Dear Dr Barakat,

Please find below the PhD amendments addressing the points raised in the report on the thesis examination. For each point raised in the joint report, I have included the comment from the joint report, a brief description of how I have addressed the point, and finally the updated text, that you can also find in the Thesis. For your convenience, I have included in all sections the relevant page number from the Thesis.

Kind regards,
Jiakun Hou

Point 1 of the joint report

The original contributions of the thesis should be better clarified and more clearly differentiated from the relevant literature. The student is encouraged to highlight the contribution of the thesis to the literature, this part requires significant attention from the student.

Addressed as follows in Chapter 1, pages 16-20:

The above mentioned comment is addressed in Chapter 1, pages 16-20. In this section original contributions of the thesis to the current Chinese banking literature are clearly identified and discussed.

Amendment 1:

Chapter 2 sets the contextual background of the Chinese banking industry and serves as the basis of the thesis, discussing issues related to our following empirical analysis of Chinese banks in Chapters 3 and 4. Chapter 2 presents an overview of the Chinese banking sector focusing mainly on the banking reforms and the main developments after the accession of China to the World Trade Organisation in 2001. In our analysis we focus on key trends concerning four key aspects of China's banking system previous to and covering our sample period 2005 to 2015: its structure; regulatory reforms; financial performance (e.g., total sector expansion, asset quality, earning competence and cost efficiency) and recent changes in business models and strategies.

In consideration of recent policy debates with respect to the 'too big to fail' status, following Beccalli, Anolli and Borello (2015), Chapter 3 investigates evidence of scale economies for Chinese banks and examines whether diversification in business models and risk-taking affect the realisation of economies of scale. We begin our analysis by estimating economies of scale and scale efficiency from a comprehensive set of cost specifications, each with different risk proxies. Recent research has suggested that systematic differences in risk among banks can substantially modify the way their costs vary with outputs, thereby producing biased estimates of bank scale economies when endogenous risk-taking is not considered in modelling bank production cost (see, for example, Wheelock and Wilson, 2012; Hughes and Mester, 2013; Bryce et al., 2015; and

Delis, Iosifidi and Tsionas, 2017). Following this assumption, our cost estimation takes into account managers' risk preference by incorporating risk management variables in the specified cost frontiers.

Therefore, our analysis contributes to the Chinese banking literature as it is one of the few empirical studies to capture risk-taking in estimating bank cost. More importantly, unlike previous research (e.g., Dong, Hamilton and Tippett, 2014; Boateng, Huang and Kufuor, 2015; and Hou et al., 2018) that also recognising bank risk in constructing a cost function, our study includes three risk proxies separately and in different combinations. We then utilise the test developed by Li (1996, 1999) to test for differences across the various measures of scale efficiency derived in the first step to identify a best fitted cost specification. The estimates of technological change are also obtained based on the preferred cost specification with an aim to shed light on the logic of the ongoing trend for consolidation within the Chinese banking industry. Additionally, the full sample is divided into different groups according to two criteria – first, splitting the sample by asset size; and second, following Brown and Glennon (2000), segmenting banks based on their portfolio composition through a clustering approach.

With respect to the second grouping criterion, we estimate clusters in terms of portfolio mix, and hence allocate banks with similar production technology into the same natural clustering group. To the author's best knowledge, our study is the first to empirically evaluate differences in the production technologies among Chinese banks. Then, our empirical findings related to bank scale economies, scale efficiency and technological change are thoroughly analysed in line with the above-generated banking groups. Built on Hughes and Mester (2013), the policy debate on 'too big to fail' is addressed via the examination of whether the cost advantages provided by large-scale banking operations are due to technological scale economies or 'too big to fail' subsidies. Our findings add to the current banking literature by informing contemporary policy debate on proposed regulatory reforms that are likely to inhibit bank growth/size and shedding the light on the policy choice for banking authorities. Finally, utilising a dynamic panel data model, we evaluate the determinants of bank scale economies so as to investigate the influences of recent regulatory reforms (in accordance with Basel III requirements)

on bank cost economies. The model is also conditioned on 'too big to fail' banks[1] in order to check the differences in performance between smaller banks and systemically important institutions.

In Chapter 4, with the background of the ongoing recapitalisation and banking reforms in China, we explore the effects of recapitalisation on banks, as well as examine the cost efficiency, profitability and stability performance of the Chinese banking sector. Our study starts with the inspection of the impacts of recapitalisation on Chinese banks by examining shadow return on equity (i.e., shadow price of equity) utilising a stochastic frontier cost function subject to a capitalisation constraint. To the best of our knowledge, only one published paper – Dong et al. (2016) – empirically examines this significant issue within the context of the Chinese banking industry, covering the period 2002 to 2011. Our analysis enriches the empirical evidence on this topic with more recent Chinese data. Then, we use Stochastic Frontier Analysis (SFA) models of Battese and Coelli (1995) and, following Simper et al. (2017), we incorporate the risk proxies identified in Chapter 3 in the frontier estimation to estimate cost efficiency scores for sample banks. Moreover, we model inefficiency as a function of a vector of exogenous (macroeconomic) factors which are expected to affect the distance of each tested bank from the estimated frontier. This constitutes a significant contribution as prior related research neglects the impacts of risk on efficiency estimation (e.g., Berger, Hasan and Zhou, 2009; Paradi, Rouatt and Zhu, 2011; and Dong, Hamilton and Tippett, 2014) and the impacts of exogenous determinants on efficiency.

In the next step of our empirical analysis, we turn our attention to the drivers of bank profitability and financial stability, and we investigate the earning ability and solvency of Chinese banks in the context of the ongoing financial transformations in China. The yielded estimation results from above studies offer valuable information for managers to strengthen banks' soundness and profit-generating capacity. The comprehension of these contributing factors also offers insights to other emerging economies whose banking sectors are undergoing significant institutional and structural change. Our

[1] Domestic systematically important banks are defined in our sample.

investigation contributes to the existing Chinese banking literature on profitability and stability determinants analysis in the following four aspects. First, our study focuses on the effect of actual cost estimates (i.e., cost efficiency scores) instead of commonly utilised cost-related financial ratios (e.g., cost to income ratio) on bank profitability and stability. Such a focus is distinct from that in other related research and consequently complements our knowledge from those studies. Lin and Zhang (2009) adopt the cost to income ratio as an efficiency proxy to examine how bank efficiency affect profitability. Similarly, Li and Zhang (2013) employ the ratio of operating expenses over total assets as a cost indicator in their bank profitability analysis. Tan (2016) utilises the overhead costs to total assets ratio to evaluate the correlation between bank efficiency and safety. However, these studies neglect the clear advantages in using estimated cost efficiency scores, as opposed to cost-related accounting ratios[2] (see a detailed interpretation of the rationale for cost efficiency scores are better efficiency proxies than the commonly employed accounting ratios on page 192 of section 4.2). Recognising the benefits of adopting cost efficiency score as an efficiency metric, our analysis use SFA models to estimate cost efficiency scores for sample banks and the scores yielded are then added into the second stage regression models of bank profitability and stability as one of the main determinants. This two-stage analysis contributes to current Chinese banking studies with a more comprehensive and robust framework to study the performance of Chinese banks.

Second, in recent years, an increasing number of studies have examined the variables that could affect bank profitability and stability within the context of Chinese banks (e.g., Shih, Zhang and Liu, 2007; Lin and Zhang, 2009; Li and Zhang, 2013; Zhang et al., 2016; Tan, Floros and Anchor, 2017; and Umar and Sun, 2018). Nevertheless, to the author's best knowledge, there are no published empirical papers on Chinese banking that focus on the effects of shadow banking activities on bank profitability and solvency. Hence, our study fills this research gap by linking shadow banking activities to bank profits and soundness. Third, there is little research that investigates the potential

[2] One such advantage is that the cost efficiency scores yielded from the frontier cost function estimation takes into account synchronously all aspects of bank performance, and can show a bank to be operating well even when individual financial performance ratios suggest the bank is inefficient.

links between short-term wholesale funding and performance for Chinese banks. One such empirical study is that by Qi and Yang (2017), which analyses how short-term wholesale funding affects Chinese banks' interest margins during the period 2000 to 2009. Our inspection of the effects of short-term wholesale funding on bank profits and solvency extends the literature by examining a dataset consisting of more recent Chinese data. Fourth, we explore the size-profitability/stability nexus, and its findings contribute to the existing banking literature by offering evidence for current regulatory discussions of downsizing in banking.

Chapter 5 concludes the thesis and analyses potential limitations and provides further research directions.

Point 2 of the joint report

The ownership structure of Chinese banks should be better clarified. The sample composition should be clearly explained with respect to the types of banks such as state-owned and joint-stock banks.

Addressed as follows in Chapter 2, pages 30-38, Chapter 3, pages 118-119 and Chapter 4, pages 240-249:

The above mentioned comment is addressed in three separate parts in Chapters 2, 3 and 4. Specifically, in Chapter 2, pages 30-38 (Amendment 2a), a discussion on the ownership structure of Chinese banks is presented – focusing on Chinese commercial banks. In terms of ownership structure, Chinese commercial banks can be partitioned into four types: state-owned commercial banks, joint-stock commercial banks, city and rural commercial banks and foreign commercial banks. We offer a detailed explanation for each of these four types of banks.

In Chapter 3, pages 118-119 (Amendment 2b), we discuss in a detailed manner the ownership structure of the selected sample Chinese banks.

In Chapter 4, pages 240-249 (Amendment 2c), for SFA cost estimation, we report summary statistics for each of these groups of banks.

Amendment 2a:

Chinese commercial banks can be classified into four types in terms of their ownership structure: (1) state-owned commercial banks, which nearly 70% of the equity is owned by the Chinese central government and Ministry of Finance; (2) joint-stock commercial banks whose major shareholders are financial holding companies, local governments or leading conglomerates in one or more specific sectors; (3) city and rural commercial banks, which primarily are owned by local governments and local enterprises; and (4) foreign commercial banks, which typically present a joint venture capital structure or a fully foreign-controlled ownership structure (Almanac of China's Finance and Banking, 2017).

As previously stated, over the period of 1978 to 1984, four stated-owned commercial banks, the 'Big Four', were created to take over the commercial banking functions (e.g., deposit-taking and lending) from the PBOC, and built the foundation of the current Chinese banking system. One key feature of the Chinese banking sector is that it is highly concentrated (i.e., dominated by stated-owned commercial banks). In the early 1990s, the Big Four held almost 91% of total deposits and 90% of total loans of the entire banking system. After 20 years of financial reforms, especially with respect to entry to the WTO and bank initial public offerings (IPOs), by the end of 2016, the market share of state-owned banks in the total banking assets had dropped considerably from around 89% in 1995 to 41% (see Figure 2.2). Such a downward tendency can also be attributed to the increased competition and more aggressive growth strategy of smaller banks (Ye, Zhang and Dong, 2019). However, they still held 52.1% of deposits and 46.5% of loans by the end of 2016; and the now stated-owned commercial banks are still "too big to fail" due to their huge size and oligopolistic roles in the real economy (Wu, Song and Chai, 2018).

It should be noted that state-owned commercial banks remained as the Big Four until 2005, when Bank of Communication restructured and transformed from the largest joint-stock bank to the fifth largest state-owned bank. Then it was demoted to 6th largest in 2016 when Postal Savings Bank of China became the 5th largest[3]. Generally, state-owned commercial banks are faced with issues around tight government controls (e.g., the government would dictate the type of services, products and loans that banks offer) due to their ownership character[4] and are tightly regulated by the PBOC and CBRC since they are the systemically important financial institutions in China (Chen et al., 2014). Furthermore, these banks have historically been burdened by high levels of non-performing loans, which in the past has contributed to the notion that the

[3] In December 2015, Postal Savings Bank of China sold 17% of its equity to 10 international investors for US$7 billion. In September 2016, it undertook an IPO of US$7.4 billion, where cornerstone investors (usually government-linked investors that have to hold onto shares for a minimum of 6 months) – committed US$5.9 billion to the deal before its launch, giving them around 80% of the offering (Lockett, 2016).

[4] As of December 2016, nearly 70% of the equity of the Big Four as well as Bank of Communication are owned by the Chinese central government and Ministry of Finance, and roughly 69% of the equity of Postal Savings Bank of China are owned by the State Post Bureau (Garnaut, Song and Fang, 2018).

Chinese banking system was "bankrupted" over the early 2000s (Lu, Thangavelu and Hu, 2005).[5]

Several joint-stock commercial banks (JSCBs) with a national presence were created in 1987. The China Merchant Bank and Bank of Communication (later restructured as a state-owned bank) were the first to enter the Chinese banking market (García-Herrero, Gavilá and Santabárbara, 2009). The market share of JSCBs then increased over the decade, reaching 19% of total Chinese banking assets by the end of 2016. There are currently 12 JSCBs. Unlike the state-owned commercial banks, they normally operate without extensive branch networks and receive capital and funding support from state-owned enterprises. Due to less interference from the government, JSCBs are usually market share winners and more aggressive and competitive in the financial services market (Lin, Sun and Wu, 2015). JSCBs are indeed typically more responsive to market conditions (they are primarily market-oriented) and have exemptions from historical policy lending regulations. They are licensed to provide a wide range of banking services, one of which is financing small and medium-sized enterprises, an area in which the state-owned commercial banks have traditionally been weak. Huang et al. (2017) note that on the basis of JSCBs' ownership structure, they can be categorised into three different types[6]:

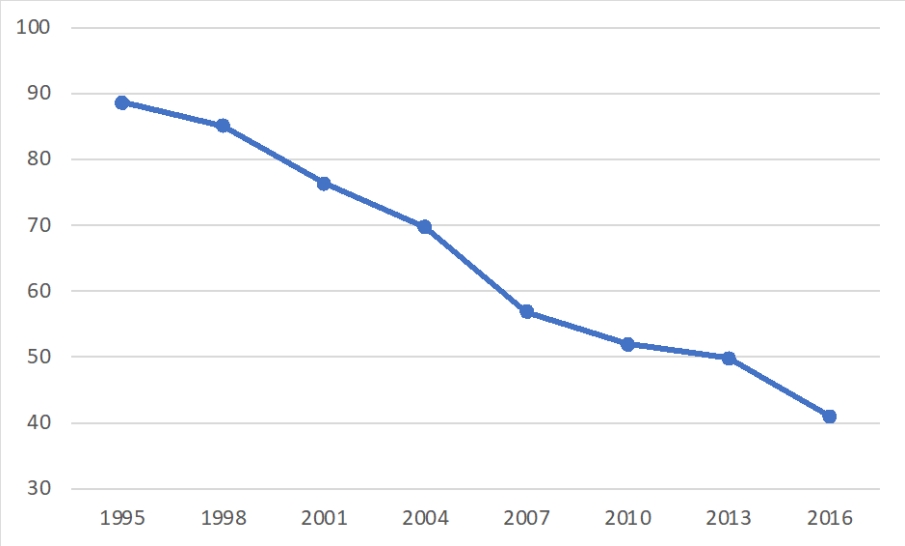
1. banks with a sectoral background;
2. banks with a local government background; and
3. banks with a financial holding company background.

Each category has distinct strengths and weaknesses (see Table 2.2) and each has distinct competitive characteristics.

[5] For a more detailed discussion on bad debt problems of the state-owned commercial banks, see the following section 2.5.

[6] The banks with a sectoral background are those JSCBs whose major shareholders are leading conglomerates in one or more specific sectors, one of the main operating incomes of these banks comes from the income earned by the financial services and products banks provide for the sectors they serve. The banks with a local government background refer to the group of JSCBs whose major shareholders are local governments, whereas the banks with a financial holding company background denotes JSCBs who are a subsidy of a financial holding company. Below Table 2.2 lists a few bank examples across the above three different categories.

Figure 2.2: The asset market share of state-owned commercial banks (%).



Source: CBRC and S&P Global Market Intelligence Platform

Table 2.2: Categorisation of joint-stock banks by shareholder background.

Category/example banks	Strengths	Weaknesses
Sectoral background:		
CMB - Shipping and transportation HXB - Steel and infrastructure	Strong commercial orientation driven by corporate shareholders; More aggressive corporate culture	Concentrated sector risk; Risk of related party transactions and hidden non-performing loans by "evergreening loans"
Local government background:		
SPDB - Shanghai city CIB - Fujian province GDB - Guangdong province	Strong relationship with corporate clients owned or supported by local government; Low-cost funding from local government deposits; Clear "home base" advantage	Subject to the open-mindedness and influence of their local government; Overlap with their city commercial banks; Concentrated geographical risk
Financial holding company background:		
CNCB - China CITIC Group CEB - China Everbright Group	Strong brand name from the parent co.; Platform for cross-selling and expanding into other financial services (e.g., brokerage, insurance, trusts, etc.)	Lack of sense of urgency and competitiveness – similar to state banks; Lack of clear market positioning

CMB: China Merchants Bank, HXB: Hua Xia Bank, SPBD: Shanghai Pudong Development Bank, CIB: Industrial Bank, GDB: China Guangfa Bank, CNCB: China CITI Bank, CEB: China Everbright Bank.

