The impact of deregulation and re-regulation on bank efficiency: evidence from Asia

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The Impact of Deregulation and Re-regulation on Bank Efficiency: Evidence from Asia

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Abstract

Following the 1997 crisis, banking sector reforms in Asia have been characterised by the emphasis on prudential regulation, associated with increased financial liberalisation. Using a panel data set of commercial banks from eight major Asian economies over the period 2001-2010, this study explores how the coexistence of liberalisation and prudential regulation affects banks' cost characteristics. Given the presence of heterogeneity of technologies across countries, we use a stochastic frontier approach followed by the estimation of a deterministic meta-frontier to provide 'true' estimates of bank cost efficiency measures. Our results show that the liberalisation of bank interest rates and the increase in foreign banks' presence have had a positive and significant impact on technological progress and cost efficiency. On the other hand, we find that prudential regulation might adversely affect bank cost performance. When designing an optimal regulatory framework, policy makers should combine policies which aim to foster financial stability without hindering financial intermediation.

1. Introduction

The post-crisis reform period in Asia has been characterised by the emphasis on the prudential regulation of banks, concomitant with an increased liberalisation of the banking systems. More specifically, while large-scale bank restructuring programmes and tighter prudential rules were put in place in those countries most affected by the 1997 crisis (e.g. Thailand, Indonesia and the Philippines), other countries, such as China, India and Vietnam, saw an acceleration of financial liberalisation over the same time period. This process resulted in substantial changes in market structure, deriving both from greater foreign presence and from increased privatisation across the region.

There is general consensus in the literature on the benefits of financial liberalisation as it fosters competition and promotes economic growth (Cetorelli and Gambera, 2001; Claessens and Laeven, 2004). Deregulation-induced competition, in turn, can translate into incentives for managers to improve efficiency (Leibenstein, 1966). However, evidence on the role of prudential regulation on bank efficiency is inconclusive. Although prudential regulation is primarily designed to strengthen systemic stability and improve the functioning of banking markets, some argue that these regulatory policies can have adverse effects on financial intermediation. Economic theory suggests that prudential regulatory tools can affect the effectiveness of financial intermediation in a number of ways. For instance, stringent capital requirements can reduce banks' borrowing costs because high capitalisation can signal lower bankruptcy risk. On the other hand, the imposition of minimum capital requirements may impose additional costs on banks. In particular, if banks are required to raise equity capital at a price higher than the interest rate on deposits, an increase in capital requirements may discourage banks' willingness to screen borrowers and lend (Thakor, 1996, Gorton and Winton, 2000). Recent years have seen an increasing interest in the academic literature in evaluating the impact of bank prudential regulation on efficiency. The empirical results, however, are rather mixed. There is evidence indicating that the current regulatory and supervisory frameworks impede the efficient operation of banks (Chortareas et al., 2012). As steps towards further regulatory reforms are taking place in many Asian economies, it is important for policy makers to ascertain whether the regulatory reforms implemented in the post 1997 crisis period successfully brought the Asian banking sector into a more

competitive, efficient and stable state. An analysis of the Asian market is significant given its unique and dynamic regional characteristics. The region comprises well developed economies such as Japan and Hong Kong, along with transitional economies such as China, India and the South-East Asian economies. In the aftermath of the Asian crisis, the process and pace of bank regulatory reforms varied substantially from country to country. Such diversification provides us with an excellent laboratory within which to understand the impact of regulatory reforms on banks' managerial decisions and bank performance. In addition, the lessons from the resolution of the Asian crisis have a strong resonance today, when many economies are embarking on the restructuring of their banking sectors in the aftermath of the 2007-2009 global financial crisis.

Thus far, the established literature that attempts to identify the potential impact of regulatory progress on bank performance has typically focused on either the European market (e.g. Chortareas et al., 2012; Delis, et al., 2011), or has been based on publicly listed banks (Pasiouras et al., 2009; Haw et al., 2010). Only a paucity of studies has addressed the Asian market. This lack of empirical evidence makes the analysis of the Asian market particularly important from the perspective of regulatory authorities. Moreover, the established literature studying the impact of regulatory environments on bank performance often focuses on either deregulatory policies or prudential regulations; hardly any literature addresses both aspects simultaneously, nor distinguishes the independent impacts of each regulatory tool on bank performance.

Against this background, this study explores how the coexistence of liberalisation and prudential regulation affected banks' cost characteristics in eight major Asian economies. We build a large panel dataset encompassing depository institutions from China, Hong Kong, India, Indonesia, Japan, Thailand, Malaysia and the Philippines, over the period 2001-2010. Given the presence of heterogeneity of technologies across countries, we use a stochastic frontier approach (SFA) followed by the estimation of a deterministic meta-frontier to provide 'true' estimates of bank cost efficiency measures. Bootstrapping techniques are also used to derive test statistics for the estimated coefficients of the meta-frontier function.

Our results show that the liberalisation of bank interest rates and the increase in foreign banks presence have a positive and significant impact on technological progress and cost efficiency. However, not all liberalisation policies have a positive

impact on banks' cost performance, thus suggesting that the appropriateness of each policy should be considered individually. In addition, we find that prudential re-regulation tends to adversely affect bank cost performance. Policies which aim to strengthen prudential regulation (for example increased capital requirements under the Basel III capital adequacy accord) should take into account the potential negative effects on bank performance, with a view to balance the need to foster stability without hindering financial intermediation.

The rest of this Chapter is structured as follows: Section 2 provides a brief overview of the banking system development in Asia. Section 3 reviews the theoretical literature and empirical findings related to banking regulatory reforms and efficiency. Section 4 describes the data and the empirical strategy. Section 5 presents the empirical results, and concluding remarks are presented in Section 6.

2. Banking in Asia: a brief overview

Banking intermediation plays an important role in economic development in Asia: deposits and bank credit to the private sector are fairly high in China, Hong Kong, Japan, Malaysia, Thailand and Vietnam compared to international standards. However, banking penetration is still below international standards in India, Indonesia and the Philippines, with deposits accounting for less than 50% of GDP; as a consequence, the level of loans extended to the private sector is rather low, being only a third of GDP.

The predominant role played by the banking sector in the financial system in Asia is apparent, and is primarily due to the under-development of capital and bond markets in many countries: for instance, in China, Thailand and Vietnam in the early 2000s the size of bank credit to GDP was three times higher than market capitalisation. Nonetheless, more recent years saw strong growth in market capitalisation, suggesting firms are reducing their reliance on banks.

Financial deregulation began in some Asian countries in the 1970s and accelerated in the 1980s; this is the case for instance of Japan, Singapore, Malaysia, Indonesia and the Philippines. Liberal policies usually commenced with interest rates deregulation and in some instances moved to the opening of capital accounts to international

investors. Table 1 outlines the interest liberalisation process of selected Asian economies. As it can be seen, while the majority of Asian economies removed interest rate restrictions between the 1970s and the early 1990s. China and India retain considerable control to date (especially in terms of deposits). The free capital flows and the liberalised interest rate regime, coupled with the weak internal management systems and complicated external economic environment, caused devastating meltdowns in the banking systems of some Asian economies with the onset of the 1997 financial crisis.

Table 1 Interest rate deregulation

Country	**Pre-crisis**	**1998 - 2003**	**2004 – 2010**
CN	Interest rates were strictly controlled.	Allow loan and deposit rates to fluctuate within a certain range.	The ceiling on deposit rates and the floor on lending rates remain heavily controlled, but lending rates are allowed to float downward by 10% over the benchmark..
HK	Interest rates on time deposit of less than 7 days were under control.	Interest rate restrictions were totally removed (July 2001).	Deregulated.
IN	The ceiling on time deposit rates was removed.	Interest rate control on loans over 200,000 Rupees was removed.	Lending rates were deregulated; interest rates on savings accounts remain heavily controlled.
ID	Deregulated (interest rate deregulation completed in 1983).	Deregulated.	Deregulated.
JP	Deregulated (interest rates controls on loans and deposits removed in 1973 and 1994, respectively).	Deregulated.	Deregulated.
MY	Deregulated (interest rates were initially deregulated between 1971 and 1981. Deposit rates were then re-controlled by the government in 1985 and removed again in 1991).	Deregulated.	Deregulated.
PH	Deregulated (in 1983).	Deregulated.	Deregulated.
TH	Deregulated (in 1992).	Deregulated.	Deregulated.
VN	Deposit rates were	Interest ceiling on	Deregulated.

	liberalised in 1996.	lending rates was removed (in 2002).

Source: The Central Banks of the selected economies.

Countries' names are shortened as follows: CN for China, HK for Hong Kong SAR, JP for Japan, IN for India, ID for Indonesia, MY for Malaysia, PH for the Philippines, TH for Thailand, VN for Vietnam. These abbreviations apply to the whole Chapter.

