -4.302 |
| | | (2.291) | | | | (2.907) |
| *log GDP* $_{t-1}$ | | 0.694 | | | | 0.771 |
| | | (0.591) | | | | (0.513) |
| *Constant* | 0.001 | 0.012 | -0.004 | -0.010 | -0.010 | 0.038 |
| | (0.016) | (0.051) | (0.015) | (0.015) | (0.015) | (0.051) |
| *Observations* | 638 | 638 | 638 | 638 | 634 | 634 |
| *(No. of banks)* | (81) | (81) | (81) | (81) | (81) | (81) |

Notes: 1. Standard errors in parentheses and *** p<0.01, ** p<0.05, * p<0.10. 2. *Bank Con* is assets of three largest banks as a share of assets of all commercial banks. 3. *Stock No* is the number of publicly listed companies per 10,000 population.

Source: Author's calculations.

In Table 5.11, the coefficient of the deregulation policy is not significant at all, which is consistent with the evidence from the density estimation in Section 5.5.[38] The efficiency level of the previous period ($\Delta\widehat{\overline{TE}}_{i,t-1}$) is the most significant variable affecting the efficiency of domestic banks, which indicates that the further the banks are away from the frontier, the easier it is for them to move towards the frontier.

[38] The distribution is almost identical in the three groups that are classified by the level of deregulation of domestic banks.

Table 5.11. Efficiency gains from removing restrictions on domestic banks

| Dependent variable | $\Delta\widehat{TE}_{i,t}^{k}$ | $\Delta\widehat{TE}_{i,t}^{k}$ | $\Delta\widehat{TE}_{i,t}^{k}$ | $\Delta\widehat{TE}_{i,t}^{k}$ | $\Delta\widehat{TE}_{i,t}^{k}$ | $\Delta\widehat{TE}_{i,t}^{k}$ |
|---|---|---|---|---|---|---|
| 2SLS model | (1) | (2) | (3) | (4) | (5) | (6) |
| *Restrictions on* | 2.663 | 2.838 | 2.730 | 3.130 | 1.464 | 2.083 |
| *domestic banks* | (2.641) | (2.774) | (2.616) | (2.606) | (2.560) | (2.799) |
| $\Delta\overline{\widehat{TE}}_{i,t-1}$ | 0.563 | 0.975** | 0.609** | 0.543** | 0.555** | 0.939** |
| | (0.373) | (0.455) | (0.260) | (0.264) | (0.274) | (0.401) |
| *Bank concentration*$_{t-1}$ | -0.153 | -0.321 | -0.166 | -0.176 | -0.175 | -0.337 |
| | (0.351) | (0.396) | (0.346) | (0.343) | (0.336) | (0.368) |
| *Stock no* $_{t-1}$ | | | 0.246 | 0.415 | 0.380 | -0.780 |
| | | | (0.733) | (0.741) | (0.755) | (1.128) |
| *Law & order* $_{t-1}$ | | | | -0.052 | -0.061* | -0.104** |
| | | | | (0.036) | (0.035) | (0.041) |
| *Z score* $_{t-1}$ | | | | | -0.002 | -0.003 |
| | | | | | (0.004) | (0.005) |
| *ln Population* $_{t-1}$ | | -1.970 | | | | -4.216 |
| | | (2.329) | | | | (3.046) |
| *ln GDP* $_{t-1}$ | | 0.822 | | | | 0.931* |
| | | (0.587) | | | | (0.516) |
| *Constant* | 0.002 | 0.003 | -0.001 | -0.007 | -0.008 | 0.034 |
| | (0.016) | (0.051) | (0.015) | (0.016) | (0.016) | (0.054) |
| *Observations* | 638 | 638 | 638 | 638 | 634 | 634 |
| *(No. of banks)* | (81) | (81) | (81) | (81) | (81) | (81) |

Notes: 1. Standard errors in parentheses and *** p<0.01, ** p<0.05, * p<0.10; 2. *Bank Con* is assets of three largest banks as a share of assets of all commercial banks. 3. *Stock No* is the number of publicly listed companies per 10,000 population.

Source: Author's calculations.

## 5.7 Concluding Remarks

Relying on data from six developing countries in Asia from 1997 to 2006, this chapter offers new evidence on the link between removing the restrictions on the banking industry and efficiency gains. It uses a two-stage DEA approach where in the first stage, the DEA score for each bank is computed and in the second stage, these scores are regressed on the indices of restrictiveness of the banking industry that are constructed by Dinh (2008). These indices serve as proxies for deregulation policies related to the removal of restrictions on foreign and domestic banks. These indices also make it possible to distinguish non-prudential restrictions on foreign and domestic banks from the general prudential regulation and supervision framework. This chapter contributes to the ongoing debate on the relationship between financial deregulation and bank efficiency by providing empirical evidence. The deregulation on foreign banks produces efficiency improvements but the same deregulation on domestic banks is not statistically significant for banking efficiency. Therefore, the results here suggest that policies to liberalise domestic banks only may not have the same impact as the policies to liberalise foreign banks.

The findings of this chapter may be consistent with the observations in Chapter 4, where bank deregulation following China's accession into the WTO is associated with increased efficiency of Chinese commercial banks. In terms of increasing the bank efficiency, the policy of liberalising foreign banks in the banking industry could be an effective policy for developing countries. Nonetheless, it is understandable from the policy maker's perspective that liberalisation of foreign banks may have some unwanted consequences. For instance, the

entry of foreign banks may be perceived to carry a degree of risk for the banking system, since it makes it more susceptible to international capital flows and speculations. Liberalisation of foreign banks also exposes the host country to prudential regulations of foreign countries, which may have less stringent requirements. These issues of risks management related to bank liberalisation are interesting on their own and certainly important for policy makers as they have to weigh the benefits of liberalising foreign banks, which the chapter has shown to be a powerful way of raising bank efficiency, against the risks that may accompany such a policy.

# Chapter 6 The Impact of M&As on Bank Efficiency

## 6.1 Introduction

In this chapter, the effect that M&As have on the efficiency of the participating bank for a sample of emerging economies are examined. In particular, this chapter investigates whether there are efficiency gains or losses to banks that are involved in an M&A, and whether the impact of M&As on efficiency could differ between target and acquiring banks. Using linear regression, the empirical evidence of this chapter shows that banks that underwent an M&A would tend to have worsened efficiency on average. However, the negative effect of M&A on efficiency is generally more pronounced for target banks. These results are robust to a series of sensitivity checks that employ various combinations of control variables in the regression analysis. They are also robust to the choice of estimation methodologies, as similar conclusions emerge from our propensity score matching analysis.

The literature on the implication of M&As of banks on their efficiency has flourished over the years. Unlike the result in this chapter that M&As generally lead to negative efficiency outcomes, existing arguments have often suggested that episodes of M&As may in fact cause banks to operate more efficiently. For example, Evanoff and Ors (2008) argue that M&As in the banking market is akin to a ‘wake-up call’ for bank managers to work harder so that they can save their jobs by helping their banks to avoid becoming potential targets. Furthermore, for inefficient banks that are in fact acquired by, or merged with, other banks, it is believed that an M&A could help boost their operations through the adoption of new

management technologies or improvement of the quality of their existing services (e.g. Evanoff and Ors, 2008).

Even in the existing empirical literature, there is ample evidence to suggest that effect of M&As on banking efficiency is positive (see, for example, Cornett et al. (2006), Campa and Hernando (2006), DeYoung et al. (2009)). However, unlike this chapter, it is also true that much of the literature focuses on developed countries. Given that financial systems in less advanced economies may be underdeveloped, it is unclear whether the positive effect of M&As on efficiency that is well known in the empirical literature holds more generally for emerging economies as well. In order to get a sense of whether the existing results are externally valid, it is important to also investigate the impact of M&As on banking efficiency from the perspective of developing countries. This is crucial especially from the policy point of view because if the outcomes of M&As differ for developed versus developing countries, results based on developed countries must be viewed with caution when informing policies related to developing countries. However, evidence of the effect of M&As based from emerging economies is tenuous at best.

One of the key challenges when focusing on developing countries is the availability of data on banks. Hence, it may be no surprise that existing research has looked mainly on developed or advanced developing countries as data is more readily available. In this chapter, several raw databases are combined to assemble a cross-sectional dataset on individual banks for a sample of emerging economies – China, India, Indonesia, Malaysia, Russia, Thailand and Vietnam. In the literature, comparisons are usually made between banks that have been

involved in an M&A and those that have not.[39] Taking a further step than existing analyses in the literature, all banks are divided into three parts: target banks, i.e. the acquired or consolidated banks; acquiring banks, i.e. acquirer or bidder in other studies; and the incumbent banks. The target banks and acquiring banks are the treated group and the control group is the incumbent banks.

For this study to be feasible, it is necessary to first obtain a measure of efficiency. To do so, this chapter employ DEA as a preliminary step to estimate the efficiency scores of banks and then use this estimated DEA scores as a dependent variable in a truncated regression model. As Angrist and Pischke (2008) argue, regressions with covariates have a similar flavour to the matching estimator based on the same covariates; the only difference is the set of weights used to construct the average treatment effect. To see if the results of this chapter are merely artefacts of the choice of methodology, the propensity score matching is also considered as a robustness check. At the very least, propensity score matching should yield similar conclusions as those from regressions; otherwise this would be indicative that some underlying methodological issues have not been taken care of.

The chapter proceeds as follows. The related literature on the efficiency impact of M&As in the banking sector is briefly discussed in Section 6.2 and this analysis is aligned with that literature. The data sources, the selection criteria of M&A events and the methodology are addressed in Section 6.3 and 6.4. The empirical results are presented in Section 6.5, and

[39] This is reminiscent of Berger and Mester (2003), Cornett et al. (2006) and Evanoff and Ors (2008) who categorize banks into two groups – 1) the merging or consolidating banks (i.e. target banks plus acquiring banks) and 2) incumbent banks, as defined by Evanoff and Ors (2008) for the banks which are not engaged in any M&A.