Source: Huang et al. (2017)

With respect to city commercial banks and rural commercial banks, both are primarily controlled by local governments as well as local enterprises. The former banks were established by consolidating urban credit cooperatives and the latter by restructuring and consolidating rural credit cooperatives within a particular region. The setting up of rural commercial banks began in 2004 (see Lin and Zhang, 2009). As the Jia (2009, page 79) states, "*they have identified a clear market niche and developed a strategy of staying focused on localities of incorporation, serving small and micro enterprises, and tailoring their products and services to seek differentiated competition with large commercial banks*". Typically, city commercial and rural commercial banks operate only in one city or region, although some city commercial banks with strong financial performance have expanded cross-regionally in recent years.

For example, the Bank of Shanghai was the first to be allowed by the PBOC to establish a branch in Beijing, in 2005. Henceforth, the number of city and rural commercial banks seeking to grow their geographical presence has increased; however, most attempts fail due to the lack of local-government support and business contacts in the new region. It should be noted that the financial performance of these institutions depends mostly on their relationships with local governments and the economic growth of the region in which banks operate. In addition, these banks tend to be unevenly distributed across the mainland: they operate more in the developed south-east regions than in the less well-developed western regions. They are more likely to be concentrated in the city where the bank was founded. As of December 2016, they held around 21% of total banking assets.

As indicated previously, China's accession to the WTO in 2001 represented the occasion on which the Chinese government agreed to open up its banking system. In December 2006, the CBRC permitted nine foreign banks to start their preparatory work for launching local branches in China (Yin et al., 2015). Currently, more foreign banks have been able to incorporate locally in China; as such, the banking competition could benefit from the increasing presence of foreign banks. Generally, Garnaut, Song and Fang (2018) point out that there are four models for foreign banks to enter the domestic banking market:

1. acquiring a minority share in an existing bank;
2. establishing a representative office or bank branch[7];
3. creating a joint venture with a domestic bank[8]; and
4. setting up a fully foreign-owned bank[9].

In China, the latter three types of foreign venture are considered to be foreign banks subject to domestic rules and regulations governing them. By the end of 2016, foreign banks had only 1% of the national market share, indicating a rather limited foreign participation in the Chinese banking industry.

Amendment 2b:

This study utilises annual accounting data, eligible and regulatory capital information for 135 Chinese commercial banks over the sample period of 2005 to 2015[10]. Among these banks, 6 are state-owned commercial banks[11] and 10 are joint-stock commercial banks[12]. City and rural commercial banks collectively account for around 68% of the sample composition, of which there are 66 city commercial banks[13] and 26 rural

[7] For example, Standard Chartered, Deutsche Bank and Singapore's DBS.

[8] HSBC in 2004 took a US$1.7 billion or 20% investment in Bank of Communications (one of the first such entries by a foreign bank). It was "*a highly structured joint-venture arrangement to cooperate in credit cards, including distribution of co-branded cards on nationwide basis*" (Hope and Hu, 2006, page 80).

[9] For example, HSBC operated 198 own-brand branches in 2014 across China and generated US$978 million in pre-tax profits (HSBC, 2014).

[10] Information was available for 184 commercial banks at the time of data collection; however, following the criteria proposed by Kosmidou (2008), only 135 commercial banks are included in the test sample for our estimation. To be incorporated into the sample, the following requirements had to be met. (i) All of the following observations with missing values, negative values or zero values are omitted: interest expense, operating expense, personnel expense, loans, other earning assets, loans and advances to banks, total assets, fixed assets, customer deposits, equity, non-performing loans and loan loss provision. (ii) All sample banks had to have at least one year of observations over 2005-2015 for the essential information and variables used in our empirical modelling.

[11] They are: Agricultural Bank of China, Bank of China, Bank of Communications, China Construction Bank, Industrial & Commercial Bank of China, and Postal Savings Bank of China.

[12] The 10 sample joint-stock commercial banks are: China Bohai Bank, China CITIC Bank, China Everbright Bank, China Merchants Bank, China Minsheng Banking, China Zheshang Bank, Hua Xia Bank, Industrial Bank, Ping An Bank, and Shanghai Pudong Development Bank.

[13] These banks are: Bank of Langfang, Bank of Beijing, Bank of Cangzhou, Bank of Changsha, Bank of Chengdu, Bank of Chongqing, Bank of Dalian, Bank of Deyang, Bank of Dongguan, Bank of Fuxin, Bank of Guangzhou, Bank of Guilin, Bank of Guiyang, Bank of Hangzhou, Bank of Inner Mongolia, Bank of Jiangsu, Bank of Jilin, Bank of Jinhua, Bank of Jinhzou, Bank of Jiujiang, Bank of Lanzhou, Bank of Liaoyang, Bank of Luoyang, Bank of Nanjing, Bank of Ningbo, Bank of Qingdao, Bank of Rizhao, Bank of Shanghai, Bank of Shaoxing, Bank of Suzhou, Bank of Taizhou, Bank of Tianjin, Bank of Weifang, Bank of Wenzhou, Bank of XI'an, Bank of Yingkou, Bank of Zhengzhou, Baoshang Bank, China Guangfa Bank, China Resources

commercial banks[14]. The remaining 27 banks are foreign commercial banks[15]. The data were downloaded from the Orbis Bank Focus Database and the SNL financial Platform. These two international databases contain high-quality financial data (i.e., micro-level banking information) on worldwide banks and are widely employed by various leading financial institutions as well as supervisory authorities (e.g., central banks) for banking studies and policymaking (BIS, 2013). Spot checks were performed with financial statements of credit institutions to confirm the quality of the data and identify possible disparities. A panel dataset is constructed since it allows study of adjustment dynamics and deals with individual heterogeneity and collinearity issues (Fu and Heffernan, 2009).

Amendment 2c:

Concerning the summary statistics of variables utilised in the cost specification (4.13), the same set of input-output mix and risk control variables are selected for the stochastic cost function in this chapter as were used in section 3.4.3. The evolutions of bank inputs, outputs and risk variables across the sample period are illustrated in

Bank of Zhuhai, Chinese Mercantile Bank, Chongqing Three Gorges Bank, Dongying Bank, Fudian Bank, Fujian Haixia Bank, Guangdong Huaxing Bank, Guangdong Nanyue Bank, Guangxi Beibu Gulf Bank, Hankou Bank, Harbin Bank, Hubei Bank Corporation, Huishang Bank, Jiangxi Bank, Longjiang Bank Corporation, Nanchong City Commercial Bank, Ningbo Commerce Bank, Panzhihua City Commercial Bank, Qilu Bank, Qishang Bank, Shengjing Bank, Weihai City Commercial Bank, Xiamen Bank, Xiamen International Bank, Zhangjiakou City Commercial Bank, Zhejiang Chouzhou Commercial Bank, Zhejiang Mintai Commercial Bank.

[14] These rural commercial banks include: Beijing Rural Commercial Bank, Changshu Rural Commercial Bank, Chengdu Rural Commercial Bank, Chongqing Rural Commercial Bank, Dongguan Rural Commercial Bank, Foshan Rural Commercial Bank, Guangdong Shunde Rural Commercial Bank, Guangzhou Rural Commercial Bank, Hangzhou United Rural Commercial Bank, Jiangsu Haian Rural Commercial Bank, Jiangsu Jiangnan Rural Commercial Bank, Jiangsu Jiangyin Rural Commercial Bank, Jiangsu Wujiang Rural Commercial Bank, Jiangsu Zijin Rural Commercial Bank, Jilin Jiutai Rural Commercial Bank, Nanhai Rural Commercial Bank, Ningbo Yinzhou Rural Cooperative Bank, Qingdao Rural Commercial Bank, Shanghai Rural Commercial Bank, Tianjin Binhai Rural Commercial Bank, Wuhan Rural Commercial Bank, Wuxi Rural Commercial Bank, Xiamen Rural Commercial Bank, Zhejiang Wenzhou Lucheng Rural Commercial Bank, Zhongshan Rural Commercial Bank, and Zhuhai Rural Commercial Bank.

[15] The sample foreign commercial banks contain: Allied Commercial Bank, Australia and New Zealand Bank (China), BNP Paribas (China), Bank of East Asia (China), Bank of Montreal (China), Bank of Tokyo Mitsubishi UFJ (China), Citibank (China), Credit Agricole CIB (China), DBS BANK (China), Dah Sing Bank (China), Fubon Bank (China), HSBC Bank (China), Hana Bank (China), Hang Seng Bank (China), Industrial Bank of Korea (China), JP Morgan Chase Bank (China), Metropolitan Bank (China), Mizuho Bank (China), Nanyang Commercial Bank (China), OCBC Bank (China), Royal Bank of Scotland (China), Shinhan Bank (China), Societe Generale (China), Standard Chartered Bank (China), Sumitomo Mitsui Bank(China), United Overseas Bank (China), and Wing Hang Bank (China).

Figures 3.1, 3.2 and 3.3, respectively. See pages 126-129 for a detailed discussion of summary statistics of bank inputs, outputs and risk terms for the whole sample over the examination period of 2005-2015. Moreover, in this section, we further report descriptive statistics for different types of sample banks – see Table 4.5, 4.6, 4.7, 4.8 and 4.9. As shown, on average, Chinese state-owned commercial banks have the highest personnel costs, with a mean value of CNY40840.98 million, followed by joint-stock commercial banks (CNY6618.79 million), rural commercial banks (CNY803.68 million), city commercial banks (CNY632.81 million) and foreign commercial banks (CNY371.11 million). Not surprisingly, for all types of banks, the balance of total interest expenses is substantially higher than those for personnel expenses and other operating expenses. This is because the underdeveloped and immature features of Chinese banking system make Chinese banks tend to rely on traditional banking services (i.e., deposit-taking) to produce their earnings.

With respect to input prices, on average, Chinese foreign commercial banks display the highest price levels among all types of banks over the sample duration of 2005-2015. Indeed, the mean of P1 is as high as 5.65 for foreign commercial banks, and the mean of P2 and P3 for this type of banks are 0.04 and 4.67, respectively. Table 4.5 show that state-owned commercial banks exhibit the largest output levels among all groups of banks. More specifically, the mean of gross loans is CNY3750842 million for sample state-owned banks, this figure is roughly 81% higher than that of joint-stock banks (CNY646656.4 million) who are the second largest group of banks in terms of output level. Meanwhile, its balance of other earning assets is CNY1850050 million – this value is almost 7 times as large as joint-stock banks (CNY270806.8 million), around 50 times, 65 times and 262 times bigger than city commercial banks (CNY36546.08 million), rural commercial banks (CNY28272.93 million) and foreign banks (CNY7039.79 million) respectively. Again, compared with the other four types of banks, state-owned banks record the highest balance of loans and advances to banks (CNY785432.9 million). In addition, it can be observed that the lowest mean value of equity (CNY4584.71 million) is reported by the group of Chinese foreign commercial banks. Whereas state-owned commercial banks report the highest equity balance (CNY471125.6 million) – an indication of their outstanding capitalisation performance across the sample period.

However, these banks are confronted with the largest risk exposures compared to other types of banks, given their mean of loan loss provision is CNY22765.68 million and their non-performing loans stock is CNY62908.98 million.

Table 4.5: Descriptive statistics of variables selected for equation (4.13) of sample state-owned commercial banks.

Variables	Mean	Std. Dev.	Min	Max
Inputs:				
X1	40840.98	20909.95	5776	77887.48
X2	118970.5	57494.96	18089	248256.5
X3	34123.86	12470.4	10127	58462.12
Input prices:				
P1	0.55	0.16	0.23	0.94
P2	0.02	0.01	0.01	0.04
P3	0.57	0.47	0.28	2.28
Outputs:				
Y1	3750842	1899740	769540	8140871
Y2	1850050	825930.9	385951.3	3488041
Y3	785432.9	408604.8	165634.4	1904833
Risk terms:				
Z1	471125.6	271322.4	80401.95	1228293
Z2	22765.68	14083.38	3850.39	63177.46
Z3	62908.98	36014.54	3098.66	154417
Total costs:				
TC	193935.3	86061.52	33992	370037.3

All values are expressed in millions of CNY.
where X1: Personnel Expenses, X2: Total Interest Expenses, X3: Other Operating Expenses, P1: X1 / Total Assets, P2: X2 / Average Customer Deposits, P3: X3 / Total Assets, Y1: Gross Loans, Y2: Other Earning Assets, Y3: Loans and Advances to Banks, Z1: Equity, Z2: Loan Loss Provision, Z3: Non-performing Loans, TC: X1+X2+X3.

Source: Author's own calculations

Table 4.6: Descriptive statistics of variables selected for equation (4.13) of sample joint-stock commercial banks.

Variables	Mean	Std. Dev.	Min	Max
Inputs:				
X1	6618.79	4839.85	313.11	21416.62
X2	27893.59	22790.87	1706.39	90395.4
X3	5656.95	3735.29	485.48	16609.24
Input prices:				
P1	1.12	0.49	0.24	2.93
P2	0.03	0.01	0.02	0.07
P3	1.03	0.50	0.47	3.25
Outputs:				
Y1	646656.4	436913.8	42544.01	1926695
Y2	270806.8	284179.7	15645.21	1780153
Y3	229023	173979.5	10170.04	820504.6
Risk terms:				
Z1	72735.41	61026.54	3562.05	246787.1
Z2	5333.49	6584.72	160.45	39230.6
Z3	7416.95	5978.42	140.69	32333
Total costs:				
TC	40169.34	30349.65	3045.21	112165.4

All values are expressed in millions of CNY.
where X1: Personnel Expenses, X2: Total Interest Expenses, X3: Other Operating Expenses, P1: X1 / Total Assets, P2: X2 / Average Customer Deposits, P3: X3 / Total Assets, Y1: Gross Loans, Y2: Other Earning Assets, Y3: Loans and Advances to Banks, Z1: Equity, Z2: Loan Loss Provision, Z3: Non-performing Loans, TC: X1+X2+X3.

Source: Author's own calculations

Table 4.7: Descriptive statistics of variables selected for equation (4.13) of sample city commercial banks.

Variables	Mean	Std. Dev.	Min	Max
Inputs:				
X1	632.81	832.51	14.24	6256.42
X2	3198.13	5054.46	58.35	37351.92
X3	568.19	745	17.05	5814.15
Input prices:				
P1	0.86	0.87	0.12	8.01
P2	0.03	0.02	0.01	0.15
P3	0.74	0.59	0.14	6.62
Outputs:				
Y1	62289.21	89296.15	2027.25	591355.8
Y2	36546.08	54105.02	158.15	421358.8
Y3	24691.61	38592.23	17.55	340015.6
Risk terms:				
Z1	8718.68	11095.79	195.47	79422.41
Z2	495.12	1056.44	2.14	14553.46
Z3	933.49	1863.85	0.14	18554.78
Total costs:				
TC	4399.14	6504.57	106.09	49422.49

All values are expressed in millions of CNY.
where X1: Personnel Expenses, X2: Total Interest Expenses, X3: Other Operating Expenses, P1: X1 / Total Assets, P2: X2 / Average Customer Deposits, P3: X3 / Total Assets, Y1: Gross Loans, Y2: Other Earning Assets, Y3: Loans and Advances to Banks, Z1: Equity, Z2: Loan Loss Provision, Z3: Non-performing Loans, TC: X1+X2+X3.

Source: Author's own calculations

Table 4.8: Descriptive statistics of variables selected for equation (4.13) of sample rural commercial banks.

Variables	Mean	Std. Dev.	Min	Max
Inputs:				
X1	803.68	783.72	27.3	3517.09
X2	2629.17	2666.85	190.85	12649
X3	505.25	384.31	67.91	1662.29
Input prices:				
P1	0.74	0.36	0.10	2.16
P2	0.03	0.01	0.01	0.07
P3	0.55	0.24	0.20	1.46
Outputs:				
Y1	60841.34	47784.55	8415.93	192997.1
Y2	28272.93	30311.37	471.65	145568.8
Y3	23101.07	30823.73	611.12	178281.7
Risk terms:				
Z1	8807.27	7396.52	901.30	32941.37
Z2	457.16	440.30	3.72	2086.06
Z3	1171.23	1444.10	81.83	8373.67
Total costs:				
TC	3938.11	3712.89	352.5	15434.51

All values are expressed in millions of CNY.
where X1: Personnel Expenses, X2: Total Interest Expenses, X3: Other Operating Expenses, P1: X1 / Total Assets, P2: X2 / Average Customer Deposits, P3: X3 / Total Assets, Y1: Gross Loans, Y2: Other Earning Assets, Y3: Loans and Advances to Banks, Z1: Equity, Z2: Loan Loss Provision, Z3: Non-performing Loans, TC: X1+X2+X3.

Source: Author's own calculations

Table 4.9: Descriptive statistics of variables selected for equation (4.13) of sample foreign commercial banks.

Variables	Mean	Std. Dev.	Min	Max
Inputs:				
X1	371.11	435.48	0.4	1762.16
X2	839.88	939.87	1.2	4616.84
X3	292.13	345.29	0.5	1672.66
Input prices:				
P1	5.65	5.80	0.18	41.74
P2	0.04	0.02	0.01	0.16
P3	4.67	5.36	0.09	42.05
Outputs:				
Y1	22726.47	23617.17	71.1	118678
Y2	7039.79	12451.46	0.17	87849.03
Y3	10869.06	10273.55	17.76	45651.9
Risk terms:				
Z1	4584.71	4392.28	41.9	28288.92
Z2	121.96	204.15	0.14	1065.24
Z3	196.24	280.74	0.28	2128.22
Total costs:				
TC	1503.13	1604.51	2.1	7091.27

All values are expressed in millions of CNY.
where X1: Personnel Expenses, X2: Total Interest Expenses, X3: Other Operating Expenses, P1: X1 / Total Assets, P2: X2 / Average Customer Deposits, P3: X3 / Total Assets, Y1: Gross Loans, Y2: Other Earning Assets, Y3: Loans and Advances to Banks, Z1: Equity, Z2: Loan Loss Provision, Z3: Non-performing Loans, TC: X1+X2+X3.

