Thesis Amendment Report

Dear Dr Barakat,

Please find below the PhD amendments addressing the points raised in the report on the thesis examination.

Kind Regards,
Yuzhu LI

Amendment Point 1: More discussion of policy implications should be included in the conclusions of the Thesis. It is hoped the implications of excellent work in the Thesis can be further drawn out and developed.

The above amendment point is addressed on pages 241-245: The implications of the findings from the Thesis have been expanded and detailed in the order of the empirical chapters under the subtitles: "**Chinese Regional Division**", "**Bank Efficiency Policies**", "**Economies of Scale Policies**" and "**Loan Loss Provisioning Behaviour**". Moreover, implications include both policy and practical implications to outline this Thesis's usefulness for both regulators and investors.

Amendment 1:

Pages 241-245:

6.3 Policy and Practical Implications

6.3.1 Chinese Regional Division

This Thesis offers a new way of regional division based on macroeconomic conditions, including GDP growth rate, GDP per capita, urbanisation, inflation rate and Herfindahl index, which are found to influence bank performance in the literature (Kasman and Yildirim, 2006, Shen et al., 2009, Bos and Schmiedel, 2007).

The results from our hybrid hierarchical k-means clustering method suggest that mainland Chinese provinces can be divided into the Eastern Municipalities (Beijing, Shanghai and Tianjin), the Northeastern and Coastal Region (Fujian, Guangdong, Heilongjiang, Inner Mongolia, Jiangsu, Jilin, Liaoning, Shandong, Zhejiang) and the Inland region (the rest of the provinces in mainland China), based on macroeconomic conditions and financial market development from 2005 to 2015. This statistical division offers a more dynamic way to define regions compared to the traditional eastern-central-western division, which is geography and

policy-driven. This new classification method offers policymakers a more updated view of Chinese regional banking markets based on China's recent economic development.

6.3.2 Bank Efficiency Policies

The meta-frontier estimation method allows for a region-tailored policy for improving bank performance in the Chinese regional banking sector, with regional disparities in economic conditions, financial development, and banking market conditions.

Firstly, our results suggest that estimating a country-frontier by pooling all banks in China, assuming that they operate under the same technology, is inappropriate. Instead, they are more appropriately modelled by assuming banks in each region operate under a different available technology, deviating from a simulated country's best available technology. This results from disparities in regional economic and financial market development. The SMF method gives a more accurate insight into the performance of the regional banking market and allows us to compare bank efficiency across regions without assuming a common frontier. By incorporating microeconomic and macroeconomic variables into the technological gap model, our results also inform the determinants of the deviation from country best practice, thus offering region-specific strategies to improve bank efficiency.

For all regional banks in China, their inefficiency mainly comes from the inaccessibility of country technology due to regional constraints, i.e., the technological gap. However, managerial inefficiency, which is the distance between individual banks and regional frontiers, still exist. Moreover, the extent to which a bank's inefficiency comes from the technological gap or managerial inefficiency differs across regions. These findings indicate that policy implications may differ across regions, despite an overarching result of a significant technological gap for all regions.

Among all three regions, the Inland Region has a slightly wider technological gap compared to the other two regions. In contrast, the North-eastern and Coastal Region has the smallest technological gap from the country meta-frontier. In terms of managerial inefficiency, banks in the North-eastern and Coastal Region deviate the furthest from their own cluster-specific frontier, indicating a relatively lower level of managerial efficiency compared to other regions. Meanwhile, the Eastern Municipalities have relatively the highest level of managerial

efficiency among all clusters. This indicates that banks in the North-eastern and Coastal Region may benefit from adopting a better managerial practice to catch up with the other two regions. Our findings suggest that better managerial efficiency can be achieved by improving bank profitability and reducing the level of riskiness in their loan portfolios, such as better pricing and loan monitoring.