Section 6.6 concludes.

## 6.2 Literature on Efficiency Impact of M&As

Financial reforms in developing countries, especially in the form of deregulation and liberalisation of the banking markets, can create an environment that is favourable for M&A activities (Berger et al. 1999). While this chapter studies the impact of the efficiency consequence of M&As in the banking industry for a sample of emerging economies, the body of literature to date has mostly looked at developed or advanced developing countries.

DeYoung et al. (2009), for example, summarise 150 studies in the literature published from 2000 onwards that examine the efficiency consequence of M&As in Europe, North America and Japan and most of these studies concur that M&As may generate substantial efficiency gains via cost reductions or profitability improvements. For instance, one of them is Cornett et al. (2006), who use operating pre-tax cash flows as a measure of bank performance for consolidated banks in the US over the period 1990–2000, to find that the good performance of consolidated banks is the result of both revenue enhancement and cost reduction activities.[40] Another is Campa and Hernando (2006), who, examining M&A activities in the European financial sector over the period 1998–2002, e.g. depository institutions, insurance carriers, commodity brokers, etc, find that target banks enjoy some improvement in the ratio of return on equity after two years from the completion of an M&A,

[40] In the work of Cornett et al. (2006) and Cornett and Tehranian (1992) in the US banking market, the operating pre-tax cash flows are defined as income before taxes and extraordinary items plus interest on subordinate notes and debentures divided by the book value of assets at year-end prior to the merger, which is used as the indicator of the operating performance of banks.

and relatively greater net interest margin after the event of acquisition.

Since M&As inevitably lead to some restructuring of the banking industry, it brings about benefits not only for the target or acquiring banks, but also for the incumbent banks that are not engaged in M&A. Evanoff and Ors (2008) investigate the performance of the non-merging US banks that continued to operate in the same market with the newly consolidated banks over the period 1984–1999. They find non-merging banks respond to the event by reducing costs.[41] Further evidence on the effect that M&As have on non-merging banks can be found in DeLong and DeYoung (2007). Focusing on 216 completed M&As in the US banking market over the period 1987–99, they find that efficiency gains may also come from the effect of banks' "learning by observing" the best and worst practices of previous M&As.

To date, the existing literature has mainly focused on developed and industrialised countries and very little has been said about the effect of M&As in the context of developing countries. The paper that has made an attempt to look at both developed and developing countries is Berger et al. (2004). Employing a dataset that spans 30 countries over the period 1985–2000, they provide an early insight that the empirical results pertaining to developed countries (e.g. France, Germany, the Netherlands, Switzerland, the US, the UK and so on) may not hold for developing or emerging economies. They argue that developed and developing countries typically have different institutional environments with different regulatory burdens and organizational culture, hence this heterogeneity in institutions implies

[41] In the analysis of Evanoff and Ors (2008), the cost efficiency is estimated in a grand SFA frontier for an unbalanced panel dataset from all US commercial banks.

that there may not be a singular effect of M&As on the banking industry for all countries at different stages of economic development. In other words, caution should be exercised when interpreting much of the existing results in the literature as they are based largely on advanced economies.

In terms of methodology, this chapter contributes to the M&A literature by using DEA generated efficiency scores as an estimate of bank performance. There are many performance measures for banks. Two decades ago, the literature has seen the widespread use of financial ratios as proxies for efficiency. In these early studies, how well a bank performs after the event of an M&A is typically measured by the changes in revenue-based financial ratios. This estimation strategy is embodied in Rhoades (1998), who employs the ratio of net income to average assets, the net income to equity ratio, and the ratio of off-balance sheet items to total assets to investigate the effect of M&As in the US banking market. However, bank efficiency is a complex phenomenon that cannot be fully reflected by the financial ratios alone, and in fact, as it has been discussed in Chapter 3, using financial ratios as measures of banking performance may even be misleading.

Therefore, to tackle the problems related to the use of financial ratios as a measure of performance, more recent research has sought to construct a direct measure of bank efficiency using a frontier model. The primary merit of this kind of analysis is to provide an overall, objectively determined, numerical value that could be used as proxy for an abstract concept such as the efficiency of a bank. In first generation models, a score for efficiency is constructed using SFA, a parametric approach that easily allows for information related to

M&As, such as indicator variables based on the year that the event takes place, to be added into the estimating equation. However, any parametric assumption is highly susceptible to model misspecification, and in turn, this could generate severe mismeasurements of banking efficiency. Furthermore, SFA assumes a general functional form for the measure of efficiency for all banks in the dataset. Clearly, for cross-country studies such as this chapter, this assumption is overly restrictive especially as financial systems in emerging economies may be significantly heterogeneous.[42] Hence, the assumption on the functional form of the production function is not likely to fit all commercial banks from different countries with the same degree of success, and as a result, the parametric approach of SFA may potentially create bias in the efficiency estimates for banks.

For the purpose of relaxing the parametric assumption, recent research has turned to non-parametric approaches, the most popular of which is the DEA. These papers usually follow a two-stage procedure, where the first stage involves estimating the efficiency scores of banks, and the second stage regresses these generated scores on a set of explanatory variables. The non-parametric methods have certain merits over the parametric methods. The main advantage is that they do not require any parametric assumption on the structure of technology, e.g. Cobb-Douglas, or on the structure of the inefficiency term. This allows the data to speak, which is critical for our cross-country analysis as the production process may vary significantly across the countries in the sample. Moreover, the assumption about

[42] In parametric analysis, e.g. SFA, the impact of the M&A could be studied in one-stage or two-stage analysis. Wang and Schmidt (2002) find that the two-stage SFA cannot provide a consistent estimation and the one-stage estimator performs much better than the two-stage estimator, but one of the assumptions is the correctly specified model.

complete homogeneity of the observations is not compulsory in DEA, unless inputs and outputs are measured in the same units. In this topic, the M&As are assumed to change the values of banks' inputs and outputs, which renders this advantage more meaningful.

Because of the reasons mentioned above, the DEA is employed in this analysis to compute the efficiency score for each bank in each year. Since the efficiency score is defined as being equal to one or greater, where a value of one marks the efficiency frontier, the second stage uses a truncated regression to examine the effect of M&As on banking efficiency. This truncated regression is implemented using maximum likelihood that takes into account that the efficiency score follows a truncated distribution (i.e. the value range of efficiency score is from one to positive infinity) (see, also, Zelenyuk and Zheka, 2006; Demchuk and Zelenyuk, 2009).

## 6.3 Data and Sample Selection

To examine the impact of M&As on bank efficiency, this chapter assembles a panel dataset using several sources. The annual bank-level data on banks' finances are compiled from the Bankscope database, and the Zephyr database provides information on banks' restructuring activities, e.g. mergers, acquisitions, initial public offerings and so on, while the Financial Structure database and World Development Indicators database from the World Bank contain information on the structure of the financial sector, i.e. indices for bank concentration, and the macroeconomic environment, i.e. total population and GDP level.

The balanced data panel consists of 960 observations from 120 banks for the period

between 2002 and 2009. All of the data are in millions of US dollars and deflated by the CPI before the estimation (see, also, Pasiouras et al., 2008). The unconsolidated data, which is the most common type in the dataset, are used but where these are not available, the consolidated data are chosen instead. The consolidated data are not employed because they include information from all branches of the bank, e.g. the financial leasing company or insurance company, which are not directly related to the bank's main business. The financial statements prepared under the IAS/IFRS have top priority as the data sources wherever possible, but it has also been necessary to rely on those prepared under LGAAP where these are the only sources available.

Two primary sets of criteria are used in selecting this data panel: (1) bank and transaction type criteria, and (2) financial data availability criteria. On the first point, only commercial banks are chosen as their business is more straightforward and universal than the businesses of other types of banking institutions, such as bank holding companies, investment banks, and real estate and mortgage banks. In addition, the final dataset is constructed for seven emerging economies – China, India, Indonesia, Malaysia, Russia, Thailand and Vietnam. These set of emerging economies are chosen because data is more readily available, and also because the authorities in these countries have carried out a set of deregulation policies to encourage the M&As in the banking market, which led to relatively more of these M&A events in the sample period than other developing countries.

It is important to clarify the difference between mergers and acquisitions: two separate entities can co-exist in an acquisition, but only one entity may emerge from a merger. In an

acquisition, both acquiring and target banks still exist as separate entities; the only change is the ownership of the target bank. In this chapter, the distinction between mergers versus acquisitions is not made and this chapter only looks at the effects of M&As on the efficiency of the target and acquiring banks, regardless of whether they are involved in a merger or in an acquisition. This is also consistent with the literature on the effect of M&As on banking efficiency, such as Buch and Delong (2004), Behr and Heid (2011), Ayadi et al. (2013), and Harjoto et al. (2012). Also, only complete cases of M&As in this chapter are considered, not incomplete cases that include M&As that are announced but not completed, withdrawn, pending or terminated.

On the second point, only banks with complete financial data throughout the sample period are chosen as the DEA approach is not amenable to missing data. In addition, this analysis do not allow for zero or negative values in the totalling of input or output variables, although the individual variable could be negative. For example, before the estimation, the observation is dropped if the value of three input variables summed together is negative or zero because the model does not permit the total amount of inputs to be negative. This implies that a bank is removed from consideration if its total input or output variables are negative, zero or missing.

For frontier analyses such as the DEA or SFA, the efficiency score is derived from a production function, and thus, the question of which input and output variables to include into the production function is a key issue. Ideally, these variables should be measured in physical units that are consistent with the assumption of the theoretical model (Klein 1971). However,

there is little agreement on what variables ought to be used as the inputs and outputs in theory, let alone in practice.