Source: Author's own calculations

Point 3 of the joint report

More details should be provided concerning the comparisons of various measures of performance and stability of subsectors/strata of Chinese banks over time.

Addressed as follows in Chapter 2, pages 40-64:

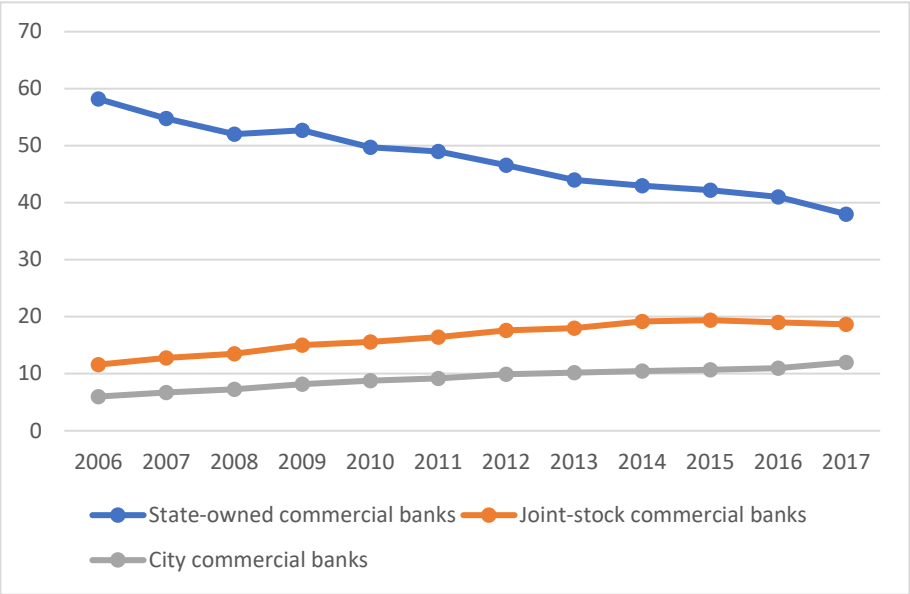
The above mentioned comment is addressed in Chapter 2, pages 40-64 (sections 2.5 and 2.6). The changes in the asset size, asset quality, earning capacity, and stability (capitalisation) of the Chinese banking system (as a whole) over time are discussed in these two sections. A detailed interpretation of the comparisons of the asset size, asset quality, earning capacity, and stability of different types of Chinese banks over time is presented in below Amendment 3. These discussions are included on separate pages in sections 2.5 and 2.6.

Amendment 3:

Asset size (Chapter 2, pages 43-44)

With the continuous and rapid growth of the asset scale of the entire Chinese banking sector, this sector's asset composition has also changed. Below Figure 2.5 presents the evolution of the market share of different types of Chinese banks in the total banking assets over time. As discussed in above section 2.4, after 20 years of banking reforms, the market share of state-owned commercial banks in the total banking assets has fallen remarkably from around 90% in 1995 to 41% in 2016, because of the strong competition and more aggressive growth strategy of the smaller banks. Figure 2.5 shows that such a downward tendency seems to continue in the future, albeit state-owned banks will remain systemically important owing to their vital roles in China's economy and their huge size. While oppositely, both Chinese joint-stock commercial banks' and city commercial banks' market share in the total banking assets exhibited a steady increasing trend. Specifically, the market share of joint-stock banks increased from below 12% in 2006 to 19% in 2016, and city commercial banks' market share almost doubled between 2006 and 2016 from around 6% to 11% during this period. However, Wu, Song and Chai (2018) suggest that these two types of banks' asset scale growth decelerated in 2017, partially as a result of the shadow-banking tightening and financial deleveraging.

Figure 2.5: Comparison of market share in the total banking assets by bank types (%).



CBRC has no disclosure on rural commercial banks and foreign commercial banks.

Source: CBRC and Wu, Song and Chai (2018)

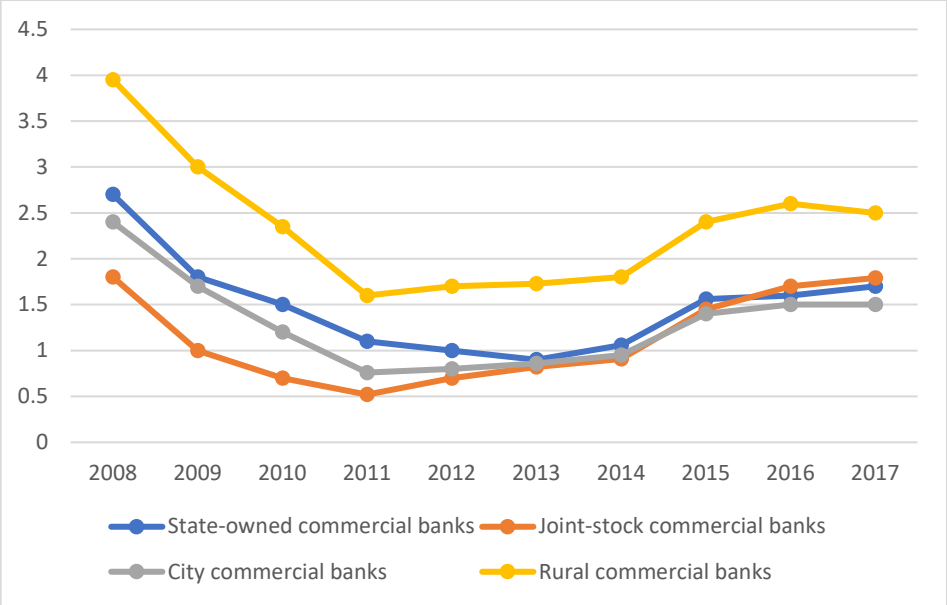
Asset quality (Chapter 2, pages 46-48)

Figure 2.7 compares the asset quality of Chinese banks with different ownership types. As shown, the quality of loan portfolios of all types of Chinese banks improved markedly at the beginning, thanks to the series of government initiatives (as discussed above) to mitigate the legacy of NPLs. Then the asset deterioration has set in for all banks since 2011. Among the four banking types, Chinese rural commercial banks remain among the worst player in the banking market. By the end of 2016, these banks' NPL ratio reached around 2.6%, much higher than that of joint-stock commercial banks at 1.7%, or of state-owned and city commercial banks at 1.6% and 1.5%, respectively. On the one hand, rural commercial banks are specialised in lending to small businesses and farmers in rural regions. Compared with other types of banks, they are likely to face higher probabilities of default risk given their customers are more vulnerable during economic downturns (Boateng, Huang and Kufuor, 2015). On the other hand, these banks' relatively small scale of profits and assets typically leads to less investments in credit risk management and thus gives rise to poorer asset quality of rural commercial

banks relative to other types of banks (Berger, Hasan and Zhou, 2009).

Other than rural commercial banks, Chinese state-owned commercial banks are the worst performer compared to city and joint-stock commercial banks, see Figure 2.7. Indeed, recently, all these major bank players have suffered pressure from their NPLs balances. CBRC (2017) examines the asset quality of Chinese state-owned commercial banks over the period of 2012 to 2017 and the results show that all 6 state-owned banks recorded a significant rise in their NPLs accounts, with the largest increase identified for the Industrial and Commercial Bank of China. In total, the 6 banks' NPLs stock amounted to CNY497.2 billion in 2017. However, it should be noticed that the value of NPL ratio of joint-stock banks has recently displayed a tendency of exceeding the level of NPL ratio of state-owned banks.

Figure 2.7: Comparison of NPL ratio by bank types (%).



NPL ratio: non-performing loan ratio, measured as the total amount of non-performing loans divided by the total amount of out-standing loans. CBRC has no disclosure on foreign commercial banks.

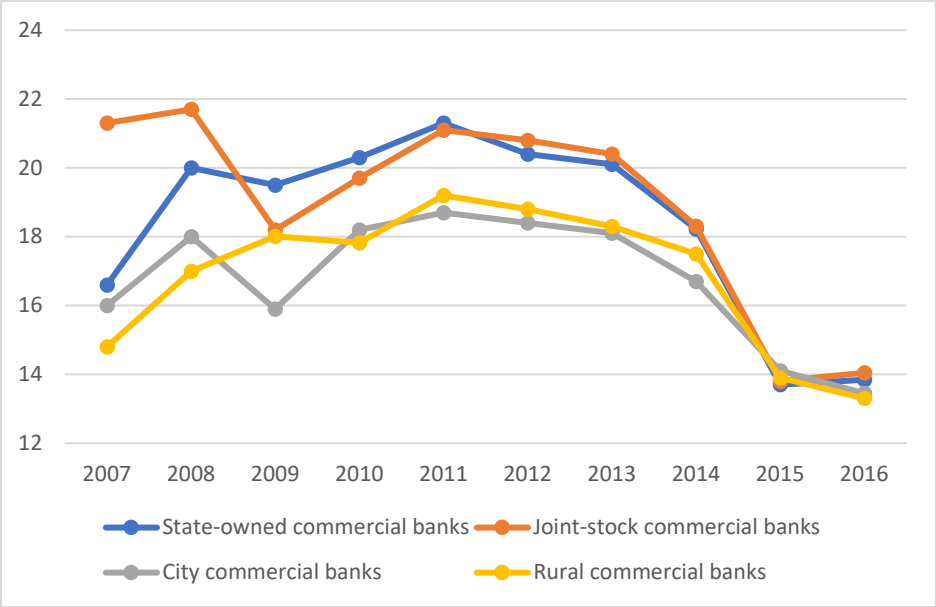
Source: CBRC and Wu, Song and Chai (2018)

Earning capacity (Chapter 2, pages 52-54)

Figure 2.10 compares the earnings of different types of Chinese banks. It shows that there has been a significant drop in the return on equity ratio for all bank types, matching the recent weak profitability performance of the Chinese banking sector. The state-owned banks and joint-stock banks are profit leaders compared with city and rural commercial banks. Indeed, the former group of banks are large Chinese banks with diversified products and services, as well as extensive branch networks, and they have natural advantages in carrying a more diversified income mix (Shih, Zhang and Liu, 2007). In contrast, the income mix of the latter group of banks is likely to be concentrated and more volatile in line with the interest rate and economic cycle (García-Herrero, Gavilá and Santabárbara, 2009). On average, there is a substantial difference in the return on equity ratio between the two groups. However, since 2013, this dispersion has been reducing, alongside the overall decrease in all banks' profits. Moreover, the continuously poor performance of the rural commercial banks could be partially explained by the fact that the growth in provisions because of banks' high NPL ratio (see Figure 2.7) has been considerably dampening their earning ability.

Actually, the period before the GFC was a 'golden era' for the development of Chinese joint-stock commercial banks as large state-owned commercial banks were busy with internal restructuring at that time (Lin and Zhang, 2009). From 2001 to 2006, the WTO accession led many joint-stock banks to go public. To illustrate, after the accession of China to the WTO in 2001, major joint-stock banks, such as the China Minsheng Bank, Huaxia Bank and Shanghai Pudong Development Bank, got listed on the A-share market. The IPOs notably improved their brand recognition and banks' access to capital markets (Wu, Song and Chai, 2018). This led to a remarkable expansion in their size and business operations. As a result, Chinese joint-stock commercial banks achieved a return on equity ratio of 19%-21% from 2001 to 2007, much higher than that of rural commercial banks, at 12%-15%, or of city and state-owned commercial banks at 14%-16% and 17%-20%, respectively (data reported by CBRC and Federal Reserve Economic Data). As displayed in Figure 2.10, the profit growth of joint-stock banks has slowed significantly after the GFC.

Figure 2.10: Comparison of ROE ratio by bank types (%).



ROE ratio: return on shareholders' equity ratio, measured as net income divided by shareholders' equity. CBRC has no disclosure on foreign commercial banks.

Source: CBRC and Wu, Song and Chai (2018)

Capitalisation (Chapter 2, pages 61-63)

Figure 2.13 presents the level of capital adequacy ratio of Chinese banks with different ownership structures. The largest state-owned commercial banks, have the highest capital position among all types of banks and satisfy the CBRC minimum requirement of 10.5% (much higher than the Basel III criterion of 8%). Indeed, as discussed above, the listing status of the BOC, BOCOM, CCB and ICBC has remarkably enhanced the capital account of Chinese state-owned commercial banks. Similarly, Chinese joint-stock, city and rural commercial banks all meet the Basel III requirement of 8% with joint-stock banks being the riskiest financial segment. On average, all types of banks are found to be more resilient to adverse economic shocks. For instance, a 12.7% capital increase was observed for state-owned commercial banks from 2014 to 2017. Meanwhile, the capital adequacy ratio of joint-stock banks enhanced from 10.6% to 12%.

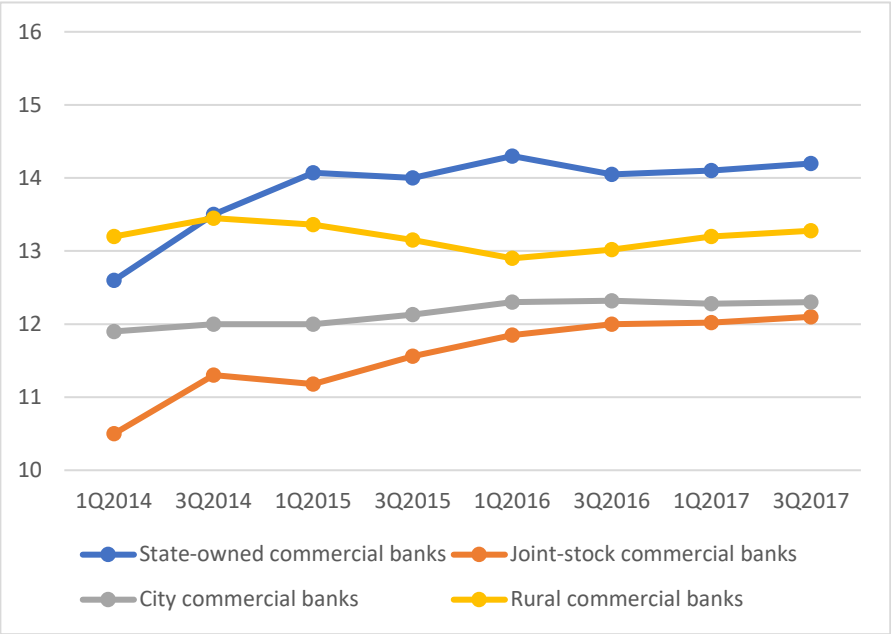
Nevertheless, Wu and Shen (2019) point out that both joint-stock and city commercial

banks have been facing increasing capital pressure recently – need more fresh capital to maintain their financial stability, given that there has been increasing risk-taking of these banks on both sides of their balance sheets. More specifically, lately, on the asset side, these banks have begun to heavily engage in investment assets, mainly more risky non-standardised credit assets that are considered capital-intensive, such as wealth management products, beneficiary rights and trust products. Indeed, the share of investment assets accounted for around 30%-40% of total assets for joint-stock and city commercial banks, as of December 2017[16]. Besides, on the liability side, a widespread shift away from stable core deposit funding towards volatile short-term wholesale funding has been reported for Chinese joint-stock and city commercial banks. This can be reflected by the fact that the total share of borrowing from the interbank market and non-financial institutions increased sharply from 12% in 2006 to 31% in 2017 and from 8% in 2006 to 23% in 2017 for joint-stock banks and city commercial banks, respectively. Meanwhile, this ratio rose from 7% to 13% for state-owned banks and rural commercial banks witnessed an increase from 8% to 15%[17]. Consequently, the risks are not evenly distributed in the banking industry – joint-stock banks and city commercial are the most leveraged banking segments. This leverage could be a significant source of systemic risk and exposes them to credit and liquidity risk (Elliott, Kroeber and Qiao, 2015; Bengtsson, 2016). All of these suggest that joint-stock and city commercial banks are more likely to face capital shortage in the case of unexpected adverse shocks compared with other types of banks. More capital buffers are needed to set aside for these banks in order to strengthen their ability to cope with adverse shocks in the financial system (or the economy).

[16] Data reported by S&P Global Market Intelligence Platform.

[17] Data reported by CBRC and S&P Global Market Intelligence Platform.

Figure 2.13: Comparison of CAR ratio by bank types (%).



CAR ratio: capital adequacy ratio, calculated by dividing a bank's capital by its risk-weighted assets. CBRC has no disclosure on rural commercial banks and foreign commercial banks.

Source: CBRC and Wu, Song and Chai (2018)

Point 4 of the joint report

The definition of "Shadow Banking" should be better clarified in the context of Chinese banks and how it may differ from (or coincide with) the common definitions of "Shadow Banking" in the relevant literature.

Addressed as follows in Chapter 2, pages 65-66:

The above mentioned comment is addressed in Chapter 2, pages 65-66, where an updated definition of shadow banking in the context of Chinese banking is provided. We further discuss how this definition differs from the current ones, found in the literature.