During the 1997 financial crisis, a number of banks failed whilst others were nationalised, restructured and later re-privatised. Bank restructuring and privatisation were motivated by governments' desire to quickly resolve financial sector problems and return banks to the private sector. From 1998 to the completion of restructuring programmes *circa* 2001, bank restructuring (in the form of compulsory M&A) worked as an exit strategy for weak banks in Indonesia, Malaysia, the Philippines, Thailand and Japan. Since the early 2000s, M&A activities have become more market-driven in the countries most affected by the financial crisis (e.g. Thailand, Indonesia, the Philippines and Japan). In countries less affected by the 1997 crisis, such as China, Hong Kong, India and Vietnam, structural changes in domestic banking sectors were primarily the result of the acceleration of bank liberalisation and of reforms in corporate governance. These dynamics in the Asian banking market have led to a significant change in market structure, which manifested in the increasingly diversified bank ownership (e.g. Indonesia, Thailand) and the efficiency-driven corporate governance reforms (e.g. China, India and Vietnam). Figure 1 illustrates the change of ownership structure before and after the banking restructuring programmes. As it can be seen, state involvement in banks is reducing especially in countries in which state-ownership was predominant, while foreign and private institutions play an increasingly important role in the banking sector.

[Insert Figure 1 about here]

The change in market structure shows up also in the increasing concentration of assets: in the period 1998-2010 the number of banks in Asia decreased considerably as a result of market consolidation between small and medium-sized banks. The five-bank concentration ratio (CR5) [1] however exhibits a mixed trend among Asian economies, as depicted in Figure 2. While the market is increasingly concentrated in countries in which the banking sector was historically dominated by families or the private sector (such as Hong Kong, Japan, Malaysia and the Philippines), a gradual

[1] CR5 is computed as the total assets share of the *5* largest banks in the system.

process of decentralisation takes place instead in those countries formerly dominated by state-ownership (such as China, Indonesia, India and Vietnam), as a result of privatisation. In terms of the overall trend of market concentration, the Herfindahl–Hirschman Index (HHI)[2] of banks' assets indicates that banking markets became increasingly concentrated in the second half of the decade (from 2006 onward) despite a declining trend in the first half of the decade as shown in Figure 2.

[Insert Figure 2 about here]

The process of deregulation allowed banks to become bigger; of particular concern for policymakers is that higher levels of concentration could adversely impact on the competitiveness of domestic banking sectors, if banks collude over the setting of interest rates. While Japan, India and Malaysia experienced a slight fall in net interest margins (NIM), other countries did not show this declining trend, as shown in Figure 3. In particular, an increase in NIM is found in Indonesia, Hong Kong and Thailand, which implies market competitiveness might not necessarily have intensified.

[Insert Figure 3 about here]

The increasing trend of NIM may suggest no increase in competitive pressures due to increased concentration in some banking markets, especially from 2006 onward. Another important element may relate to the shift in regulatory focus from bank deregulation to bank re-regulation. Bank re-regulation was implemented post-1997 in an attempt to reduce the risks associated with financial deregulation, and the process gained increasing attention in recent years due to the adoption of international banking practices (i.e. the Basel Accords). Under the new regulatory regime, increasing emphasis has been given to improving bank capital adequacy, strengthen supervisory powers and enhance information disclosure and transparency. Indeed, improving banks' supervisory and regulatory frameworks by complying with the Basel accords has been put on the agenda in almost all Asian banking markets.

With the efforts made by governments to strengthen the banking system post-1997, most Asian banking sectors seem now to be healthier than a decade ago. For example, as shown in Figure 4, the average capital adequacy ratio (*CAR*) exceeded 9% of total assets in the majority of Asian economies, and the non-performing loans (*NPL*) ratio

[2] The HHI index is computed as the sum of the squares of the asset shares of banks in each country.

saw a steady decline from nearly 18% to less than 3% over the period. In addition, Asian banking markets saw a continuous growth of return on assets (*ROA*) and a fall of cost to income ratios (*CIR*), suggesting banks managed to grow over time by improving operational inefficiency.

[Insert Figure 4 about here]

In recent years also Asian banks suffered from the global financial crisis of 2007-2009, although the overall effect has been limited. This reflects, to a certain extent, the lessons learned from the Asian financial crisis of 1997, and more importantly, the subsequent efforts in strengthening the prudential regulations of the banking system.

Even if the Asian banking markets appear to have been resilient to the recent financial crisis, many uncertainties remain about the long term developments. The key concern is how to achieve a sustainable development by striking a balance between bank deregulation and re-regulation. The review of historical reforms and the exploration of how these reforms affect banks competitive conduct, soundness and efficiency may have important policy implications; these could help policy makers upgrade their prudential and supervisory frameworks, especially for those countries that are still undergoing a period of transformation.

3. Literature review

Financial deregulation (or liberalisation) refers to the implementation of policies that reduce the restrictions imposed on banks, such as the lifting of restrictions on banks entry, on permissible activities, and on interest rates. The primary aim of deregulation policies is to foster competition and improve the efficiency of financial intermediaries. However, the ultimate effects of liberalisation on the financial sector are controversial.

In an early study, Bauer et al. (1993) find the average annual growth rates for US banks during the period between 1977 and 1988 to be negative or close to zero. They attribute the poor performance of US banks to financial deregulation as it raised banks' cost of funding and increased competition from non-bank financial intermediaries. This view is supported by other studies which also document poor performance and little efficiency improvements during the post-deregulatory period in the US (Grabowski et al., 1993; Elyasiani and Mahdian, 1995; Humphrey and Pulley, 1997; Berger and Mester, 2001).

In contrast, studies focusing on Europe tend to show that deregulatory policies positively impacted on bank efficiency (see, for example, Berg 1992; Zaim, 1995; Hasan and Marton, 2003). More recent cross-country studies investigating the Central and Eastern European banking industries during the period 1998-2003, also document a productivity improvement along with the progress of institutional and structural reforms (Koutsomanoli et al., 2009).

A positive relationship between banking reforms and efficiency is also found in studies focusing on the Asian banking market. Gilbert and Wilson (1998) measure the productivity change of Korean banks during the deregulation and privatisation period (1980s and early 1990s). They find that Korean banks dramatically altered their input and output mix which led to productivity growth. The authors attribute this productivity growth to the responses of local banks to the deregulation and privatisation policies implemented over the period. Similarly, Leightner and Lovell (1998) find high productivity growth in the Thai banking market between 1990 and 1994 and attribute the result to financial liberalisation. Chen et al. (2005) examine the impact of China's financial deregulation in the mid-1990s; their results show that deregulation led to the improvement of cost efficiency. Looking at India, Kumbhakar and Sarkar (2003) find no growth in banks' total factor productivity (TFP) following financial liberalisation in the early 1990s, and attribute this result to the very dominant position of public sector banks and the fact that these did not respond to deregulation policies. Extending the period of observation to 1992-2009 Casu et al. (2013) find instead that Indian banks enjoyed positive sustained growth in TFP, mainly led by technical progress and by the increasingly dominant position of foreign banks.

Overall, the empirical evidence on the effect of deregulatory policies on bank productivity growth and efficiency is inconclusive. This outcome may relate to the fact that deregulation relates to many different policy initiatives that can impact on bank performance in different ways. However, the existing literature tends to treat deregulation as one policy, instead of considering its multi-faceted nature. In addition, deregulation is a continuous process, and the existing literature may not sufficiently capture these dynamics. These issues may explain the contradictory findings and may hamper policy inference.

In addition to the fact that liberalisation happens over time and through different policy initiatives, another complication results from the fact that often governments

attempt to pre-empt the potential negative effects of deregulation by implementing policies which aim to strengthen the regulatory framework and the resilience of financial institutions. Prudential regulation (also known as re-regulation) refers to the enforcement of a mixture of *supervisory policies* that aim to monitor banks' activities and *restrictive policies* that aim to protect the banking sector from excessive risk-taking. Over the decades, the instruments of prudential re-regulation have evolved in a number of ways. Firstly, given the increasing complexity of the banking business, the objective of official supervision shifted from monitoring banks' activities to fostering banks' internal management. Secondly, capital norms tightened over time. Thirdly, private monitoring that relies on market mechanisms to discipline banks' activities became a key tool of the supervisory system. These elements constitute the three pillars of international banking practices on capital adequacy and regulation (known as the Basel accords).

Theoretical arguments suggest that the instruments of prudential regulation may have opposite effects on bank performance. Let's consider the three pillars of capital regulation: (i) minimum capital requirements; (ii) supervisory review and (iii) market discipline.

As we discussed earlier, higher capital may lower banks' cost of borrowing as banks are perceived as safer and less likely to fail. However, the imposition of higher capital ratios might burden banks with unnecessary costs. In particular, if banks are forced to raise equity capital at a price higher than the interest rate on deposits, an increase in capital requirements may discourage bank lending (Thakor, 1996, Gorton and Winton, 2000).