The choice of variables in this chapter is driven by considerations of feasibility. In this chapter, proxies based on the aggregated analogues of these variables are used for the estimation. For example, to obtain a measure of the cost of capital, a proxy based on interest expenses is used. These proxies, generally, are expressed in monetary units and this makes it convenient to measure the inputs and outputs required for the DEA analysis. To evaluate the DEA scores in the first stage, three input variables – fixed assets, total non-interest operating expenses and interest expenses – and two output variables (net interest income and other operating income) are selected.[43]

On the input side, Berger et al. (1999) examine how M&As allow the banks to achieve a more profitable scale or scope, e.g. by reducing the fixed cost of the banks. Focarelli and Panetta (2003) look at the US banking market over the period 1990–98 and find that the event of M&A would increase the market power of banks, and these banks were subsequently able to reduce the deposit rate in the short term, hence reduce their interest expense. On the output side, the two proxies that are utilised to approximate the incomes of banks have previously been considered by Drake et al. (2009). The net interest income is included to capture the efficiency of banks' liability management, which is the process of managing the bank's net interest margin. The non-interest operating income is another output variable chosen in this

[43] The common input variable with Chapters 4 and 5 is the non-interest operating expenses, which are the proxy of variable cost in this analysis. Due to the different research focus to Chapters 4 and 5, the fixed assets and interest expenses are selected to replace the other operating expenses and total provisions in those chapters.

study to capture the profitability of banks.

Table 6.1 shows the summary statistics of input and output variables. The first feature of this dataset is that the mean of the interest expenses (mean value is $361.03m) is nearly three times that of the fixed assets and larger in absolute terms than the mean of the non-interest operating expenses, which means that most of the banks' costs are for capital in the selected countries. Similarly, most of the income is still from the net interest income ($329.47m), so it is the main revenue for the banks. That feature points out that the selected banks still mainly rely on the traditional business, e.g. the loan lending.

Table 6.1. Summary statistics of input and output variables (US$ million)

| Variable name | | Mean | S. D. | Min. | Max. |
|---|---|---|---|---|---|
| **Input** | Fixed assets | 134.10 | 365.57 | 0.10 | 4,408.04 |
| | Non-interest operating expenses | 226.12 | 562.97 | 0.27 | 6,765.93 |
| | Interest expenses | 361.03 | 945.50 | 0.26 | 12,292.96 |
| **Output** | Net interest income | 329.47 | 820.46 | 0.25 | 9,757.92 |
| | Other operating income | 141.90 | 411.37 | 0.08 | 6,479.06 |

Note: The time period is from 2002 to 2009.
Source: Author's calculations.

The control variables in the regression analysis cover the impact from three levels: the bank level, industry level and country level. Following the literature, the total assets and total equity are two bank level control variables to sort out the impact of the bank size and capitalisation. For industry and country level control variables, the proxy of bank

concentration is used to remove the impact from the market structure, and the total population and GDP is added to control the country level variation.

The summary statistics are provided for the control variables in Table 6.2. The standard deviations of total assets ($323.43m) and total equity ($1,933.74m) are far bigger than their means, which shows that the size of the bank (as measured by the assets) and the equity vary widely in the dataset. In the dataset, the maximum value of the total equity is from the BOCom in China in 2009. For the country level variables, the maximum value of the population ($1,331.38m) and GDP level ($4,991,256m) is also from China in 2009.

Table 6.2. Summary statistics of control variables in the regression

| Variable type | Variable name | Mean | S.D. | Min. | Max. |
|---|---|---|---|---|---|
| Bank level | Total assets | 123.47 | 323.43 | 0.01 | 4,424.45 |
| (US$ million) | Total equity | 816.35 | 1,933.74 | 1.12 | 24,080.28 |
| Industry level | Bank concentration | 44.15 | 12.85 | 20.46 | 81.61 |
| Country level | Population (millions) | 552.86 | 534.94 | 24.52 | 1,331.38 |
| | GDP (US$ million) | 910,173 | 1,042,592 | 35,058 | 4,991,256 |

Note: The time period is from 2002 to 2009.
Source: Author's calculations.

## 6.4 Methodology

The two-stage DEA approach is employed where the first stage uses all observations to estimate a grand efficiency frontier, based on which the DEA score of each bank in each year is constructed. A single DEA score, which ranges from one to infinity, measures the

efficiency of a bank in a particular year relative to the most efficient frontier across all banks and years, which the DEA score indicating the efficient frontier has a value of one. Hence, the larger the DEA score, the more inefficient a bank is during that year. In order to capture scale efficiency, so that doubling the inputs would double the output, this chapter considers a CRS frontier in the analysis.[44] The observations that coincide with this frontier would represent banks that are operating at their optimal size and at full efficiency in employing their inputs to produce outputs.

After obtaining the DEA score in the first stage, the truncated regression model is employed to study the response of bank efficiency to the M&As. This is a natural approach as DEA scores are distributed on a half line from one to infinity, hence would have a truncated distribution. While consistency is not affected by running a least squares regression of DEA scores on the covariates of interest, the DEA method is a non-parametric approach, hence the regression estimators would converge more slowly than the parametric root-T rate. Consequently, the least squares estimates may suffer from small sample bias and inference in finite samples could be affected. Simar and Zelenyuk (2007) recommend truncated regression instead of ordinary least squares regression and their suggestion has become common in recent statistical analyses that consider the DEA score as a dependent variable.

To evaluate the effect of M&As on the efficiency of banks, a dummy variable is constructed to indicate a target bank ($Target_{i,t}^{k}$), which is equal to one if bank *i* in country *k* has successfully been acquired in an M&A at year *t*. For instance, if bank *i* in country *k* is

[44] The difference between the CRS and VRS frontier is explained in greater detail in Chapter 3.

acquired at $t$, then $Target_{i,t}^{k} = Target_{i,t+1}^{k} = \cdots = 1$ but $Target_{i,t-1}^{k} = \cdots = Target_{i,t-2}^{k} = 0$. This analysis also constructs a dummy variable to indicate an acquiring bank ($Acquiring_{i,t}^{k}$), which is equal to one if bank *i* in country *k* has successfully acquired at year *t*. The truncation regression utilizes maximum likelihood estimation to estimate the response of the estimated efficiency score ($\widehat{TE}_{i,t}^{k}$) on the target bank and acquiring bank dummy based on the estimating equation:

$$\widehat{TE}_{i,t}^{k} = \beta_0 + \beta_1 Target_{i,t}^{k} + \beta_2 Acquiring_{i,t}^{k} + \gamma' C_{i,t} + \alpha_t + u_{i,t}^{k} \quad (6.1)$$

The vector $C_{i,t}$ is for the control variables, which include the variables from the bank, industry and country level. Conditioning on the covariates represented by the vector $C_{i,t}$ ensures that banks involved in an M&A would be roughly comparable to those that are not, so that we can interpret banks involved in M&As as a treatment group and those that are not involved as a control group. The inclusion of time effects ($\alpha_t$) allows us to control for all systemic, macroeconomic shocks. This is important because without doing so, macroeconomic events may drive both M&A activities and the efficiency of banks, causing the relationship between M&As and banking efficiency to be spurious. All other factors that influence efficiency are captured collectively by $u_{i,t}^{k}$, which is assumed as an idiosyncratic error term from a truncated normal distribution.

The impact of M&A on efficiency may take place both immediately and with a lag. To allow for M&As to influence the banking industry gradually across time, this chapter considers how banking efficiency could be affected by an M&A event for up to eight years. This follows from previous work that includes Evanoff and Ors (2008) and Focarelli and

Panetta (2003) who look at whether M&As could have both immediate and longer term effects on the banking industry. To identify the impact from the M&As, the control group is chosen to be the incumbent banks (or non-M&As banks), so that contrast can be made between banks that are involved in M&As and those that are not.

To look more finely at the effect of M&As on target and acquiring banks, the following model is considered since it could capture the effect of being a target bank on efficiency:

$$\widehat{TE}_{i,t}^{k} = \beta_0 + \beta_1 Target_{i,t}^{k} + \beta_2 C_{i,t} + \alpha_t + u_{i,t}^{k} \quad (6.2)$$

The sample that is used to estimate Eq. 6.2 excludes all acquiring banks so that we can isolate the effect of M&As on banking efficiency for target banks only. By the same token, this chapter also considers a model that captures the effect of being an acquiring bank on efficiency:

$$\widehat{TE}_{i,t}^{k} = \beta_0 + \beta_1 Acquiring_{i,t}^{k} + \beta_2 C_{i,t} + \alpha_t + u_{i,t}^{k} \quad (6.3)$$

but this time around, the sample that is used to estimate Equation (6.3) excludes all target banks so that this analysis can compare the efficiency scores of the acquiring banks with those of the incumbents.

## 6.5 Empirical Results

Table 6.3 presents the DEA score of each country in each year from 2002 to 2009.

Table 6.3. Efficiency score of each country in each year

| Country | Obs. | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|
| China | 18 | 1.588 | 1.537 | 1.316 | 1.220 | 1.135 | 1.000 | 1.018 | 1.078 |
| India | 29 | 1.616 | 1.453 | 1.351 | 1.521 | 1.661 | 1.657 | 1.785 | 1.715 |
| Indonesia | 21 | 1.814 | 1.595 | 1.423 | 1.695 | 1.746 | 1.610 | 1.603 | 1.580 |
| Malaysia | 16 | 1.325 | 1.242 | 1.317 | 1.315 | 1.241 | 1.394 | 1.273 | 1.269 |
| Russia | 20 | 1.410 | 1.475 | 1.552 | 1.413 | 1.473 | 1.450 | 1.398 | 1.176 |
| Thailand | 6 | 1.719 | 1.356 | 1.140 | 1.167 | 1.591 | 1.480 | 1.364 | 1.109 |
| Vietnam | 10 | 1.643 | 1.533 | 1.429 | 1.395 | 1.345 | 1.279 | 1.610 | 1.440 |
| Annual Average | | 1.588 | 1.456 | 1.361 | 1.389 | 1.456 | 1.410 | 1.436 | 1.338 |

Source: Author's calculations.