Amendment 4:

The term 'shadow banking' was coined by McCulley (2007), although the literature on shadow banking has not reached a consensus on its definition. According to Hou et al. (2018), widely used definitions of shadow banking can be categorised into two perspectives. "*The first perspective, outlined by the Federal Reserve Bank of New York, defines shadow banking as financial institutions, markets and instruments that can reproduce the core business of commercial banks. The second perspective views shadow banking as a system of credit intermediation that involves activities and institutions outside the regular banking regulation system (Financial Stability Board, 2011)*" (Hou et al., 2018, page 308). Both emphasise the role of non-bank financial intermediaries in replicating the core businesses of traditional banks (i.e., the functions of liquidity, maturity and credit transformation).

In short, in developed countries, shadow banks denote primarily unregulated financial intermediaries outside the banking system that still transfer credit to the system. That is, shadow banking, which originated in the wave of financial liberalisation in the 1980s, refers to the collection of non-bank financial institutions that serve bank-like activities (primarily lending) but outside normal bank regulations in advanced economies (Hou et al., 2018). Typically, these non-bank financial intermediaries have no access to the deposits, have no ability to borrow from public liquidity sources such as central banks, and are not subject to traditional banking regulations. They are normally parallel with

commercial banks to transfer credit to the system through many financially innovative activities (e.g., securitisations, mortgages and repurchase agreements) with a relatively higher leverage ratio (Bengtsson, 2016).

However, in contrast to shadow banking in developed economies, shadow banking in China has a different definition. China has a bank-centred shadow banking market; that is, shadow banking operations mainly take place inside the banking sector, with commercial banks playing a major role and only a small portion of shadow banking activities being undertaken by non-bank financial intermediaries (Li and Lin, 2016). In China, shadow banking basically comprises banks' regulatory arbitrage practices (e.g., bankers' acceptances) that circumvent regulatory requirements in order to offer credits to individuals and businesses who are incapable of acquiring funds from traditional commercial banks (PBOC, 2013; Lin, Sun and Wu, 2015).

For instance, certain banks are restricted by regulations (e.g., lending quotas such as the 75% loans to deposits ratio[18]) from extending credits to certain industries that need funding (Financial Stability Board, 2018). Some large banks are reluctant to offer credits to small and medium-sized firms due to the information asymmetry that can stem from these firms' potentially distorted financial reports. Hence, banks innovate new financial instruments to transfer funds in such a way that the regulations on lending can be circumvented. For example, banks can utilise interbank accounts that have fewer lending restrictions or cooperate with unregulated financial intermediaries in offering funds. In simple terms, differing from the aforementioned definition of shadow banking in developed economies, the Chinese style shadow banking describes the practices of banks to offer liquidity to the system without making loans to avoid violating various regulations[19]. In this thesis, we utilise shadow banking activities to represent such regulatory arbitrage practices of sample Chinese banks.

[18] The Chinese government removed the 75% cap on the loans to deposits ratio in May 2015.

[19] According to the PBOC (2013), typically, the following types of financial activities would be considered as banks' shadow banking transactions: inter-bank market activities, wealth management products, trust beneficiary rights, guarantees, financial leasing and bankers' acceptances.

Point 5 of the joint report

A graph should be added to show how the reforms have led to shrinking weights of state-owned banks in China (i.e., the proportion of state-owned Chinese banks over time).

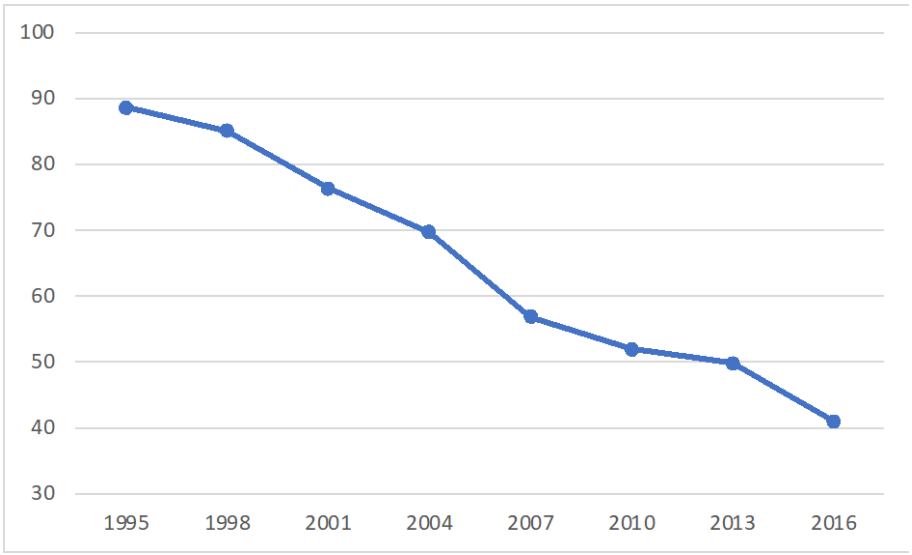
Addressed as follows in Chapter 2, page 31:

The above mentioned comment is addressed in Chapter 2, page 31. A new graph (Figure 2.2) that exhibits changes in the market share of state-owned commercial banks in the total banking assets over time is provided.

Amendment 5:

As previously stated, over the period of 1978 to 1984, four stated-owned commercial banks, the 'Big Four', were created to take over the commercial banking functions (e.g., deposit-taking and lending) from the PBOC, and built the foundation of the current Chinese banking system. One key feature of the Chinese banking sector is that it is highly concentrated (i.e., dominated by stated-owned commercial banks). In the early 1990s, the Big Four held almost 91% of total deposits and 90% of total loans of the entire banking system. After 20 years of financial reforms, especially with respect to entry to the WTO and bank initial public offerings (IPOs), by the end of 2016, the market share of state-owned banks in the total banking assets had dropped considerably from around 89% in 1995 to 41% (see Figure 2.2). Such a downward tendency can also be attributed to the increased competition and more aggressive growth strategy of smaller banks (Ye, Zhang and Dong, 2019). However, they still held 52.1% of deposits and 46.5% of loans by the end of 2016; and the now stated-owned commercial banks are still "too big to fail" due to their huge size and oligopolistic roles in the real economy (Wu, Song and Chai, 2018).

Figure 2.2: The asset market share of state-owned commercial banks (%).



Source: CBRC and S&P Global Market Intelligence Platform

Point 6 of the joint report

More details should be offered about the previous reform stages of the Chinese banking sectors and how these previous reforms may have impacted on the performance and stability of Chinese banks during the sample period 2005-2015. More clarifications on how the student has taken on consideration the implications of previous reforms in the model specifications and methods.

Addressed as follows in Chapter 2, pages 40-64 and Chapter 4, page 217:

The above mentioned comment is addressed in two separate parts in Chapters 2 and 4. Specifically, in Chapter 2, sections 2.5 and 2.6 (pages 40-64) discuss banks' performance after the country's accession to the WTO in 2001 and analyses the improvements in the capitalisation (stability) of Chinese banks. A detailed explanation of Chinese banking reforms (i.e., the NPLs disposal, financial liberalisation and bank recapitalisation) and how these reforms may affect the asset quality, earning capacity, and stability of banks over the past two decades (containing the sample period 2005-2015) is provided in below Amendment 6a. These discussions are added on separate pages in sections 2.5 and 2.6.

In Chapter 4, page 217 (Amendment 6b), we clarify how the proposed specifications take into account the implications of these banking reforms in estimation.

Amendment 6a:

<u>Asset quality (Chapter 2, pages 44-46)</u>

Another significant impact worth noting is that the reforms have greatly eased the NPL burdens of Chinese banks. Indeed, there were heavy issues of bad debt amongst Chinese banks in the 1990s, given that the industry's average NPL ratio was normally as high as 18% to 29% during this period (China Statistical Yearbook, 2005). In the 1990s, much of the lending by Chinese banks went to state-owned enterprises (SOEs); many of these were operating at a loss and so relied on bank loans to continue financing their operations, and ultimately failed to repay their loans (Fu and Heffernan, 2009). This was particularly the case for the Big Four, which represented over 90% of total banking assets throughout the 1990s (Turner, Tan and Sadeghian, 2012). As state

banks, the Big Four conducted a huge amount of policy-directed lending to SOEs during the late 1980s and 1990s (García-Herrero, Gavilá and Santabárbara, 2006). Essentially, they were forced to assume the function of a finance department and to provide financial support to SOEs at this time[20]. Adding to banks' NPLs in the early 1990s, bank lending contributed to a boom and subsequent bust in the Chinese real estate market (Berger, Hasan and Zhou, 2009).

Most of the NPLs were on the balance sheets of the Big Four (that is, ICBC, BOC, CCB and ABOC) (Turner, Tan and Sadeghian, 2012). Then the issuance of the Commercial Banking Law in 1995 was cited as a milestone indicating that the Chinese government sought to alleviate the NPL burdens through institutional reforms. In three stages of banking reform, the Chinese central government proposed a sequence of initiatives to ease the legacy of NPLs and strengthen the capital position of these largest banks. In specific, those initiatives mainly included[21]: (1) NPL carve-out: Four state-owned asset management companies (AMCs) were founded in 1999 to acquire the NPLs of the Big Four. Three rounds of NPL carve-out occurred across the period of 1999 to 2008 to clean up the banks' balance sheets. That is, in the first round, the Big Four transferred NPLs predating 1996 (a total amount of US$170 billion) to the four AMCs during 1999-2000. In the second round, auctions were utilised to transfer non-performing assets. In total, the equivalent of US$15.6 billion and US$18.1 billion in NPLs was auctioned from CCB and BOC to the four AMCs across 2001-2004. The third round proceeded with the approval of an NPL disposal of US$85.5 billion from ICBC to one of the AMCs (Huarong). (2) Capital injection: BOC and CCB each accepted US$22.5 billion of cash contribution to equity base from China's foreign exchange reserve in 2003. In 2005, ICBC got US$15 billion of capital injection, whereas ABOC received CNY130 billion of capital injection in 2008. (3) Foreign strategic investment: HSBC purchased a 19.9% stake of BOCOM in 2004. Temasek and Bank of America invested in CCB in 2005, and Goldman Sachs and RBS became the strategic investors of ICBC and BOC, respectively,

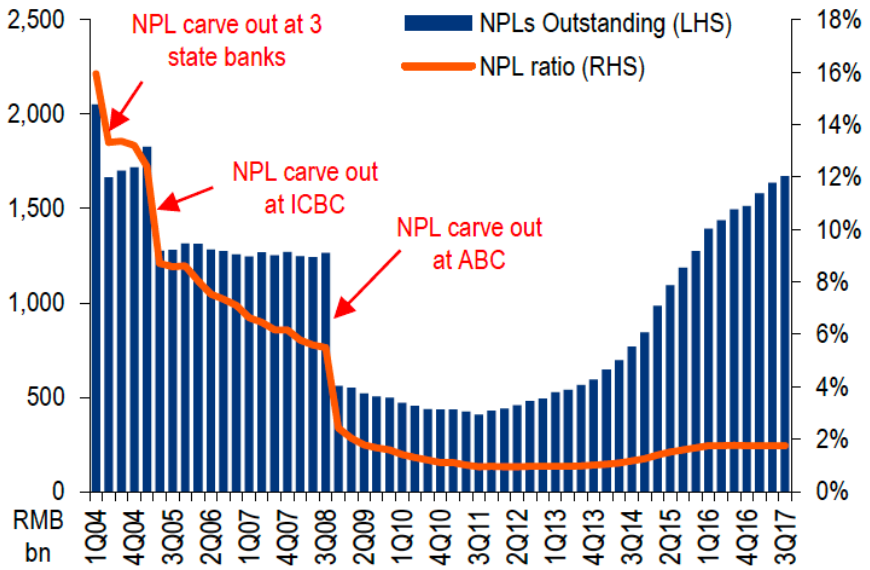
[20] Lardy (1999) and Ma and Fung (2002) also make this point.

[21] According to discussions concerning NPL disposal in García-Herrero, Gavilá and Santabárbara (2006) and Wu, Song and Chai (2018), our study summarises the major initiatives that Big Four have undergone to resolve their NPL burdens in this section.

in 2006. Most of these raised capitals were utilised to provision or write-off NPLs in the Big Four (Wu, Song and Chai, 2018).

With these efforts, the quality of Chinese banks' loan portfolios enhanced markedly. Figure 2.6 shows that banks' NPL ratio declined by more than 90% (from 16% to 1%) over 2004 to 2011, although the situation worsened again thereafter. While the NPL ratio had doubled by 2017 reaching 2%, the total size of NPLs rose by a factor of 3, from below CN500 billion in 2011 to over CN1,500 billion in 2017. Since the GFC, China has encountered overcapacity problems because of sluggish domestic demand and investment, despite a stimulus package of CNY4 trillion from the government to boost the capacity of domestic enterprises. During the economic downturn, borrowers' debt-servicing ability weakened and the NPL balance started to build up on banks' balance sheets. Chang et al. (2014) suggest that excessive risk-taking in the shadow banking market also contributed to the deterioration in banks' asset quality.

Figure 2.6: Chinese banking sector: asset quality



NPL ratio: non-performing loan ratio, measured as the sum of non-performing loans divided by the total sum of outstanding loans the bank holds.
ICBC: Industrial and Commercial Bank of China, ABC: Agricultural Bank of China.

Source: Wu, Song and Chai (2018)

Earning capacity (Chapter 2, pages 49-52)

Financial liberalisation is typically deemed as one of the important elements of China's banking sector reform (Dong, Girardone and Kuo, 2017). According to García-Herrero, Gavilá and Santabárbara (2006) and Dong, Girardone and Kuo (2017), during the past four decades, liberalisation efforts have gone in the following three directions. First, market-oriented practices are introduced and promoted in the operating of the Chinese banking industry. For instance, the credit quotas on Big Four were removed and government intervention in commercial lending was forbidden in 1999. From the end of 1999, private capital was permitted to enter joint-stock commercial banks and city commercial banks. Besides, the remuneration of excess reserves was cut by the PBOC four times[22] over 1998-2005, in order to encourage banks to invest their assets instead of hoarding liquid assets. Second, interest rates are liberalised by the PBOC. The process of interest rate liberalisation is gradual and not yet completed. It contains the market-based reform of lending and deposit rates, as well as liberalisation of inter-bank lending rates and bond market interest rates; see below Table 2.3 for a list of major initiatives completed during this process. Overall, this liberalisation allows banks to price their deposits and loans independently and improves the role of market forces in resource allocation. Third, the Chinese banking market has gradually opened up to foreign competitors since 2001. To illustrate, foreign banks were only permitted to provide foreign currency services in 2001. Then they were allowed to provide local currency services – including deposit-taking, loans, and other services – to foreign corporate clients and individuals from 2002, to Chinese enterprises from 2003, and to Chinese individual customers from 2006[23] (WTO WT/L/432, 2001).

The financial liberalisation discussed above is usually believed to remarkably enhance bank governance, efficiency and competition in China, thereby improving the earning

[22] Reserve requirements lowered from 20% to 8% in 1998, and again to 6% in 1999. A further reduction on reserve requirements from 1.62% to 0.99% was observed over 2002-2005 (García-Herrero, Gavilá and Santabárbara, 2006).

[23] Later, from 2006, the Chinese government has been proposed a series of initiatives to further relax the operating environment for foreign banks. For instance, making efforts to enhance autonomy in business development for foreign banks, one of the latest policy amendments on foreign banking institutions is that foreign banks can engage in custodian and consultancy services without prior Chinese government approval from 2017 (CBRC, 2017a).

ability of Chinese banks (Berger, Hasan and Zhou, 2009; Liu, 2017). Indeed, benefiting from China's sustained rapid economic growth[24] and the phased removal of NPLs of the Big Four and the financial liberalisation discussed above, the profitability of Chinese banks greatly increased in the first decade of the century (see Figure 2.9). The industry average of banks' return on equity (ROE) ratio increased from only 4% in 2002 to 15% in 2005, 18% in 2007 and more than 20% in 2010. Another profitability proxy, the return on assets (ROA) ratio, almost doubled over the period 2002 (0.65%) to 2010 (1.14%). Nevertheless, with further deregulation, the profit margins of Chinese banks have been under pressure in recent years. As shown in Figure 2.9, both ROE and ROA decreased after 2013.

Hou et al. (2018) propose that several factors may account for the more recent reduction in bank profitability in China. These include: (i) the increase in internet finance disrupting banks' core interest-rate bearing business; (ii) banks' non-interest income being reduced by both Fintech and policy headwinds; (iii) the rise in banks' NPLs; and (iv) deregulation of interest rates significantly lowering banks' net interest margin. An earlier study by Xu, van Rixtel and van Leuvensteijn (2016) suggested that the traditional interest income on average represents roughly 70% of Chinese banks' total earnings. As such, the profitability of Chinese banks is mostly driven by the credit and interest rate cycles. Accordingly, it is no surprise to see recent unfavourable bank margins, since the Chinese economy has seen low interest rates and low inflation. In this thesis, we examine empirically the factors underlying the profitability of Chinese banks in Chapter 4.

[24] Throughout the 2000s, China's GDP has maintained an average annual growth rate of around 10% each year (World Bank Open Data).