Official supervision may reduce market failures by monitoring banks and improving the quality of bank lending (Beck et al., 2006). Powerful supervisors, however, may abuse their powers to benefit their associates and extract bribes (Shleifer and Vishny, 1998; and Quintyn and Taylor, 2002) with detrimental effects on bank intermediation.

Finally, the success of market discipline is conditional on two premises: 1) investors must be able to identify banks' financial conditions in a timely and accurate manner; 2) investors' reactions to a change in the financial conditions of a bank must influence the behaviour of other banks (Bliss and Flannery, 2002). Given the complexity and opacity of the banking sector, the effective implementation of private monitoring is

difficult even in developed economies. For this reason, a reliance on private monitoring may lead to the exploitation of depositors and poor bank performance.

One of the earlier works investigating the regulation-efficiency relationship is that of Demirgüç-Kunt et al. (2003). The authors assess the effects of bank regulations, market structure and national institutions on the cost of intermediation (measured as bank net interest margin and overhead expenditure). The regulatory environment is captured by variables on bank entry, reserve requirements, activity restrictions and an overall index of bank freedom. Using a sample of 72 countries over the period 1995-1999, they find that tightening regulations on bank entry, bank activities, reserve requirements and bank freedom increases the cost of intermediation, but the role of these regulatory variables becomes insignificant when controlling for economic freedom or property rights protection. These results support the view that bank regulations cannot be viewed independently. Barth et al. (2004) provide an insight on the association between re-regulatory policies and bank development, performance and stability. The authors find that tightening activity restrictions lowers banks' efficiency, a result consistent with the findings of Demirgüç-Kunt et al. (2003). In addition, the authors show that policies that enforce accurate information disclosure and private monitoring work best to enhance bank efficiency, whereas they find no statistically significant evidence that capital requirements and official supervisory power improve bank performance.

Following the above two seminal papers a voluminous literature supports the view that private monitoring contributes to the improvement of bank efficiency (e.g., Pasiouras et al., 2009; Haw et al., 2010; Delis et al., 2011), while only limited evidence supports the view that official supervisory oversight and capital requirements help improve financial intermediation (Pasiouras et al., 2009). In particular, Chortareas et al. (2012) find that all interventionist supervisory and regulatory policies, such as capital restrictions, official supervision and private monitoring, hamper the efficient operation of banks. These results raise a cautionary flag as to the efficacy of capital requirements and bank supervision on bank performance.

Despite the growing literature, there is still a paucity of studies investigating the above issues with reference to the Asian banking markets. Thangavelu and Findlay (2012) examine the impact of bank off-balance sheet activities, foreign penetration,

bank regulation and supervision on the efficiency of six South-east Asian banking markets between 1994 and 2008. They find that official supervision helps improve banks' efficiency but that private monitoring actually decreases it. Zhao et al. (2008, 2010) and Casu et al. (2013) identify a sustained productivity growth in India following the prudential re-regulation period (post-1998 onward), but the authors do not identify which re-regulatory policy contributed to the observed productive growth. Banker et al. (2010) investigated the post-1997 regulatory changes in Korea and found that policies aimed at strengthening banks' capital structures and risk management do not have a uniform impact on bank productivity, but rather favour strategically privileged banks. The evidence from the Asian banking market seems to show that supervisory oversight works better than private monitoring, possibly because it is more difficult for emerging economies to move towards a disclosure strategy, given that information asymmetry problems are more acute in those countries.

This study aims to fill these gaps in the literature by providing insights on the impact of each regulatory instrument on bank cost efficiency. In particular, this study estimates whether cost efficiency improved in Asian banking markets after the 1997 crisis. Furthermore it specifically assesses the impact of different deregulation and re-regulation policies on bank cost efficiency.

4. Methodology, data, variables and descriptive statistics

4.1 Methodology

The stochastic frontier approach is used to model banks' cost characteristics. The general stochastic cost frontier in a panel data setting is given as:

$$TC_{it} = \mathrm{TC}(Q_{it}, w_{it}) + \mathrm{v_{it}} + \mathrm{u_{it}} \qquad (4.1)$$

where *TC* is observed total cost; Q and *w* correspond to vectors of outputs and input prices respectively; v is a symmetric random noise term, and u is a non-negative term representing firm-level inefficiency. The subscripts *i* and *t* denote the *i*-th firm and the *t*-th period respectively. Following Battese and Coelli (1995), firm-level inefficiency can be explained by a series of covariates such as bank characteristics or other

exogenous factors. This is done by modelling the inefficiency term, u_{it}, as a function of the composite factors y_{it}, as follows:

$$\mathrm{u_{it}} = y_{\mathrm{it}}\delta + \eta_{it}, \qquad (4.2)$$

Equations (4.1) and (4.2) are estimated simultaneously in one stage, thus overcoming the econometric problems associated with two-stage approaches (Kumbhakar and Lovell, 2003; Greene, 2005).

Many researchers have noticed that the assumption of a common ("pooled") frontier in a cross-country scenario is quite unwarranted given the differences in banking environments and the level and quality of services associated with bank intermediation (Berger and Humphrey, 1997; Dietsch and Lozano-Vivas, 2000, Chaffai et al., 2001; Bikker, 2002). If banking technology across countries is not homogeneous the estimation of a pooled frontier will produce biased results. As a solution, Battese and Rao (2002) and Battese et al. (2004) propose a *meta-frontier* model: this involves defining an overarching mathematical function to envelope the deterministic components of the country-specific stochastic frontiers. The functional form of the metafrontier is the same as that of the stochastic frontiers that it envelops, and the coefficients are estimated by linear programming. The intuition behind the metafrontier is that technological spillovers do exist so that all countries have theoretical access to a superior technology (the meta-technology), regardless of whether they actually make use of it or not. This approach thus allows for the identification of comparable efficiency scores for the banks of different countries. The distance of each bank from the metafrontier defines its metaefficiency score (*Meta-E*) and it is made up of two components, as shown in Equation (4.3): the technology gap ratio (*TGR*) and the bank's efficiency score relative to its country-specific frontier (*CF-E*):

$$\mathrm{Meta\text{-}E_{it}} = \mathrm{CF\text{-}E_{it}} * \mathrm{TGR_{it}} \qquad (4.3)$$

The *TGR* measures the distance between a country frontier and the metafrontier, so in essence the extent to which the technology of a country lags behind the meta-technology. The *TGR* scores are bound between 0 and 1, with values closer to 1 indicating a closer proximity to the meta-technology and *viceversa*. The *CF-E* measures the distance of a bank from its country specific frontier and it too is bound

between 0 and 1; as a result then the *Meta-E* score is bound between 0 and 1 too, as can be easily seen from Equation (4.3).

The meta-frontier model is a non-stochastic approach, which means no distribution is associated to the estimators thus ruling out the testing of hypotheses. One way to get around this problem is through *bootstrapping* (Efron, 1981, Efron and Tibshirani, 1986). Bootstrapping is a computationally intensive, non-parametric approach for making statistical inference when traditional parametric inference is unavailable (Mooney and Duval, 1992). It involves continuously resampling with replacement from the original sample data so as to derive an empirical estimator of the sampling distribution of a statistic. We will use the bootstrapping approach to derive confidence intervals and test statistics for the estimated coefficients of the meta-frontier.

4.2 Data

We collected data from different sources to construct a panel database containing bank-level data and country level data from eight Asian economies (China, India, Japan, Hong Kong, Thailand, Malaysia, Indonesia and the Philippines) over the period 2001-2010. The sample includes all types of depository institutions (commercial banks, saving banks and cooperatives) except for cooperative banks from Japan[3], which results in a total of 3805 observations. Financial information is obtained from Bankscope. Data on regulatory variables is obtained from the World Bank survey database (Barth et al., 2001, 2006, 2007) and the Economic Freedom Index of the Heritage Foundation.

We conduct the analysis at the bank level. Following an established banking literature, we specify a translog stochastic cost function[4], where the dependent variable is measured by bank total costs (*TC*). In the specification of the inputs and outputs, we follow the intermediation approach (Sealey and Lindley, 1977) and specify input

[3] The exclusion of the cooperative banks of Japan from our sample is primarily due to the following consideration. There are more than 400 cooperative banks in Japan and they are small, locally based, and considered as "not-for-profit" organisations (Liu and Wilson, 2010). Kano and Tsutsui (2003) find that loan markets for cooperative banks in Japan are segmented by prefecture, implying that they do not compete on the same platform as the regional and national players. We therefore exclude Japanese cooperative banks from our sample.