Our findings suggest that banks in all three regions would benefit significantly from better technology. This can be firstly achieved through the acceleration of urbanisation. Since the Inland region still consists of a relatively large proportion of rural areas, progressing on urbanisation and developing local infrastructure can help banks improve their ability to transform inputs into outputs more efficiently. Secondly, our model indicates that the regional Chinese banking sector is highly concentrated. Thus its efficiency can be improved through a higher level of competition. Policymakers should welcome new entrants and challengers into the local banking market. In the meantime, policymakers may encourage increased foreign banks presence as there may exit a spillover effect from foreign assets, bringing managerial know-how and healthy competition into the domestic market. The methods to encourage foreign bank entry may include lowering the barrier of entry, further liberating restrictions and allowing a broader scope of banking services to be provided by foreign banks to create more competitive banking markets.

6.3.3 Economies of Scale Policies

Narrowing the gap between the regional and the national technological frontiers may also increase the degree of economies of scale for banks in all three regions. Notably, for banks in the Inland region and North-eastern and Coastal Region, which are currently operating with diseconomies of scale, adopting a superior technology can allow them to start enjoying economies of scale. This indicates that if regional banks move towards the national technology meta-frontier, mergers and acquisitions will reduce average costs. Banks in Eastern Municipalities are currently operating with economies of scale. Our findings indicate that by adopting a better technology, banks can enjoy an even greater degree of economies of scale.

Regarding determinants of economies of scale, it is beneficial for Chinese regional commercial banks to continue complying with Basel III or even more stringent capital and liquidity regulations, as a higher level of capital and liquidity ratio is likely to increase economies of

scale for Chinese regional banks. In order to achieve a higher degree of economies of scale, banks are also encouraged to diversify their business model and engage in more non-traditional bank activities such as investment banking businesses. It is also found that lowering the credit risk in their loan portfolio would help banks achieve a higher level of economies of scale.

6.3.4 Loan Loss Provisioning Behaviour

In terms of loan loss provisioning, regulators should be aware of banks' earnings management practice, which is prevalent across all regions and bank types. That is, it is practised by state-owned banks, joint-stock banks as well as regional city and rural commercial banks. Chinese banks exercise income smoothing more aggressively during economically distressing periods, and listed banks engage more in income smoothing than non-listed banks. Furthermore, a bank's funding structure, i.e., whether it relies more on retail deposits or wholesale funding, affects income manipulations and earnings quality. Policymakers should pay closer attention to banks that rely more on wholesale funding, as earnings figures for these banks are found to have a higher degree of discretionary component. Therefore, regulating and monitoring earnings should be more stringent for banks with listed status, relying more on wholesale funding and during economic downturns. This finding should prompt regulators to favour policies that can enhance the market discipline of the Chinese commercial banking sector and support a sounder financial system. In terms of practical implications, investors should pursue other supplementary information when making investment decisions on Chinese banks, particularly for banks with listed status and higher reliance on wholesale funding.

In terms of banks' loan loss provisioning behaviours, Chinese banks are largely procyclical to economic conditions. This behaviour can amplify the economic cycle, making credit shortages more severe during an economic downturn. To avoid such problems, regulators should encourage a more forward-looking dynamic provisioning method rather than the current backwards-looking practice.

Furthermore, loan loss provisions in Chinese banks also do not signal good news. Instead, it is a signal of extra expense. Therefore, investors should be warned that a higher provisioning level is not a sign of financial resilience against future losses. Instead, it is an expense that reflects a higher level of credit risk in the bank loan portfolio. Hence, the loan loss provisioning behaviour should be continuously monitored to reflect any change in its behaviour in real-time

in order to provide an up-to-date picture of the current provisioning practice. This may also help enhance market transparency and disclosure of accounting information, helping investors make better-informed decisions.

Amendment Point 2: It would help to have more discussion of why corporate governance variables have not been included in the analysis. In this discussion it would helpful to review the impact of corporate governance variables in the models estimated and indicate why these variables are not included in the analysis and particularly in the analysis appearing in chapter 5 considering loan loss provisions.

Response: The review of impacts of corporate governance variables in the models estimated and the reasons for not including them are explained in footnote 15 on pages 187 and footnote 16 on page 203. in chapter 5 considering loan loss provisions. The potential impact of corporate governance on earnings management is explained in the hypothesis development section and the model specification section. The main reason is corporate governance being outside the scope of the study, especially for small private regional banks, which are the focus of this Thesis.