The number in each column from 2002 to 2009 is the average efficiency score of the observations from each country in that particular year. In these seven countries, the efficiency of banks increased faster in Thailand. The worse performing year in our sample period in terms of efficiency performance is 2002 while the best performing year is 2009. On average, the efficiency of the banks has increased in nearly all seven countries in our sample. The only exception is India, where bank efficiency has decreased slightly from 1.616 in 2002 to 1.715 in 2009. Interestingly, the best improving country in terms of banking efficiency is China. This is not inconsistent with Chapter 4 that documents the rapid deregulation of the Chinese banking industry that is required of China's accession into the WTO.

In the second stage of the analysis, several control variables are added into the regression equation to control for confounders so that conditional on these covariates, the M&A event is reasonably exogenous. To check for the sensitivity of the results, this chapter runs a series of regressions with different covariates and the results are reported in Table 6.4. First, the most basic model without additional covariates is considered (Column (1)). Through successive steps, the analysis includes controls to capture bank level characteristics (Column (2)), then industry level characteristics (Column (3)) and finally country level characteristics (Column (4)).

A priori, one would expect that M&As would improve the efficiency of the banks. This is certainly true in the literature that looks mainly at developed countries. However, as Table 6.4 shows, this observation is not supported in this study. In particular, when bank, industry, or country level characteristics are added, the effect of acquiring or being acquired on the banks' own efficiency score is positive and highly statistically significant. This implies that compared to the reference group (non-M&A banks), an M&A event may actually deteriorate the efficiency performance of both target and acquiring banks in the sample of emerging economies. From the policy perspective, M&As may not necessarily create banks that are even more efficient, not at least in the countries under consideration. A recommendation to improve the financial sector of these countries by encouraging M&A activities may therefore be misguiding and counter-productive.

Table 6.4. Effects of M&As by dummy variables in all banks

| *Dependent variable* | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $\widehat{TE}_{i,t}^{k}$ | Model | Model | Model | Model |
| *Target banks* | 0.096 | 0.292*** | 0.280*** | 0.308*** |
| *（Yes=1,No=0）* | (0.094) | (0.087) | (0.089) | (0.083) |
| *Acquiring banks* | -0.101 | 0.228** | 0.206** | 0.245*** |
| *（Yes=1,No=0）* | (0.100) | (0.098) | (0.096) | (0.092) |
| *log Assets* | | 0.579*** | 0.565*** | 0.562*** |
| | | (0.057) | (0.056) | (0.060) |
| *log Equity* | | -0.774*** | -0.780*** | -0.773*** |
| | | (0.068) | (0.067) | (0.072) |
| *Bank concentration* | | | -0.014*** | -0.016*** |
| | | | (0.002) | (0.002) |
| *log Population* | | | | 0.175*** |
| | | | | (0.036) |
| *log GDP* | | | | -0.278*** |
| | | | | (0.047) |
| *Year dummy* | *Yes* | *Yes* | *Yes* | *Yes* |
| *Constant* | 3.278*** | 2.748*** | 3.587*** | 7.610*** |
| | (0.096) | (0.181) | (0.226) | (0.769) |
| $\sigma$ | 0.958*** | 0.876*** | 0.859*** | 0.841*** |
| | (0.029) | (0.025) | (0.026) | (0.025) |
| *Observations* | 937 | 937 | 937 | 937 |

Notes: The truncated model is estimated by the maximum-likelihood estimation and $\sigma$ is the variance of the estimated model. 23 observations are removed since they are on the frontier. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.10.

Source: Author's calculations.

Table 6.4 also shows that whether or not a bank is a target or an acquiring bank in an M&A matters for efficiency. For instance, the coefficient on the target banks dummy for target banks meanders around 0.3, while the coefficient on the acquiring banks dummy is around 0.22. The empirical results suggest that efficiency loss may be more severe for target banks than for acquiring banks in an M&A event. There are several reasons why this may be so. Firstly, M&A could benefit target banks by replacing inefficient managers with efficient ones, but managers in target banks who understand their vulnerability would have much incentive to delay the restructuring process. Secondly, the most profitable assets and promising projects in the target banks could be transferred to the acquiring banks in the restructure process and this contributes negatively to the efficiency of the target banks (Greenbaum and Thakor, 2007).

Since the regression results are sensitive to the dataset employed, the regression equation in Table 6.4 is estimated in Table 6.5 for target banks, but the observations from acquiring banks are removed.[45] The coefficient of the dummy variable is still significantly positive with respect to the estimated efficiency score and the value is around 0.30, which indicates that the M&As result in reducing the efficiency of the target banks.

[45] This arrangement is the same as the work from Cummins and Xie (2008) in the US property-liability insurance industry over the period 1994-2003. In their study, the impact of M&As is tested on target firms and acquiring firms separately, and the empirical evidence points to the positive correlation between the event of M&As and the efficiency gains (estimated by DEA approach) in the target and acquiring firms.

Table 6.5. Effects of M&As by dummy variables and acquiring banks excluded

| *Dependent variable* | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $\widehat{TE}_{i,t}^{k}$ | Model | Model | Model | Model |
| *Target banks* | 0.067 | 0.315*** | 0.287** | 0.320*** |
| *（Yes=1,No=0）* | (0.132) | (0.118) | (0.126) | (0.115) |
| *log Assets* | | 0.661*** | 0.645*** | 0.652*** |
| | | (0.060) | (0.059) | (0.065) |
| *log Equity* | | -0.907*** | -0.918*** | -0.921*** |
| | | (0.074) | (0.074) | (0.079) |
| *Bank concentration* | | | -0.015*** | -0.017*** |
| | | | (0.003) | (0.003) |
| *log Population* | | | | 0.158*** |
| | | | | (0.040) |
| *log GDP* | | | | -0.267*** |
| | | | | (0.051) |
| *Year dummy* | *Yes* | *Yes* | *Yes* | *Yes* |
| *Constant* | 3.273*** | 2.699*** | 3.603*** | 7.645*** |
| | (0.109) | (0.190) | (0.241) | (0.832) |
| $\sigma$ | 1.003*** | 0.893*** | 0.872*** | 0.855*** |
| | (0.034) | (0.029) | (0.030) | (0.030) |
| *Observations* | 778 | 778 | 778 | 778 |

Notes: The truncated model is estimated by the maximum-likelihood estimation and $\sigma$ is the variance of the estimated model. 182 observations from acquiring banks are removed. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.10.

Source: Author's calculations.

In Table 6.6, the observations from the target banks are removed when the impact of the M&As on acquiring banks is estimated. As it turns out, changing the composition in the sample for the analysis does not materially affect the main findings in Table 6.4. Hence, the results from Table 6.4, Table 6.5 and Table 6.6 tell a consistent story.

First, they show that the effect of M&A on efficiency could differ between target and acquiring banks. Second, they demonstrate that an M&A event could make banks perform worse upon an M&A completion. This is reminiscent with Behr and Heid (2011), who in the context of the German banking market over the period 1995–2000, found that the profitability of the banks engaged in the M&As had deteriorated by 25 per cent in the merger year that is mainly due to increased cost from restructuring. In the US banking market, Rhoades (1998) summarises the results of nine case studies on the efficiency effects of individual bank M&As, and finds that four of the banks that underwent the M&A process clearly demonstrated an improvement in cost efficiency but five did not.

Table 6.6. Effects of M&As by dummy variables and target banks excluded

| *Dependent variable* | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $\widehat{TE}_{i,t}^{k}$ | Model | Model | Model | Model |
| *Acquiring banks* | -0.072 | 0.277** | 0.247** | 0.291*** |
| *（Yes=1,No=0）* | (0.112) | (0.111) | (0.108) | (0.104) |
| *log Assets* | | 0.593*** | 0.579*** | 0.576*** |
| | | (0.059) | (0.058) | (0.063) |
| *log Equity* | | -0.793*** | -0.802*** | -0.792*** |
| | | (0.072) | (0.071) | (0.076) |
| *Bank concentration* | | | -0.015*** | -0.016*** |
| | | | (0.003) | (0.002) |
| *log Population* | | | | 0.178*** |
| | | | | (0.038) |
| *log GDP* | | | | -0.280*** |
| | | | | (0.049) |
| *Year dummy* | *Yes* | *Yes* | *Yes* | *Yes* |
| *Constant* | 3.246*** | 2.707*** | 3.580*** | 7.574*** |
| | (0.102) | (0.186) | (0.232) | (0.797) |
| σ | 0.985*** | 0.900*** | 0.881*** | 0.862*** |
| | (0.031) | (0.027) | (0.028) | (0.028) |
| *Observations* | 858 | 858 | 858 | 858 |

Notes: The truncated model is estimated by the maximum-likelihood estimation and $\sigma$ is the variance of the estimated model. 102 observations from target banks are removed in the estimation. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.10.
Source: Author's calculations.

The results raise further questions on why M&A is successful for improving the efficiency of banks in developed countries but not in the developing countries of our sample. In the literature related to developed countries, M&A is usually a good thing from the banking performance perspective. Cornett et al. (2006) look at the US banking industry in 1997 and find that the operating performance of merged banks has increased significantly after an M&A, and argue that this could be a result of both revenue enhancement and cost reduction activities.[46] Focusing on the M&As between the banks and non-banking financial firms in the US financial market over the period 1992–2005, Harjoto et al. (2012) argue that the main reason for banks to engage in these kinds of M&A transactions is to reduce their potential costs and increase their revenue. Harjoto et al. (2012) find that the operating performance of merged banks increases significantly after the M&As.

To get a feel of whether the regression results are credible, it is also important to look at whether estimated effects of the control variables are sensible. From Tables 6.4 to 6.6, this appears to be the case. For instance, by working as a cushion against unexpected losses, sound capital position that is captured by higher *log Equity* would increase the efficiency of banks. Assets, however, could be difficult to manage when they are large. For example, Shaffer (1993) finds that the consolidated banks in the US banking market in 1988 were not guaranteed to enjoy scale efficiencies when their size was increased. Berger and Mester (1997) estimate the efficiency of US commercial banks, and find that the M&As do not

[46] In their study, the proxy of the bank performance is the mean change in industry-adjusted operating pre-tax cash flow return on assets in the two years after the bank merger relative to that in the two years before the mergers.

necessarily result in efficiency promotion for the big banks.[47] This may explain why the effect of *log Assets* on the DEA score is positive.