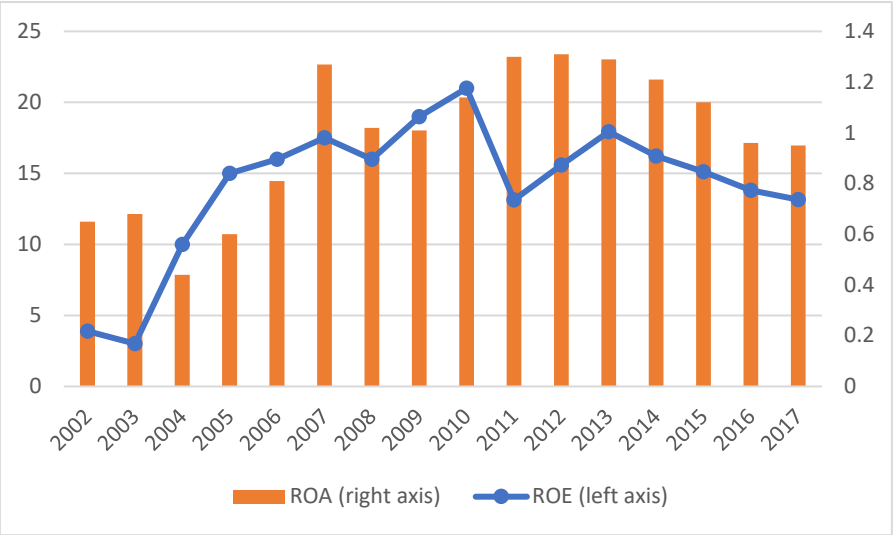
Table 2.3: Interest rate liberalisation process.

Market-based reform of lending and deposit rates
Loans
1987 Surcharge until 20% on reference rates on loans (working capital)
1996 The band changes to +-10% around reference rates
1998 Increase of upper limit to 20% (RCCs 50%)
1999 Increase of upper limit to 30% (RCCs and large enterprises 10%)
2003 Increase of upper limit to pilot RCCs to 100%
2004 Increase of upper limit to 70% and to RCCs to 100%, lower limit remains at 90%
2004 Liberalisation of upper limit of RMB lending rates (excluding RCCs, that increase until 130% above reference rates)
Deposits
1999 Negotiation on rates on over CNY30 million deposits with maturity above 5 years for insurance companies
2002 Same scheme for Social Security Fund
2003 Same scheme for China Postal Saving and Remittance Bureau
2004 All kind deposit rates can adjust downward
Liberalisation of inter-bank lending rates
1990 Pilot liberalisation of inter-bank lending market and rates
1996 Creation of unified inter-bank market
1996 Abolish the upper limit of interbank lending rates
Liberalisation of bond market interest rates
1996 Market based issuance of government bonds on pilot markets (stock markets)
1997 Utilization of the inter-bank market to deal in inter-bank bond repo transactions. Liberalisation of the bond repo interest rates
1998 Market-based issuance of financial bonds by the policy banks
1999 Market-based issuance of government bonds

RCCs: rural credit cooperatives.

Source: PBOC (2005) and García-Herrero, Gavilá and Santabárbara (2006)

Figure 2.9: Chinese banking sector: profitability (%).



ROA (right axis): return on assets ratio, estimated as net income divided by total assets; ROE (left axis): return on shareholders' equity ratio, estimated as net Income divided by shareholders' equity.

Source: S&P Global Market Intelligence Platform and Federal Reserve Economic Data

Capitalisation (Chapter 2, pages 55-61)

In addition to the NPLs problem discussed above, we now turn to discuss another long-standing obstacle that has hindered the Chinese banks: the undercapitalisation of the Chinese banking system. Indeed, over the 1990s and early 2000s, Chinese banks were plagued by severe capital shortages. The capital to assets ratio of Chinese banks was 4.91% in 1993, 3.78% in 1995, 2.77% in 1997, 4.78% in 1999, 4.21% in 2001 and 3.09% in 2003 (PBOC, 1998 and García-Herrero, Gavilá and Santabárbara, 2009). At this time, the Chinese banking was seriously undercapitalised relative to minimum international regulatory standards. China made huge efforts to improve the capitalisation of its banking system. The government proposed a set of initiatives, including direct capital injection, acquiring fresh capital from foreign investors and raising new capital through listing banks on stock exchanges (McGuinness and Keasey, 2010; Dong et al., 2016).

Specifically, during the period of the first phase, the second phase and early stage of the third phase of Chinese banking reform, the National People's Congress has worked hard to mitigate the deterioration in the balance sheets of the Big Four. For example,

in March 1998, it passed a plan submitted by the State Council to issue special government bonds to provide capital injection into these banks. The total value of this capital injection plan amounted to CNY270 billion (US$32.5 billion, equivalent to nearly 3% of China's GDP or 55% of central government revenues in that year). Later, in December 2003, the Central Huijin Investment Company was established, based on the investment of foreign exchange reserves by the State Administration of Foreign Exchange. Central Huijin injected a total of CNY499.6 billion (US$60.4 billion) into the Big Four: US$45 billion into the BOC and CCB in December 2003, CNY3 billion into the BOCOM in June 2004, and US$15 billion into the ICBC in April 2005, in the second phase of the plan. All funding sources were generated from the country's official foreign exchange reserves and borrowing from the Ministry of Finance.

Meanwhile, Chinese government has permitted foreign strategic investors entering domestic banks' capital for the purpose of diversifying ownership and strengthening management quality. To illustrate, Bank of America acquired 9% of CCB (amounting to US$2.5 billion) in 2005, whereas Temasek, a state-owned financial holding company from Singapore, also invested in CCB with US$1 billion in the same year. In 2006, Goldman Sachs and RBS invested in ICBC and BOC, respectively. Across the period of 2004 to 2008, a total of 24 domestic banks raised new capital from 36 foreign investors (García-Herrero, Gavilá and Santabárbara, 2009).

The IPO decisions made by the state-owned banks during the WTO post-accession period were widely considered to be a big step forward for Chinese banks to strengthen their capital positions (Ariff and Can, 2008). As Table 2.4 shows, the listing status of the ICBC increased its capital account by CNY97.1 billion, leading to an overall 44.3% capital increase in 2006 compared with the pre-IPO capital balance of CNY326.2 billion. Capital reserve increases for the BOC and CCB were CNY71.1 and CNY42.1 billion, and there was an 80.9% increase in the capital performance of the Bank of Communications.

Table 2.4: Total capital increases from banks' public listing (CNY billion).

Bank	Total capital (at the end of previous term) [a]	Proceeds from IPO including issuance cost [b]	Share capital increase [c]	Capital reserve increase [d]	Percentage of total capital increase by IPO [e=(c+d)/a]
ICBC	326.2	126.6			
	(June 2006)	46.6			
Total		173.3	47.5	97.1	44.3
BOC	233.8	90.0			
	(Dec. 2005)	20.0			
Total		110.0	35.9	71.1	45.8
CCB	200.9	74.6	30.5	42.1	36.1
	(June 2005)				
BOCOM	52.1	18.0			
	(Dec. 2004)	25.2			
Total		43.2	9.9	32.3	80.9

ICBC: Industrial and Commercial Bank of China, BOC: Bank of China, CCB: China Construction Bank, BOCOM: Bank of Communications.

Source: Ariff and Can (2008)

The recapitalisation programmes discussed above reflect China's efforts to restructure state-owned commercial banks and are crucial elements in its banking reform process (Dong et al., 2016). All these programmes have significantly boosted capital positions of Chinese banks, thereby enhancing the stability of the banking industry. Indeed, the capital to assets ratio of the Chinese banking system increased substantially from 3.09% in 2003 to 6% in 2008, again to 8.44% in 2015[25]. The capitalisation of Chinese banks was further strengthened after China's accession to the Basel Committee on Banking Supervision in 2009[26]. Since then, China has been able to discuss conditions of the global financial market and monetary policy with other central authorities, as well as to facilitate cooperation with these organisations in the banking regulatory area.

[25] Data reported by S&P Global Market Intelligence Platform and PBOC.

[26] At its 10th-11th March 2009 meeting, the Basel Committee announced the expansion of its membership and it invited representatives from following countries to join it: Australia, Brazil, China, India, Korea, Mexico and Russia (Knaack, 2017).

Besides, China has made commitments to fully adhere to the Basel II capital framework, and later Basel III capital rules[27] (CBRC, 2011a). Following Basel III guidance, the CBRC and PBOC undertook a programme of promoting a well-capitalised and stable banking sector in China.

For instance, following the Basel III capital criteria, the CBRC issued a series of capital rules in 2011 (see Table 2.5) to update the previous relaxed domestic regulations in order to boost the quality and quantity of the core capital of Chinese banks[28]. Specifically, Basel III required a minimum of 4.5% in core Tier 1 capital ratio, an increase from the earlier 2% level in Basel II (BIS, 2011). However, Table 2.6.2 displays that the CBRC amended this requirement and implemented a 5% rule for core capital across the Chinese commercial banks. In addition, the CBRC enforced a minimum of 6% in Tier 1 capital adequacy ratio and a minimum of 8% in capital adequacy ratio. It should be pointed out that an additional 2.5% of capital conservation buffer is further required by the CBRC over and above the minimum capital requirements, finally equalling 7.5% in core Tier 1 capital ratio, 8.5% in Tier 1 capital adequacy ratio and 10.5% in total capital adequacy ratio (CBRC, 2011a).

[27] It should be noted that Chinese banks were never regulated under Basel I regulations; the CBRC moved directly to Basel II and Basel III standards. Under the new Basel III requirements, the initiation of new capital rules for Chinese banks started from 1st January 2013, representing a new landmark regulatory scheme for the Chinese banking system.

[28] Overall, Basel III imposes tighter requirements on bank capital and eligible capital instruments in order to force banks to focus on core capital elements instead of debt-like substitutes (BIS, 2011).

Table 2.5: Regulatory capital requirements on Chinese banks.

	CBRC requirements
Regulatory capital adequacy ratio calculation	A commercial bank shall use the following formula to calculate its capital adequacy ratios: **1. Capital adequacy ratio:** ➢ $\frac{Total\ capital-Regulatory\ deductions}{Risk\ weighted\ assets} * 100\%$ **2. Tier 1 capital adequacy ratio:** ➢ $\frac{Tier\ 1\ capital-Regulatory\ deductions}{Risk\ weighted\ assets} * 100\%$ **3. Common equity Tier 1 capital adequacy ratio:** ➢ $\frac{Common\ equity\ T1-Regulatory\ deductions}{Risk\ weighted\ assets} * 100\%$
Regulatory requirements on capital adequacy	The total regulatory capital of a commercial bank consists of the sum of common equity Tier 1 capital, additional Tier 1 capital and Tier 2 capital. A commercial bank shall be subject to the following minimum capital requirements at all times: 1. Common equity Tier 1 capital adequacy ratio no less than 5%; 2. Tier 1 capital adequacy ratio no less than 6%; 3. Capital adequacy ratio no less than 8%. A commercial bank shall be subject to the capital conservation buffer over and above the minimum capital requirements. The conservation buffer shall be 2.5% of total risk weighted assets of the bank and comprised of common equity tier 1 capital. A systemically important bank shall be subject to a capital surcharge in addition to the minimum capital requirements.

Where the Table offers a summary of current regulatory capital requirements that specified by the CBRC (in line with Basel III standards) on Chinese banks.

Source: CBRC (2011a)

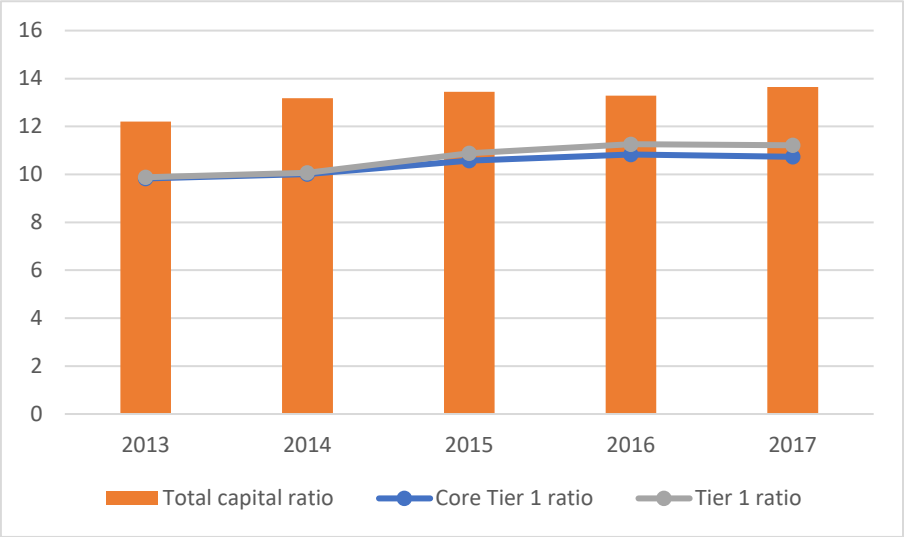
Moreover, given that the world banking system's increasing complexity has tended to put financial stability at risk, the Basel Committee introduced a new countercyclical buffer in 2010, and an additional capital buffer was added in 2013 for identified global systemically important banks (BIS, 2013a). See specific explanations concerning the list of global systemically important banks and their corresponding capital surcharge in section 3.3.2. Correspondingly, Chinese systemically important banks (i.e., the Big Four as identified by BIS based on the five-indicator appraisal framework)[29] were subject to an additional capital surcharge (1% or 1.5%) in addition to above minimum capital requirements in order to limit the negative externalities associated with the potential failure of these "too big to fail" banking institutions (see Table 3.2).

Overall, in accordance with rigorous international standards, the CBRC implemented a tighter regulatory framework that addresses qualified capital and higher minimum capital requirements in the Chinese banking system[30]. Therefore, the banks witnessed notable improvements in their resilience to adverse shocks in recent years through a substantial strengthening of their capital positions (see Figure 2.12), albeit the entire sector remains undercapitalised compared with debt financing. Evidently, as exhibited in Figure 2.12, Chinese banks' various capital indicators all meet the CBRC's minimum capital requirements. For example, the Tier 1 ratio was 9.88% in 2013, 10.88% in 2015, and 11.21% in 2017; all the values were higher than the minimum requirement of 8.5% (much higher than the Basel III criterion of 6%).

[29] In this respect, section 3.3.2 details BIS's process of identification of global systemically important banks based on the five-indicator appraisal framework.

[30] Following Basel III guidance, liquidity caps (i.e., a minimum requirement of 100% in liquidity coverage ratio and net stable funding ratio) were also introduced to Chinese banks to address the increasing concern about over-leveraging and the build-up of systemic risks in the banking market (BIS,2013b and BIS, 2014).

Figure 2.12: Chinese banking sector: capital performance (%).



Source: S&P Global Market Intelligence Platform

Amendment 6b:

It is worth noting that model specifications (4.2) and (4.3) consider the implications of those Chinese banking reforms discussed in Chapter 2 on bank profitability and stability. More specifically, how those reforms (i.e., the NPLs disposal and bank recapitalisation) significantly improve the asset quality and capitalisation of Chinese banks are detailly analysed in sections 2.5 and 2.6. Correspondingly, the non-performing loans ratio ($NPLs_{it}$) and Tier 1 regulatory capital ratio ($T1_{it}$) are incorporated in specifications (4.2) and (4.3) to capture the influences of the NPLs disposal and recapitalisation on bank performance over the sample period 2005-2015. Besides, as stated in section 2.3, the more mature banking operations following bank restructuring reforms substantially accelerate China's economic growth, resulting in three decades of 10% compound annual real GDP growth. Such implication is addressed by including $GDPGR_t$ in our specifications. Similarly, the inclusion of IR_t reflects our consideration of exploring the effects of interest rate liberalisation (as discussed in section 2.5) on bank earnings and soundness.

Point 7 of the joint report

Table 3.5 on page 85: not clear about its contents and what they mean. Identify the types of banks in an additional column. Add rankings by year.

Addressed as follows in Chapter 3, pages 91-97:

The above mentioned comment is addressed in Chapter 3, pages 91-97. In this section, we offer an explanation of the calculation method and meaning of systemic importance scores (the scores in Table 3.5) of 15 TBTF Chinese banks. Furthermore, a new column is added to Table 3.5 to describe the ownership types of these 15 TBTF banks. Moreover, an additional table, Table 3.6 is included, with the yearly rankings of the 15 TBTF banks in terms of their systemic importance scores across the period of 2008 to 2015.

Amendment 7:

This means, as shown in Table 3.4, the five categories of indicators adopted in our study to appraise a bank's systemic importance are: 'size', 'complexity', 'financial institution infrastructure', 'interconnectedness' and 'public confidence'. Consistent with the BIS methodology, all five categories are assigned an equal weight of 20%. As for sub-indicators, the total weight of a category (i.e., 20%) will be equally distributed to all sub-indicators in that category. For instance, there are three sub-indicators under the category of 'financial institution infrastructure' in our approach (see Table 3.4, column 'Approach for China'), each will be appointed a weight of a third of 20% (that is approximately 6.67%). Then the score on each sub-indicator is calculated as follows: (1) to divide individual bank amount by the aggregate amount across all 15 banks that are recognised to be TBTF; and (2) this calculated result is then weighted by the sub-indicator's weight. In this way, the final systemic importance score of a bank is the sum of weighted scores on all sub-indicators of this bank (there are nine sub-indicators under our measurement method), and such a score reveals the level of systemic importance of a bank in the banking system. The higher the score, the higher the level of systemic importance of a bank.