[4] For the construction of a translog cost function see Ray (1982). For the application of the function in the banking literature see Mester (1996) and Altunbas and Molyneux (1996), among others.

prices (*w*) as price of labour (*PL*), price of physical capital (*PC*), and price of funds (*PF*), respectively; outputs (*Q*) are defined as net loans (*LN*), other earning assets (*OEA*), and net fees and commissions (*NFC*). We also incorporate risk factors (*X*), proxied by the capital ratio (*CR*), the volatility of returns on assets (*VOroa*) and loan loss provisions *(LLP).* In line with the aims of the analysis, we include a deregulation indicator *(Dereg)* and a re-regulation indicator (*Rereg),* measuring the extent to which the banking market of a country is liberalised and the strength of prudential regulations respectively. A quadratic time trend (*T* and T^2) and the annual GDP growth (*GDP-growth*) are included in the cost frontier to capture technological progress over time and to control for the macroeconomic environment. Next, we model the determinants of inefficiency of Equation (4.3), and we include indices of activity restrictions (*ACTR*) and credit market deregulation (*CMD*) and indices that reflect the strength of capital stringency policy (*CAPS*), supervision power (*SUPP*) and market discipline (*MARD*). All regulatory indices are scaled by the maximum value in each group to ensure that regulatory variables are bound between 0 and 1 and take an equal weight in the estimation. We also include ownership dummies (*D-State, D-Private, D-For, D-Coop*) and control for the degree of market concentration (*HHI*). Table 2 summarises the definitions of the variables.

Table 2 Variables specification

Variable	Specification
Dependent variable	
TC	Total Cost (*TC*) = Interest Expenses + Operating Expenses
Determinants of the cost frontier	
Input prices (*w*)	
PL (w_1)	Price of Labour = Personnel Expenses /Total Assets
PC (w_2)	Price of Capital = (Other Operating Expenses + Loan and other Impaired changes) / Total Assets
PF (w_3)	Price of Funds = Interest Expenses/ (Total Deposits+ Money Market and Short-term funding +Other Funding+ Long-term Funding)
Outputs (*Q*)	
LN (Q_1)	Net Loans = Gross Loans – Reserves for Impaired Loans
OEA (Q_2)	Other Earning Assets
NFC (Q_3)	Net Fees and Commissions
Risk factors (*X*)	
CR (X_1)	Equity Capital Ratio = (Equity Capitals+ Reserves) /(Total Loans)
VOroa (X_2)	Volatility of ROA = Standard Deviation of Return on Assets

LLR (X_3)	Loan Loss Provision = Reserved for Impaired Loans/Total Loans
Control variables	
GDP-growth	Annual GDP Growth Rate
Regulatory variables	
Dereg	Deregulation indicator, the mean values of ACTR and CMD.
Rereg	Re-regulation indicator, the mean values of CAPS, SUPP and MARD.
Determinants of inefficiency	
- Regulatory variables	
ACTR	**Activities restrictions:** an index measuring the degree to which authorities allow banks to engage in fee-based activities, and the degree of regulatory restrictiveness on the mixing of banking and commerce. The degree of restrictiveness for each activity is quantified on a scale from 1 to 4, corresponding to 'prohibited' 'restricted', 'permitted', and 'unrestricted'. The index is the average of the scale of the activities; higher values indicate fewer restrictions on banking activities.
CMD	**Capital market deregulation:** an index reflecting the degree to which a banking market is liberalised. The index includes information from 4 categories: the ownership of banks, foreign bank competition, private sector credit and interest rate controls. Each category is assigned values between 0 to10. The index is the average of the values of each category. Higher values indicate a more liberalised banking system.
CAPS	**Capital stringency:** index based on the answers to the survey questions regarding the overall capital stringency. The values assigned to the index range from 0 to 7, with higher values indicating greater capital stringency.
SUPP	**Supervision power:** the index measures whether supervisory authorities can take specific actions to prevent and correct problems. A value of 1 is assigned to a 'yes' answer and a value of 0 to a 'no' answer. This variable is the sum of these assigned values which range from 0 to 15, with higher values indicating greater supervisory power.
MARD	**Market discipline:** the index captures the degree to which accurate information is disclosed to the public. The values assigned to the index range from 0 to 7, with higher values indicating more transparency and hence greater private supervisory power.
- Ownership dummies	
D-State	1 if banks are ultimately owned by the state, 0 otherwise;
D-Private	1 if banks are identified as private banks and ultimately owned by domestic private sector, 0 otherwise;
D-For	1 if banks are ultimately owned by foreign organisations or other parties, 0 otherwise;
D-Coop	1 if banks are credit cooperatives, or rural banks, 0 otherwise.
- Market structure indicator	
HHI	The Herfindahl - Hirschman Index. Values range from 0 to 1, with higher values indicating greater market concentration.

Note: The definition of *CMD* is based on the database of the Economic Freedom Index; other regulatory variables are based on Barth et al. (2001).

Table 3 summarises the variables by country. As can be seen, the average size of banks in Japan, China and Hong Kong is substantially larger than in other counties in the sample. Banks in Japan, China and Hong Kong also have lower input prices relative to their neighbouring countries. In addition, countries which were most affected by the Asian crisis tend to have higher capital ratios, larger return volatilities and higher LLP (columns 9-11). In terms of the degree of liberalisation, Hong Kong and the Philippines are highly liberalised while China, Indonesia and India lag behind the regional average (columns 12-14). As to the strength of prudential regulations, China has the least stringent capital requirements and India the highest (27.5% and 83.3% respectively, column 15). Both countries grant less power to official supervision (column 16). China however, places greater effort on information disclosure to foster market discipline (column 17). Overall, Japan, Hong Kong and the Philippines implement relatively austere prudential and supervisory frameworks (column 18). Turning to ownership structure, state ownership still plays a predominant role in the banking markets in China, India and Indonesia. Finally, the banking market is highly concentrated in Hong Kong but fragmented in Japan and India.

Table 3 Sample descriptive statistics

Country	Dep. vars	Outputs (*Q*s)			Input prices (*w*s)			Macro-con. ition	Risk factor (*X*s)			Deregulation indicators			Re-regulation indicators				Ownership dummies				Concentration
	TC	LN	OEA	NFC	PL (%)	PC (%)	PF (%)	GDP growth (%)	CR (%)	VO (roa) (%)	LLP (%)	CMD	ACTR	Dereg	CAPS	SUPP	MARD	Rereg	D_State (%)	D_Private (%)	D_For (%)	D_Coop (%)	HHI (%)
Col.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
HK	844	13,382	15,952	330	0.60	0.67	1.64	4.0	11.9	0.3	1.0	97.3	97.1	97.3	75.9	78.6	85.7	89.8	0.00	20.4	79.6	0.00	25.9
JP	968	33,996	23,025	239	0.37	0.83	0.47	0.7	6.4	0.4	1.6	86.8	63.2	80.2	66.7	92.9	68.5	90.8	0.00	100	0.00	0.00	7.22
CN	1,539	27,507	22,018	219	0.52	0.87	1.59	10.9	8.4	0.3	2.6	68.8	42.5	61.5	27.5	76.1	89.9	77.5	67.9	29.4	1.18	1.49	12.9
IN	927	7,433	4,427	170	1.04	1.44	5.15	7.4	11.4	0.2	1.8	70.8	60.4	67.9	83.3	75.8	42.9	77.5	73.8	20.9	4.47	0.82	7.2
ID	250	1,224	1,181	37	1.46	2.35	6.10	5.2	17.5	0.9	6.1	76.2	47.2	68.1	50.0	96.4	57.1	85.4	51.0	18.3	30.6	0.00	10.4
MY	434	6,252	2,405	105	0.73	1.26	2.42	4.5	14.3	0.5	4.2	80.6	62.2	75.5	49.6	93.5	64.4	85.7	22.9	54.6	22.5	0.00	9.6
PH	145	998	970	40	1.17	2.47	3.20	4.8	19.7	0.5	7.4	90.7	83.3	88.6	80.6	92.9	57.1	91.0	8.29	90.4	1.25	0.02	9.2
TH	540	8,223	3,424	113	0.77	1.79	1.94	4.3	12.0	0.9	6.1	87.0	55.2	78.1	59.0	76.4	64.8	78.2	35.0	60.0	4.99	0.00	10.6

Notes: a) The cost and outputs (in columns 1-4) are the arithmetic average of each country and are expressed as per 1,000,000 USD. The amount is deflated using 2005 as base year.

b) Input prices and ownership variables are expressed as asset-weighted averages.

c) *Dereg* (Column 14) is the average of columns 12-13, and *Rereg* (column 18) is the average of columns 15-17.

d) All regulatory variables are scaled by the maximum values of each group to ensure the regulatory variables are bound between 0 and 1 and therefore carry an equal weight in the estimation.

e) Countries' names are shortened as follows: CN for China, HK for Hong Kong SAR, JP for Japan, IN for India, ID for Indonesia, MY for Malaysia, PH for the Philippines, TH for Thailand, VN for Vietnam. These abbreviations apply to the whole Chapter.