## 6.6 Sensitivity Analyses

In the sensitivity checks, the robustness of the main qualitative results of the analysis is examined: (1) an M&A event could deteriorate the efficiency of the banks involved, and (2) the negative effect of M&A on efficiency is stronger for target than for acquiring banks.

The first sensitivity check replaces dummy variables for target or acquiring banks with year indicator variables in order to capture the cumulative effects of M&As. For the year indicator, an integer variable for each target ( $Target_{i,t}^{k}+$ ) and acquiring bank ($Acquiring_{i,t}^{k}+$) is constructed that is equal to one for the first year after the event and up to a maximum of value of seven that corresponds to the seventh year after the event. Table 6.7 shows the effect of M&As based on the year indicator variable. Just as before, banks would be worse on average in terms of efficiency if they participate in an M&A. The negative effect of M&A on efficiency is stronger for target banks than for acquiring banks. This is also supported in Tables 6.8 and 6.9 that perform pair-wise comparisons between target banks and incumbent banks (Table 6.8) and between acquiring banks and incumbent banks (Table 6.9).

[47] Berger and Mester (1997) look at almost 6,000 US commercial banks over the period of 1990-95. Using the distribution free approach they find that an increase in bank size can reduce the operating costs, but it is difficult for the larger banks to create new revenue flows.

Table 6.7. Effects of M&As by indicator variables in all banks

| *Dependent variable* | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $\widehat{TE}_{i,t}^{k}$ | Model | Model | Model | Model |
| *Target+* | 0.013 | 0.054*** | 0.054*** | 0.061*** |
| | (0.017) | (0.016) | (0.016) | (0.016) |
| *Acquiring+* | -0.025 | 0.043* | 0.040* | 0.044** |
| | (0.024) | (0.024) | (0.023) | (0.022) |
| *Log Assets* | | 0.571*** | 0.558*** | 0.555*** |
| | | (0.056) | (0.056) | (0.060) |
| *Log Equity* | | -0.761*** | -0.769*** | -0.761*** |
| | | (0.067) | (0.067) | (0.071) |
| *Bank concentration* | | | -0.014*** | -0.016*** |
| | | | (0.002) | (0.002) |
| *Log Population* | | | | 0.172*** |
| | | | | (0.036) |
| *Log GDP* | | | | -0.274*** |
| | | | | (0.046) |
| *Year dummy* | *Yes* | *Yes* | *Yes* | *Yes* |
| *Constant* | 3.278*** | 2.754*** | 3.603*** | 7.595*** |
| | (0.096) | (0.180) | (0.225) | (0.770) |
| σ | 0.958*** | 0.878*** | 0.861*** | 0.843*** |
| | (0.029) | (0.025) | (0.026) | (0.025) |
| *Observations* | 937 | 937 | 937 | 937 |

Notes: The truncated model is estimated by the maximum-likelihood estimation and $\sigma$ is the variance of the estimated model. 23 observations are removed since they are on the frontier. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.10.

Source: Author's calculations.

Table 6.8. Effects of M&As by indicator variables and acquiring banks excluded

| *Dependent variable* | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $\widehat{TE}_{i,t}^{k}$ | Model | Model | Model | Model |
| *Target+* | 0.010 | 0.064*** | 0.062*** | 0.069*** |
| | (0.022) | (0.020) | (0.020) | (0.019) |
| *log Assets* | | 0.658*** | 0.643*** | 0.650*** |
| | | (0.059) | (0.059) | (0.065) |
| *log Equity* | | -0.904*** | -0.916*** | -0.920*** |
| | | (0.074) | (0.074) | (0.079) |
| *Bank concentration* | | | -0.015*** | -0.017*** |
| | | | (0.003) | (0.003) |
| *log Population* | | | | 0.158*** |
| | | | | (0.040) |
| *log GDP* | | | | -0.267*** |
| | | | | (0.051) |
| *Year dummy* | *Yes* | *Yes* | *Yes* | *Yes* |
| *Constant* | 3.274*** | 2.711*** | 3.619*** | 7.663*** |
| | (0.109) | (0.190) | (0.241) | (0.831) |
| $\sigma$ | 1.003*** | 0.893*** | 0.873*** | 0.856*** |
| | (0.034) | (0.029) | (0.030) | (0.030) |
| *Observations* | 778 | 778 | 778 | 778 |

Notes: The truncated model is estimated by the maximum-likelihood estimation and $\sigma$ is the variance of the estimated model. 182 observations from acquiring banks are removed.
Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.10.
Source: Author's calculations.

Table 6.9. Effects of M&As by indicator variables and target banks excluded

| *Dependent variable* $\widehat{TE}_{i,t}^{k}$ | (1) Model | (2) Model | (3) Model | (4) Model |
|---|---|---|---|---|
| *Acquiring+* | -0.019 | 0.051** | 0.047* | 0.053** |
| | (0.026) | (0.026) | (0.025) | (0.024) |
| *log Assets* | | 0.589*** | 0.576*** | 0.573*** |
| | | (0.058) | (0.058) | (0.063) |
| *log Equity* | | -0.785*** | -0.795*** | -0.785*** |
| | | (0.071) | (0.070) | (0.076) |
| *Bank concentration* | | | -0.015*** | -0.016*** |
| | | | (0.003) | (0.002) |
| *log Population* | | | | 0.175*** |
| | | | | (0.038) |
| *log GDP* | | | | -0.277*** |
| | | | | (0.049) |
| *Year dummy* | *Yes* | *Yes* | *Yes* | *Yes* |
| *Constant* | 3.245*** | 2.698*** | 3.579*** | 7.545*** |
| | (0.102) | (0.185) | (0.232) | (0.798) |
| $\sigma$ | 0.985*** | 0.901*** | 0.881*** | 0.863*** |
| | (0.031) | (0.027) | (0.028) | (0.027) |
| *Observations* | 858 | 858 | 858 | 858 |

Notes: The truncated model is estimated by the maximum-likelihood estimation and $\sigma$ is the variance of the estimated model. 102 observations from target banks are removed in the estimation. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.10.
Source: Author's calculations.

The second sensitivity check considers a different methodology from truncated regressions. When M&As are involved, Behr and Heid (2011) argue that the sample selection issue might be a problem as banks engaged in M&As could be the relatively inefficient ones in the market. Behr and Heid (2011) suggest that the propensity score matching should be employed, since it can help to control for common characteristics of banks involved in M&As and those that did not. Following this suggestion, propensity score matching is

considered as another way to estimate the effect of M&As. The goal is to estimate the average treatment effect (ATT) on the treated group, where the 'treatment group' refers to the target or acquiring banks.[48] The control group consists of incumbent banks in the market as before. As discussed by Angrist and Pischke (2008), the difference between the regression and propensity score matching comes largely from the weighting scheme of the treatment effect, so the results from propensity score matching and the regression should be in the same direction. Table 6.10 shows the results from the propensity score matching. The estimated ATT is 0.22 for the target banks and 0.3313 for the acquiring banks. Based on the results from the propensity score matching, the effect of an M&A event is still positive on the DEA score of banks on average.

Table 6.10. Effects of M&As in the propensity score matching

| *Variable* | Sample | Estimate | S.D. | T-Stat. |
|---|---|---|---|---|
| $\widehat{TE}_{i,t}^{k}$ *(Target banks)* | *Unmatched* | 0.1641 | 0.2060 | 0.80 |
| | *ATT* | 0.2200 | 0.2523 | 0.87 |
| $\widehat{TE}_{i,t}^{k}$ *(Acquiring banks)* | *Unmatched* | -0.0269 | 0.1292 | -0.21 |
| | *ATT* | 0.3313*** | 0.1363 | 2.43 |

Note: S.D. does not take into account estimation of the propensity score.

Source: Author's calculations.

Since the propensity score matching puts the most weight on covariate cells containing those which are most likely to be treated and the regression puts the most weight on covariate

[48] In practice, the propensity score matching is used in two steps. First, the probability to be the target banks or acquiring banks is estimated using the Logit model. Then the estimates of the effect of treatment are computed either by matching the fitted values from the first step or by a weighting scheme.

cells where the conditional variance of treatment status is largest, the results in these two different measures are slightly different. The result for target banks is not significant in propensity score matching, which is different to the result from the regression analysis, but the result for acquiring banks is significant, which is the same as the findings from the regression analysis.

## 6.7 Concluding Remarks

Due to the deregulation policies in the field of bank takeovers, the banking industry in emerging economies has undergone rapid consolidation. To explore the efficiency impact of M&As in the context of emerging economies, this chapter explores how the efficiency of the banks responds to M&As using the bank-level dataset from China, India, Indonesia, Malaysia, Russia, Thailand and Vietnam over the period 2002–09.

In the two-stage DEA, the DEA score of each bank in each year is calculated first. The results from the first stage analysis show that the efficiency of the banks is increased in most of countries, except India, in which the efficiency of the banks is neutral over the sample period. In the second stage, the truncated model and the propensity score matching method are employed. Taking a further step than the most existing studies, all banks in this analysis are separated into three groups: target banks, acquiring banks and incumbent banks. Since the treated group in this analysis is the target banks and acquiring banks, and the incumbent banks are the control group, the regression equation in the second stage is estimated in different data compositions. This conclusion is supported by the empirical results which are

robust in the sensitivity analyses that employ different measures, sample composition, and alternative statistical procedures.