Amendment 2:

Page 187, Footnote 15: In addition to listed status and financial crisis, the degree of earnings management may also be impacted by corporate governance. The literature concerning the impact of corporate governance on earnings management mainly focuses on non-financial firms. Within the limited literature on the impact of corporate governance on banking firms, Sullivan and Spong (2007) find that bank managers are more likely to manipulate earnings when they have a higher level of wealth concentrated in the bank's stock holdings. Cornett et al. (2009) study the impact of corporate governance mechanism on earnings management using a sample of large publicly traded bank holding companies. They use pay-for-performance sensitivity, board independence and capital ratio as main corporate governance variables. They find that increased board independence, reduced CEO pay-performance sensitivity and a higher level of capital are linked to reduced earnings management. Leventis and Dimitropoulos (2012) investigate corporate governance and earnings management on US-listed banks during the Sarbanes-Oxley Act era (2003-2008) and find strong evidence that well-governed banks

engage less in aggressive earnings management using LLPs, in addition to realised security gains and losses. We do not investigate how corporate governance, such as board independence and CEO compensation, impact earnings management, as it is outside the scope of this study.

Page 203, Footnote 16: As discussed in footnote 15, we do not investigate the effects of corporate governance variables such as executive compensation, internal controls and board independence on discretionary LLPs as they are out of the scope of this study. The only variables in our model that could potentially capture corporate governance of banks are capital ratio and listed status in model 8 (a,b,c,d). Cornett et al. (2009) argue that shareholders can limit bank managers' ability to invest in negative-NPV projects and force bank managers to distribute free cash flow to shareholders when banks have lower capital levels, i.e., higher leverage. Moreover, banks with lower capital adequacy levels are subject to more scrutiny by regulators, thus having less chance to manipulate earnings. However, our results from model 8 (a,b,c,d) (See result analysis in section 5.4) indicate that there is no evidence suggesting capital adequacy affect earnings management for Chinese banks.

Amendment point 3: It would be helpful to develop a broader critical discussion as to the limitations and drawbacks of the models adopted and employed in Chapters 3 and 4.

Response: The below critical discussions on the limitations and drawbacks are added to each of the models.

<u>Amendment 3:</u>

Below discussion on limitations are added to the Corrected Ordinary Least Squares (COLS) Regression Model:

Pages 57-58: The main advantage of COLS is that it does not impose any specific assumption on the distribution of inefficiency, and it is easy to compute. The major disadvantage is that the frontier function is assumed to be deterministic. Therefore, the deviation from the frontier is assigned to inefficiency without considering any random shocks. Moreover, The COLS model is also very sensitive to outliers (Kumbhakar et al., 2015). As a result, the inefficiency estimated using COLS may have an upward bias, meaning that the inefficiency can be overestimated.

Below limitations are added to distribution-free models:

Page 60, 1st paragraph: The main advantages of distribution-free approaches are that the estimation does not depend on the distributional assumptions of the inefficiency term u_i and they are easy to estimate. On the other hand, the disadvantage is that there is a lack of information in terms of the statistical properties of the estimators of u_i. To distinguish inefficiency effects from random errors, we need to add a random error term and impose a distributional assumption for both inefficiency and statistical errors, the parameters of which can be estimated using maximum likelihood estimators. Section 3.6 will discuss this method in detail.

Limitations of Green(2005) TFE model:

Pages 64-65: There are several limitations of Greene (2005) 's TFE model. The first problem is the vast number of parameters to be estimated, especially when the number of firms in the sample is large. The second issue is the incidental parameters problem resulting from fixed effects α_i in the frontier model. The incidental parameters problem arises when the number of parameters increases with the number of cross-sections, rendering the estimates of vector β to be biased and inconsistent. Greene (2005) find that in a sample with small and relatively large group sizes, there indeed exist evident biases both in estimates of coefficients and inefficiency. However, when T is large, there seems to be less bias in the parameter estimates. He also finds that the random-effects model produces more distorted results, and it is less consistent, especially with the assumption of efficiency being independent of explanatory variables. To resolve the incidental parameters problem, Wang and Ho (2010) updates Greene(2005)'s models through within and first-difference transformation of the model while the closed-form likelihood function is maintained. As α_i s are dropped from the model, consistent estimates can be obtained, meaning that the incidental parameter problem would be eliminated. As the number of parameters needing estimation is reduced, the difficulty of estimating too many parameters is also reduced.