5. Empirical results

As a starting point, a likelihood-ratio (LR) test is conducted to test the null hypothesis of technological homogeneity in the sample. We strongly reject the null hypothesis (with a p-value of 0.000) and conclude that banks from different countries indeed operate under different technologies, which justifies the use of the meta-frontier approach.

In what follows, we first discuss the estimation of the country-specific frontiers and the determinants of bank cost inefficiency. We then look at the results of the estimation of the meta-frontier and discuss the dynamics of banks meta-cost efficiency scores.

5.1 Country stochastic frontiers

The results of the country-specific estimations abide with the microeconomic theory requirements of a cost frontier[5], with positive and significant inputs and outputs cost elasticities. Technical progress, measured by the quadratic time trend, is mainly non-significant, with the only exception of Hong Kong. Efficiency levels are reasonably high in each country and do not show significant changes over time (this is shown in Figure 5 later on). Looking at the determinants of inefficiency (the *y* variables of Equation (4.3)) the results show that the relaxation of activities restriction *(ACTR)* does not have a uniform impact on banks' cost efficiency. Capital market deregulation *(CMD)* that liberalises interest rates, enhances private and foreign penetration and facilitates credit allocation positively impacts cost efficiency. The findings suggest that deregulation can improve banks' cost performance but the overall effects of liberalisation policies appear to be multi-faceted and should be considered individually.

Turning to the re-regulation indicators, capital policies *(CAPS)* have a negative impact on banks' efficiency, possibly because higher capital requirements increase banks' costs. We find no convincing evidence that official supervision *(SUPP)* and market discipline *(MARD)* improve banks' efficiency, possibly because government intervention may intensify agency conflicts which in turn can hinder the progress of

[5] For reasons of space the results of the estimation of the country-specific frontiers are not reported but they are available upon request.

cost efficiency. It is also necessary to point out that many Asian economies are characterised by the absence experienced regulators, poor quality on-site supervision and poor law enforcement. These institutional weaknesses may undermine the quality and effectiveness of official supervision. Finally, it may be more difficult for transitional economies to move towards a disclosure-based supervisory regime given the opacity of the banking system. Policy makers who are trying to upgrade their regulatory framework should take into account the potential negative impact of current re-regulatory instruments on bank efficiency.

5.2 The estimation of the meta-frontier

Table 4 reports the estimated coefficients of the meta-frontier. The confidence intervals and standard errors derived from bootstrapping are also reported in the table. It is noticeable that the vast majority of the bootstrapped standard errors are relatively small, indicating that the coefficients are precisely estimated and hence representative of the meta-cost frontier.

Focusing on the impact of regulatory variables on meta-cost technology, the results show that financial deregulation *(Dereg)* that removes restrictions on banks' activities, liberalises interest rates, or enhances foreign penetration, positively impacts on the meta-cost technology. For instance, if the deregulation indices were to increase by 0.1 units, this would induce a reduction of cost by 5.57% (holding other factors constant). These findings seem to support ongoing policies aimed at further liberalising banking systems. However, banking re-regulation (*Rereg*) seems to adversely shift banks' cost technology, possibly because conforming to a more rigorous prudential regulatory system raises banks' costs. But the effect is relatively mild and statistically insignificant, so we remain cautious in interpreting this outcome.

The quadratic time trend (T and T^2) exhibits a concave pattern with the inflection point occurring after almost 9 of the 10 years of the sample, thus indicating a regress of cost technologies in 2001-2009. The finding is consistent with Sun and Chang (2011) who also detected a regress of cost technology in banks' operations in their analysis of bank risk and cost efficiency of eight emerging markets in Asia. The outcome may relate to the fact that banks had to increase their efforts to clean up non-performing assets on their balance sheets after the 1997 crisis. In addition, extra

resources spent on risk control, new business initiatives and technological innovation might have contributed to this pattern of cost technology.

Estimates of bank risk factors indicate higher capital ratios *(CR)* are not associated with greater costs. We interpret this as a signalling effect, that is, a well-capitalised bank may signal higher retained earnings and greater cost savings. Returns volatility (*VOroa*) is associated with lower bank costs. The result is in line with Isik and Hassan (2002) and Havrylchyk (2006). The level of loan loss provisions (*LLP*), however, has no significant effect on bank cost.

Table 4 Parameter estimations of meta-frontier

Variable	Coef		Std-Err	T-ratio	95% Conf. Interval	
Ln*TC*						
Constant	-0.4926		0.6050	-0.8142	-1.8325	0.4541
Ln(LN)	0.4937	***	0.1906	2.5901	0.2296	0.8966
ln(OEA)	0.8039	***	0.1981	4.0572	0.4231	1.1383
Ln(NFC)	-0.0371		0.0326	-1.1384	-0.1110	0.0205
$0.5[\ln(LN)]^2$	0.1204	***	0.0302	3.9813	0.0593	0.1767
Ln(LN)*ln(OEA)	-0.1062	***	0.0395	-2.6885	-0.1893	-0.0495
Ln(LN)*ln(NFC)	-0.0097	*	0.0057	-1.6983	-0.0150	0.0078
$0.5(\ln OEA)^2$	0.0695		0.0503	1.3802	0.0224	0.1816
Ln(OEA)*ln(NFC)	0.0126	**	0.0057	2.2045	-0.0038	0.0186
$0.5(\ln NFC)^2$	0.0007		0.0015	0.4639	-0.0022	0.0035
Z_2	0.0515		0.1267	0.4067	-0.1604	0.3258
Z_3	0.3833	***	0.1027	3.7330	0.1570	0.5578
Z_{12}	0.0705	***	0.0169	4.1721	0.0149	0.0826
Z_{13}	-0.0588	***	0.0139	-4.2282	-0.0880	-0.0320
Z_{23}	-0.0930	***	0.0115	-8.0963	-0.1061	-0.0607
Ln(LN)*Z_2	-0.0083		0.0269	-0.3088	-0.0305	0.0683
Ln(LN)*Z_3	-0.0364	***	0.0144	-2.5358	-0.0449	0.0081
Ln(OEA)*Z_2	0.0380		0.0309	1.2312	-0.0536	0.0597
Ln(OEA)*Z_3	0.0346	**	0.0150	2.3109	-0.0098	0.0459
Ln(NFC)*Z_2	-0.0075		0.0061	-1.2398	-0.0149	0.0087
Ln(NFC)*Z_3	-0.0020		0.0020	-0.9947	-0.0056	0.0023
GDP_growth	-0.0054	**	0.0027	-1.9703	-0.0070	0.0042
T	0.0952	***	0.0185	5.1532	0.0288	0.1049
T^2	-0.0053	***	0.0013	-4.2074	-0.0069	-0.0017
Ln(CR)	-0.0373	***	0.0086	-4.3110	-0.0556	-0.0208
Ln[VO(roa)]	-0.0171	**	0.0069	-2.4692	-0.0331	-0.0063
Ln(LLP)	-0.0003		0.0013	-0.2356	-0.0034	0.0016
Dereg	-0.5573	***	0.0216	-3.9921	-0.1281	-0.0384

Rereg	0.0088	0.0173	0.0631	-0.0045	0.0633
Obs	3805				

Note: (a) Homogeneity in input prices is imposed, the cost function is therefore estimated in its transformational form, where, $Z_2=lnPC-lnPL$, $Z_3=lnPF-lnPL$, $Z_{12}=lnPL*lnPC-0.5(lnPL)^2-0.5(lnPC)^2$, $Z_{13}=lnPL*lnPF-0.5(lnPL)^2-0.5(lnPF)^2$, $Z_{23}=lnPC*lnPF-0.5(lnPC)^2-0.5(lnPF)^2$.

5.3 The evolution of meta-cost efficiency

Based on the estimation of the metafrontier, we can easily obtain the estimations of meta-cost efficiency scores for individual banks. To see how meta-cost efficiency evolved over time, in Figure 5 we plot the changes in the industry average meta-cost efficiency scores (*Meta-E*), technology gap ratios (*TGR*) and efficiency scores benchmarked by country frontiers (*CF-E*).

The figure shows that Asian banking markets experienced considerable improvements in meta-cost efficiency over the 2000s, except for Malaysia. These improvements suggest that bank deregulatory polices, such as the liberalisation of interest rates and the relaxation of foreign bank entry, have transformed the financial landscape as they seem to have fostered reductions in managerial slack and allocative inefficiency. Moreover, when decomposing the meta-cost efficiency into its components, we find that while *CF-E* scores remain roughly unchanged over time, *TGR*s improve considerably. These results seem to suggest that the improvement in meta-efficiency is primarily driven by the advances of domestic technologies towards regional best practices (measured by the *TGR*s). The findings also suggest that domestic banks have equipped themselves with better technology to embrace international competition.

