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Effects of Credit Market Freedom on Output Reallocation in China's Banking Sector Through the Intermediation of Cost X-inefficiency

Woon Kan Yap, Siong Hock Law, and Judhiana Abdul-Ghani*

This study examines the effects of credit market freedom on the dynamics of Chinese banks' output reallocation through the intermediation of cost X-inefficiency. We find two distinct regimes that underpin the mechanism of foreign banks and domestic banks respectively. Credit market freedom is found to significantly foster cost X-efficiency among the foreign banks, which subsequently lead to marginally more efficient allocation of outputs with efficient foreign banks gain market shares at the expense of those inefficient ones. On the other hand, the same circuit of effects does not apply to the domestic banks. Therefore, arguably foreign banks attach more importance to efficiency, while domestic banks leech on to state protection for their respective existence.

Key Words: Economic freedom; Cost X-efficiency; Resource reallocation; Boone indicator.

JEL Classification Numbers: D2, G21, G28.

1. INTRODUCTION

Since China's accession as the 143rd member of the World Trade Organization (WTO) on 11 December 2001, its banking sector has been liberalized substantially but not necessary sufficiently. Among some of the initiatives undertaken to restore the market incentive structure are: decentralization of banks' ownership, lower entry barriers in addition to reduced restrictions on foreign entities and greater allowance of market forces in the determination of interest rate. However, the jury is still out with respect to the efficacy of these initiatives in lessening the state's grip on the banking sector.

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While the ceiling of lending rate and floor of deposit rate have been sequentially removed by 2005, these actions do nothing to foster competitiveness of the banking sector as the lending rate floor and deposit rate ceiling still persist until 2013 and 2015 respectively, albeit they are progressively relaxed throughout the years. Despite China's arduous journey towards a fully liberalized interest rate mechanism was wrapped up in 2015, it takes only less than a year for China to reinstitute the lending rate floor with Beijing as the first loan market to be reined in. While the reinstatement is well-intended to avoid excessive shocks to the banking system as banks race each other to the bottom, it, nevertheless, derails China from the market economy status that it beseeches.

On the diversification of state's bank ownership, the result is not spectacular, either. While the state holds minimal equity in city commercial banks (CCB) and rural commercial banks (RCB) at 10.85% and 13.63% respectively as at 2012¹, CCB and RCB in turn control only 11.5% and 7.5% of the total banking assets. On the other hand, total assets of state-owned commercial banks (SOCB) and joint-stock commercial banks (JSCB) respectively make up a hefty 41.6% and 18.7%² of the industry's total banking assets. But then, 69.6% and 31.1%³ of SOCB's and JSCB's equities are respectively under the state's control as at 2014. Consequently, the Chinese banking sector is not only highly concentrated as alluded by Park (2013) but the high concentration is also perpetrated through substantial state ownership in SOCB and to a lesser extent in JSCB.

In effect, traces of protectionist initiatives still linger in the Chinese banking sector despite it has been more than a decade since its accession to WTO membership accompanied by its best effort for reform. While their lingering existence is often justified for strategic purposes, such remnants of protectionism undoubtedly distort the market incentive structure, which then leads to inefficiency in the allocation of resources. The materialization of allocative inefficiency is catalyzed by the state protection offered to incompetent banks, which then obstructs the inherent mechanism of market forces that otherwise would have displaced these unproductive banks and reallocate outputs to the more efficient ones.

Therefore, the objective of this present study is to examine the effects of credit market freedom on the extent of banks' output reallocation as intermediated by their level of cost X-inefficiency. In the context of this present study, the extent of output reallocation is construed as the competitive pressure that is measured as the bank's profits impairment that arises due to peer rivalry. Leveraging on the Efficient Structure (ES) hy-

¹Based on the statistics provided by Hsiao et al. (2015, p72)

²Based on China Banking Regulatory Commission (CBRC) Report 2014

³Numbers tabulated by authors based on individual SOCB and JSCB banks annual reports.

pothesis proposed by Demsetz (1973), efficient banks tend to gain market share at the expense of those inefficient ones as outputs are reallocated from the latter to the former until the latter are exterminated. Thus, the competition-enhancing effects of credit market freedom on the banks' output reallocation is expected to be intermediated by their level of cost X-inefficiency.

While extant literature that studies the implications of economic freedom on banks' performance has recently gained traction (see Chortareas, Girardone and Ventouri, 2013; Chortareas, Kapetanios and Ventouri, 2016; Djalilov and Piesse, 2016; Gropper, Jahera and Park, 2015; Lin, Doan and Doong, 2015; Sufian and Habibullah, 2010 and 2011; Sassi, 2013 and Sufian and Zulkibri, 2015), none has particularly and adequately addressed the corresponding impact of freedom on the banking sector's outputs reallocation mechanism. Thus, this study fills a large gap in the literature by examining the extended effects of freedom on the dynamics of output reallocation among the incumbent banks of the Chinese banking sector through the intermediation of cost X-inefficiency.

In order to examine the dynamics of output reallocation, the Boone indicator (Boone, Van Ours and Wiel, 2007 and Boone, 2008) is used to measure the shift in banks' competitive pressure as determined by their level of cost X-efficiency. In turn, cost X-efficiency is estimated by duly accounting for the prevailing extent of freedom in the credit market. The fundamental of Boone indicator relies extensively on the assumption that firms are inherently cost-minimizers in conformance to the neo-classical framework. However, such restrictive assumption is more idealistic in nature than practical, given the firms' non-maximizing behavior as expounded by Leibenstein (1966, 1978). Thus, this present study pioneers a new approach to estimate the Boone indicator by relaxing the stylized cost-minimizing assumption of the banks. Our approach involves making adjustment to the Boone indicator estimation so that any slacks in the banks' cost minimization.

We account these slacks in cost minimization as cost X-inefficiencies, which measures the banks' sluggishness in cost performance relative to the predicted best performance from a sample that is representative of the industry. The sluggishness is attributable to either technological deficiency or a chosen non-minimizing effort position by members of the firms⁴. Empirically, we estimate the banks' cost X-efficiency by estimating the now widely used Battese and Coelli (1995)'s technical inefficiency effect model, which is one of the estimation models under the Stochastic Frontier Anal-

⁴A conventional argument that members of the firms choose an effort position that maximize individual utility rather than the firm profits. Leisure or inertia are elements in the vector space of the former but not the latter.

ysis (SFA) tradition that allows for the parameterization of the mean cost X-inefficiency.

On the policy implication of this present study, the yielded results will drum in the importance of freedom in fostering sufficient market fluidity for the efficient banks to displace the inefficient ones. Mirroring Darwin's theory on natural selection that can be summed up as survival of the fittest, market fluidity is essential to ensure survival of the efficient banks over the inefficient ones so that resources are efficiently allocated, which then leads to greater banking stability. Given the established bi-directional causality between financial development and economic growth by Shan and Qi (2006), stability of the banking sector plays an important role to insulate the economy from output shocks as the Chinese economy attempts to structurally rebalance⁵ itself in these few year. Although banking stability can be "artificially" hold up through state purported intervention, such means is not sustainable in the long-run as it exerts tremendous strain on the public budgets. Instead, efficiency in output reallocation instigated through market fluidity fosters stability intrinsically over the long-run through the accumulation of cost X-efficiency.

Our analysis reveals that foreign banks and domestic banks in the Chinese banking sector go by two distinct regimes. For the foreign banks, credit market freedom is found to significantly foster cost X-efficiency that is uncovered to have significant marginal conditioning effects on the dynamics of output reallocation. As a result, foreign banks' outputs are reallocated in a marginally more efficient manner with higher profits distributed to the more efficient foreign banks at the expense of those that are inefficient. Contrariwise, forces of competition are rather dormant among domestic banks. Neither the effects of credit market freedom on cost X-efficiency nor the conditioning effects of cost X-inefficiency on output reallocation is significant for the domestic banks. Therefore, arguably foreign banks attach more importance to efficiency, while domestic banks leech on to the state protection for their respective survival.

Lastly, this paper is set out as such: section 2 proceeds to review the recent and relevant literatures, while section 3 outlines the model specification and methodology, prior to the reporting and discussion of empirical results in section 4. Lastly, section 5 presents the conclusion.

⁵Despite Hu, Lu and Xiao (2011) have uncovered evidence in support of the Chinese economy's transition to a high growth, low volatility state, such transition is led by state-directed gross capital formation, which is unsustainable in the long-run. Consequently, structural rebalancing that reallocates growth to household consumption from fixed investment has ascended to be one of the major national economic agenda since the 12th five-year economic plan (2011-2015) and continues to be of concern in the 13th economic plan.

2. REVIEW OF THEORETICAL AND EMPIRICAL LITERATURE

In order to expound on the effects of output reallocation through forces of competition, it is necessary for us to provide a brief discourse on the theoretical constructs of the Boone indicator before delving into extant empirical literature that lends weight to our hypothesis, which postulates the causal effect of economic freedom on output reallocation.