Another limitation regarding Greene(2005)'s fixed effects models relates to their inability to separate persistent inefficiency from unobserved heterogeneity. Although Greene (2005) 's TFE and TRE models can separate individual heterogeneity from time-varying inefficiency,

they do not consider persistent technical inefficiency, which can represent effects of inputs such as management which does not vary over time, unless there is a change in policy or ownership (Kumbhakar et al., 2015). This problem is solved by the more recent development of models that overcome the limitation of earlier models by separating firm effects, persistent inefficiency and time-varying inefficiency. For example, Kumbhakar et al. (2014) split error term into four components: firm-specific heterogeneity, short-run time-varying efficiency, persistent time-invariant inefficiency and random shocks.

Page 65, Footnote 5: We do not go into details of the more recent models that separate persistent inefficiency from time-varying inefficiency, such as Kumbhakar et al. (2014), as these models are outside the scope of this Thesis.

A critical summary is also added to consolidate the drawbacks of the models further:

Page 66, 1st paragraph:

3.6.3. A Summary of Efficiency Models

Empirical studies using models such as the Battese and Coelli (1995) model often simply pool the panel data and treat them as cross-sectional. That is, the same units observed at different points in time are treated as separate units. However, these models do not take into account the time-invariant and individual-specific characteristics contained in panel data. Among the abovementioned models, including the distribution-free models and stochastic models, only Schmidt and Sickles (1984) and Greene (2005) 's True Fixed Effects Model (TFE) account for the time-invariant individual heterogeneity within the panel data. Schmidt and Sickles (1984) distribution-free model assumes inefficiency to be individual-specific and time-invariant. However, the unobserved heterogeneity is contained within the inefficiency term, meaning that the model cannot distinguish inefficiency effects from unobserved time-invariant heterogeneity. Therefore, the inefficiency estimated using the time-invariant inefficiency models such as Schmidt and Sickles (1984) might partially and entirely be attributable to individual heterogeneity (Greene, 2005). Another drawback of time-invariant inefficiency models is that it might not be reasonable to assume that the inefficiency of a firm does not over time, especially when the frontier is estimated over an extended period. In contrast, Greene

(2005) ’s TFE model allows for the separation of individual effects from inefficiency. However, it suffers from the drawbacks of estimation difficulty and incidental parameter problems. Furthermore, it is unable to separate persistent inefficiency from individual heterogeneity. More recent models, such as Kumbhakar et al. (2014)’s four-error-component model, are aimed to tackle these issues.

In Chapter 5, the below discussion on limitations of linear programming meta-frontier approach is added:

Page 98,: There are several drawbacks of the above two-step approach. Firstly, there is no statistical property in second step estimation, as it is calculated using linear or quadratic programming algebra, which relies on simulations or bootstrapping. Secondly, it is unable to incorporate exogenous environmental variables that impact inefficiency into the estimation. Thirdly, it does not take into consideration of any idiosyncratic shocks.

The below limitation and rationale are added for the meta-frontier model we have adopted in the Thesis:

Page 102, Footnote 6: The inefficiency model we adopt here, i.e., the Battese and Coelli (1995) model, has the limitation that it is not a ‘true’ panel data model, meaning that it does not consider the unobserved individual heterogeneity in the estimation process. We adopt Battese and Coelli (1995) model here, instead of Greene (2005) ’s true fixed effect model, is mainly due to the significant increase in the number of parameters in Greene (2005)’’s TFE model, making convergence during the maximum likelihood estimation process a technical difficulty. Moreover, adopting Battese and Coelli (1995) also avoid the potential incidental parameters problems which are likely to be present if Greene (2005)’s TFE model is estimated, rendering coefficients biased.

Amendment point 4: In chapter 4, we would like to see more consideration of the implications of foreign exposure and cross border loans for Chinese banks and the analysis in this chapter.