Based on the data from the emerging economies, this exercise finds no evidence to support a positive relationship between the M&A event and efficiency gains in the target or acquiring banks, holding constant a set of standard economic variables. The banks engaged in the M&As might sacrifice efficiency to merge with other banks after the event. According to the results from the regression analysis, the target banks have to sacrifice more efficiency in the M&A event than acquiring banks do, at least in the first eight years, which is the time span of this analysis.

The empirical results in this chapter partially explain the reason why some banks remain independent, rather than be acquired or 'be eaten'. As one of the possible consequences of being target banks, managers are likely to lose their jobs since they are redundant in the new consolidated banks and the profitable assets might be transferred to the acquiring banks, which could be one of the reasons for the M&As. Since the M&As occurs due to a lot of reasons or in order to achieve some strategic objectives (e.g. increasing the market power, entering to a new market or enjoying the economies of scale), it does not necessarily result in the efficiency gains in banking industry. On the contrary, the efficiency of the banks could be sacrificed during the restructure process.

# Chapter 7 Conclusions

The positive effect of a well-functioning financial sector on economic growth is a well-documented empirical regularity in the literature. Being a critical component of the financial sector, the banking industry is in the unique position to stimulate economic growth given its power to channel financial resources to the most viable firms and projects. This is especially true in developing countries as their capital markets (stock exchanges and bond markets) are relatively undeveloped, hence firms in these countries will rely even more heavily on banks for external finance. Therefore, it is critical for governments of emerging economies to focus on developing a strong banking industry, possibly through the introduction of financial liberalisation and deregulation policies, such as the deregulation of the banking industry to allow for foreign competition and through policies encouraging M&A activities. This thesis hopes to shed light on the implications of these deregulation measures on the efficiency of the banking system.

As a contribution to the literature, this thesis focuses on the banking industries of emerging economies, such as China, India and Russia. It contributes to provide further evidence for the impacts of financial deregulation policies on bank efficiency. It also contributes to the literature by utilising recently developed methods in efficiency analysis (e.g. the bootstrapping and density estimation techniques) to investigate the efficiency gains of banks from deregulation policies. The efficiency impacts of deregulation policies are analysed from two directions: (1) deregulation policies for foreign and domestic banks and (2)

the banks' takeover activities or M&As.

To provide a closer look on what deregulation of the banking system might entail and its correlation with the efficiency of banks, the thesis focuses on China as a case study first. In Chapter 2, the main financial reform policies in China's banking industry are reviewed for the period from 1979 to 2006. Since the commencement of economic reforms in China, the banking reforms have been at the centre of China's overall efforts to transform a centrally planned economy into a market economy. As a consequence of these financial reforms, the four SOBs became the main participants in the banking industry, but their monopolistic status was later challenged by the entry of JSCBs and city banks. From 2006, the restrictions on foreign banks were removed which gave foreign banks more freedom to operate in China's banking industry.

Given that banks in China are the main source of external finance for firms and for the general public, an efficiently run banking industry is crucial for a well-functioning economy. The Chinese government carried out several deregulation policies aiming at raising the efficiency of banks. Chapter 4 examines the effect that banking deregulation following China's WTO accession has had on the efficiency of commercial banks during 2000 to 2009. Following the literature, a DEA model combined with the bootstrapping technique proposed by Simar and Wilson (1998; 2000) is used to calculate the bias corrected efficiency scores of 154 commercial banks. The evidence shows that the average bank efficiency has increased between 2000 and 2007, but decreased in 2008. These results are robust to adopting different input and output specifications and aggregation methods in computing the annual efficiency

score. One possible reason for the decreased efficiency in 2008 could be the financial crisis, since some existing research shows that the financial crisis deteriorates financial reports of the Chinese commercial banks.

One of the challenges in the study that focuses on one country, such as in Chapter 4 of this thesis, is that the observations from case studies may not hold generally for other countries, since different countries may well have very different financial sector and under a different macroeconomic situation. In addition, the evidence from the Chinese banking industry cannot determine the causation between the deregulation policies and efficiency gains in the market. In Chapter 5 and Chapter 6 of this thesis, the different kinds of the deregulation policies are studied. In order to protect the banks in the market from competition, the non-prudential restrictions are imposed by limiting the entry of newcomers and restricting the nature and scope of newcomers once they have entered, regardless of whether they are domestic or foreign (Dinh, 2008). In Chapter 5, the impact of removing non-prudential regulations is investigated, while the efficiency impact of M&As is explored in Chapter 6, since it is a specific form of market entry that can increase the competition in the banking market.

To obtain more general results on the effect of deregulation on banking efficiency, Chapter 5 employs a cross-country analysis to investigate the effect of deregulation on banks for a sample of developing countries in Asia (i.e. China, India, Indonesia, Malaysia, Pakistan and Thailand) over the period 1996–2007. First, the DEA scores of banks in the selected countries are estimated and then the estimated DEA score of each bank in each year is

regressed on the indices of non-prudential restrictions (Dinh 2008) that represent how restrictive are policies affecting the banking industry in each country. Higher values of these indices capture banking environments that are more restrictive and less deregulated.

When regressing the DEA scores on the non-prudential restriction measures, one of the key concerns is that of reverse causality as these measures could be a response to a poorly functioning banking industry. In addition, well-functioning banks could also clamour for more deregulations by the government, hence the non-prudential restriction measures that are used as regressors could be endogenous. Since causality implies correlation, if reverse causality is indeed true, then the previous period DEA scores could be correlated with the current period restriction measures. Hence, this chapter deals with the problem of reverse causality by including the DEA scores in the previous period as a control variable.

The regression results show that deregulation policies that reduce restrictions on foreign banks have enhanced the efficiency of banks, while the liberalisation of domestic banks has not resulted in significant efficiency gains in the selected countries of this study. This result is reminiscent of the findings in Lehner and Schnitzer (2008), who show that the deregulation of foreign banks has encouraged them to provide a larger range of products in the market. This is also beneficial to domestic banks as such deregulation policies offer domestic banks a way to learn new banking technology from foreign banks. While the thesis finds that removing restrictions on foreign banks has been helpful to the banking industry as a whole, deregulation policies for domestic banks in giving them more freedom to manage their asset portfolio (such as cash, securities and loans) had not achieved the same effect. One possible

reason is the liberalisation of the foreign banks could create a channel for technological transfers from overseas. This result has important policy implications – it implies that for deregulation to be effective, a "shock therapy" of deregulating the activities of foreign banks would be more effective than a stepwise approach of first deregulating domestic banks.

Deregulation of the banking industry can take place in many ways, one of which is through creating an environment that is favourable for M&A activities. Chapter 6 studies the effect that M&As have on the efficiency of the banking system. The literature has suggested that M&As could affect efficiency by pushing banks to operate more efficiently so as to avoid becoming potential targets, and also through the adoption of new management technologies or improvement of service quality for weaker banks that have been merged (e.g. Evanoff and Ors, 2008).

Using panel data from emerging economies from 2002 to 2009, Chapter 6 investigates the consequence of M&As on the efficiency of the banking system for seven emerging economies. It looks specifically at how efficiency may be impacted for three distinct groups of banks: target banks, acquiring banks, and incumbent banks (non-M&A banks). In this chapter, the DEA score of all banks in selected countries is calculated first. After that, a truncated regression approach and propensity score matching are utilised to investigate the effects of M&As on the treated group (i.e. the target banks and acquiring banks).

When bank, industry and country-level characteristics are controlled, the chapter finds that banks that are involved in an M&A become more inefficient. However, the decline in

efficiency is more severe for target than for acquiring banks. These two conclusions are robust to the use of different control variables, data compositions, and estimation methodologies. The fact that target banks are the worst affected group following M&As could imply that these M&As generally do not take improving the efficiency of target banks as an objective of an M&A. However, such M&As could still act as a "wake-up" call to managers in the industry, who may lose their jobs in such an event when profitable assets in the target banks are transferred to the acquiring banks.

Summarising the findings in Chapter 4, 5 and 6, the deregulation policies to removing the non-prudential restrictions on foreign banks are more effective than other kinds of deregulation policies, such as the policies on domestic banks. In terms of modes of entry, Greenfield entry also appears to contribute more to efficiency than do M&As. The first conclusion might be qualified by the reference to the risks that are perceived at least by policy makers to be associated with foreign entry. These results in that case pose an important dilemma for the design of banking policy. The second result on M&As should not be read to be the basis of a case against that mode of entry, but rather that M&As may contribute to other objectives. At the same time, significant effects of M&As on efficiency might not be observed in the short term.

The work here highlights a number of areas for further work. In the literature, most of existing analyses focus on the developed countries, but the dataset used in this thesis is from the emerging economies. Previous studies have found in the developed countries (mainly in the US) that M&As could increase the efficiency of the banks engaged in M&As. The

empirical evidence in this thesis suggests that the efficiency effect of M&As could be different in the developed or developing countries. Since the research focus of this thesis is on developing countries, the efficiency effect of M&As in the developed countries is not studied. There is further interesting research to examine whether the conditions in developing countries might imply different results for M&As.

Second, there are two kinds of M&As in the market, namely the vertical and horizontal M&As as they are known in the theory of banks' takeover activities. Vertical M&As include banks acquiring other types of firms, for example the firms producing bank card terminals, and horizontal M&As mean that the banks acquire other banks. This thesis focuses on the horizontal M&As in the banking market. However, the acquiring banks could acquire other banks for different reasons, such as to enter a new market, obtain economies of scale, or acquire the profitable assets from target banks. For future work, it will be interesting to look more closely at the motivations for and effects of horizontal versus vertical M&As on the efficiency of the banking system.

Finally, the risk management is one of the main activities of banks. Deregulation polices on foreign banks could increase the efficiency of the banks in the market, but it is still possible to increase risks in the financial market. These issues of risks management are beyond the scope of this thesis but worthy of continuing attention.