2.1. Theoretical constructs of Boone indicator

The key intuition embedded in the Boone indicator is built on the ethos that competition impairs firms' economic rents. In addition to that, inefficient firms are expected to be punished more severely as competition intensifies and therefore, resources hoarded by these inefficient firms are resultantly reallocated to the efficient ones for more productive use. Thus, outputs of the latter are expected to increase at the expense of the former. This ensures efficient allocation of resources to foster stability and resilience of the banking sector against external shocks.

The context of Boone indicator's theoretical setup is an industry with each firm i producing one symmetrically differentiated product. The inverse demand function for the i th firm then takes the following form:

$$p(q_i, q_{-i}) = a - bq_i - d \sum_{i \neq j} q_j \quad (1)$$

$p(q_i, q_{-i})$ and q_i are the market price and output of firm i as determined by the quantity-setting Cournot-Nash equilibrium. a is the intercept that represents the market size, while b represents the market elasticity of demand. Coefficient d denotes the degree of substitutability between q_i and q_j from the consumers' perspective and therefore, d also measures the extent of rivalry that underpins the interactions among the firms. In addition, it is assumed that $0 < d < b$.

The profit maximization problem is then given as:

$$\max \pi_i = (p_i - c_i)q_i \quad (2)$$

$$\max \pi_i = \left(a - bq_i - d \sum_{i \neq j} q_j \right) q_i - c_i q_i \quad (3)$$

where c_i is the constant marginal cost of firm i . It should be noted that profit maximization occurs when cost is minimized. Therefore, the constant marginal cost refers to the equilibrium between marginal cost and average cost, where average cost is at the lowest. Hence, it is also a proxy for firm

i 's level of efficiency. Taking the first order condition of (3), it yields:

$$\frac{\partial \max \pi_i}{\partial q_i} = a - 2bq_i - d \sum_{i \neq j} q_j - c_i = 0 \quad (4)$$

By solving (4) for N number of firms, the yielded solution below (from Boone, 2008) determines firm i 's level of output that is consistent with the Cournot-Nash equilibrium.

$$q(c_i) = \frac{\left(\frac{2b}{d} - 1\right) a - \left(\frac{2b}{d} + N - 1\right) c_i + \sum_{j=1}^N c_j}{[2b + d(I - 1)] \left(\frac{2b}{d} - 1\right)} \quad (5)$$

Few conclusions can be made from (5). Firstly, assuming c_i is constant, an increase in d , which represents intensification of firm rivalry will reduce $q(c_i)$ and resultantly, the $\max \pi_i$. However, the profit impairment induced by higher d on output and therefore, profit is mitigated with lower marginal cost, c_i following higher cost efficiency. On the other hand, profit impairment for inefficient firms will be aggravated with higher c_i (lower cost efficiency). In other words, outputs of inefficient firms along with their profits will be reallocated to the efficient firms as competition increases.

At the outset, (5) reveals that the underlying notion of competition adopted by the Boone indicator is sympathetic towards the Austrian school. It conceives competition as the dynamic rivalry process among the incumbent firms rather than being a steady state as upheld by the neo-classicists. In addition, the effects of output reallocation encapsulated in Boone et al. (2007) and Boone (2008) is an exemplification of Demsetz's ES hypothesis, which challenges the traditional wisdom of postulating a negative correlation between concentration and competition. According to Demsetz, concentration and competition can be positively correlated. The positive correlation is underpinned by the effects of output reallocations from inefficient firms to the efficient ones following intensification of competition. Resultantly, market share and profits will be concentrated on the efficient banks. This offers an alternative and refreshed perception on market concentration, which otherwise has been fixatedly associated with stifled competition that leads to slacks as suggested by Hicks (1935)'s quiet life (QL) hypothesis.

However, (2) and (3) show that the theoretical basis of Boone indicator is fundamentally built upon the assumption that the incumbent firms are inherent cost minimizers. As c_i denotes the constant marginal cost that cuts through the firms' average cost at its minimum, the sampled firms are expected to be scale efficient. Nonetheless, whether it is due to lack of motivation, imperfect contracts or maximization of the managers' personal utilities, the assumption that firms being inherent cost minimizers is ar-

guably too idealistic (see Leibenstein, 1966 and 1978). Therefore, there is a reasonable doubt that the estimated Boone indicator is resultantly biased. In order to compensate, this present study makes adjustments to account for the banks' cost X-inefficiency in the estimation of Boone indicator for the Chinese banking sector.

2.2. Empirical evidence in support of the output reallocation effects

The notion of output reallocation that underpins the theoretical constructs of Boone indicator and the ES hypothesis is empirically well-supported. Studies such as Stiroh (2000) and Stiroh and Strahan (2003) affirm the dynamics of market share reallocation in the US banking sector from 1976 to 1998 following proliferation of rivalrous competition due to deregulation. One of their key revelations alludes that market share of the successful banks, measured by return on equity (ROE) tend to increase at the expense of the poorly-performing ones. As the forces of rivalry intensify following deregulation, the latter will be resultantly displaced by the former. Such mechanism of eliminating the inefficient banks will then reallocate factors of production to other banks that can make better use of them. The eventual impact is an improvement in the aggregate performance of the banking sector.

Stiroh (2000) reveals that such competitive mechanism that leads to efficient reallocation of factors is especially important during periods of falling profits to fortify the industry performance against external shocks. This accentuates the stability-enhancing effects of output reallocation through the elimination of inefficient banks, while channeling factors of production to the efficient ones. The resultant allocative efficiency expectedly leads to greater stability as the improved aggregate productivity of the banking sector begets stronger resilience against external shocks.

Along the same vein, Bos, van Santen and Schilp (2009) examine the nexus between restructuring and the dynamics of profits reallocation in the US and European banking sectors from 1995 to 2004. To this end, they come to an overall conclusion that the US banking sector exhibits greater flexibility in profits reallocation than their European counterpart. Indeed, a positive slack-reducing reallocation effect is noted in the US banking sector as successful banks are seen to appropriate assets from the less successful ones in their quest to exploit cost scale economies to compensate their destroyed profits due to restructuring. This indicates that market forces in the US banking sector are not as restricted as the European banking sectors.

Findings of Schaeck and Cihak (2010, 2014) yield the equivalent conclusion as those earlier studies. Firstly, a positive correlation between competition and bank soundness or stability is perceived through the channel

of efficiency. However, weak banks are expected to benefit less from competition in terms of soundness than the better performing banks. This is plausibly explained by the reallocated profits from the inefficient banks to the better-performing ones induced by rivalrous competition, which then brings about greater stability or soundness in the latter as compared to the former.

Since output reallocation constitutes the foundation of which the ES hypothesis is built upon, effects of output reallocation is also corroborated by those empirical studies that lend support to the ES hypothesis. While Homma, Tsutsui and Uchida (2014) find that market power decreases the Japanese bank efficiency in support of the QL hypothesis, they also note that efficient banks tend to grow in market share at the expense of those that are inefficient and therefore actualizes the prediction of ES hypothesis. Such hybrid efficient structure noted in the Japanese banking sector also prevails in the Portuguese banking sector. Despite market concentration still matters for the Portuguese banks' performances as revealed by Mendes and Rebelo (2003), the performance-enhancing effects of profit X-efficiency is also indubitable.

Similarly, Park and Weber (2006) find that bank efficiency significantly determines the Korean banks' profitability and therefore, affirming the relevance of the ES hypothesis in explaining the Korean banking sector's profit-structure relationship. The same applies to the ASEAN banking sectors as corroborated by Khan, Kutan, Naz and Qureshi (2017), which find that cost efficiency promotes growth in the ASEAN banks' market shares. In Bo?a (2017), only partial evidence is yielded in support of the ES hypothesis as the underpinning profit-structure of the Slovak banking sector. While technical efficiency and scale efficiency are found to significantly increase the banks' ROE, such results do not apply consistently to other index of profitability like return on asset (ROA).

Other empirical studies, which include Aeillo and Bonanno (2015) and Phan, Daly and Akhter (2016) have also lent weight to the ES hypothesis by postulating a positive correlation between bank efficiency and market concentration in the Italian and the emerging ASEAN banking sectors respectively. The uncovered positive correlation between efficiency and market share / profitability by the abovementioned studies testifies the central tenet of ES hypothesis, which reinforces the growth of efficient banks at the expense of the inefficient ones to foster higher aggregate efficiency or productivity in the intermediation of financial resources.

Nonetheless, Fedele and Mandovani (2014) propose a model, which calls for government intervention to grease the financial intermediation logjam that often appears in the form of credit crunch following a financial crisis outbreak. In contrast to the neo-classical's assertion, the additional credit and guarantees provided by the non-profit public financial institutions are

necessary to bridge the informational asymmetries that often transpire after a financial crisis takes place as trust between economic actors obliterates. Despite the primacy effect of freedom in fostering an efficient financial intermediation process, at times government intervention is called for to break any gridlock that prevents the market forces to tend towards equilibrium. However, Fedele and Mandovani (2014) do qualify that government intervention in the form of credit guarantees should be sufficiently low as not to undermine banks' incentive to monitor borrows' behavior.