Amendment 4:

Pages 112-113: This chapter also aims to shed some light on the impact of foreign exposure, especially foreign bank presence, on the Chinese banking system. The foreign exposure of Chinese banks can be seen in the form of the rapid growth of cross-border loans and an increase of cross-border capital inflow in the form of foreign investment, foreign ownership and the establishment of foreign banks. As of mid-2018, Chinese banks' cross-border lending represents around 7% of all cross-border lending globally and 24% of all cross-border lending to merging market and developing economics (EMDE) borrowers. Chinese banks lend to 135 out of 143 EMDEs and 30 out of 31 advanced economies (AEs) (Cerutti et al., 2020). Moreover, China has also witnessed an acceleration of cross-border capital inflow in the form of direct and indirect investments in recent years. Zhao and Xu (2021) suggest that direct and indirect investment can lead to bank credit growth. They also suggest that since foreign banks have the advantage of more advacned financial innovation and a more mature business model, they may create competition and attract high-quality customers away from domestic banks. This will force local banks to accept customers with lower credit standards, thus leading to a higher level of non-performing loans.

Levine (1997) believes that foreign bank entry can boost financial development directly via providing high-quality banking services and indirectly through three channels. Firstly, foreign banks increase pressure for domestic banks to cut costs and increase efficiency in order to stay competitive in the banking market. Secondly, foreign bank presence promotes more rigorous accounting, auditing, and ratings by relevant institutions. Thirdly, they create pressure on the local governments to enhance local financial infrastructures such as supervisions, legislation and regulations in the financial market, accelerating domestic financial development. This is especially prevalent in developing economies where governments are under pressure to match international supervisory and regulatory standards. In addition, Levine (1997) also adds that lowering the barrier of foreign bank entry and alleviating the restrictions may allow more comprehensive access to foreign capital markets and improve the quality and availability of financial services of domestic banks via intensifying competition and facilitating the implementation of new management, skills, and technologies.

There are mainly two ways foreign banks enter a domestic market. One way is directly entering the market by opening branches. Another way of foreign bank entry is via shareholding as strategic investors. In terms of the empirical literature, the results are mixed regarding the impact of bank entry on domestic bank performance. On the one hand, empirical studies show that foreign bank entry generally has a positive impact on the efficiency and profitability of domestic banks. On the other hand, it is found that foreign bank entry may destabilise the domestic banking market via excessive competition. Sturm and Williams (2004) find that allowing foreign banks access to the Australian banking market through deregulation prompts improvement in local bank efficiency. However, Barajas et al. (2000) find that profitability and credit quality may decrease due to higher quality customers switching from domestic to foreign banks. Claessens et al. (2001) also find evidence for a reduction in profitability for domestic banks as a result of foreign bank entrance. Unite and Sullivan (2003) find that foreign bank entry reduces profits for domestic banks but improves their operating efficiency. Lensink and Hermes (2004) find that for a less developed banking market, foreign bank entry raises costs for domestic banks in the short term and make them less efficient.

Amendment point 5: It would useful to have a more developed discussion of the different methods employed to define economic markets and justify why the methods adopted in the Thesis are suitable.

Amendment 5:

Pages 83-86: To conduct our meta-frontier analysis, we first need to define the different technology groups. Recall Chapter 3, we define technology as a decision unit's ability to transform inputs into outputs. The combination of inputs and outputs a firm chooses is constrained by the opportunities and resources available to them, depending on in which industry, region or country the production occurs. The differences can range from the availability of capital, labour, quality of resources to the social and economic environment (O'Donnell et al., 2008). The most common methods adopted to define the technology groups in the meta-frontier banking literature are either by ownership types (Kontolaimou and Tsekouras, 2010, Goyal et al., 2019, Abdul-Majid et al., 2017) or geographical locations(Bos

and Schmiedel, 2007, Huang and Fu, 2013, Lee and Huang, 2017). Among the limited number of Chinese banking meta-frontier studies, to our knowledge, they all focus on the heterogeneity of ownership types rather than geographical or economic environments(Lee and Huang, 2019, Zhu et al., 2020, Yin et al., 2018). In particular, they assume state-owned banks, joint-stock banks, city commercial, and foreign banks operate in different market segments due to different economic, financial, political and geographical restrictions. This is indeed a plausible method to classify technology groups since these studies include all banks with different ownership types in the sample. As our study includes city and rural commercial banks only, there is minimal heterogeneity in terms of ownership types in our sample. Instead, the primary heterogeneity in our sample comes from geographical and economic environments.