In terms of differentials of cost performance between countries, the Japanese banking market is the most cost efficient. We tentatively explain this result as the outcome of the banking reforms (the so-called 'Financial Big Bang') implemented in Japan in the late 1990s, which aimed to foster a market-based mechanism and thereby to increase banks' incentives for cost-saving. In addition, some banking innovation (such as the IT revolution) implemented in Japan in the early 2000s, aimed at providing high-quality services at lower costs also contributed to the efficient outcome of Japanese banks. In contrast, the Malaysian banking market is relatively cost inefficient and experienced little progress of cost performance over time. This poor performance can be ascribed to Malaysia's high market concentration and to its increasingly stringent

capital norms. In addition, prudential policies (such as restrictions on foreign bank entry and branching) imposed in Malaysia over the past decade may also have hampered banks' incentives for cost reduction.

[Insert Figure 5 about here]

6. Conclusions

This study examined the impact of the coexistence of bank deregulation and prudential re-regulation on banks' cost characteristics in eight major Asian economies over the period 2001-2010. As a first step, this Chapter explored the impact of bank regulation and market structure on cost efficiency by estimating country-specific frontiers. We then examined the factors that affect the meta-cost technology. We find that financial deregulation that liberalises bank's interest rates, removes activities restrictions and enhances foreign penetration, positively impacts on cost technology. This finding underscores the importance of further liberalising banking systems in Asia. Bank re-regulation does not seem to have a significant impact on banks' cost technology. However, given the relatively short time period since the implementation of re-regulatory policies, the long-term effects are still uncertain. Overall, meta cost technology in Asia has regressed over the period 2001-2009. This may relate to the fact that banks had to increase their efforts to clean up their balance sheets after the 1997 crisis. Additional resources spent on risk control, new business initiatives and technological innovation may also have contributed to this results.

We also find that banks' meta-cost efficiency improved considerably overtime in most Asian economies except for Malaysia. This improvement is closely related to the progress of domestic technology towards the 'super-national' technology represented by the meta-frontier. The analysis suggests domestic banks have equipped themselves with better technology to embrace international competition. Overall, the coexistence of deregulatory and re-regulatory frameworks observed in Asia appears to be beneficial for banks' cost performance, given the significant improvement of bank cost efficiency observed in the past decade. However, there are signs of a slowing down of such performance in recent years, which may be associated with the increasing emphasis on bank prudential re-regulation. These results highlight the

importance of combining policies which aim to foster financial stability with policies which promote financial intermediation.

References:

Altunbas, Y., and P. Molyneux (1996) 'Economies of scale and scope in European banking', *Applied Financial Economics* 6(4): 367-375.

Banker, R. D., H. Chang, and S.Y. Lee (2010) 'Differential Impact of Korean Banking System Reforms on Bank Productivity', *Journal of Banking & Finance* 34: 1450-1460.

Barth, J. R., G. Caprio, and R. Levine (2001) *The Regulation and Supervision of Banks Around the World: A New Database,* Vol. 2588, World Bank-free PDF.

Barth, J.R., G. Caprio, and R. Levine (2004) 'Bank Supervision and Regulation: What Works Best?' *Journal of Financial Intermediation* 13: 205-48.

Battese, G.E., and T.J. Coelli (1995) 'A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data', *Empirical Economics* 20: 325-332.

Battese, G.E., and D.S.P. Rao (2002) 'Technology Gap, Efficiency and a Stochastic Meta-frontier Function', *International Journal of Business and Economics* 1 (2): 1-7.

Battese, G.E., D.S.P. Rao, and C.J. O'Donnell (2004) 'A metafrontier Production Function for Estimation of Technical Efficiencies and Technology Gaps for Firms Operating Under Different Technologies', *Journal of Productivity Analysis* 21: 91-103.

Bauer, P. W., A.N. Berger, G.D. Ferrier, and D.B. Humphrey (1993) 'Efficiency and Productivity Growth in US Banking', in Fried, H.O., C.A.K. Lovell, and S.S. Schmidt (eds) *The Measurement of Productive Efficiency: Techniques and Applications,* Oxford University Press, 386-413.

Beck, T., K.A. Demirgüc, and R. Levine (2006) 'Bank supervision and Corruption in Lending', *Journal of Monetary Economics* 53: 2131-63.

Berg, S.A. (1992) 'Mergers, Efficiency and Productivity Growth in Banking: The Norwegian Experience 1984-1990', *Working Paper, Norges Bank,* Oslo, Norway.

Berger, A. N., and D.B. Humphrey, (1997) 'Efficiency of Financial Institutions: International Survey and Directions for Future Research', *European Journal of Operational Research,* 98, 175-212.

Berger, A. N., and L.J. Mester (2001) 'Explaining the Dramatic Changes in Performance of U.S. Banks: Technological Change, Deregulation and Dynamic Changes in Competition,' *Centre for Financial Institutions Working Papers 01-22,* Wharton School Centre for Financial Institutions, University of Pennsylvania.

Bikker, J. (2002) 'Efficiency and Cost Differences across Countries in a Unified European Banking Market', *Dutch National Bank Staff Reports* 87.

Bliss, R.R., and M.J. Flannery (2002) 'Market Discipline in the Governance of U.S. Bank Holding Companies: Monitoring versus Influence', *European Finance Review* 6: 419–437.

Casu B., Ferrari A., Zhao T., (2013): "Regulatory reform and productivity change in

Indian banking" *Review of Economics and Statistics*, 95-3, pages 1066-1077.

Cetorelli, N., and M. Gambera (2001) 'Banking Market Structure, Financial Dependence and Growth: International Evidence from Industry Data', *The Journal of Finance* 56 (2): 617-648.

Chaffai, M.E., M. Dietsch, and A. Loxano-Vivas (2001) 'Technological and Environmental Differences in the European Banking Industries', *Journal of Financial Services*, Research 19 (2/3): 147-162.

Chen, X., M. Skully, and K. Brown (2005) 'Banking Efficiency in China: Application of DEA to Pre- and Post-deregulation eras: 1993-2000', *China Economic Review* 16, 229-245.

Chortareas, G., C. Girardone, and A. Ventouri (2012) 'Bank Supervision, Regulation and Efficiency: Evidence from the Europena Union', *Journal of Financial Stability* 8(4): 292-302.

Claessens, S., and L. Laeven (2004) 'What Drives Bank Competition? Some International Evidence', *Journal of Money, Credit, and Banking* 36 (3).

Delis, M. D., P. Molyneux, and F. Pasiouras (2011) 'Regulations and Productivity Growth in Banking; Evidence from Transition Economies', *Journal of Money, Credit and Banking*, 43(4).

Demirgüç-Kunt, A., L. Laeven, and R. Levine (2003) 'Regulations, Market Structure, Institutions, and the Cost of Financial Intermediation', *NBER working paper* no. 9890, August.

Dietsch, M., and A. Lozano-Vivas (2000) 'How the Environment Determines Banking Efficiency: A Comparison between French and Spanish Industries', *Journal of Banking & Finance* 24: 985-1004.

Efron, B. (1981) 'Nonparametric Standard Errors and Confidence Intervals', *Canadian Journal of Statistics* 9: 139-172.

Efron, B., and R. Tibshirani (1986) 'Bootstrap Methods for Standard Errors, Confidence Intervals, and Other Measures of Statistical Accuracy', *Statistical Science* 1: 54-57.

Elyasiani, E., and S.M. Mahdian (1995) 'The Comparative Efficiency Performance of Small and Large US Commercial Banks in the Pre- and Post-deregulation Eras', *Allied Economics* 27: 1069-1079.

Gilbert, R.A., and P.W. Wilson (1998) 'Effects of Deregulation on the Productivity of Korean Banks', *Journal of Economics & Business* 50: 155-155.

Gorton, G., and A. Winton (2000) 'Liquidity Provision, Bank Capital, and the Macroeconomy', *Bank Capital, and the Macroeconomy* (October 9).

Grabowski, R., N. Rangan, and R. Rezvanian (1993) 'Organisational Forms in Banking: An Empirical Investigation of Cost Efficiency', *Journal of Banking and Finance* 17: 531-538.

Greene, W.H. (2005) 'Reconsidering Heterogeneity in Panel Data Estimators of the Stochastic Frontier Model', *Journal of Econometrics* 26: 269-303.

Hasan, I., and K. Marton (2003) 'Development and Efficiency of the Banking Sector in a Transitional Economy: Hungarian Experience', *Journal of Banking Finance* 27: 2249-2271.

Havrylchyk, O. (2006) 'Efficiency of the Polish Banking Industry: Foreign versus Domestic Banks', *Journal of banking & Finance* 30: 1975-1996.

Haw, I. M., S.S.M Ho, B. Hu, and D. Wu (2010) 'Concentrated Control, Institutions, and Banking Sector; An International Study', *Journal of Banking & Finance* 34: 485-497.