2.3. Empirical studies on the nexus between freedom and competition

Theoretically, greater freedom or autonomy in the banking sector is postulated to diminish the banks' market power as they are compelled to compete on a level playing field without any shot in the arm by the government. Hence, freedom is expected to erode the banks' economic rents by fostering rivalry or competitiveness among the incumbent banks. Though, results from extant empirical studies are generally in support of such postulation, pockets of inconsistency are found especially in large cross-country studies.

Studies that have provided evidence to affirm a positive relationship between freedom and competition include Delis (2012), which finds that reforming the banking sector with more liberal policies increases competition. Specifically, the level of competition increases at a much faster pace for economies with institutional endowment as compared to economies with poor politico-institutional milieu. Similarly, upon examining the drivers of competition in the banking sectors of 50 countries, Claessens and Laeven (2004) reveal that fewer restrictions on banking activities aids competition.

In the same vein, Demirguc-Kunt, Laeven and Levine (2004) note that countries with conducive economic freedom and banking freedom tends to have lower banks' net interest margin as a result of greater forces of competition. In addition, Mirzaei and Moore (2014), having examined banking systems of 146 countries, found evidence of the expected positive relationship between economic freedom and competition. Albeit, the positive relationship is only apparent in advanced and emerging countries. Apart from that, Lee and Hsieh (2014) has also uncovered empirical evidence in support of a positive relationship between banking reform (such as removal of entry barriers) and competition across a large sample of 15,920 individual banks from 90 countries.

Contrariwise, Bikker and Spierdijk (2010) sample over 25,000 banks and find that higher regulation index, despite imposing greater restriction on banking activities, leads to higher level of competition as measured by H-statistic. Nevertheless, the underlying nature of the regulation was not discerned. If the regulation enforced is of anti-trust type, then competition is expectedly imbued. Equally intriguing results were uncovered in a

cross-country study by Delis, Kokas and Ongena. (2016), in which financial freedom is unexpectedly found to play no role in determining the banks' market power. Apart from that, the incompetence of liberalization and reform to instigate forces of competition is also supported by Abdelkader and Mansouri (2013), which finds that the Tunisian banks are still operating under monopoly conditions despite bouts of reforms and liberalization initiatives implemented.

Regardless whether these aforementioned studies affirm the causality between freedom and competition, there is a consistent gap that prevails in the literature. It is apparent that the estimated freedom-induced competitive pressure does not take into account of the conditioning effect of bank efficiency and also the simultaneous effect that freedom has on efficiency. Conjecturally, competitive pressure in the form of profit erosion for efficient banks is likely to be lower than the inefficient ones. As a result, this study duly accounts for the conditioning effect of bank efficiency on the freedom-competition relation to corroborate the determinacy of efficiency on the competition-instigated output reallocation.

3. METHODOLOGY

In order to carry out the research objective of this present study, the accompanied methodological framework is made up by two stages. The first stage involves estimating the cost X-inefficiency by using the SFA approach. Thereafter, the estimated cost X-inefficiency scores are entered as argument in the second stage regression to analyze the individual banks' competitive pressure and the effects of output reallocation.

3.1. Measuring bank competitive pressure

By substituting (5) into (2) in section 2.1, what we get is a causal relationship between profit and marginal cost as output quantity is endogenously determined and output price is assumed to be fixed. Therefore, the widely-used econometric model to estimate the Boone indicator as advocated by Boone et al. (2007) is given as the following cost-profit function:

$$\ln \pi_{it} = \rho_0 + \rho_1 \ln MC_{it} + \varepsilon_{it} \quad (6)$$

where π_{it} denotes firm i 's non-negative profit before tax for the t -th period and MC_{it} indicates the marginal cost, while ε_{it} is the idiosyncratic error term. The coefficient, ρ_1 , which measures the profit elasticity of marginal cost is known as the Boone indicator. ρ_1 represents the average competitive pressure that each bank faces. The theoretically consistent value of ρ_1 has to be less than zero. However, how much impairment on bank profit that arises out of the estimated competitive pressure is contingent on its cost

efficiency relative to other banks, which is denoted by its marginal cost. It should be noted that (6) does not normally control for other profit determinants as it is the unconditional cost-profit relation that is of relevance in ascertaining the Boone indicator. Since the banks' profit before tax enters the model in the form of logarithm, it is necessary to be non-negative. For this purpose, the actual individual bank's profit before tax is scaled up by the sample's most negative value. Such transformation produces π_{it} that is non-negative.

Nonetheless, as we have emphasized in section 2.1, the innate assumption of (6) is that the banks are operating at their minimum average cost curve so that profit is maximized. Based on the duality of cost and production functions, the equilibrium between marginal cost and average cost occurs when average cost is at the minimum (scale efficiency), while the bank's total product is at its peak, which is synonymous to maximized productivity. However, as argued in section 2.1, firms are not inherent maximizers in practice based on Leibenstein (1966, 1978). Therefore, to compensate for any slacks in productivity or scale inefficiency, we adjust the econometric model of (6) to the below:

$$\ln \pi_{it} = \rho_0 + \rho_1 \ln AC_{it} + \rho_2(\text{ineff}_{it} * \ln AC_{it}) + \rho_3 \text{ineff}_{it} + \varepsilon_{it} \quad (7)$$

where AC_{it} is the average cost and ineff_{it} is the measure of cost X-inefficiency that is unconstrained by the inherent assumption of banks' profit-maximization behavior. The intuition behind (7) is to discern the conditioning effect of cost X-inefficiency on the Boone indicator, which measures the extent of rivalry-induced output reallocation as the impairment of average cost on banks' profits. The conditioning effect of X-inefficiency can be appreciated by algebraically rearranging (7) as below:

$$\ln \pi_{it} = \rho_0 + (\rho_1 + \rho_2 \text{ineff}_{it}) \ln AC_{it} + \rho_3 \text{ineff}_{it} + \varepsilon_{it} \quad (8)$$

From (8), it is apparent that the aggregate competitive pressure ($\rho_1 + \rho_2 \ln \text{ineff}_{it}$), which connotes the Boone indicator is necessary to be less than zero so that it impairs bank's profit for any given amount of average cost. ineff_{it} is entered into the model as a constitutive variable to avoid model misspecification as asserted by Brambor, Clark and Golder (2005). Incidentally, the total effects of X-inefficiency on banks' profits is expected to be negative, of which one part of the total effects is conditioned on average cost, while another part is a direct effect measured by the coefficient, ρ_3 . Furthermore, to avoid problem of multicollinearity in (7), we orthogonalize $\text{ineff}_{it} * \ln AC_{it}$, so that they are independent of $\ln AC_{it}$ and ineff_{it} . The procedure of orthogonalization is carried out by first regressing the interaction term with the two constitutive variables, $\ln AC_{it}$ and ineff_{it} .

The resulting residuals, being the orthogonalized interaction term, are then entered into (7).

Given the substantial state intervention in domestic banks through equity ownership, more enumerated insights on the competitive pressure and reallocation effects can be obtained by decomposing the sample into domestic and foreign banks by using a binary dummy variable. As a result, (8) is further augmented as below:

$$\begin{aligned} \ln \pi_{it} = & \rho_0 + (\rho_1 + \rho_2 \text{ineff}_{it}) \ln AC_{it} + \rho_3 \text{ineff}_{it} \\ & + (\rho_4 + \rho_5 \text{ineff}_{it}) \ln AC_{it} * \text{foreign} + \varepsilon_{it} \end{aligned} \quad (9)$$

The dummy variable foreign will take on the value 1 for foreign banks and value 0 for domestic banks. It follows then, ρ_2 and ρ_5 represent the conditioning effects of inefficiency on the foreign banks' output reallocation while $(\rho_1 + \rho_2 \text{ineff}_{it})$ and $(\rho_4 + \rho_5 \text{ineff}_{it})$ are the respective Boone indicators that capture the banks' extent of output reallocation, which is also synonymous to the total effects of average cost on profits. Delving deeper into the constructs, ρ_5 is considered as the marginal conditioning effects of inefficiency⁶ that is accruable to the foreign banks.

Notably (9) does not control for the quantity of output sold, which is expected to be correlated with π_{it} and AC_{it} . Therefore, $Cov(AC_{it}, \varepsilon_{it})$ is not expected to be zero. Thus, in order to account for the problem of endogeneity, unlike most studies that estimate the cost-profit function with fixed effect model, this present study uses the system Generalized Method of Moment (GMM) estimator proposed by Blundell and Bond (1998). Besides that, just like the fixed effect model, system GMM also controls for the banks' heterogeneity. For the purpose of robustness, we use the system GMM variant with two-step and robust standard error estimation. Particularly, we follow Van Leuvensteijn, Bikker, Van Rixtel and Sørensen (2011) to omit the short-run dynamics in the system GMM model as the Boone indicator is determined by the long-run cost-profit relation. Specifically, we only consider the plausible effects of endogeneity between AC_{it} and π_{it} , while ineff_{it} is considered strictly exogenous.