Traditionally, the boundaries of banking markets are mainly based on geographical locations as the boundaries of banking markets are believed to be defined by the demand side. Consumers of financial services, including households and businesses, define the markets, meaning that banking markets are initially local and small. Kwast et al. (1997) find that financial services markets are predominantly geographically local for both households and businesses in the US banking system. This is especially true for depository institutions where most customers including both households and businesses are local. They also find that both asset and credit services cater to local customers within each state in the US. Radecki (1998), however, argues that due to the relaxation of branching restrictions and reorganisation of bank holding companies, banking markets are larger and more competitive in the US. It is also driven by the fact that products provided by financial institutions are becoming more homogenous. Jackson and Eisenbeis (1997) employ a multivariate cointegration analysis using a sample of consumer deposit rates from 29 different local banking markets to test if consumer deposits rates in distinct geographical locations are genuinely independent. They find strong evidence that deposits rates are well-integrated in a national market, proving that interstate restrictions do not restrict the market locally. On the other hand, regarding the UK banking market, Ashton (2009) find that there still exist regional deposit markets. Utilising an OLS regression model to test the impact of branch overlap on dissimilarity of interest rates between bank pairs, substantial differences were found in interest rates between banks with regionally focused branch networks. In addition, branch overlap does not have a significant impact on interest rate setting.

We believe that regional markets do exist in the Chinese banking system, especially for city and rural commercial banks, which are primarily built upon the one-city-one-bank rule. Liu and Wu (2008) define city and rural commercial banks as endogenous institutions. This is because city and rural commercial banks are developed locally and serve the local market. However, the literature is inconsistent in terms of how to group provinces into larger regions. According to the National Bureau of Statistics in China (NBSC), the most common divisions are the Western, the Intermediate and the Eastern zone, based on geographical differences and ease of policy implementation (NBSC, 2021). Yang et al. (2015) adopts an Exploratory Spatial Data Analysis (ESDA) approach and divide Chinese regions into Yangtze River, Delta Bohai Sea region, Pearl River Delta, Northeast region. Central region and Western region, based on economic development and reform, urbanisation and workers population. They find that the performance of Industrial and Commercial Bank of China is significantly better in developed Yangtze River Delta and Bohai Sea regions and underperform in the other four areas. Liu and Wu (2008) divide the mainland Chinese banking industry into three types of local banking systems: the developed systems, the developing systems, and the underdeveloped systems, based on bank assets per capita, bank branches per million people, and bank ownership diversification in 2006. However, to the best of our knowledge, it is based on arbitrary thresholds rather than statistical or econometric methods. Furthermore, it does not consider any exogenous environmental factors such as macroeconomic conditions that may impact bank performance.

We focus on differences in technology and cost structures and define markets as where banks have a similar level of resources such as capital and labour and a similar level of economic and physical infrastructure development. It means that due to these conditions, banks in each cluster have access to the same level of optimal combination of inputs and outputs, and the deviation from regional technology frontier solely comes from managerial inefficiency. In other words, banks choose different combinations of inputs and outputs in order to compete in their respective market, and the optimal combination is largely restricted by their local economic environment.

Provincial data from NBSC indicates that during our study period from 2005-2015, there is a significant regional disparity in terms of macroeconomic indicators. For example, as of 2015, gross regional product (GRP) per capita is much higher in the Eastern Coastal region compared

to other parts of the country. Similarly, unemployment tends be to evidently higher, reaching an average of 4% in the Central and Northeast region compared to around 2.5% in the South-Eastern region. The inflation rate is higher in the Western and Central regions in China compared to the Eastern region. The data not only confirms our understanding of regional disparity in terms of the economic environment but also prompts us to adopts more advanced statistical methods to group provinces into larger regions as provincial macroeconomic indicators follow vastly different patterns.

Clarification point I: In Chapter 4 can you please briefly clarify the implications if a particular bank has merged during the sample period? It would be helpful to report how such an eventuality might influence the analysis.