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# Appendix

Table A.4.1. Distribution of observation number by groups

| Groups | 2009 | 2008 | 2007 | 2006 | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| All banks | 74 | 161 | 257 | 340 | 404 | 455 | 496 | 526 | 542 | 549 |
| | 74 | 87 | 170 | 170 | 234 | 221 | 275 | 251 | 291 | 258 |
| Domestic | 51 | 113 | 188 | 262 | 317 | 361 | 395 | 421 | 434 | 439 |
| banks | 51 | 62 | 126 | 136 | 181 | 180 | 215 | 206 | 228 | 211 |
| Private | 49 | 109 | 182 | 254 | 307 | 348 | 379 | 402 | 414 | 418 |
| banks | 49 | 60 | 122 | 132 | 175 | 173 | 206 | 196 | 218 | 200 |
| City | 37 | 82 | 140 | 197 | 237 | 267 | 291 | 307 | 314 | |
| banks | 37 | 45 | 95 | 102 | 135 | 132 | 159 | 148 | 166 | |

Source: Author’s calculations.

Table A.4.2. Correlation matrix in intermediation approach (all banks)

| | Deposits | Non-Interest operating Expenses | Loan Loss provisions | Net loans | Other earning assets | Commission and fees | Other operating income |
|---|---|---|---|---|---|---|---|
| Deposits | 1.00 | 0.99 | 0.90 | 0.98 | 0.98 | 0.86 | -0.07 |
| Non-Interest operating. Expenses | 0.99 | 1.00 | 0.89 | 0.97 | 0.97 | 0.86 | -0.11 |
| Loan loss provisions | 0.90 | 0.89 | 1.00 | 0.87 | 0.91 | 0.72 | 0.06 |
| Net loans | 0.98 | 0.97 | 0.87 | 1.00 | 0.94 | 0.84 | -0.04 |
| Other earning assets | 0.98 | 0.97 | 0.91 | 0.94 | 1.00 | 0.87 | -0.15 |
| Commission and fees | 0.86 | 0.86 | 0.72 | 0.84 | 0.87 | 1.00 | -0.36 |
| Other operating income | -0.07 | -0.11 | 0.06 | -0.04 | -0.15 | -0.36 | 1.00 |

Source: Author's calculations.

Table A.4.3. Correlation matrix in profit approach (all banks)

| | Non-interest operating expenses | Loan loss provision | Other operating expenses | Other operating income | Net interest income | Commission and fees |
|---|---|---|---|---|---|---|
| Non-interest operating expenses | 1.00 | 0.89 | 0.92 | -0.11 | 0.97 | 0.86 |
| Loan loss provisions | 0.89 | 1.00 | 0.77 | 0.06 | 0.90 | 0.72 |
| Other operating expenses | 0.92 | 0.77 | 1.00 | 0.02 | 0.82 | 0.77 |
| Other operating income | -0.11 | 0.06 | 0.02 | 1.00 | -0.20 | -0.36 |
| Net interest income | 0.97 | 0.90 | 0.82 | -0.20 | 1.00 | 0.84 |
| Commission and fees | 0.86 | 0.72 | 0.77 | -0.36 | 0.84 | 1.00 |

Source: Author’s calculations.

Table A.4.4. Correlation matrix in product approach (all banks)

| | Non-interest operating expenses | Loan loss provisions | Other operating expenses | Net loans | Other operating income | Other earning assets | Deposits | Commission and fees |
|---|---|---|---|---|---|---|---|---|
| Non-interest operating expenses | 1.00 | 0.89 | 0.92 | 0.97 | -0.11 | 0.97 | 0.99 | 0.86 |
| Loan loss provisions | 0.89 | 1.00 | 0.77 | 0.87 | 0.06 | 0.91 | 0.90 | 0.72 |
| Other operating expenses | 0.92 | 0.77 | 1.00 | 0.94 | 0.02 | 0.82 | 0.91 | 0.77 |
| Net loans | 0.97 | 0.87 | 0.94 | 1.00 | -0.04 | 0.94 | 0.98 | 0.84 |
| Other operating income | -0.11 | 0.06 | 0.02 | -0.04 | 1.00 | -0.15 | -0.07 | -0.36 |
| Other earning assets | 0.97 | 0.91 | 0.82 | 0.94 | -0.15 | 1.00 | 0.98 | 0.87 |
| Deposits | 0.99 | 0.9 | 0.91 | 0.98 | -0.07 | 0.98 | 1.00 | 0.86 |
| Commission and fees | 0.86 | 0.72 | 0.77 | 0.84 | -0.36 | 0.87 | 0.86 | 1.00 |

Source: Author’s calculations.

Table A.4.5. DEA scores in profit approach, average

| Groups | Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| All banks | Original | 1.0802 | 1.0605 | 1.0436 | 1.0623 | 1.0494 | 1.0561 | 1.0436 | 1.0888 | 1.0978 | 1.1390 |
| | S.D. | 0.0216 | 0.0214 | 0.0131 | 0.0214 | 0.0163 | 0.0154 | 0.0120 | 0.0238 | 0.0285 | 0.0066 |
| | Corr. | 1.1166 | 1.0784 | 1.0602 | 1.0827 | 1.0622 | 1.0750 | 1.0607 | 1.1170 | 1.1320 | 1.2398 |
| | Lower | 1.0672 | 1.0270 | 1.0309 | 1.0324 | 1.0250 | 1.0380 | 1.0319 | 1.0669 | 1.0664 | 1.2246 |
| | Upper | 1.1526 | 1.1101 | 1.0802 | 1.1119 | 1.0882 | 1.0978 | 1.0778 | 1.1572 | 1.1793 | 1.2518 |
| Domestic banks | Original | 1.0657 | 1.0520 | 1.0546 | 1.0398 | 1.0359 | 1.0388 | 1.0314 | 1.0462 | 1.0527 | 1.1166 |
| | S.D. | 0.0142 | 0.0162 | 0.0127 | 0.0094 | 0.0077 | 0.0068 | 0.0059 | 0.0086 | 0.0098 | 0.0045 |
| | Corr. | 1.0969 | 1.0746 | 1.0858 | 1.0582 | 1.0530 | 1.0542 | 1.0441 | 1.0643 | 1.0751 | 1.2097 |
| | Lower | 1.0617 | 1.0372 | 1.0552 | 1.0326 | 1.0343 | 1.0396 | 1.0311 | 1.0432 | 1.0531 | 1.1991 |
| | Upper | 1.1177 | 1.0965 | 1.1036 | 1.0715 | 1.0647 | 1.0655 | 1.0541 | 1.0784 | 1.0918 | 1.2163 |
| Private banks | Original | 1.0737 | 1.0661 | 1.0504 | 1.0487 | 1.0419 | 1.0435 | 1.0393 | 1.0790 | 1.0768 | 1.1344 |
| | S.D. | 0.0180 | 0.0218 | 0.0164 | 0.0165 | 0.0112 | 0.0099 | 0.0095 | 0.0209 | 0.0192 | 0.0056 |
| | Corr. | 1.1038 | 1.0970 | 1.0732 | 1.0671 | 1.0594 | 1.0588 | 1.0530 | 1.1018 | 1.1063 | 1.2365 |
| | Lower | 1.0648 | 1.0431 | 1.0382 | 1.0280 | 1.0346 | 1.0379 | 1.0318 | 1.0575 | 1.0639 | 1.2247 |
| | Upper | 1.1354 | 1.1251 | 1.0958 | 1.0902 | 1.0757 | 1.0753 | 1.0693 | 1.1375 | 1.1378 | 1.2469 |
| City banks | Original | | 1.5057 | 1.4969 | 1.5036 | 1.3851 | 1.3263 | 1.2062 | 1.1506 | 1.2712 | 1.3962 |
| | S.D. | | 0.1245 | 0.1062 | 0.0870 | 0.0671 | 0.0593 | 0.0451 | 0.0401 | 0.0540 | 0.0278 |
| | Corr. | | 1.6864 | 1.6629 | 1.6770 | 1.5031 | 1.4426 | 1.2833 | 1.2042 | 1.3929 | 1.6050 |
| | Lower | | 1.4203 | 1.4462 | 1.4943 | 1.3591 | 1.3027 | 1.1900 | 1.1163 | 1.2797 | 1.5478 |
| | Upper | | 1.9092 | 1.8553 | 1.8328 | 1.6200 | 1.5504 | 1.3636 | 1.2699 | 1.4890 | 1.6616 |

Notes: the 95 per cent of confidence interval (lower and upper bound) is provided for the bias-corrected DEA score (Corr.) based on 1,000 replications in the stage of bootstrapping; Original means the DEA score without bootstrapping; S.D. means the standard deviation of the bias-corrected DEA score.

Source: Author's calculations.