For the purpose of postestimation hypothesis testing, the standard error of the total effects of average costs (Boone indicator) for domestic banks is computed as below:

$$\sigma_{\frac{\partial \ln PBT}{\partial \ln \text{avgcost}}} = \sqrt{\text{var}(\hat{\rho}_1) + \overline{\text{ineff}}^2 \text{var}(\hat{\rho}_2) + 2 * \overline{\text{ineff}} * Cov(\hat{\rho}_1, \hat{\rho}_2)} \quad (10)$$

⁶Note that the total conditioning effects of efficiency for foreign banks should be recovered as $\rho_2 + \rho_5$, of which ρ_2 is the conditioning effects associated with domestic banks. Therefore, ρ_5 is interpreted as the extent of conditioning effects ascribed to the foreign banks that are over and above the conditioning effects of domestic banks.

where $\overline{\text{ineff}}$ is the mean X-inefficiency of domestic banks. Similarly, the respective standard errors for the total effects of average costs for foreign banks and the total effects of X-inefficiency can be recovered through the formula encapsulated in (10) by replacing the relevant parameters.

3.2. Measuring bank cost X-inefficiency

The individual bank's cost X-inefficiency, ineff_{it} , in (7) is estimated by using the SFA approach, which was simultaneously but independently proposed by Meeusen and Van den Broeck (1977) and Aigner, Lovell and Schmidt (1977). Consistent with Dong, Hamilton and Tippet (2014), we estimate a global cost frontier for the Chinese banking sector, which is given in matrix form as below:

$$TC_{it} = x_{k,it}\beta_k + v_{it} + u_{it} \quad k = 1, 2, \dots, N; t = 1, 2, \dots, T \quad (11)$$

where TC_{it} is the total cost, which is explained by a $(1 \times k)$ vector of explanatory variables that consist of non-negative values output quantity, input prices and constant 1 as the first element. β_k is a $(k \times 1)$ vector of parameters to be estimated. Hence, $x_{k,it}\beta_k$ constitutes the bank's production technology set that produces fixed quantity of outputs with the desirable number of inputs based on the given input prices. $v_{it} + u_{it}$ are the composed error terms, where v_{it} is the idiosyncratic error term and u_{it} is the non-negative one-sided error term that denotes cost X-inefficiency, ineff_{it} . Further to that, the decomposed error terms are assumed to follow the below distributional assumptions:

$$v_{it} \sim N(0, \sigma_v^2) \quad (12)$$

$$u_{it} \sim N^+(\mu, \sigma_u^2) \quad (13)$$

(12) indicates that v_{it} is a white noise process, while (13) suggests that u_{it} follows a truncated normal distribution with a constant variance, σ_u^2 , a constant mean, μ , and a truncation point of zero. A notable contribution from Battese and Coelli (1995) (BC95)'s technical inefficiency effect model to the SFA approach is to allow for the parameterization of μ by a vector of determinants (known as Z-variables) as shown below:

$$\begin{aligned} \mu &= Z_{it}\delta \\ Z_{it} &= f(C_{it}, CMRI_t) \end{aligned} \quad (14)$$

In our estimation, the Z-variables are comprised of a vector of bank-specific control variables, C_{it} , and credit market regulation index, $CMRI_t$. The Z-variables are further expounded in section 3.2.2 below. All the parameters in (11) and (13) are estimated concurrently by using the maximum

likelihood (ML) estimator. Appropriate parameter values are obtained by maximizing the log-likelihood function derived in Battese and Coelli (1993) as the joint density function of the observed dependent variable.

For purpose of estimation, the cost frontier assumes the transcendental logarithm (translog) specification as shown in (15) below:

$$\begin{aligned}
\ln TC_{it} = & a_0 + \sum_{j=1}^2 \beta_{1,j} \ln Q_{j,it} + \frac{1}{2} \sum_{j=1}^2 \sum_{k=1}^2 \beta_{2,jk} \ln Q_{j,it} \ln Q_{k,it} \\
& + \sum_{m=1}^3 \beta_{3,m} \ln P_{m,it} + \frac{1}{2} \sum_{m=1}^3 \sum_{n=1}^3 \beta_{4,mn} \ln P_{m,it} \ln P_{n,it} \\
& + \sum_{j=1}^2 \sum_{m=1}^3 \beta_{5,jm} \ln Q_{j,it} \ln P_{m,it} + \beta_6 \text{year} + \beta_7 \text{year}^2 \\
& + \sum_{j=1}^2 \beta_{8,i} \ln Q_{j,it} \text{year} + \sum_{m=1}^3 \beta_{9,m} \ln P_{m,it} \text{year} + v_{it} + u_{it}
\end{aligned} \tag{15}$$

where $Q_{j,it}/Q_{k,it}$ are the outputs indexes and $P_{m,kt}/P_{n,kt}$, are the indexes for input prices year denotes time trend, which also accounts for technological progress. β_1 to β_9 are the unknown parameters to be estimated. u_{it} is the measured cost X-inefficiency, which is distributed based on (13) and specified as below:

$$\begin{aligned}
u_{it} = & \delta_0 + \delta_1 \frac{LLP}{TL_{it}} + \delta_2 \frac{TL}{TA_{it}} + \delta_3 EQASS_{it} \\
& + \delta_4 \ln TA_{it} + \delta_5 CMRI_t + \varepsilon_{it}
\end{aligned} \tag{16}$$

ε_{it} is a white noise error term that is normally distributed with zero mean and constant variance σ_ε^2 , while truncated at $-Z_{it}\delta$ i.e. $\varepsilon_{it} \geq -Z_{it}\delta$ so that u_{it} is non-negative. The other determinants of u_{it} are sequentially expounded as below:

LLP/TL is a measure of banks' credit risk, which is computed by dividing loan loss provision with total loan. Since 2004, China has adopted a risk-based approach known as five-category loan classification system to group the outstanding loans into five categories in accordance to their default risks and to make the necessary provision against them. Therefore, higher credit risk in the banks' portfolio will necessarily attract higher amount of provision. In this direction, we expect LLP/TL to have an intuitive positive impact on cost X-inefficiency.

TL/TA as the ratio between total loans and total asset denotes the banks' liquidity position. Loan, as compared to other earning securities, are long-term assets because under conventional circumstances, there exists

no secondary market for loans. Hence, a higher value of TL/TA implies shortage of liquidity in the banks, which poses substantial risk for the banks to meet their short-term liability. This in turn increases their susceptibility to bank runs. Consequently, it calls for higher cost of borrowing in the interbank market. In addition, García-Herrero, Gavilá and Santabábara (2009) assert that loans attract higher operational cost due to search, origination and monitoring. As such, a higher ratio of TL/TA is expected to lead to higher average cost.

EQASS is a measure of capitalization that is computed as the ratio between capital equity and bank's total assets. From the cost perspective, Berger and Mester (1997) argue that higher capitalized banks are more cost efficient as dividends paid on equity are not treated as expense, while interests paid on deposits are. Further, given perfect information, Pasiouras and Kosmidou (2007) and Kosmidou (2008) assert that higher level equity will likely attract lower borrowing costs for banks due to lower insolvency risk. Thus, higher EQASS will arguably lead to higher cost X-efficiency.

LNTA, computed as the natural logarithm of total asset is a proxy for the banks' size. The structural characteristics of the Chinese banks are widely disparate with the size of SOCB many times larger than CCB or RCB. As the scale of operation is intrinsically linked to unit cost, we expect the cost performance of the banks is considerably heterogenous across the banks of different sizes. Thus, it is important to control the estimated cost X-inefficiency for bank size. More specifically we anticipate a non-linear relationship between bank size and cost X-efficiency. Although banks have to be of sufficient size to benefit from economies of scale, any size larger than the threshold will lead to diseconomies. This is robustly supported by studies that include Ariff and Can (2008) and Maudos et al. (2002) which find that medium-sized banks are more cost efficient than the small or large banks in the Chinese and the European banking sector respectively. Besides that, Kumbhakar and Wang (2007) postulate an optimal size for the Chinese banks, which the SOCB and JSCB are operating slightly below it. However, Huang and Fu (2013) note the contrary. Upon computing the scale efficiency, they find that Chinese banks tend to be oversized and therefore, further reduction in size will yield savings in costs.