Correspondingly, the calculated systemic importance scores of 15 TBTF banks over the

period of 2008 to 2015 are specified in Table 3.5[31]. It shows that the internationally recognised Big Four have high systemic impact on Chinese banking, given that in total they accounted for 63.64% systemic importance of the entire industry in 2015, although this was down from 70.42% in 2005. Throughout 2008-2015, every year, the 6 state-owned commercial banks in total accounted for over 70% systemic importance of the whole banking sector. Meanwhile, the remaining 9 joint-stock banks were observed to present little domestic systemic importance. For example, the Industrial Bank was found to contribute only about 4.4% importance to the Chinese banking system in 2015, and China Zheshang Bank hardly imposed any systemic impact on Chinese banking over 2008-2015 with an average score of only 0.4%. Nevertheless, the collective systemic importance of these 9 banks kept increasing between 2008 and 2015 (their total score increased from 18% in 2008 to 25.6% in 2015). Such an increasing tendency indicates domestic systemic importance is distributed among the system more evenly.

Table 3.6 exhibits the yearly rankings of the 15 TBTF banks in terms of their systemic importance scores during 2008 to 2015. As shown, across this period, the four biggest systemic risk conveyors remained as the Big Four throughout. Among the Big Four, the Industrial and Commercial Bank of China (ICBC) is the single largest conveyor of systemic risk, accounting for 21.1% systemic importance of the whole system in 2008, and this was 18.8% in 2010, 20.4% in 2012, and 18.4% in 2015. Interestingly, Bank of China (BOC) accounted for roughly 13% systemic importance in 2015, ranking it fourth on the list; that figure represents a decline from around 17% in 2005, when it ranked third. However, BOC has been regarded as one of the G-SIBs and has made it onto the Financial Stability Board's list since it was first published in 2011, while ICBC has been on the list only from 2013. This reflects how different choices of financial indicators do produce discrepancies and/or global systemic importance does not necessarily equal domestic systemic importance. As stated above, BOC has long been considered to be one of the G-SIBs due to its high significance in both complexity and cross-jurisdictional activity dimensions, whereas our domestic method alters the 'cross-

[31] It should be noticed that the PBOC only began stress testing on designated banks from 2008 – which means the bank list adopted by us can only be traced back to 2008 – even though our sample covers the period from 2005 to 2015.

jurisdictional activity' to 'domestic sentiment' criteria which the other three banks of the Big Four would be benefit.

In conclusion, in addition to the Big Four, Bank of Communications, Postal Savings Bank of China, Industrial Bank, China Merchants Bank, China Minsheng Bank, Shanghai Pudong Development Bank, China CITIC Bank, China Everbright Bank, Ping An Bank, Hua Xia Bank, and China Zheshang Bank are determined as 'too big to fail' banks in the Chinese domestic banking market in our sample. After the GFC, the costs and risks of TBTF bailouts have highlighted the debates concerning the role and benefits of size of banks and the impacts of public safety net subsidies that accrue with both size and complexity (He and Chen, 2016). This is particularly the case for China; IMF's Chinese financial system stability assessment report (2017) emphasises that Chinese TBTF banks call for more close monitoring due to their critical performance in the funding market. The report shows that there is an increasing concern among policymakers about the probability of these TBTF banks repeating the 'Lehman episode' as their wholesale borrowing increases.

Table 3.4: The indicator-based measurement approach for China (compared with the standard BIS approach).

Category (and weighting)	Standard BIS approach	Approach for China
Size (20%)	➢ Intra-financial system assets (6.67%) ➢ Intra-financial system liabilities (6.67%) ➢ Securities outstanding (6.67%)	➢ Total assets (20%)
Complexity (20%)	➢ Notional amount of over-the-counter (OTC) derivatives (6.67%) ➢ Level 3 assets (6.67%) ➢ Trading and available-for-sale securities (6.67%)	➢ Held-to-maturity securities (10%) ➢ Trading securities (10%)
Financial institution infrastructure (20%)	➢ Assets under custody (6.67%) ➢ Payments activity (6.67%) ➢ Underwritten transactions in debt and equity markets (6.67%)	➢ Residential mortgage loans (6.67%) ➢ Corporate and commercial loans (6.67%) ➢ Government securities (6.67%)
Cross-jurisdictional activity (20%)	➢ Cross-jurisdictional claims (10%) ➢ Cross-jurisdictional liabilities (10%)	Not included
Interconnectedness (20%)	➢ Intra-financial system assets (6.67%) ➢ Intra-financial system liabilities (6.67%) ➢ Securities outstanding (6.67%)	➢ Loans and advances to banks (10%) ➢ Deposits from banks (10%)
Deposits from banks (Public confidence)	Not included	➢ Total customer deposits (20%)

Source: BIS (2013a) and Chen et al. (2014)

Table 3.5: The calculated systemic importance scores of 15 TBTF banks over 2008-2015.

Banks	Types	2008	2009	2010	2011	2012	2013	2014	2015
ICBC	State-owned	0.211	0.199	0.188	0.211	0.204	0.193	0.187	0.184
ABOC	State-owned	0.149	0.179	0.150	0.145	0.160	0.161	0.165	0.167
CCB	State-owned	0.176	0.168	0.153	0.148	0.145	0.164	0.163	0.155
BOC	State-owned	0.168	0.160	0.163	0.155	0.139	0.132	0.132	0.130
BOCOM	State-owned	0.068	0.065	0.070	0.062	0.057	0.058	0.055	0.058
PSBC	State-owned	0.048	0.048	0.054	0.051	0.051	0.054	0.054	0.050
IB	Joint-stock	0.024	0.023	0.033	0.036	0.040	0.041	0.042	0.044
CMB	Joint-stock	0.035	0.036	0.037	0.033	0.036	0.037	0.039	0.042
CMSB	Joint-stock	0.024	0.023	0.028	0.030	0.038	0.031	0.036	0.037
SPDB	Joint-stock	0.020	0.024	0.035	0.036	0.034	0.034	0.032	0.035
CITIC	Joint-stock	0.029	0.030	0.029	0.036	0.029	0.032	0.031	0.034
CEB	Joint-stock	0.022	0.023	0.029	0.026	0.027	0.022	0.022	0.022
PAB	Joint-stock	0.009	0.009	0.011	0.011	0.017	0.019	0.019	0.019
HXB	Joint-stock	0.015	0.011	0.017	0.017	0.017	0.016	0.016	0.017
CZB	Joint-stock	0.002	0.002	0.003	0.004	0.004	0.005	0.006	0.007

ICBC: Industrial & Commercial Bank of China, ABOC: Agricultural Bank of China, CCB: China Construction Bank, BOC: Bank of China, BOCOM: Bank of Communications, PSBC: Postal Savings Bank of China, IB: Industrial Bank, CMB: China Merchants Bank, CMSB: China Minsheng Banking Corporation, SPDB: Shanghai Pudong Development Bank, CITIC: China CITIC Bank Corporation, CEB: China Everbright Bank, PAB: Ping An Bank, HXB: Hua Xia Bank, CZB: China Zheshang Bank.
State-owned: state-owned commercial banks, Joint-stock: joint-stock commercial banks.

Source: Author's own calculations

Table 3.6: The yearly rankings of 15 TBTF banks by systemic importance scores over 2008-2015.

Banks	Types	2008	2009	2010	2011	2012	2013	2014	2015
ICBC	State-owned	1	1	1	1	1	1	1	1
ABOC	State-owned	4	2	4	4	2	3	2	2
CCB	State-owned	2	3	3	3	3	2	3	3
BOC	State-owned	3	4	2	2	4	4	4	4
BOCOM	State-owned	5	5	5	5	5	5	5	5
PSBC	State-owned	6	6	6	6	6	6	6	6
IB	Joint stock	9	12	9	9	7	7	7	7
CMB	Joint-stock	7	7	7	10	9	8	8	8
CMSB	Joint-stock	10	11	12	11	8	11	9	9
SPDB	Joint-stock	12	9	8	8	10	9	10	10
CITIC	Joint-stock	8	8	11	7	11	10	11	11
CEB	Joint-stock	11	10	10	12	12	12	12	12
PAB	Joint-stock	14	14	14	14	13	13	13	13
HXB	Joint-stock	13	13	13	13	14	14	14	14
CZB	Joint-stock	15	15	15	15	15	15	15	15

ICBC: Industrial & Commercial Bank of China, ABOC: Agricultural Bank of China, CCB: China Construction Bank, BOC: Bank of China, BOCOM: Bank of Communications, PSBC: Postal Savings Bank of China, IB: Industrial Bank, CMB: China Merchants Bank, CMSB: China Minsheng Banking Corporation, SPDB: Shanghai Pudong Development Bank, CITIC: China CITIC Bank Corporation, CEB: China Everbright Bank, PAB: Ping An Bank, HXB: Hua Xia Bank, CZB: China Zheshang Bank.
State-owned: state-owned commercial banks, Joint-stock: joint-stock commercial banks.

Source: Author's own calculations

Point 8 of the joint report

In the empirical regressions, instead of the TBTF dummy, the student could have used the yearly scores/rankings of the whole sample. It needs to be clarified why such scores/rankings have not been used in the empirical regressions. More details should be provided about non-TBTF Chinese banks and which subsectors/strata they belong to.

Addressed as follows in Chapter 3, pages 110-112 and pages 181-182:

The above mentioned comment is addressed in two separate parts in Chapter 3. That is, in Chapter 3, pages 110-112 (Amendment 8a), we explain our rationale for choosing to include the new generated TBTF dummy variable instead of yearly scores/rankings into the baseline regression. A description with respect to non-TBTF sample banks is also presented.

In Chapter 3, pages 181-182 (Amendment 8b), we compare the empirical results obtained when yearly systemic importance scores are considered with those obtained when the TBTF dummy variable is selected for estimation to further validate our choice to utilise the TBTF dummy variable to examine the significance of 'too big to fail'.

Amendment 8a:

Then, with an eye to the significance of 'too big to fail', the TBTF dummy variable and its interaction term with $T1_{it}$ is added into baseline regression (3.23). Accordingly, the extended model can be specified as:

$$SE_{it} = const + \alpha SE_{it-1} + \beta_1 SEC_{it} + \beta_2 SFTF_{it} + \beta_3 LR_{it} + \beta_4 LRsq_{it} + \beta_5 LLP_{it} + \beta_6 T1_{it} + \beta_7 TBTF_i + \beta_8 T1_{it} * TBTF_i + v_{it} \quad (3.24)$$

where $TBTF_i$ is a dummy variable that takes the value of 1 for the 15 Chinese TBTF banks[32] (as identified in section 3.3.2), or 0 otherwise.

[32] To recap, based on the PBOC's stress testing bank list, those 15 listed Chinese banks are the so-called 'too big to fail' banks in the Chinese banking market and are potential D-SIBs in nature. They are the Big Four, Bank of Communications, China CITIC Bank, China Everbright Bank, China Merchants Bank, China Minsheng Banking Corporation, China Zheshang Bank, Hua Xia Bank, Industrial Bank, Ping An Bank,

Here, our focus is to examine whether the TBTF status of these 15 banks increases the level of scale economies attained by them. Correspondingly, a new dummy variable, $TBTF_i$, is generated and included into above regression (3.24) for estimation. In this way, our sample (135 Chinese commercial banks[33]) is partitioned into two groups: 15 TBTF banks and 120 non-TBTF banks. Then, the question of whether TBTF banks are able to realise a higher extent of cost economies than non-TBTF banks is investigated. As mentioned, such an examination offers empirical evidence for current regulatory discussions of downsizing in banking. The rationale for us to use the $TBTF_i$ dummy variable instead of the yearly systemic importance scores/rankings in regression (3.24) to examine the significance of 'too big to fail' is because the information of systemic importance scores/rankings is only available for the 15 TBTF banks and using these scores/rankings for estimation cannot meet our aim of comparing the capacity of TBTF banks relative to non-TBTF banks in attaining cost economies.

That is, when the yearly systemic importance scores/rankings rather than the $TBTF_i$ dummy variable are used in estimation, our focus will change from examining whether TBTF banks can achieve more scale economies than non-TBTF banks to evaluating the effects of bank systemic importance on scale economies. Accordingly, the choice to include the yearly systemic importance scores/rankings instead of the $TBTF_i$ dummy variable as a determinant of scale economies in estimation defeats the purpose of our analysis. Besides, as specified in above Tables 3.5 and 3.6 on pages 96-97, the data of yearly systemic importance scores/rankings is only available for the 15 TBTF banks. Regarding the 120 non-TBTF sample banks, they will display missing values for the yearly systemic importance scores/rankings variable during estimation, and this can lead to a biased estimate of the coefficient of this variable in the regression. Moreover, by generating the $TBTF_i$ dummy variable, its interaction term with $T1_{it}$ then can be considered in estimation, enriching our analysis by offering information on whether capital strength affects the realisation of scale economies of TBTF banks and non-TBTF banks differently.

Postal Savings Bank of China, and Shanghai Pudong Development Bank.

[33] See section 3.4.3 on pages 118-119 for a detailed interpretation of our sample collection.

Looking at these two groups of banks, section 3.3.2 evaluates the systemic importance of the 15 Chinese TBTF banks. To briefly recap, 6 state-owned commercial banks and 9 joint-stock commercial banks are recognised as TBTF banks in our study, whereby the 6 state-owned banks dominate the systemic importance at a high level (see Table 3.5). With respect to the 120 non-TBTF banks in our sample, they are made up of 1 joint-stock commercial bank, 66 city commercial banks, 26 rural commercial banks as well as 27 foreign commercial banks. Interestingly, one joint-stock bank, China Bohai Bank, cannot demonstrate itself as potential systemically important and hence is not deemed to be a domestic systemically important bank in our sample. This is mainly due to its relatively small asset size compared with the asset scale of the 9 TBTF joint-stock banks and its limited network of contractual obligations with other financial institutions (Chen et al., 2014).

That is, China Bohai Bank, a newly established joint-stock bank in 2005, is the smallest nationwide commercial bank. In 2015, its asset size was CNY421,352 million, much smaller (nearly 38% less) than the size of the smallest joint-stock bank on the TBTF list (namely China Zheshang Bank). Besides, China Bohai Bank exhibits a rather limited extent of systemic interconnectedness, considering its small scale of exposures to intra-financial system assets and liabilities. For example, the total amount of loans and advances to banks of China Zheshang Bank was CNY52,261 million in 2015, this figure is about three times bigger than that of China Bohai Bank (CNY17,899 million)[34]. In consequence, China Bohai Bank is not on the TBTF list. Concerning the remaining city commercial banks, rural commercial banks and foreign commercial banks in our sample, they tend to be recipients of systemic risk and, in the case of unexpected shocks, can be severely affected by the spill-over effects that arise from the distress of banks that are TBTF. In conclusion, to examine the significance of TBTF, the differences in performance between TBTF banks and non-TBTF banks in achieving scale economies are inspected. Its findings shed the light on the policy choice for banking authorities.

[34] Data reported by Orbis Bank Focus Database.

Amendment 8b:

As was mentioned in section 3.4.2, to examine the significance of TBTF, the extended model (3.24) is used. With respect to $TBTF_i$, our result is in accordance with Beccalli, Anolli and Borello (2015), whereas a significantly negative relationship (-0.339) is seen between the TBTF status and economies of scale (see column D of Table 3.28). This implies that greater cost economies can be realised for 15 TBTF banks in China. For Chinese D-SIBs (the TBTF dummy variable taking the value of 1), the value of the coefficient on $T1_{it}$ (-0.257) and the coefficient on the interaction term $T1_{it} * TBTF_i$ (2.699) reveal the effects of $T1_{it}$ on scale economies for these banks. The aggregate value of 2.442 indicates that holding higher levels of regulatory capital actually reduces cost economies, particularly for TBTF banks, as these banks face higher compliance-related costs than non-TBTF institutions.

Interestingly, when the dummy variable and interaction term are considered, equation (3.24) shows that the influence of $T1_{it}$ on scale economies depends on the TBTF status of sample banks – tightened Basel III capital requirements adversely affect scale economies for TBTF banks while boosting the levels of economies of scale for non-TBTF banks. Similar to the conclusion drawn by us in above section 3.5.2, again, our analysis of determinants of economies of scale suggests that the need to break up TBTF banks does not seem to be justified for our Chinese sample. Moreover, given what the world banking sector experienced during the GFC, Zedda and Cannas (2017) point out that regulatory authorities have heaped unprecedented attention upon the banking industry with the aim to ensure the stability of the financial system. Nevertheless, there is increasing debate regarding the costs of numerous regulations implemented during the last decade, and the main concern is that the regulatory burden is not only applying high compliance costs[35] on large financial institutions (as demonstrated by our findings relating to the TBTF in regression 3.24), but is also

[35] To illustrate, Schorr (2019) has quantified and investigated the potential effect of the G-SIB capital buffer on JP Morgan Chase and Bank of America. To calculate the additional cost of the 'capital buffer' (see Table 3.2), Schorr compares the incremental Basel III Tier 1 capital cost for these two systemically important banks relative to the cumulative capital cost if they were split into smaller entities (thus avoiding the G-SIB charge). Based on the empirical analysis, he points out that the incremental Basel III Tier 1 common capital required for JP Morgan Chase and Bank of America would be US$24 billion on a combined basis versus that of an equivalent non-G-SIB bank.

inhibiting innovation[36] (e.g., Pasiouras, Tanna and Zopounidis, 2009; Bongini and Nieri, 2014; Schmaltz et al., 2014; and Buchak et al., 2018). This serves as a reminder to policy makers that they should balance the need for safety of the financial system with the need to promote financial innovation and dynamism when they formulate regulations for banking.