Humphrey, D. B., and L.B. Pulley (1997) 'Banks' Responses to Deregulation: Profits, Technology and Efficiency', *Journal of Money, Credit and Banking* 29: 73-93.

Isik, I., and M.K. Hassan (2002) 'Technical, Scale and Allocative Efficiencies of Turkish Banking Industry', *Journal of Banking & Finance* 26: 719-766

Kano, M., and Y. Tsutsui (2003) 'Geographical Segmentation in Japanese Bank Loan Markets', *Regional science and Urban Economics* 33(2): 157-173.

Koutsomanoli, F. A., D. Margaritis, and C. Staikouras (2009) 'Efficiency and Productivity Growth in the Banking Industry of Central and Eastern Europe', *Journal of Banking & Finance* 33(3): 557-567.

Kumbhakar, S. C., and C.A.K. Lovell (2003) *Stochastic Frontier Analysis*, Cambridge University Press.

Kumbhakar, S.C., and S. Sarkar (2003) 'Deregulation, Ownership, and Productivity Growth in the Banking Industry: Evidence from India', *Journal of Money, Credit, and Banking* 35(3):403-424

Leibenstein, H. (1966) 'Allocative Efficiency vs. 'X-Efficiency'', *American Economic Review* 56: 392-415.

Leightner, J.E., and C.A.K. Lovell (1998) 'The Impact of Financial Liberalisation on the Performance of Thai Banks', *Journal of Economics and Business* 50:115-131.

Liu, H., and J.O. Wilson (2010) 'The Profitability of Banks in Japan', *Applied Financial Economics* 20(24): 1851-1866.

Mester, L.J. (1996) 'A Study of Bank Efficiency Taking into Account Risk-preferences', *Journal of Banking & Finance* 20: 1025-1045.

Mooney, C.Z., and R.D. Duval (1992) 'Bootstrap Inference: A Preliminary Monte Carlo Evaluation', *American Political Science Association*, Chicago.

Pasiouras, F., S. Tanna, and C. Zopounidis (2009) 'The Impact of Banking Regulations on Banks' Cost and Profit Efficiency; Cross-country Evidence', *International Review of Financial analysis* 18: 294-302.

Quintyn, M., and M. Taylor (2002) 'Regulatory and Supervisory Independence and Financial

Stability', *International Monetary Fund working paper* No. 02/46, March.

Ray, S.C. (1982) 'A translog cost function analysis of US agriculture, 1939–77'. *American Journal of Agricultural Economics* 64(3): 490-498.

Sealey, C., and J.T. Lindley (1977) 'Inputs, outputs and a Theory of Production and Cost at Depository Financial Institution', *Journal of Finance* 32: 1251-1266.

Shleifer, A., and R. Vishny (1998) *The Grabbing Hand; Government Pathologies and Their Cures*, Harvard University Press, Cambridge.

Sun, L., and T.P. Chang (2011) 'A Comprehensive Analysis of the Effects of Risk Measures on Bank Efficiency: Evidence from Emerging Asian Countries' *Journal of Banking & Finance* 35: 1727-1735.

Thakor, A. (1996) 'The Design of Financial Systems: An Overview', *Journal of Banking & Finance* 20(5): 917-948.

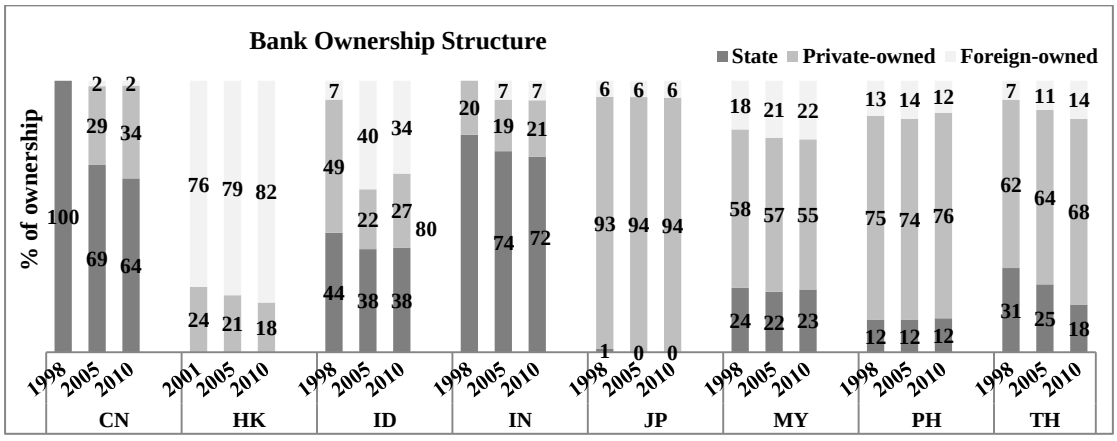
Thangavelu, S. M., and C. Findlay (2012) 'Bank efficiency, regulation and response to crisis of financial institutions in selected Asian countries', *Real and Financial Integration in Asia* 2*:* 133.

Zaim, O. (1995) 'The Effect of Financial Liberalisation on the Efficiency of Turkish Commercial Banks', *Applied Financial Economics* 5: 257-264.

Zhao, T., B. Casu, and A. Ferrari (2008) 'Deregulation and Productivity Growth: a Study of Indian Commercial Banking', *International Journal of Business performance Management* 10(4): 318-343.

Zhao, T., B. Casu, and A. Ferrari (2010) 'The Impact of Regulatory Reforms on Cost Structure, Ownership and Competition in Indian Banking', *Journal of Banking & Finance* 34: 246-254.

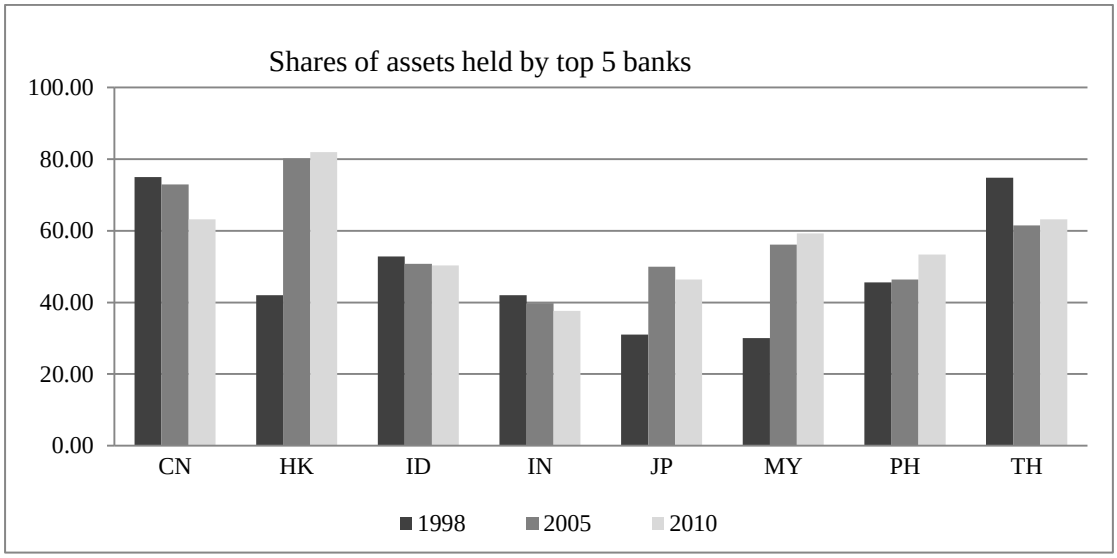
Figure 1 Bank ownership structure in selected Asian economies