Amendment 6:

Page 115, Footnote 8: Due to frontier estimation requirement, if one variable for a bank is missing for a particular year, all data during that year are deemed missing. Our panel data set is unbalanced due to the unavailability of data and entry of new banks. To be best of our knowledge, there is minimum (if any) exit of a bank in our sample caused by merger or bankruptcy. Peng and Han (2021) report that only two Chinese banks have gone bankrupt over the past few decades. As there is a minimum occurrence of mergers, acquisitions and bankruptcies, it is likely that the incompleteness of our panel data is primarily due to random missing data and new bank entry. Baltagi and Chang (1994) find that making incomplete panel data balanced by dropping observations may worsen the performance of estimators. Dionne et al. (1998) also confirm that entry/exit of incomplete panel data may not cause biases to regression estimates when the reasons for the missing data are not endogenous to the frontier model. That is, the causes of data incompleteness are not determinants of the cost structure, such as an exit that is caused by lower productivity and efficiency of the bank. Thus bank exit seems to be more of a problem than bank entry. As there is minimum occurrence of bank mergers and bankruptcies in our sample period, it is feasible to not consider entry/exit biases in our estimation process.

Pages 123-124, Footnote 10: The cluster analysis results reflect an overall picture of macroeconomic conditions in 31 provinces over 2005-2015. Provinces with similar macroeconomic traits and following similar trends of economic change over the period are grouped into the same cluster. We do not allow clusters to move across years, in order to maintain fixed technology groups for the construction of a meta-frontier later on. Moreover, to our best knowledge, it is unlikely for any bank in our sample to move the location of their headquarter and operation over the period, given that we only include city and rural commercial banks which are established to serve their local market. Given that we only include city and rural commercial banks that primarily operate within their own local market, any potential mergers and restructuring would be likely on the regional level, especially when central and provincial governments are largely involved in such decisions. For example, in 2021, Liaoning province decides to merge 12 local banks into one provincial-level bank (Reuters, 2021). Such a merger would not impact the cluster as they would still be included in the same technology group to construct the meta-frontier.

Pages 160-161, Footnote 13: Please note that as our sample is an unbalanced panel dataset, the number of observations changes over the sample period. Thus, for example, increasing efficiency from one year to another does not necessarily mean that the same banks become more efficient over the years. Rather it indicates that the overall efficiency of banks in a region improves. For example, the entry of new banks may indirectly improve regional bank efficiency by bringing in new technology and business know-how and healthy competition into the local banking market, indirectly narrowing the region-country technological gap and improves regional bank efficiency.

Clarification point II: In chapter 4 there are no hypothesises stated. If possible and for the purposes of consistency with other chapters can this be revisited please?

Response: The below hypotheses are added in Chapter 4.

<u>Amendment 7:</u>

Page 108:

H1: Banks with a higher level of capital may have either a higher or lower level of cost efficiency

H2: More profitable banks are more cost-efficient.

H3: Chinese banks with a higher level of non-performing loans are less cost-efficient.

Page 110:

H4: Banks in regions with higher GDP levels and growth rates operate closer to meta-frontier

Page 111:

H5: A higher level of inflation rate widens the technological gap between regional frontier and the national meta-frontier

H6: Market concentration may have either positive or negative impacts on technological gaps.

Page 113:

H7: Foreign Bank presence promotes narrowing of technological gaps.

Clarification point III: Can the following sentence please be clarified - p.101 'HHI measures the competitiveness and level of concentration of banking market in a certain region.'

Response: The above sentence is replaced by the version below.

Amendment 8:

Page 111 (moved from p.101), line 4-6: Herfindahl–Hirschman Index (HHI), calculated as the sum of squares of market shares of all firms in a market, is one of the most widely used measurements for concentration. The value of HHI can range from 0 to 10,000, indicating from a market with a large number of firms to monopoly. It is determined by both the number of

banks in the market and the inequality of the distribution of asset shares. A low HHI Index usually indicates low concentration, and a market with an HHI higher than 1800 points is generally considered to be highly concentrated.

Carification point IV: On page 25 'A' is not a capital in the sentence 'Since 2007, A few city commercial banks expanded their operation outside their province rapidly, although to this date, majority of them still operate regionally (Sun et al., 2013).

It would also be helpful to amend any other typographic or grammatical errors which exist in the Thesis.

Response: "A" is changed from capital letter to lower-case letter. All other typographic or grammatical errors are corrected, including the sentence mentioned on page 25.

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