Other than the bank-specific control variables, another variable that is entered as one of the cost X-inefficiency correlates, which is of particular interest in this present study is the credit market regulation index (CMRI) compiled by the Fraser Institute. CMRI measures the degree of freedom in the Chinese banking credit market by observing developments in three areas of the domestic credit market: 1) bank ownership structure to ascertain the prevalence of private ownership; 2) amount of credit supplied to private sector; and 3) allowance of market forces to determine interest rate. Thus, countries that allow market forces to take precedence in the

credit allocation to private entities will resultantly be allotted with higher ratings by this index.

In order to gain more granular insight on the implication of credit market freedom on banks' inefficiencies, we decompose the freedom effects by using dummy interaction technique. Consequently, (15) is further augmented as below:

$$\begin{aligned} u_{it} = & \delta_0 + \delta_1 \frac{LLP}{TL_{it}} + \delta_2 \frac{TL}{TA_{it}} + \delta_3 EQASS_{it} + \delta_4 \ln TA_{it} \\ & + \delta_5 CMRI_t + \delta_6 CMRI_t * SOCB + \delta_7 CMRI_t * JSCB \quad (17) \\ & + \delta_8 CMRI_t * CCB + \delta_9 CMRI_t * RCB + \varepsilon_{it} \end{aligned}$$

where SOCB, JSCB, CCB and RCB are the binary dummy variables that take on the value zero or one to represent the respective ownership structures⁷. Through the simple set up above, we are able to estimate the ownership-specific freedom effects. For example, the freedom effect for SOCB is derived by augmenting δ_5 with δ_6 as shown below:

$$\delta_5 CMRI_t + \delta_6 CMRI_t * SOCB \quad (18)$$

Given $SOCB = 1$ and substitute to (18):

$$\delta_5 CMRI_t + \delta_6 CMRI_t * 1 \quad (19)$$

$$(\delta_5 + \delta_6) CMRI_t \quad (20)$$

By repeating the same steps, the freedom parameters for all ownership types can be recovered. For the purpose of ascertaining the significance of the ownership-specific parameters through hypothesis testing, the standard errors can be recovered by using the formula below:

$$\sigma_{(\delta_5 + \delta_6)} = \sqrt{var(\delta_5) + var(\delta_6) + 2 * cov(\delta_5, \delta_6)} \quad (21)$$

Finally, to recover the cost X-efficiency score, the following formula is adopted:

$$CE_{it} = \exp(-u_{it}) \quad (22)$$

(22) is at variance with the formula suggested by Coelli (1996), which takes the form $CE_{it} = \exp(u_{it})$, instead. However, the slight alteration in (22) has the advantage of bounding CE_{it} between the values zero and one i.e. $0 \leq CE_{it} \leq 1$, which enables more intuitive interpretation. The closer CE_{it} is to zero, the less cost efficient the bank is. Contrariwise,

⁷Note that the dummy variable for foreign bank is excluded to avoid dummy variable trap.

as CE_{it} tends towards 1, then the banks will become more cost efficient. To be theoretically consistent, the cost function is required to be linearly homogenous to degree one in input prices, which requires the sum of all input prices to increase at the same proportion as the total cost. Such restriction can be achieved by imposing the following constraints on the parameters:

$$\sum_{m=1}^3 \beta_{3,m} = 1 \quad (23)$$

$$\sum_{i=1}^2 \sum_{m=1}^3 \beta_{5,jm} = 0 \quad (24)$$

$$\sum_{m=1}^3 \sum_{n=1}^3 \beta_{4,mn} = 0 \quad (25)$$

We impose the constraints presented in (23) to (25) by normalizing the total cost and all the input prices with the third input price, P_3 i.e. price of labor. In addition, the translog functional form also requires the second order parameters to be symmetric: $\beta_{2,jk} = \beta_{2,kj}$ and $\beta_{4,mn} = \beta_{4,nm}$.

To estimate (15), it is necessary to discern the banks' inputs and outputs based on their operational cycle. To this end, we adhere to the intermediation approach as proposed by Sealey and Lindley (1977), which considers the banks' primary function as financial intermediaries that provide loans and investments to deficit agents by combining inputs that are made up of loanable funds from surplus agents, physical capital and labour. Hence, following established studies such as Weill (2003, 2004) and Vander Venet (2002), proxies for the output vector in (15) are specified as loan assets (Q_1) and other earning assets (Q_2) respectively, while input prices include: price of loanable funds (P_1), which is computed by dividing total interest expense with total deposits; price of physical capital (P_2), as the quotient of overhead expense net off personnel expense to fixed assets; and lastly, price of labour (P_3), which is calculated as the ratio of personnel expense to total asset. Incidentally, proxies for the input prices are consistent with established studies on bank efficiency like Pasiouras, Tanna and Zoupounidis (2009) and Lozano-Vivas and Pasiouras (2010).

3.3. Data and variables

Our sample includes only commercial banks that operate in the Chinese banking sector, which are comprised of SOCB, JSCB, CCB, RCB and locally incorporated foreign banks. There are 178 banks updated as commercial banks in Bankscope. However, majority of these banks do not provide any update on "personnel expense" in the database, therefore, due

to data limitation, our final sample is restricted to 107 banks observed over 7 years from 2007 to 2013. Therefore, in total, our sample consists of 410 bank-year observations. Table 1 below provides the descriptive statistics of the variables used.

TABLE 1.

Descriptive statistics

Variable	Acronym	Mean	Std Dev	Min	Max
Profit Before Tax (USD million)	PBT	3,110	8,221	-30	61,611
Total Cost (USD million)	TC	5,410	12,605	2	80,374
Loans (USD Million)	Q_1	100,715	247,572	16	1,586,493
Other Earning Assets (USD Million)	Q_2	66,265.34	155,365.17	6	889,104
Price of Loanable Funds	P_1	0.02	0.02	0.001	0.182
Price of Fixed Capital	P_2	1.76	2.75	0.09	22.13
Price of Personnel	P_3	0.006	0.002	0	0.02
Credit Market Freedom Index	CMRI	7.01	0.21	6.73	7.21
Loan loss provision per total loan (%)	LLP/TL	0.85	3.75	-5	60.43
Total loan per total asset (%)	TL/TA	0.55	0.14	0.048	0.904
Capitalization Ratio (%)	EQASS	8.92	6.36	2.2	59.06
Natural Logarithm of total asset	LNTA	10.3	2.04	3.53	18.15

In addition, appendix 1 provides a summary of variables' descriptions and their data sources.

4. RESULTS AND DISCUSSION

Results of our estimation are conveyed in two stages. The first stage depicts the partial slope coefficients of the estimated frontier model along with the determinants of cost X-inefficiency (Z-variables) in (15). By this means, effect of credit market freedom along with other inefficiency correlates are discerned accordingly. Thereafter, the conditioning effect of cost X-inefficiency on the dynamics of output reallocation is expounded in the second stage, where the estimated Boone indicator and other relevant partial coefficients of the cost-profit function encapsulated in (9) are presented.

4.1. Estimated coefficients of the cost X-inefficiency determinants

Table 2 contains estimation results from the frontier model of Eq.15. Part A of Table 2 produces the partial slope coefficients of all the bank-specific control variables, while Part B reports the partial slope coefficients associated with credit market freedom (as measured by CMRI) that are

specific to each ownership structure.⁸ At the outset, it is intriguing that the loan loss provision measured by LLP/TL exerts no effect on bank cost X-inefficiency, despite its direct implication on the bank cost performance. This could be due to the low non-performing loan (NPL) ratio in the Chinese banking sector, which stands at 1.2% as at 2014. The prevailing low NPL is a result of the setup of four asset management corporations (AMC) in 1999 to absorb the bad and non-performing assets from the banking system.

The variable TL/TA as proxy of liquidity is found to be positively associated with cost X-inefficiency at the 10% level of significance. This is consistent with the assertion made by García-Herrero et al. (2009) that term loan attracts higher operational cost than other earning assets such as securities. Apart from that, the strain on liquidity brought upon by higher composition of term loan could instigate higher cost of borrowing for the incumbent banks. Intriguingly, higher capitalization proxied by EQASS is found to increase cost X-inefficiency as underlined by the significant positive relationship between the two at less than 1% level. This is at odds with the conclusions yielded by Berger and Mester (1997), Pasiouras and Kosmidou (2007) and Kosmidou (2008). The contradiction could be explained by the peculiarity in the ownership structure of the Chinese banks, whose equities are mainly owned by the state. As revealed by Fries, Neven, Seabright and Taci (2006) the state banks in the transitioning economies of Eastern Europe countries are consistently weak in controlling their cost. Similarly, granted with access to the state's coffer, it is conjectured that the Chinese banks tend to have soft budget constraints and therefore, they do not have any incentive to exercise discipline in cost management.

In addition, a significant negative relationship at less than 1% level is uncovered between bank size (measured by $\ln TA$) and cost X-inefficiency. This reinforces the findings of Huang and Fu (2013), which allude that the existing average size of the Chinese banks is beyond the optimal threshold. This is particularly relevant to the Big Four, which refers to the four state-owned commercial banks. Such diseconomies of scale indicate abundant wastages in the resources that are invested into the banking system through state ownership.