Indeed, the above examination is conducted by incorporating $TBTF_i$ dummy variable and its interaction term with $T1_{it}$ into baseline regression (3.23) for estimation. The rationale for us to employ this dummy variable instead of the variable of yearly systemic importance scores/rankings to inspect the significance of 'too big to fail' in our scale economies determinants analysis is detailly specified in section 3.4.2. Here, to take a step further, we include the yearly systemic importance scores[37] into regression (3.23) for estimation to investigate whether the empirical results yielded from this estimation are similar to those obtained when $TBTF_i$ is chosen for estimation. The empirical findings produced when yearly systemic importance scores are added are displayed in Table 7.6 in Appendix A. A comparison of the parameter estimates in Table 7.6 (column D) and Table 3.28 (column D) shows that these two sets of results are broadly similar[38].[39] In this circumstance, $TBTF_i$ is chosen over yearly systemic importance

[36] In this regard, the UK the 2013 Financial Services Act, the Switzerland 2011 TBTF Banking Act, the United States Dodd-Frank Act, the European Union proposal on the structural reform of banks. Specifically, in January 2014 the European Commission proposed a structural reform aimed at minimising the risky activities of the EU's 30 systemically important banks (European Commission, 2014). Starting in 2017, the proposal bans proprietary trading for banks that are labelled by international regulators as TBTF in the global economy, or whose activities surpass certain financial thresholds.

[37] As shown in Table 3.5, the data of yearly systemic importance scores is only available for the 15 TBTF sample banks. Accordingly, the 120 non-TBTF sample banks will be confronted with missing values issue with respect to this variable during estimation. To address this, we assign a value of 0 to this variable for all non-TBTF sample banks during estimation. Whereas TBTF sample banks will take the actual value of yearly systemic importance scores (as specified in Table 3.5) in estimation.

[38] Specifically, the empirical results when $TBTF_i$ and its interaction term with $T1_{it}$ are included into baseline regression (3.23) for estimation are presented in column D of Table 3.28. Then, instead of $TBTF_i$, we incorporate the variable of yearly systemic importance scores and its interaction term with $T1_{it}$ into equation (3.23) for estimation. Its empirical findings are displayed in column D of Table 7.6 (in Appendix A). By comparing these two sets of results, we find that each of the same variables yields two similar parameter estimates (excluding the parameter estimates on $T1_{it}$) that show the same sign and are both statistically significant/insignificant. The model results exhibited in columns A, B and C of Table 7.6 are identical to those displayed in columns A, B and C of Table 3.28, as the three same models are estimated (see the footnote below each table that explains the estimation models for each column of model results).

[39] Besides, this demonstrates the robustness of our proposed model estimation – parameter estimates

scores in examining the significance of TBTF since utilising $TBTF_i$ would be more in line with the purpose of our analysis (see related discussions on page 111) and the estimation of its interaction term with $T1_{it}$ enriches our study by giving information on whether capital strength imposes different impacts on the realisation of economies of scale for TBTF banks and non-TBTF banks.

provide valid information for our scale economies determinants study of Chinese banks.

Table 3.28: Empirical findings for equation (3.23).

Explanatory variables	OLS – equation (3.23)	FE – equation (3.23)	GMM – equation (3.23)	GMM – equation (3.24)
	A	**B**	**C**	**D**
SE_{it-1}	0.739***	0.522***	0.568***	0.602***
	(0.023)	(0.028)	(0.067)	(0.042)
SEC_{it}	-0.102***	-0.076	-0.075	-0.003
	(0.032)	(0.050)	(0.102)	(0.076)
$SFTF_{it}$	0.128**	-0.135*	-0.235	-0.007
	(0.062)	(0.077)	(0.357)	(0.248)
LR_{it}	-0.419***	-0.663***	-1.186***	-0.684***
	(0.088)	(0.119)	(0.447)	(0.165)
$LRsq_{it}$	0.514***	0.632***	1.176**	0.636***
	(0.128)	(0.175)	(0.592)	(0.206)
LLP_{it}	0.147***	0.117***	0.342**	0.267***
	(0.026)	(0.029)	(0.147)	(0.046)
$T1_{it}$	0.054	0.068	0.280	-0.257*
	(0.062)	(0.140)	(0.397)	(0.188)
$TBTF_i$				-0.339**
				(0.143)
$T1_{it} * TBTF_i$				2.699*
				(1.385)
_cons	0.328***	0.553***	0.633***	0.541***
	(0.032)	(0.039)	(0.102)	(0.058)
R-sq (overall):	0.753	0.709		
Breusch-Pagan	0.000			
Modified Wald test		0.000		
Number of IVs (groups)			63(118)	82(118)
Hansen-J-statistics			0.269	0.348

Difference-in-Hansen test (SE_{it-1})		0.530	0.572
Difference-in-Hansen test for levels equation		0.684	0.555
AR (1)		0.008	0.003
AR (2)		0.847	0.535

**Correlation is statistically significantly different from zero at the 10% level, **Correlation is statistically significantly different from zero at the 5% level, ***Correlation is statistically significantly different from zero at the 1% level. Standard errors are in parenthesis.*

SE_{it-1}: the autoregressive term, SEC_{it}: the securities to total assets ratio (%); $SFTF_{it}$: the short-term funding to total funding ratio (%); LR_{it}: the liquid assets to total customer deposits ratio (%); $LRsq_{it}$: the quadratic term of LR_{it}, LLP_{it}: the loan loss provision to total loans ratio (%), $T1_{it}$: the Tier 1 regulatory capital ratio (measured as the Tier 1 capital minus regulatory deductions as a percentage of bank risk-weighted assets), $TBTF_i$: the dummy variable that takes the value of 1 for the domestic systemically important banks and 0 for the remaining banks, and $T1_{it} * TBTF_i$: the interaction term of $T1_{it}$ and $TBTF_i$.

Column A shows the estimation result of the dynamic base model as in equation (3.23) through the ordinary least squares (OLS) approach, column B is the estimation result of the dynamic base model as in equation (3.23) through the fixed effects approach, column C presents the estimation result of the dynamic base model as in equation (3.23) through a two-step System Generalised Method of Moments approach, column D is the estimation result of the dynamic base model as in equation (3.23) through a two-step System Generalised Method of Moments approach by adding on the TBTF dummy variable and its interaction term with the Tier 1 regulatory capital ratio.

R-sq represents the R squared value (overall) to show the fitness of the OLS and FE estimation, Hansen-J-statistics tests the joint validity of all instrumental variables included, Difference-in-Hansen test confirms the validity of specified subsets instruments, AR (1) and AR (2) are the Arellano-Bond test for checking the assumption of no autocorrelation in error terms.

Table 7.6: Empirical findings when yearly systemic importance scores are added into baseline equation (3.23).

Explanatory variables	OLS – equation (3.23)	FE – equation (3.23)	GMM – equation (3.23)	GMM – equation (3.24)
	A	**B**	**C**	**D**
SE_{it-1}	0.739***	0.522***	0.568***	0.555***
	(0.023)	(0.028)	(0.067)	(0.065)
SEC_{it}	-0.102***	-0.076	-0.075	-0.295***
	(0.032)	(0.050)	(0.102)	(0.095)
$SFTF_{it}$	0.128**	-0.135*	-0.235	-0.195
	(0.062)	(0.077)	(0.357)	(0.214)
LR_{it}	-0.419***	-0.663***	-1.186***	-0.998***
	(0.088)	(0.119)	(0.447)	(0.334)
$LRsq_{it}$	0.514***	0.632***	1.176**	0.924**
	(0.128)	(0.175)	(0.592)	(0.506)
LLP_{it}	0.147***	0.117***	0.342**	0.319***
	(0.026)	(0.029)	(0.147)	(0.099)
$T1_{it}$	0.054	0.068	0.280	0.517
	(0.062)	(0.140)	(0.397)	(0.415)
$SCORE_{it}$				-4.369***
				(1.171)
$T1_{it} * SCORE_{it}$				33.633***
				(10.288)
_cons	0.328***	0.553***	0.633***	0.609***
	(0.032)	(0.039)	(0.102)	(0.131)
R-sq (overall):	0.753	0.709		
Breusch-Pagan	0.000			
Modified Wald test		0.000		
Number of IVs (groups)			63(118)	81(118)
Hansen-J-statistics			0.269	0.319

Difference-in-Hansen test (SE_{it-1})		0.530	0.624
Difference-in-Hansen test for levels equation		0.684	0.630
AR (1)		0.008	0.039
AR (2)		0.847	0.659

**Correlation is statistically significantly different from zero at the 10% level, **Correlation is statistically significantly different from zero at the 5% level, ***Correlation is statistically significantly different from zero at the 1% level. Standard errors are in parenthesis.*

SE_{it-1}: the autoregressive term, SEC_{it}: the securities to total assets ratio (%); $SFTF_{it}$: the short-term funding to total funding ratio (%); LR_{it}: the liquid assets to total customer deposits ratio (%); $LRsq_{it}$: the quadratic term of LR_{it}, LLP_{it}: the loan loss provision to total loans ratio (%), $T1_{it}$: the Tier 1 regulatory capital ratio (measured as the Tier 1 capital minus regulatory deductions as a percentage of bank risk-weighted assets), $SCORE_{it}$: yearly systemic importance scores, and $T1_{it} * SCORE_{it}$: the interaction term of $T1_{it}$ and $SCORE_{it}$.

Column A shows the estimation result of the dynamic base model as in equation (3.23) through the ordinary least squares (OLS) approach, column B is the estimation result of the dynamic base model as in equation (3.23) through the fixed effects approach, column C presents the estimation result of the dynamic base model as in equation (3.23) through a two-step System Generalised Method of Moments approach, column D is the estimation result of the dynamic base model as in equation (3.23) through a two-step System Generalised Method of Moments approach by adding on the yearly systemic importance scores and its interaction term with the Tier 1 regulatory capital ratio.

R-sq represents the R squared value (overall) to show the fitness of the OLS and FE estimation, Hansen-J-statistics tests the joint validity of all instrumental variables included, Difference-in-Hansen test confirms the validity of specified subsets instruments, AR (1) and AR (2) are the Arellano-Bond test for checking the assumption of no autocorrelation in error terms.

Point 9 of the joint report

Add a table summarising the variables used in chapter 3. Tables showing results for Models 1-4 should be moved to the appendix. The focus in chapter 3 should be on the results for Model 5.

Addressed as follows:

Amendment 9a (Chapter 3, page 117):

We have added a new table, Table 3.7, that summarises the variables included in the proposed model specifications (3.23) and (3.24). See Table 3.7 on the next page.

Amendment 9b (Appendix A, pages 335-338):

The four tables that display the estimates of scale economies and scale inefficiency for Models 1-4 are moved to Appendix A.

Amendment 9c (Chapter 3, page 138):

To clarify that the empirical results analysed in Chapter 3 are the results obtained from Model 5, the following few sentences are presented at the beginning of section 3.5.2.

The proposed cost equation (3.3) with related share equations is estimated by the maximum likelihood estimator utilising the seemingly unrelated regression technique. As previously stated, the Li test demonstrates that Model 5 (which includes all three risk variables) is considered as the best fitted model specification in relation to the efficiency of the Chinese banking sector. Thus, the following discussion is based on the empirical findings of Model 5 only.

Table 3.7: Variables incorporated in the proposed model specifications (3.23) and (3.24).

Incorporated variables	Notation	Measurement	Testing effects
Dependent variables:			
Scale economies	SE	Estimated by equation (3.9)	
Bank specific variables:			
Securities to total assets ratio	SEC	$Total\ securities/total\ assets$	Asset diversification
Short-term funding to total funding ratio	$SFTF$	$(Interbank\ borrowings + certificates\ of\ deposit + short\ term\ bonds)/total\ funding$	Funding strategy
Liquidity ratio	LR	$Liquid\ assets/deposits\ and\ short\ term\ funding$	Liquidity risk
Loan loss provision ratio	LLP	$Loan\ loss\ provisions/gross\ loans$	Credit risk
Tier 1 regulatory capital ratio	$T1$	$\frac{Tier\ 1\ capital - Regulatory\ deductions}{Risk\ weighted\ assets} * 100\%$	Capital strength
Too big to fail	$TBTF$	A dummy variable that takes the value of 1 for the 15 Chinese TBTF banks, or 0 otherwise.	TBTF status

For the list of 15 Chinese TBTF banks, see footnote 84.

Source: Author's own calculations

Point 10 of the joint report

Add discussions on cost efficiency in different strata: sizes, ownerships etc. Add tables to show changes of cost efficiency over time for different bank types. Add discussions on explaining the trends of cost efficiency overtime from the tables mentioned in the previous point.

Addressed as follows in Chapter 4, pages 255-260:

The above mentioned comment is addressed in Chapter 4, pages 255-260. In this section, we break down the estimates of cost efficiency by bank asset size and bank types – see Table 4.11 and 4.12 – and address the interpretations of our findings across each size group and each type of banks over 2005-2015.

Amendment 10:

To deepen our investigation, sample banks are grouped on the basis of asset size to further examine cost efficiency[40]. Table 4.11 displays the estimates of cost efficiency for the sample banks in each asset group for each year. The table shows that asset group 3 has the largest mean value of cost efficiency (86.43%) among the 4 asset groups, implying that these medium-large banks on average are the most cost-efficient banks in the sample. During the sample period, it can be observed that banks in asset group 4 yielded fairly close cost efficiency scores as banks in asset group 3. The mean of cost efficiency for this group of largest banks is 86.22%. This higher level of cost efficiency for banks in asset group 4 relative to banks within asset groups 1 and 2 could be because they obtain subsidies and favourable treatment from the government (Wheelock and Wilson, 2012; Zha et al., 2016). Furthermore, these larger banks are considered to be protected by implicit government guarantees and hence are more likely to be capable of attracting funds even when paying lower interest rates (on borrowing) than other smaller banks.

Concerning the banks in asset group 2, these medium-small banks enjoyed high levels

[40] See Table 3.17 for the classification of asset size groups. To recap, asset group 1 are the sample banks in the lowest quartile (banks with the lowest average asset size) and asset group 4 are the sample banks in the highest quartile (banks with the highest average asset size).

of cost efficiency as those banks in asset groups 3 and 4 up until the start of the GFC. Then, their efficiency score declined substantially from 90.29% in 2008 to 81.7% in 2015. Asset group 1, containing those smallest banks, produces the smallest mean efficiency score (82.44%) among the 4 size groups, and thus is the group with the worst practice. Indeed, noticeable efficiency variations are witnessed between this asset group and groups 3 and 4 (see Table 4.11). Such findings are in accordance with what has been reported by Zha et al. (2016), where largest commercial banks were found to be able to achieve greater cost economies than their smaller counterparts in a sample of Chinese banks. Nevertheless, across the sample period of 2005-2015, asset group 4 is the only one to exhibit an overall upward trend in cost efficiency estimates (its score rose by nearly 31% from 63.41% to 82.88%), while a gradual yet fluctuating downward tendency is seen for the other three groups.

Having analysed above the estimation findings based on four asset groups, we now compare the cost efficiency of different types of Chinese banks. Table 4.12 gives the cost efficiency estimates obtained for sample banks in each type at each tested year. As shown, on average, foreign commercial banks are the most cost-efficient, with a mean efficiency score of 87.08%, followed by rural commercial banks (86.4%), joint-stock commercial banks (85.94%), city commercial banks (85.29%) and state-owned commercial banks (79.74%). Indeed, in our sample, foreign commercial banks are the best practice banks that define the efficiency frontier. The high cost efficiency levels achieved by this type of banks could be a result of superior managerial expertise, governance and technology. Our findings are in line with prior work, such as Berger, Hasan and Zhou (2009), Matthews (2013) and Dong et al. (2016). These studies suggest that the more mature operations and a more relaxed regulatory environment of foreign banks relative to domestic banks allow them to more efficiently spread costs over their outputs.

Regarding the rural commercial banks and city commercial banks, the key driver that supports the superior cost performance of these two types of banks could be the increased competition within their specific bank segments. Across the sample period, we find that the cost efficiency estimates produced for city commercial banks and rural

commercial banks are roughly similar (see Table 4.12). To illustrate, city commercial banks record a mean of 85.67% for cost efficiency score in 2005, and the yearly cost efficiency score for rural commercial banks is 86.44% in 2005. There is only a 0.89% difference between these two scores. Similarly, year 2008 reports a 0.33% difference and a 0.19% difference is observed in year 2011. However, the dispersion in the levels of cost efficiency between these two types of banks has been increasing since 2011, alongside the overall reduction in cost efficiency scores for both types. The mean cost efficiency score for rural commercial banks is 84.25% in 2015, a decrease of about 3% from 86.44% in 2005. City commercial banks' mean efficiency estimate declined noticeably from 85.67% to 80.14% over 2005-2015.