Table A.4.6. DEA Scores in intermediation approach, average

| Groups | Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| All banks | Original | 1.0681 | 1.0574 | 1.0449 | 1.0577 | 1.0467 | 1.0528 | 1.0425 | 1.0808 | 1.0848 | 1.1368 |
| | Corr. | 1.0978 | 1.0802 | 1.0639 | 1.0798 | 1.0601 | 1.0716 | 1.0580 | 1.1062 | 1.1166 | 1.2391 |
| | S.D. | 0.0171 | 0.0158 | 0.0123 | 0.0169 | 0.0144 | 0.0135 | 0.0110 | 0.0203 | 0.0237 | 0.0060 |
| | Lower | 1.0607 | 1.0428 | 1.0356 | 1.0387 | 1.0264 | 1.0413 | 1.0334 | 1.0615 | 1.0608 | 1.2275 |
| | Upper | 1.1274 | 1.1055 | 1.0839 | 1.1044 | 1.0832 | 1.0934 | 1.0758 | 1.1398 | 1.1543 | 1.2497 |
| Domestic banks | Original | 1.5359 | 1.5015 | 1.4749 | 1.4465 | 1.3529 | 1.3140 | 1.1860 | 1.1552 | 1.2477 | 1.386 |
| | Corr. | 1.6987 | 1.6804 | 1.6498 | 1.6130 | 1.4781 | 1.4253 | 1.2618 | 1.2192 | 1.3581 | 1.5892 |
| | S.D. | 0.0818 | 0.0969 | 0.0862 | 0.0717 | 0.0531 | 0.0588 | 0.0358 | 0.0319 | 0.0430 | 0.0316 |
| | Lower | 1.5471 | 1.4709 | 1.4721 | 1.4550 | 1.3678 | 1.2898 | 1.1877 | 1.1477 | 1.2662 | 1.5243 |
| | Upper | 1.8755 | 1.8484 | 1.806 | 1.7367 | 1.5700 | 1.5235 | 1.3238 | 1.2735 | 1.4324 | 1.6527 |
| Private banks | Original | 1.0518 | 1.0457 | 1.036 | 1.0334 | 1.0300 | 1.0363 | 1.0295 | 1.0507 | 1.0494 | 1.1141 |
| | Corr. | 1.0752 | 1.0657 | 1.0540 | 1.0490 | 1.0440 | 1.0507 | 1.0405 | 1.0676 | 1.0705 | 1.2065 |
| | S.D. | 0.0122 | 0.0173 | 0.0117 | 0.0090 | 0.006 | 0.0074 | 0.0072 | 0.0110 | 0.0109 | 0.0040 |
| | Lower | 1.0508 | 1.0203 | 1.0231 | 1.0275 | 1.0299 | 1.0332 | 1.0247 | 1.0412 | 1.0466 | 1.1974 |
| | Upper | 1.0964 | 1.0863 | 1.0688 | 1.0612 | 1.0536 | 1.0620 | 1.0520 | 1.0856 | 1.0885 | 1.2131 |
| City banks | Original | | 1.0691 | 1.0440 | 1.0739 | 1.0516 | 1.0585 | 1.0512 | 1.1069 | 1.1205 | 1.1512 |
| | Corr. | | 1.0906 | 1.0602 | 1.0987 | 1.0651 | 1.0768 | 1.0704 | 1.1428 | 1.1615 | 1.261 |
| | S.D. | | 0.0294 | 0.0154 | 0.0254 | 0.0165 | 0.0206 | 0.0154 | 0.0314 | 0.0384 | 0.008 |
| | Lower | | 1.0175 | 1.0239 | 1.0401 | 1.0303 | 1.0295 | 1.0346 | 1.0664 | 1.0781 | 1.2442 |
| | Upper | | 1.1284 | 1.0830 | 1.1364 | 1.0915 | 1.1051 | 1.0937 | 1.1903 | 1.2221 | 1.2753 |

Notes: 1. The 95 per cent of confidence interval (lower and upper bound) is provided for the bias-corrected DEA score (Corr.) based on 1,000 replications in the stage of bootstrapping. 2. Original means the DEA score without bootstrapping. 3. S.D. means the standard deviation of the bias-corrected DEA score.
Source: Author's calculations.

Table A.4.7. DEA Scores in product approach, average

| Groups | Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| All banks | Original | 1.5691 | 1.5699 | 1.5348 | 1.5083 | 1.4094 | 1.3761 | 1.2906 | 1.2608 | 1.4088 | 1.4622 |
| | S.D. | 0.1069 | 0.0973 | 0.0901 | 0.0842 | 0.0698 | 0.0632 | 0.0435 | 0.0447 | 0.0658 | 0.0485 |
| | Corr. | 1.7502 | 1.7774 | 1.7507 | 1.6919 | 1.5657 | 1.5224 | 1.4422 | 1.3786 | 1.592 | 1.7052 |
| | Lower | 1.5397 | 1.6008 | 1.5747 | 1.539 | 1.4331 | 1.3981 | 1.3523 | 1.2857 | 1.4597 | 1.6300 |
| | Upper | 1.9457 | 1.9618 | 1.9145 | 1.855 | 1.693 | 1.6381 | 1.5201 | 1.4581 | 1.7166 | 1.8031 |
| Domestic banks | Original | 1.0761 | 1.0582 | 1.0601 | 1.0443 | 1.0384 | 1.0413 | 1.0337 | 1.0513 | 1.0593 | 1.1244 |
| | S.D. | 0.0166 | 0.019 | 0.0145 | 0.0103 | 0.0078 | 0.0078 | 0.0069 | 0.0105 | 0.0116 | 0.0047 |
| | Corr. | 1.1106 | 1.0828 | 1.0933 | 1.0645 | 1.0564 | 1.0574 | 1.0464 | 1.0704 | 1.0837 | 1.2226 |
| | Lower | 1.0715 | 1.0341 | 1.0613 | 1.0407 | 1.039 | 1.0398 | 1.0318 | 1.0465 | 1.0566 | 1.2113 |
| | Upper | 1.1388 | 1.1072 | 1.1138 | 1.079 | 1.0685 | 1.0703 | 1.0582 | 1.0881 | 1.1024 | 1.2298 |
| Private banks | Original | 1.0817 | 1.0698 | 1.0567 | 1.0465 | 1.0382 | 1.046 | 1.0412 | 1.0856 | 1.0854 | 1.1348 |
| | S.D. | 0.0246 | 0.0366 | 0.0238 | 0.0194 | 0.0121 | 0.0112 | 0.0105 | 0.0265 | 0.0242 | 0.0063 |
| | Corr. | 1.1119 | 1.0909 | 1.0797 | 1.0588 | 1.0508 | 1.0617 | 1.053 | 1.1055 | 1.1127 | 1.2329 |
| | Lower | 1.0597 | 0.9954 | 1.0219 | 1.0153 | 1.0212 | 1.0353 | 1.0311 | 1.0427 | 1.0584 | 1.2196 |
| | Upper | 1.1568 | 1.1318 | 1.1082 | 1.0848 | 1.0691 | 1.0801 | 1.0724 | 1.146 | 1.152 | 1.2443 |
| City banks | Original | | 1.0845 | 1.0636 | 1.0535 | 1.0441 | 1.0501 | 1.0512 | 1.1032 | 1.1047 | 1.1478 |
| | S.D. | | 0.0528 | 0.0316 | 0.0261 | 0.0155 | 0.0127 | 0.0132 | 0.0364 | 0.0287 | 0.0077 |
| | Corr. | | 1.1083 | 1.0862 | 1.0685 | 1.0578 | 1.0663 | 1.0673 | 1.1247 | 1.1401 | 1.2546 |
| | Lower | | 0.9752 | 1.0055 | 1.0022 | 1.0209 | 1.0397 | 1.0385 | 1.0411 | 1.0809 | 1.2384 |
| | Upper | | 1.1646 | 1.1235 | 1.1016 | 1.0810 | 1.0872 | 1.0902 | 1.1786 | 1.1867 | 1.2690 |

Notes: 1. The 95 per cent of confidence interval (lower and upper bound) is provided for the bias-corrected DEA score (Corr.) based on 1,000 replications in the stage of bootstrapping. 2. Original means the DEA score without bootstrapping. 3. S.D. means the standard deviation of the bias-corrected DEA score.
Sources: Author's calculations.

Table A.5.1. Deregulation index (1997–2006)

| Country | Type | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| China | Foreign | 0.44 | 0.44 | 0.44 | 0.44 | 0.41 | 0.40 | 0.39 | 0.38 | 0.37 | 0.37 | 0.408 |
| | Domestic | 0.17 | 0.17 | 0.15 | 0.15 | 0.15 | 0.15 | 0.14 | 0.13 | 0.13 | 0.14 | 0.148 |
| India | Foreign | 0.38 | 0.38 | 0.38 | 0.38 | 0.40 | 0.38 | 0.38 | 0.37 | 0.37 | 0.36 | 0.378 |
| | Domestic | 0.10 | 0.10 | 0.10 | 0.10 | 0.12 | 0.12 | 0.12 | 0.11 | 0.11 | 0.11 | 0.109 |
| Indonesia | Foreign | 0.20 | 0.19 | 0.18 | 0.18 | 0.19 | 0.19 | 0.18 | 0.20 | 0.20 | 0.20 | 0.191 |
| | Domestic | 0.10 | 0.10 | 0.10 | 0.10 | 0.11 | 0.11 | 0.11 | 0.12 | 0.12 | 0.12 | 0.109 |
| Malaysia | Foreign | 0.38 | 0.38 | 0.38 | 0.38 | 0.39 | 0.39 | 0.37 | 0.38 | 0.37 | 0.36 | 0.378 |
| | Domestic | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.090 |
| Pakistan | Foreign | 0.36 | 0.37 | 0.36 | 0.36 | 0.35 | 0.35 | 0.35 | 0.36 | 0.36 | 0.36 | 0.358 |
| | Domestic | 0.11 | 0.10 | 0.10 | 0.10 | 0.10 | 0.09 | 0.09 | 0.10 | 0.10 | 0.10 | 0.099 |
| Taiwan | Foreign | 0.31 | 0.31 | 0.31 | 0.31 | 0.32 | 0.32 | 0.32 | 0.34 | 0.34 | 0.33 | 0.321 |
| | Domestic | 0.09 | 0.09 | 0.09 | 0.09 | 0.10 | 0.10 | 0.10 | 0.11 | 0.11 | 0.11 | 0.099 |
| Thailand | Foreign | 0.36 | 0.36 | 0.35 | 0.35 | 0.37 | 0.37 | 0.37 | 0.38 | 0.38 | 0.38 | 0.367 |
| | Domestic | 0.07 | 0.07 | 0.07 | 0.07 | 0.09 | 0.09 | 0.09 | 0.09 | 0.11 | 0.11 | 0.086 |

Source: Dinh (2008).

**100 words abstract**

This thesis uses bank level data and data envelopment analysis approach to provide empirical evidence on the efficiency impact of deregulation policies in banking industry. Firstly, the efficiency of Chinese banks are evaluated in order to gather the empirical evidence on the relationship between the World Trade Organization accession and efficiency gains of commercial banks. Secondly, the impact of the deregulation policies on foreign banks and domestic banks are explored in Asian banking industries. Finally, the efficiency impact of mergers and acquisitions is investigated in a range of emerging economies.