Part B of Table 2 reveals that greater freedom in the credit market consistently reduces cost X-inefficiency across all ownership types. This conforms to our expectation. There are multiple channels to realize the efficiency-enhancing effects of freedom. Firstly, as state involvement in the banking system rescinds, banks are compelled to strike out on their own and therefore, igniting their self-sufficiency. Secondly, lesser state intervention also

⁸Due to the exhaustive number of estimated parameters in a translog functional forms, coefficients associated with the frontier arguments are not presented but available upon request.

TABLE 2.

Partial slope coefficients for z-variables

	Coefficient	Corrected Std Error	p-value
A. Bank-specific control variables			
Intercept (δ_0)	5.86	3.00	0.052**
<i>LLP/TL</i> (δ_1)	0.02	0.05	0.704
<i>TL/TA</i> (δ_2)	0.60	0.36	0.096*
EQASS (δ_3)	0.03	0.01	0.002***
LnTA (δ_4)	-0.50	0.12	-0.000***
B. Credit Market Regulation Index (CMRI) by type of ownership			
Foreign Bank (δ_5)	-0.57	0.35	-0.108
SOCB (δ_6)	-0.03	0.37	-0.928
JSCB (δ_7)	-0.24	0.37	-0.51
CCB (δ_8)	-0.37	0.37	-0.318
RCB (δ_9)	-0.38	0.53	-0.478

Note : 1) Above are correlates of cost X-inefficiency

2) *, **, *** significant at the 10%, 5% and 1% levels respectively for two-tailed test.

allows banks to pursue product or cost innovations freely. However, the estimated freedom-induced negative effects on bank cost X-inefficiency are largely not significant, except for foreign banks, which is marginally significant at the 10% level. This reflects inadequacy in the state's liberalization initiatives as shown by those remnants of protectionist policies that are expounded in section 1.0.

4.2. Distribution of cost X-efficiency scores

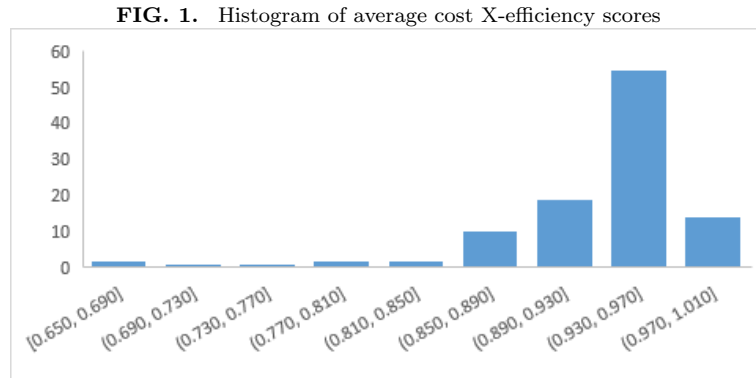
Consistent with Ariff and Can (2008), Table 3 reveals JSCB as the most cost-efficient ownership structure, whilst the average cost X-efficiency scores are quite uniformly distributed across the remaining ownership structures. Incidentally, the mean efficiency across the sample stands at 0.928.

TABLE 3.

Average scores of cost X-efficiency by ownership structure

Type of Ownership	Average Cost X-efficiency
SOCB	0.925
JSCB	0.942
CCB	0.922
RCB	0.930
Foreign	0.930
Average	0.928

Figure 1 shows the histogram of the efficiency scores, which depicts its distribution across the sample.



It is apparent that the distribution of cost X-efficiency scores is leftward skewed. In other words, the sample banks are generally cost efficient with more than 60% of them have efficiency scores above 0.93.

4.3. The Boone indicator and output reallocation effects

Upon ascertaining the banks' X-efficiency / inefficiency scores and their relations with credit market freedom, the extent of output reallocation and the conditioning effect of inefficiency can then be discerned. Table 4 depicts the estimated parameters for the cost-profit relation that decomposes the sample into foreign and domestic banks as represented by (9).

TABLE 4.

The Boone indicator and inefficiency conditioning effects by ownership structure

	Coeff	Corrected Std Error	p-value
Dep var: $\ln PBT$			
$\ln \text{avgcost}(\rho_1)$	-0.504	1.056	0.633
$\ln \text{avgcost} * \text{ineff}(\rho_2)$	-2.696	4.210	0.522
$\text{ineff}(\rho_3)$	-4.715	2.258	0.037**
$\ln \text{avgcost_foreign}(\rho_4)$	-0.666	0.091	0.000***
$\ln \text{avgcost} * \text{ineff_foreign}(\rho_5)$	-4.252	2.465	0.084*
constant (ρ_0)	8.823	3.632	0.015
AR(1) p-value	0.142		
AR(2) p-value	0.489		
Hansen test p-value ⁹	0.221		
Difference-in-Hansen	0.820		

Note : *, **, *** significant at the 10%, 5% and 1% levels respectively for two-tailed test

Table 4 shows that ρ_2 , which represents the conditioning effects of inefficiency on output reallocation for domestic banks (dummy variable, foreign=0), is expectedly negative but not significant at any conventional level. To compute the domestic banks' Boone indicator as the total effects of average cost, we derive the first-order condition as below:

$$\frac{\partial \ln PBT}{\partial \ln \text{avgcost}} = -0.504 - 2.696 * 0.071 = -0.695 \quad (26)$$

(26) shows that on average 1% increase in average cost will reduce the domestic banks' profits by 0.695% based on their average cost X-inefficiency at 0.071. To examine the significance of the estimated Boone indicator, its standard error is computed to be 1.398 by adopting the formula in (10). Hence, neither the Boone indicator nor the conditioning effects of inefficiency is considered significant for the domestic banks. Such insignificant results are within expectation due to the remnants of protectionist policies that are still prevailing in the Chinese banking sector, which hinder the market forces from working out their effects on output reallocation.

On the other hand, estimation results for the foreign banks reveal the opposite. ρ_5 , which connotes the marginal conditioning effects of inefficiency on the dynamics of output reallocation that is attributable to the foreign banks, is not only found to be negative but also significant at less than the conventional 10% level. This is consistent with the prediction of ES hypothesis. Compared to foreign banks that are cost efficient, those inefficient ones with higher cost X-inefficiency will resultantly face greater marginal profit impairments¹⁰ following more efficient reallocation of outputs. Consequently, the cost efficient ones with higher cost X-inefficiency will gain in outputs and market share. Incidentally, the increase in the Boone indicator or the increased effects of average cost for foreign banks (dummy variable, foreign = 1) over the domestic banks is recovered as below:

$$\frac{\partial \ln PBT}{\partial \ln \text{avgcost} \partial \text{foreign}} = -0.666 - 4.252 * 0.071 = -0.968 \quad (27)$$

(27) shows that 1% increase in average cost will cause the reduction in the foreign banks' profits to increase by 0.968%. The corresponding standard error is 0.249. As a result, the estimated increase in Boone indicator for

⁹Since we use robust two-step GMM estimator to account for heteroscedastic error terms, Roodman (2009) asserts that Hansen test statistic for overidentification of instruments is more superior than Sargan test.

¹⁰Marginal profit impairment refers to the amount of foreign banks' profits impaired over and above the impaired amount due to the domestic banks following reallocation of outputs.

foreign banks over the domestic banks is highly significant at less than 1% level.

Estimation results depicted in Table 4 provide evidence that the source of insignificant effects of freedom arises from the domestic banks due to some forms of state protection. Although foreign banks do benefit along the way especially through interest rate control, generally they are relatively independent. Therefore, any inefficiency and slack in productivity noted in the foreign banks will lead to significant profit impairment due to peer rivalry, which then instigates reallocation of outputs from the inefficient banks to the efficient ones. Relating the uncovered negative relationship between credit market freedom and foreign banks' cost X-inefficiency in Table 2 to the implications of cost X-inefficiency on foreign banks' output reallocation in Table 4, we can then infer that freedom plays a significant role on foreign banks' output reallocation through the intermediation of bank efficiency. On the other hand, the regime for domestic banks differ. Firstly, freedom is found to play no role in determining the domestic banks' cost efficiency. Secondly, the manner of which domestic banks' outputs are reallocated is also uncovered to be independent from cost efficiency. This sows the seeds for the inefficient allocation of resources among the domestic banks, which will lead to weakened resistance against external shocks in the long-run.