Compared with state-owned commercial banks, joint-stock commercial banks are able to realise much higher levels of efficiency gains during the tested period. This better cost performance of joint-stock commercial banks confirms the general expectation that joint-stock banks outperform state-owned banks as they have no historical NPL burdens as in state-owned banks and better risk management practices, and are subject to less government interventions (see, Ariff and Can, 2008; Berger et al., 2009; Hou, Wang and Li, 2014; Pessarossi and Weill, 2015; and Dong et al., 2016). Nevertheless, our results are contrary to Dong, Hamilton and Tippett (2014) whose study finds that state-owned banks are the winners in comparison to joint-stock banks in attaining cost efficiencies in China. Differences in such results may be due to different input-output mix, methodologies, and particularly different periods being analysed. An interesting point worth noting is that joint-stock commercial banks have the largest variations with regard to cost efficiency in the sample.

As for the worst player in the banking market, Chinese state-owned commercial banks, on average, they are around 8% less cost-efficient than the best practice banks – foreign commercial banks. The huge restructuring costs (a result of banks' choice of active merger and acquisition responding to the GFC) and massive expenses which related to the previous misconduct instances may explain the low efficiency levels generated by state-owned commercial banks. Moreover, their cost performance can be burdened with additional capital regulations due to the 'too big to fail' incentive (Schmaltz et al.,

2014). Yet, these banks might benefit from the fintech or e-banking initiatives, giving rise to recent improvements in their cost efficiencies. Table 4.12 presents that their cost efficiency score increased from 75.75% in 2005 to 80.81% in 2015. Such findings are in accordance with the results documented in Huang and Fu (2013), where enhancements in cost efficiency were found for Chinese state-owned banks, which was attributed to the intense competitive pressure forcing these banks to be more efficient by upgrading technologies and operating on market principles.

Table 4.11: Estimated cost efficiency scores in each asset size group.

Year	**Asset group 1**	Std. error	**Asset group 2**	Std. error	**Asset group 3**	Std. error	**Asset group 4**	Std. error
2005	63.41%	0.079	85.71%	0.011	85.46%	0.012	86.66%	0.010
2006	88.59%	0.017	89.10%	0.008	87.67%	0.008	88.89%	0.007
2007	90.83%	0.004	90.35%	0.010	89.71%	0.007	90.17%	0.005
2008	91.07%	0.006	90.29%	0.012	91.70%	0.003	91.80%	0.005
2009	79.58%	0.027	85.90%	0.013	87.67%	0.008	85.04%	0.023
2010	81.03%	0.036	84.36%	0.015	88.27%	0.008	86.59%	0.022
2011	84.94%	0.021	85.36%	0.010	88.17%	0.006	88.16%	0.011
2012	82.07%	0.022	82.62%	0.011	84.94%	0.014	84.33%	0.012
2013	81.42%	0.025	79.70%	0.015	83.00%	0.013	83.28%	0.011
2014	81.05%	0.023	82.37%	0.010	83.17%	0.009	82.42%	0.010
2015	82.88%	0.012	81.70%	0.012	80.94%	0.016	81.08%	0.011
Full sample	82.44%	0.008	85.22%	0.004	86.43%	0.004	86.22%	0.004

Cost efficiency scores are estimated through equations (4.13) and (4.14) by the Battese and Coelli (1995) model.
See Table 3.17 for the classification of asset size groups.

Source: Author's own calculations

Table 4.12: Estimated cost efficiency scores of different types of banks.

Year	**State-owned**	**Joint-stock**	**City**	**Rural**	**Foreign**
2005	75.75% (0.038)	85.80% (0.019)	85.67% (0.007)	86.44% (0.026)	80.75% (0.099)
2006	79.50% (0.018)	91.56% (0.008)	88.04% (0.007)	87.56% (0.014)	89.36% (0.029)
2007	81.06% (0.025)	89.72% (0.030)	90.62% (0.002)	88.51% (0.011)	91.73% (0.007)
2008	77.89% (0.016)	91.64% (0.004)	90.97% (0.003)	90.67% (0.008)	91.68% (0.018)
2009	79.50% (0.013)	80.95% (0.070)	84.17% (0.013)	86.66% (0.015)	88.25% (0.012)
2010	81.06% (0.008)	81.41% (0.090)	86.06% (0.010)	86.17% (0.014)	85.13% (0.034)
2011	77.89% (0.007)	89.45% (0.011)	86.07% (0.009)	86.24% (0.008)	89.78% (0.007)
2012	81.20% (0.044)	84.73% (0.019)	82.95% (0.007)	85.06% (0.007)	87.24% (0.010)
2013	81.87% (0.019)	84.24% (0.014)	81.84% (0.007)	84.70% (0.007)	85.34% (0.011)
2014	80.61% (0.012)	84.31% (0.022)	81.67% (0.001)	84.09% (0.011)	84.26% (0.020)
2015	80.81% (0.008)	81.47% (0.019)	80.14% (0.027)	84.25% (0.008)	84.31% (0.012)
Full sample	79.74% (0.021)	85.94% (0.008)	85.29% (0.003)	86.40% (0.003)	87.08% (0.006)

Cost efficiency scores are estimated through equations (4.13) and (4.14) by the Battese and Coelli (1995) model. Standard errors are in parenthesis.
State-owned: state-owned commercial banks, Joint-stock: joint-stock commercial banks, City: city commercial banks, Rural: rural commercial banks, Foreign: foreign commercial banks.

Source: Author's own calculations

Point 11 of the joint report

Add more details about the policy implications of the thesis for Chinese banking stakeholders and regulators.

Addressed as follows in Chapter 5, pages 302-304:

The above mentioned comment is addressed in Chapter 5, pages 302-304, where we have added a section discussing the policy implications of the thesis for Chinese bank managers, regulatory authorities and the government.

Amendment 11:

5.2 Policy Implications

The empirical findings discussed above have various policy implications to Chinese bank managers, regulators and governmental authorities. First, scale economies that arise from off-balance sheet businesses suggest that diversification and deregulation do indeed contribute to the development of Chinese banking and should be considered in the policy agenda for the subsequent marketisation reforms of Chinese banks. The cost savings enjoyed by those largest banks in our sample suggest that policy initiatives that limit the size of large banks to alleviate TBTF concerns would put Chinese large banks at competitive disadvantage. Additionally, size restrictions may be ineffective as they work against market forces and induce banks to circumvent them. Evading the restrictions could therefore push risk-taking outside of the more regulated banking sector without necessarily decreasing systemic risk. In this sense, instead of downsizing, there is a need for Chinese regulatory authorities to introduce a series of new capital and liquidity requirements to update previous relaxed domestic regulations compliant with recent prudent international standards, in order to mitigate TBTF subsidies. Besides, the technological progress that has been shaping the Chinese market justifies bank consolidation and concentration. Hence, the industry-wide consolidation of efficient larger banks with inefficient smaller banks should be encouraged in the Chinese market for the aim of pursuing system efficiency.

Second, by examining the effects of recent regulatory reforms (in accordance with Basel III rules) on bank performance (i.e., scale economies, profitability and stability in our

case), our findings suggest that policy makers should balance the need for soundness of the financial system with the need to encourage financial innovation and dynamism when they devise regulations for banking. That is, new banking regulations such as the Basel III regime impose constraints on banks in the form of more liquidity and capital and also to restrain riskier areas of banking operation – all of which are aiming at reducing systemic risk and strengthening banks' ability to withstand adverse shocks. However, satisfying such prudential rules could enforce significant costs on banks. In our sample, these costs refer to the reduced bank scale economies and profits. Thus, when formulating regulations for banks, policy markets should bear in mind the trade-off between safety of the industry and the cost of implementing these regulations. Moreover, when splitting the sample by the TBTF status for a comparative analysis, our estimation results question the Basel Committee's approach whereby it provides only a one-size-fits-all regulatory regime for a banking landscape with a wide expanse of smaller and regional banks, numerous medium-sized banks, as well as very large and complicated banks. Indeed, we suggest that various regulatory criteria should be formulated to fit different sizes of banks, in order to lessen the operational burdens imposed by the need to comply with complicated rules for non-TBTF banks.

Third, our findings with regard to cost efficiency estimation suggest that for banks to achieve greater cost efficiency, bank managers need to ensure they have superior risk management expertise. In addition, on the macroeconomic effects to bank cost efficiency, bank managers should be capable of responding to uncertainties related with changing macroeconomic settings such as inflation and GDP growth, among others. This indicate that relevant monetary and fiscal policies aimed at stabilising inflation and sustaining the high GDP growth rate should be proposed by the Chinese government to boost bank efficiency.

Fourth, based on the empirical results of our bank profitability and financial stability determinants analysis, the following recommendations are made. (i) Chinese banks should improve their ability to manage the associated implicit costs in order to attain the profit-increasing effects of shadow banking activities. Banks also need to ensure they have adequate risk monitoring of their shadow banking operations to fully exploit

the stabilising effects of shadow banking activities. Furthermore, the fact that banks can aggressively conduct such regulatory arbitrage practices suggests regulatory gaps in the Chinese banking system. This could be a call for the close monitoring of banks' market conduct to support timely and informed policy decisions regarding proper changes in regulations. (ii) Improper government interventions are found to impose costs on Chinese banks in terms of reduced profitability. This would suggest that Chinese government should consider carefully when conducting interventions in the banking sector, government interventions are supposed to be carried out in a sense of promoting a more competitive and stable domestic banking market, instead of inducing extra operational costs for banks. (iii) At country level, there is a justification for the employing of a semi-floating exchange rate scheme by the government in China to foster bank performance.

Point 12 of the joint report

Discuss the relevance of board-level governance such as managerial compensation, board independence, board size, and board structure to your theoretical framework and empirical analysis. Address these points in research limitations and directions for further research. Add explanations on the limitation of the thesis and some directions for future research.

Addressed as follows in Chapter 5, pages 304-308:

The above mentioned comment is addressed in Chapter 5, pages 304-308. In this section, we discuss the limitations of the thesis and give directions for future research. Among the limitations presented, one limitation – the stochastic cost function used in our study does not address the potential effects of board-related features on cost efficiency of banks – is discussed in detail.

Amendment 12:

This thesis offers evidence in regard to scale economies, cost efficiency, and the profit and stability performance of Chinese banks. Our findings, however, are nonetheless subject to limitations. For instance, the method used to examine whether estimated scale economies are affected by TBTF considerations will reveal the true parameters of the cost specification only if our approach to the identification of TBTF banks is appropriate. Although the approach employed seems to perform well, it is unlikely to be perfect. Besides, as discussed in section 3.4.2, the system GMM estimator adopted to conduct bank profitability and stability determinants analysis could suffer from the finite sample bias when weak instruments problem exists. In our study, this issue is addressed by allowing both lagged differences and lagged levels to be utilised as instruments during estimation. Recently, Jung et al. (2015) propose an alternative approach. That is, they suggest using a suboptimal weight matrix which contains the estimated variance ratio of the individual effects to that of the idiosyncratic error term for the system GMM estimator to reduce the finite sample bias whilst increasing its asymptotic efficiency. Although the method we used seems to behave well, future studies would be worthwhile to apply the aforementioned alternative approach to handle the finite sample bias for the purpose of enhancing the performance of the

dynamic panel data model.

In addition, we choose the stochastic frontier approach (SFA) rather than data envelopment analysis (DEA) to estimate the cost efficiency of Chinese banks for the purpose of the thesis. More specifically, our proposed bank cost specification follows Batesse and Coelli (1995) in allowing the inefficiency term to be an explicit function of several exogenous (macroeconomic) factors and in assuming all bank-specific effects are components of the bank inefficiency term. Nevertheless, related empirical banking efficiency studies do not provide a consensus on whether or not these bank-specific time-invariant effects should be regarded as a part of this one-sided error term; it seems to be more of a choice depending on the explanation of empirical results (Kumbhakar, Lien and Hardaker, 2014). Consequently, for the future, it will be important to examine the efficiency of the Chinese banking by permitting the further decomposition of inefficiency in terms of bank-specific effects in a SFA model.

Moreover, our proposed stochastic cost function (4.13) assumes the minimisation of bank costs is contingent on five aspects, i.e., managerial inefficiency, time trend, risk effects, environmental effects and statistical noise. The board-related characteristics, such as board size, board independence and executive compensation, are not included in our cost specification for the purpose of the thesis – this could be a limitation of this thesis. Although a bank's senior management and board of directors are primarily accountable and responsible for the performance of the bank, as highlighted by the Basel Committee on Banking Supervision, the literature on bank cost efficiency dealing with the potential impacts of board-level governance is rather limited. Agoraki, Delis and Staikouras (2010) examine the association between board structure, in terms of board composition and size, and bank cost efficiency using a sample of European banks. They find an increased number of non-executive directors reduces cost efficiency and banks with smaller board size are more cost-efficient. Similarly, a negative correlation with regard to board size and bank cost efficiency is also documented in Ladipo and Nestor (2009), Adams and Mehran (2012) and Pathan and Faff (2013). These studies normally hold the view that the larger the board, the less effective it is at monitoring management. This could be due to greater agency costs, especially in terms of

communication and coordination difficulties and free-riding issues among directors.

Employing a dataset of US commercial banks, Titova (2016) reports an inverted U-shape correlation between board size and bank cost efficiency, suggesting there is a trade-off between benefits and costs of larger boards. Besides, this paper finds an inverted U-shape association between board independence and efficiency. Specifically, lower levels of cost efficiency are observed for banks where the Chairman also executes the CEO responsibility. Nevertheless, a higher proportion of independent board members in banks with unitary leadership structure might mitigate the conflict of interest and lower efficiency stemming from CEO duality. Pathan, Skully and Wickramanayake (2007) present strong evidence to demonstrate the benefits of having independent directors. By examining Thai banks, the study finds that bank efficiency is enhanced by strengthening internal corporate governance mechanisms through greater board independence.[41]

Focusing on the evaluation of the impacts of executive compensation on efficiency of Chinese banks, Molyneux and Linh (2014) show that executive compensation adversely affects cost efficiency, which is attributed to managers abusing their power to design compensation packages that maximise their own benefits at the cost of banks. Such a negative influence is observed to be more severe during the GFC. In contrast, the empirical results yielded by Livne, Markarian and Mironov (2013) and Dong, Girardone and Kuo (2017) support the proposal that high executive compensation contributes to the greater efficiency of banks. They argue that the compensation scheme mitigates agency issues and impels top executives to improve their mutual monitoring activities. In this circumstance, more cost savings can be generated through strengthened internal corporate governance. Moreover, another key finding of Dong, Girardone and Kuo (2017) is that the greater gender diversity on boards (more female directors) introduce a positive effect on bank efficiency whilst reducing risk profile of banks. Such findings

[41] Pathan, Skully and Wickramanayake (2007) demonstrate that independent directors tend to be more effective in decreasing opportunistic costs, disciplining and monitoring managers, and protecting the benefits of stakeholders, since they need to protect their reputation for independent directorships in the banking industry.

differ from several previous studies including Carter et al. (2010) and Pathan and Faff (2013), which reported the irrelevance of gender diversity for bank performance.

Overall, the empirical studies have obtained mixed results on the correlation between board-related characteristics and cost efficiency. As stated, only a small set of studies has reviewed the impacts of board-level variables on bank cost efficiency. For Chinese banking, the related empirical studies are even rare. One possible explanation for this phenomenon is that the data collection process for board governance research on the Chinese banking sector is challenging and time-consuming (Molyneux and Linh, 2014). Similarly, the reason for us not to consider board-related features in our cost efficiency estimation and second stage regressions is because our sample size limits our ability to fully collect corporate governance data for sample Chinese banks. That is, specifically, our study first attempts to collect corporate governance data for sample Chinese banks from two well-known databases in the banking literature – the Orbis Bank Focus Database and the SNL financial Platform. These two international databases contain high-quality financial data on Chinese banks. However, with respect to the corporate governance data, such as the variable of the total number of directors on the board, the variable of the number of independent directors on the board and the variable of executive compensation, majority of Chinese banks included in these two databases are observed to display missing values for these board-level variables during the sample period. To illustrate, for the variable of the total number of board directors, only 47 and 32 banks in our sample are able to download valid data for this variable (that can be utilised for estimation) from the Orbis Bank Focus Database and the SNL financial Platform, respectively. A similar situation applies to the executive compensation variable, for which only 16 sample banks can collect valid data from the SNL financial Platform for this variable, whereas the Orbis Bank Focus Database does not contain such information on Chinese banks.

When we attempt to collect corporate governance data from four Chinese databases[42] which contain financial and governance data on Chinese banks, our study is confronted

[42] They are the China Stock Market and Accounting Research Database, Wind-Economic Database, China Center for Economic Research database and Shenzhen GTA Database.

with the same problem as above. Besides, manually collecting corporate governance data from each sample bank's annual reports also does not address this issue, as most of the sample Chinese rural commercial banks do not disclose corporate governance information in their financial statements. Nevertheless, Rowe, Shi and Wang (2011) and Luo (2015) question the quality of corporate governance data collected through this manual collection method due to reporting irregularities among Chinese banks, less standardisation in proxy statements, and language issues. Indeed, because of data availability and quality issues discussed above, this thesis does not consider board-related characteristics in bank performance analysis. In the future, a new dataset consisting of Chinese banks with access to high quality and valid corporate governance data should be created by us in order to examine the potential impacts of board-related characteristics on banking performance.