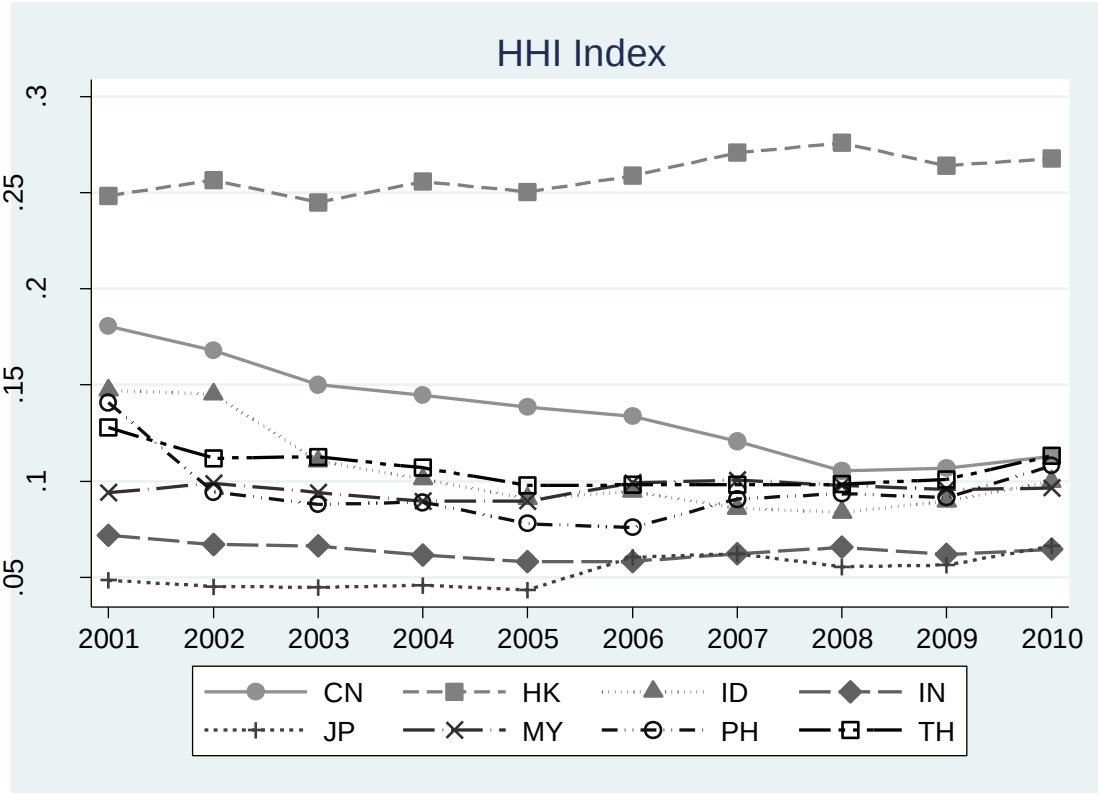


Data sources: country data from Bank Regulation and Supervision Survey (BRSS), Round I-IV, released by the World Bank in 2001, 2003, 2007 and 2012[6]. HK and VN's data are compiled by the authors.

[6] Note the four-round data capture the information corresponding to the period 1998-99, 2001, 2005, 2008-2010, respectively.

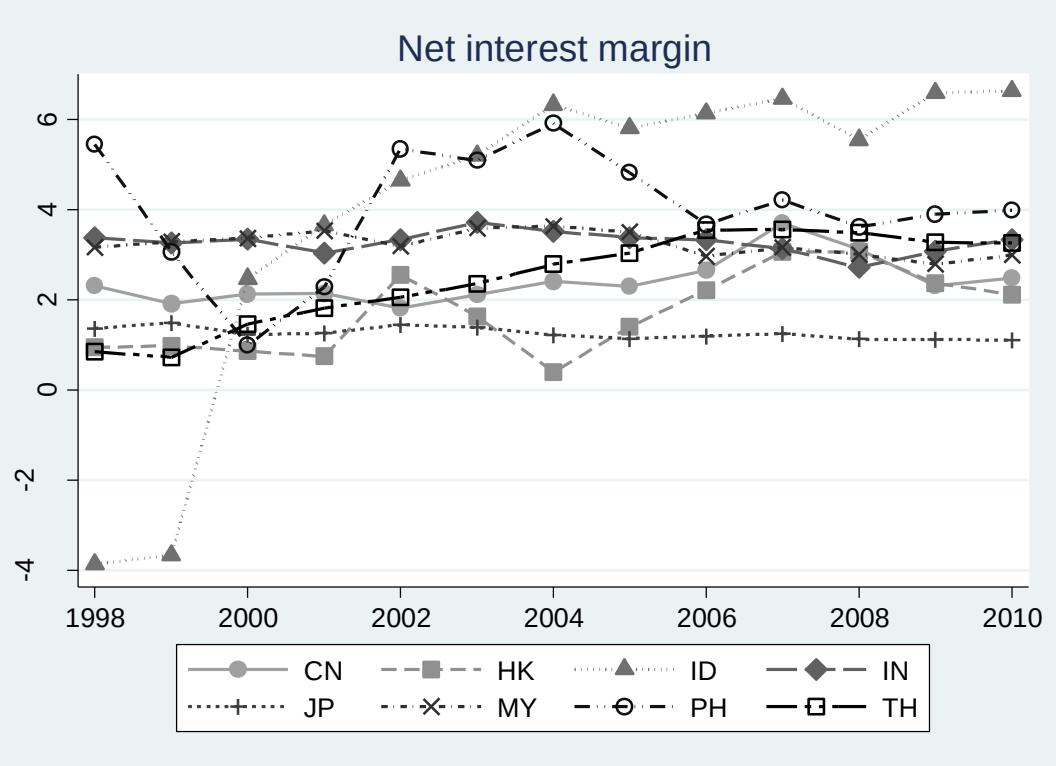
Figure 2 Market concentration indicators





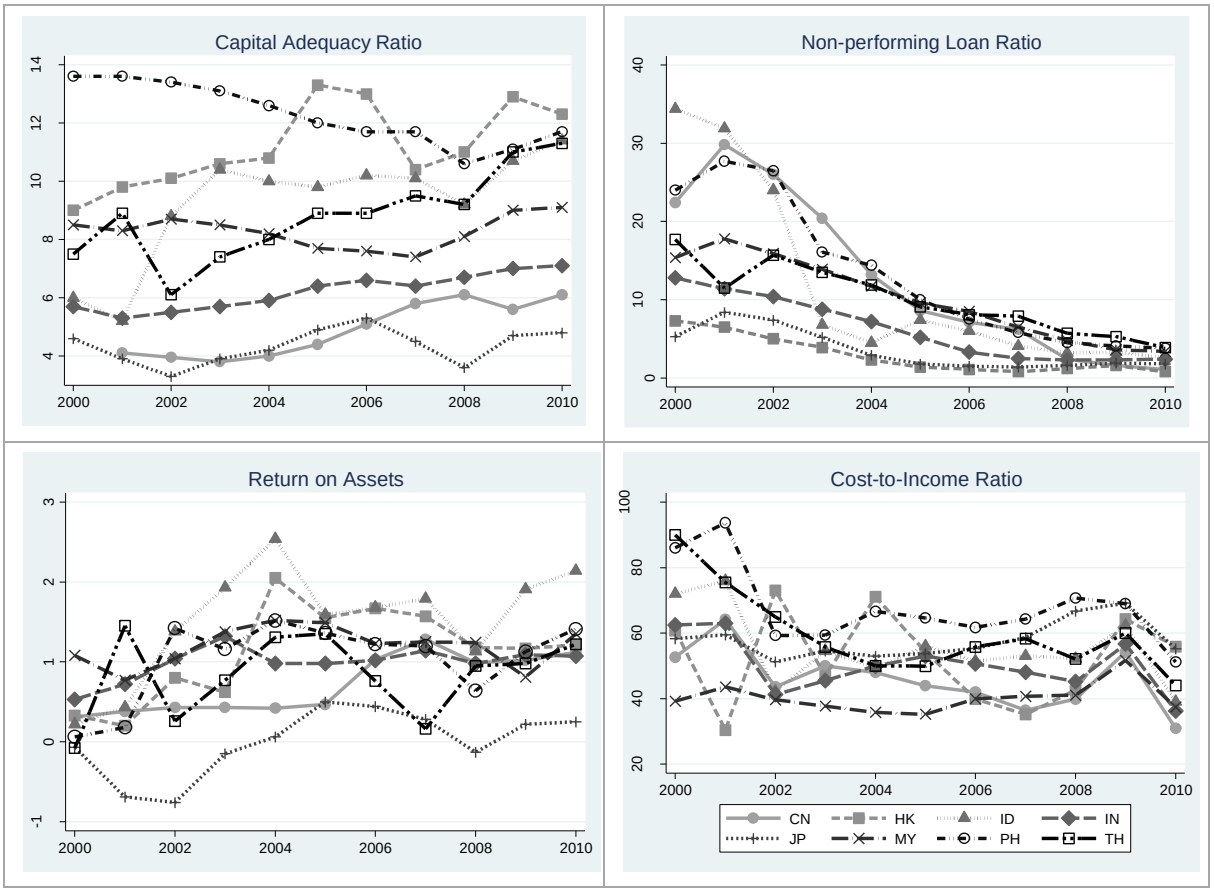
Sources: Bank Supervision and Regulation Survey (the World Bank, 2001, 2007, 2012); Bankscope database.

Figure 3 Net interest margin (NIM) by country



Note: Net interest margin computed as a share of its interest-bearing (total earning) assets.
Source: Financial Development and Structure Dataset **(**The World Bank, 2013).

Figure 4 Indicators of banking system performance



Notes: (a) Vietnam's data are not available for Capital Adequacy Ratio (CAR) and Non-performing Loans (NPLs). (b) CAR is computed as total capital as a percentage of total assets.

Data source: Financial Development and Structure Dataset (The World Bank, 2012, 2013).

Figure 5 Decomposition of meta-cost efficiency scores.