As mentioned, the variable, ineff is entered into (7) as a constitutive term. Nonetheless, the coefficient ρ_3 cannot be interpreted as the total effects of ineff. Instead, to ascertain the total effects of ineff for domestic banks, the first-order derivative of profits with respect to ineff when foreign=0 is computed as below:

$$\frac{\partial \ln PBT}{\partial ineff} = -4.715 - 2.696 * 3.518 = -14.185 \quad (28)$$

While (28) shows that one percentage point increase in X-inefficiency reduces domestic banks' profits by 14.19% when the mean of $\ln \text{avgcost}$ is 3.518, the total effects of inefficiency for domestic banks is largely insignificant as the associated standard error of 13.87 is almost as equally large as the estimated total effects. On the other hand, the total effects of inefficiency for foreign banks is computed as below:

$$\frac{\partial \ln PBT}{\partial ineff} = -4.715 - 4.252 * 3.483 = -19.525 \quad (29)$$

Since the associated standard error is 10.32, the total effects of X-inefficiency on foreign banks' profits is significant at the 6% level. This reinforces our earlier supposition that due to the absence of state protection on foreign banks, X-efficiency plays an important role in safeguarding their profits

and market share. A lower X-inefficiency will yield lower impairment on their profits through the conditioning effects of average cost and the direct effects. On the other hand, foreign banks with high X-inefficiency will be saddled with larger profit impairment.

5. CONCLUSION AND POLICY RECOMMENDATION

This present study sets off to examine the effects of credit market freedom on the Chinese banks' extent of output reallocation through the intermediation of cost X-inefficiency. For this purpose, we first ascertain the effect of credit market freedom on cost X-inefficiency by using the technical inefficiency effect model proposed by Battese and Coelli (1995) under the SFA approach. Thereafter, the freedom-accounted cost X-inefficiency score is entered as a conditional variable in the cost-profit function to determine its conditioning effects on the extent of output reallocation. By this means, the regimes undertaken by domestic and foreign banks respectively are examined and contrasted. The effect of output reallocation is instigated by competitive pressure that arises through peer rivalry, which is measured as the Boone indicator. By entering the cost X-inefficiency score as conditional variable, the scale inefficiency is innovatively controlled for, which is not accounted in the conventional Boone indicator model.

Properties of market principles allude that annulation of state coercion fosters efficiency, which serves as an insulation against pressure from competition. This corresponds to Demsetz's ES hypothesis, which suggests market fluidity having arisen from reallocation of outputs from the inefficient banks to the efficient ones, fosters performances of the latter. To this effect, the assimilated findings of this study conclude that credit market freedom only determines the fluidity of foreign banks' output reallocation, whilst output reallocation among the domestic banks is rather constricted and not significantly affected by the degree of prevailing freedom in the credit market.

In regard to the channel of mechanism, higher credit market freedom is found to significantly reduce the foreign banks' cost X-inefficiency, whilst its effect on the domestic banks is hardly significant due to the traces of protectionist policies in place. In turn, a higher cost X-inefficiency is revealed to augment the foreign banks' competitive pressure, which leads to significantly larger extent of output reallocated in the form of profit impairment. As a result, a positive effect of credit market freedom on the output reallocation dynamics of foreign banks could be ascertained.

Therefore, empirical evidences yielded in this present study postulate a key notion that efficiency is integral to the foreign banks' survival against freedom-induced peer rivalry. On the other hand, freedom has no significant impact on the domestic banks' cost X-inefficiency and the conditioning

effects of inefficiency scores on the output reallocation of domestic banks is also uncovered to be not significant. This unambiguously indicates the lack of market fluidity among the domestic banks in contrast to the foreign banks.

On policy recommendation, while state protection is a convenient and direct short-run approach to fend off any external shock, in the long-run it disrupts the domestic banks' assimilation of efficiency. Given that efficiency fosters intrinsic stability within the banking system through an efficient mechanism of output reallocation, state protection has the effects of weakening the banking sector in the long-run. Therefore, the relevant regulatory body should be steadfast on their long-term goal of allowing greater market forces in the banking system to foster quality growth. Instead of putting the domestic banks in straightjackets, they should be afforded with greater freedom to pursue course of actions to better their interest, while limiting their access to public funds via state ownership so that they are obliged to observe their budget constraints religiously. Meanwhile, measures such as greater transparency, more efficient monitoring mechanism and more diverse private equity ownership should be put in place to safeguard any excessive risk-taking by the domestic banks following prevalence of freedom.

APPENDIX

TABLE 1.

Description and Descriptive Statistics of Variables			
Variable	Acronym	Description	Source
Profit Before Tax (USD mil)	PBT	The remains of bank's revenue after netting off all costs incurred in generating the revenue	Bankscope
Total Cost (USD mil)	TC	All costs incurred to fund the bank's operation to generate revenue	Bankscope
Loans (USD mil)	Q_1	Book value of the net loan (exclude loans to FI)	Bankscope
Other Earning Assets (USD mil)	Q_2	Advances and loans to FIs; securities; derivatives; insurance assets; derivatives; investment	Bankscope
Price of Loanable Funds	P_1	Opportunity cost incurred on fund usage. Computed by dividing total interest expense by total deposit	Bankscope and author's computation

TABLE 1—*Continued*

Variable	Acronym	Description	Source
Price of Fixed Capital	P_2	Opportunity cost incurred on fixed asset usage. Computed by dividing overhead expense net off expense on personnel by book value of fixed asset	Bankscope and author's computation
Price of Personnel	P_3	Cost incurred on labour force. Computed by dividing personnel expense by total assets	Bankscope and author's computation
Credit Market Freedom Index	CMRI	A composite index that amalgamates three components: 1) bank ownership; 2) private sector credit; and 3) interest rate controls, to proxy the extent of freedom in the credit market	Heritage Foundation
Loan loss provision per total loan (%)	LLP/TL	A measure on the banks' credit risk. Computed by dividing loan loss provision for year t by outstanding net loan	Bankscope and author's computation
Total loan per total asset (%)	TL/TA	A measure on the banks' liquidity position. Computed as the ratio of net loan outstanding to total asset	Bankscope and author's computation
Capitalization Ratio (%)	EQASS	A measure of the banks' capital equity strength as reflected by the quotient between equity at book value and total asset	Bankscope
Natural Logarithm of total asset	LNTA	A measure on the banks' size based on their total assets expressed in natural logarithmic form	Bankscope and author's computation
Average cost	$\ln avgcost$	Unit cost computed as the quotient between total cost and total asset	Bankscope and author's computation

REFERENCES

- Abdelkader, Ines Ben and Faysal Mansouri, 2013. Competitive conditions of the Tunisian banking industry: An application of the Panzar-Rosse model. *African Development Review* **25**, 526-536.
- Aiello, Francesco and Graziella Bonanno, 2016. Bank efficiency and local market conditions. Evidence from Italy. *Journal of Economics and Business* **83**, 70-90.
- Ariff, Mohamed and Luc Can, 2008. Cost and profit efficiency of Chinese banks: A non-parametric analysis. *China Economic Review* **19**, 260-273

- Aigner, Dennis J., C. A. Knox Lovell and Peter Schmidt, 1977. Formulation and Estimation of Stochastic Frontier Production Function Models. *Journal of Econometrics* **6**, 21-37
- Battese, George E. and Timothy J. Coelli, 1993. A stochastic frontier production function incorporating a model for technical inefficiency effects. Working Papers in Econometrics and Applied Statistics No. 69, Department of Econometrics, University of New England, Armidale
- Battese, George E. and Timothy J Coelli, 1995. A model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical Economics* **20**, 325-332
- Berger, Allen N. and Loretta J. Mester, 1997. Inside the black box: What explains differences in the efficiencies of financial institutions? *Journal of Banking and Finance* **21**, 895-947
- Bikker, Jacob A. and Laura Spierdijk, 2010. Measuring and explaining competition in the financial sector. *The Journal of Applied Business and Economics* **11**, 11-42.
- Bod'a, Martin, 2017. Market power and efficiency as the source of performance in banking: a case study of the Slovak banking sector. *International Review of Applied Economics* Available at: <http://www.tandfonline.com/doi/abs/10.1080/02692171.2017.1360845> . [14 December 2017]
- Boone, Jan, Jan van Ours, and Henry van der Wiel, 2007. How (not) to measure competition. TILEC Discussion Paper No 2007-014, Tilburg University
- Boone, Jan, 2008. A new way to measure competition. *The Economic Journal* **118**, 1245-1261.
- Bos, Jaap W., Peter C. van Santen, and Paul Schilp, 2009. Reallocating profits in restructuring industries: evidence from European and US banking. Discussion Paper Series/Tjalling C. Koopmans Research Institute 09-12.
- Brambor, Thomas, William Roberts Clark, and Matt Golder, 2005. Understanding interaction models: Improving empirical analyses. *Political analysis* **14**, 63-82.
- China Regulatory Banking Commission Annual Report 2014
- Chortareas, Georgios E., Claudia Girardone, and Alexia Ventouri, 2013. Financial freedom and bank efficiency: Evidence from the European Union. *Journal of Banking & Finance* **37**, 1223-1231.
- Chortareas, Georgios E., Claudia Girardone, and Alexia Ventouri, 2009. Efficiency and productivity of Greek banks in the EMU era. *Applied Financial Economics* **19**, 1317-1328.
- Chortareas, Georgios E., George Kapetanios, and Alexia Ventouri, 2016. Credit market freedom and cost efficiency in US state banking. *Journal of Empirical Finance* **37**, 173-185.
- Claessens, Stijn and Luc Laeven, 2004. What drives bank competition? Some international evidence. *Journal of Money, Credit, and Banking* **36**, 563-583.
- Delis, Manthos D., 2012. Bank competition, financial reform, and institutions: The importance of being developed. *Journal of Development Economics* **97**, 450-465.
- Delis, Manthos D., Sotirios Kokas, and Steven Ongena, 2016. Foreign ownership and market power in banking: Evidence from a world sample. *Journal of Money, Credit and Banking* **48**, 449-483.
- Demirgüç-Kunt, Asli, Luc Laeven, and Ross Levine, 2004. Regulations, market structure, institutions, and the cost of financial intermediation. *Journal of Money, Credit, and Banking* **36**, 593-622.

- Demsetz, Harold, 1973. Industry structure, market rivalry, and public policy. *The Journal of Law and Economics* **16**(1), 1-9.
- Djalilov, Kurshid and Jennifer Piesse, 2016. Determinants of bank profitability in transition countries: What matters most? *Research in International Business and Finance* **38**, 69-82.
- Dong, Yizhe., Robert Hamilton, and Mark Tippett, 2014. Cost efficiency of the Chinese banking sector: a comparison of stochastic frontier analysis and data envelopment analysis. *Economic Modelling* **36**, 298-308.
- Fedele, Alessandro and Andrea Mantovani, 2014. Credit Availability in the Crisis: Which Role for Public Financial Institutions? *Annals of Economics & Finance* **15**, 161-183.
- Fries, Steven., Damien Naven, Paul Seabright, and Anita Taci, 2006. Market entry, privatization and bank performance in transition. *Economics of Transition* **14**, 579-610.
- García-Herrero, Alicia, Sergio Gavilá, and Daniel Santabábara, 2009. What explains the low profitability of Chinese banks? *Journal of Banking & Finance* **33**, 2080-2092.
- Gropper, Daniel M., John S. Jahera Jr, and Jung Chul Park, 2015. Political power, economic freedom and Congress: Effects on bank performance. *Journal of Banking & Finance* **60**, 76-92.
- Hicks, John, 1935. Annual surevy of economic theory: The theory of monopoly. *Econometrica* **3**, 1-20.
- Homma, Tetsushi, Yoshiro Tsutsui, and Hirofumi Uchida, 2014. Firm growth and efficiency in the banking industry: A new test of the efficient structure hypothesis. *Journal of Banking & Finance* **40**, 143-153.
- Hu, Angang, Jie Lu, and Zhengyan Xiao, 2011. Has China's Economy Become More Stable and Inertial? Nonlinear Investigations Based on Structural Break and Duration Dependent Regime Switching Models. *Annals of Economics and Finance* **12**, 157-181.
- Huang, Mei-Ying and Fu, Tsu-Tan, 2013. An examination of the cost efficiency of banks in Taiwan and China using the metafrontier cost function. *Journal of Productivity Analysis* **40**, 387-406.
- Khan, Habib Hussain, Ali M. Kutan, Iram Naz, and Fiza Qureshi, 2017. Efficiency, growth and market power in the banking industry: New approach to efficient structure hypothesis. *The North American Journal of Economics and Finance* **42**, 531-545.
- Kosmidou, Kyriaki, 2008. The determinants of banks' profits in Greece during the period of EU financial integration. *Managerial Finance* **34**, 146-159.
- Kumbhakar, Subal C. and Dan Wang, 2007. Economic reforms, efficiency and productivity in Chinese banking. *Journal of Regulatory Economics* **32**(2), 105-129.
- Lee, Chien-Chiang and Hsieh Meng-Fen, 2014. Bank reforms and competition: New global evidence. *Asia-Pacific Journal of Financial Studies* **43**, 649-689.
- Leibenstein, Harvey, 1966. Allocative efficiency vs. "X-efficiency". *The American Economic Review* **56**, 392-415.
- Leibenstein, Harvey, 1978. On the basic proposition of X-efficiency theory. *The American Economic Review* **68**, 328-332.
- Lin, Kun-Li., Anh Tuan Doan, and Doong Shuh-Chyi, 2015. Changes in ownership structure and bank efficiency in Asian developing countries: The role of financial freedom. *International Review of Economics & Finance* **43**, 19-34.

- Lozano-Vivas, Ana and Fotios Pasiouras, 2010. The impact of non-traditional activities on the estimation of bank efficiency: international evidence. *Journal of Banking & Finance* **34**, 1436-1449.
- Maudos, Joaquin, José M. Pastor, Francisco Pérez, and Javier Quesada, 2002. Cost and profit efficiency in European banks. *Journal of international financial markets, institutions and money* **12**, 33-58.
- Meeusen, Wim and Julien van den Broeck, 1977. Efficiency estimation from Cobb-Douglas production functions with composed error. *International Economic Review* **18**, 435-444.
- Mendes, Victor and João Rebelo, 2003. Structure and performance in the Portuguese banking industry in the nineties. *Portuguese Economic Journal* **2**, 53-68.
- Mirzaei, Ali and Tomoe Moore, 2014. What are the driving forces of bank competition across different income groups of countries? *Journal of International Financial Markets, Institutions and Money* **32**, 38-71.
- Park, Kang H., 2013. Testing for competition in the South Korean and Chinese commercial banking markets. *Asia-Pacific Journal of Financial Studies* **42**, 56-75.
- Park, Kang H. and William L. Weber, 2006. Profitability of Korean banks: Test of market structure versus efficient structure. *Journal of Economics and Business* **58**, 222-239.
- Pasiouras, Fotios and Kyriaki Kosmidou, 2007. Factors influencing the profitability of domestic and foreign commercial banks in the European Union. *Research in International Business and Finance* **21**, 222-237.
- Pasiouras, Fotios, Sailesh Tanna, and Constantin Zopounidis, 2009. The impact of banking regulations on banks' cost and profit efficiency: Cross-country evidence. *International Review of Financial Analysis* **18**, 294-302.
- Phan, Hanh Thi My, Kevin Daly, and Selim Akhter, 2016. Bank efficiency in emerging Asian countries. *Research in International Business and Finance* **38**, 517-530.
- Roodman, David, 2009. How to do xtabond2: An introduction to difference and system GMM in Stata. *The Stata Journal* **9**, 86-136.
- Sassi, Houda, 2013. The impact of bank regulations and institutions on efficiency in selected MENA banks. *International Journal of Economics and Finance* **5(8)**, 84.
- Čihák, Martin and Klaus Schaeck. 2010. How well do aggregate prudential ratios identify banking system problems? *Journal of Financial Stability* **6**, 130-144.
- Sealey, C. W. Jr and J. T. Lindley, 1977. Inputs, outputs and a theory of production and cost at depository financial institutions. *The Journal of Finance* **32**, 1251-1266.
- Shan, Jordan and Qi Jianhong, 2006. Does Financial Development Lead Economic Growth? The Case of China. *Annals of Economics and Finance* **7**, 197.
- Stiroh, Kevin J. 2000. Compositional Dynamics and the Performance of the U.S. Banking Industry. Federal Reserve Bank of New York Staff Report, No. 98
- Stiroh, Kevin J. and Philip E. Strahan, 2003. Competitive dynamics of deregulation: Evidence from US banking. *Journal of Money, Credit, and Banking* **35**, 801-828.
- Sufian, Fadzlan and Muzafar Shah Habibullah, 2010. Does economic freedom fosters banks' performance? Panel evidence from Malaysia. *Journal of Contemporary Accounting & Economics* **6**, 77-91.
- Sufian, Fadzlan and Muzafar Shah Habibullah, 2011. Opening the black box on bank efficiency in China: Does economic freedom matter? *Global Economic Review* **40**, 269-298.

Sufian, Fadzlan and Muhamed Zulkhibri, 2015. The Nexus between Economic Freedom and Islamic Bank Profitability in the MENA Banking Sectors. *Global Business Review* **16** (5_suppl), 58S-81S.

Van Leuvensteijn, Michiel, Jacob A. Bikker, Adrian A.R.J.M van Rixtel, and Christoffer Kok Sørensen, 2011. A new approach to measuring competition in the loan markets of the euro area. *Applied Economics* **43**, 3155-3167.

Vander Vennet, Rudi, 2002. Cost and profit efficiency of financial conglomerates and universal banks in Europe. *Journal of Money, Credit, and Banking* **34**, 254-282.

Weill, Laurent, 2003. Banking efficiency in transition economies. *Economics of transition* **11(3)**, 569-592.

Weill, Laurent, 2004. Measuring cost efficiency in European banking: A comparison of frontier techniques. *Journal of Productivity Analysis* **21(2)**, 133-152.