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Bank efficiency in emerging Asian countries

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ABSTRACT

The paper examines the relationships between market concentration, bank competition and X-efficiency in banking across six emerging Asian countries—Bangladesh, India, Indonesia, Malaysia, the Philippines and Vietnam—over the period 2005–12. Market concentration has a positive effect on X-efficiency, whereas competition has a negative effect on X-efficiency. Moreover, bank size and gross domestic product growth have positive influences on X-efficiency whereas liquidity risk is negatively related to X-efficiency. In addition, the study has important policy implications for governments and banks with respect to increasing X-efficiency of banking.

1. Introduction

The determinants of bank efficiency are discussed in the vast literature on banking. Numerous studies have found that market concentration and bank competition are significant determinants of bank efficiency; for example, Berger and Hannan (1998), Casu and Girardone (2006), Chen (2009), Delis and Papanikolaou (2009), Delis and Tsionas (2009), Ferreira (2013), Hauner and Peiris (2005), Kirkpatrick et al. (2008), Koetter et al. (2008, 2012), Maudos and de Guevara (2007), Turk Ariss (2010) and Williams (2012). Studies by Casu and Girardone (2009) regards the influence of market concentration on bank efficiency arising from merger and acquisition (M&A) provide conflicting results. In addition several studies investigating the relationship between competition and efficiency have reported contradictory results; Casu and Girardone (2006, 2009), Chen (2009), Fang et al. (2011), Fu and Heffernan (2009), Kirkpatrick et al. (2008), Koetter et al. (2008, 2012), Maudos and de Guevara (2007), Pruteanu-podpiera et al. (2008), Schaeck and Cihak (2008), Turk Ariss (2010) and Williams (2012).

Theoretically the relationships between market concentration, competition and bank efficiency are interpreted by three main hypotheses: the quiet life hypothesis (QLH), the information generation hypothesis (IGH) and the efficient structure

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hypothesis (ESH). According to the QLH; Berger and Hannan (1998) and Hicks (1935), market concentration (or market power) is negatively associated with bank efficiency because market power allows banks to enjoy a 'quiet life' (i.e. allows banks freedom from competition), which in turn reduces bank managers' efforts to maximise their bank's efficiency. By contrast, the IGH hypothesis (Marquez, 2002) proposes a negative relationship between competition and efficiency. Here competition among banks leads to a decline in their information-gathering capacity and increases the probability of adverse borrower selection and thus increases bank inefficiency. The final hypothesis considered here is the ESH (Demsetz, 1973; Smirlock, 1985) which proposes a positive relationship running from efficiency to market concentration (or bank competition).

The majority of banking studies have tested these hypotheses in the context of developed countries such as the US and European countries. By contrast few studies have examined these relationships within the context of developing economies. Moreover, the relationships between market concentration, bank competition and bank efficiency are considered separately in these studies with only a handful of studies investigating the effects of both concentration and competition on bank efficiency.

The emerging Asian banking structure changed significantly after the 1997 Asian crisis due to the rapid development in banking consolidations brought about by M&A. Generally banking services across emerging markets has experienced a significant increase in competition from the presence of foreign banks and privatisation. However current research examining the effects of market concentration and bank competition on bank efficiency in emerging Asian countries has not kept pace with these developments. To address this vacuum in the literature, this research examines the relationships between concentration, competition and X-efficiency across the six Asian countries during 2005–12.

In this research bank competition is estimated using two Lerner indices: the conventional and the efficiency-adjusted Lerner. Tobit regressions are then performed to examine the relationships between market concentration, bank competition and bank efficiency. In our empirical modelling we employ two-stage least squares (2SLS) to address endogeneity problems, which in turn avoids the associated bias due to the probability of causality running from bank efficiency to market concentration and bank competition.

This study makes three main contributions to the extant literature. First, previous studies have examined the market concentration–bank efficiency and bank competition–bank efficiency relationships separately. Our research develops five models that examine the relationships between market concentration and efficiency, bank competition and efficiency, and the relationship between market concentration, bank competition and bank efficiency across selected emerging Asian countries pre- and post-GFC. Secondly, we test for the QLH and the IGH hypothesis in these economies. Thirdly, this study investigates the relationship between market concentration, bank competition and bank efficiency both for the full sample of six countries, and separately for each country, and then suggests some recommendations to improve bank efficiency in these countries.

This paper is organised as follows: the next section reviews the relevant literature on the relationships between market concentration, bank competition and bank efficiency. Section two discusses the data and methodology. Section four presents the estimated results for X-efficiency along with an in-depth discussion about the effects of both market concentration and competition on X-efficiency. Finally section five provides a conclusion and some policy implications.

2. Market concentration, bank competition and bank efficiency: an overview

2.1. Related hypotheses

2.1.1. The efficient structure hypothesis

The Efficient Structure Hypothesis (ESH) proposed by Demsetz (1973) posits relationships between market concentration, competition and efficiency. This hypothesis states that efficient firms can lower costs of production and thus gain both higher profits and larger market shares. The ESH is supported by Smirlock's (1985) study on banking, which showed that concentration does not explain American banks' profitability. Market concentration is the result of leading banks' superior efficiency in gaining a higher market share. Efficient banks with comparative advantage in product can achieve a larger market share that results in higher market concentration levels. Therefore, the ESH proposes a positive influence of bank efficiency on concentration.

Moreover, Smirlock (1985) proposed that the most efficient banks can gain the larger market shares from other less efficient banks in the market. Thus, the market becomes more concentrated and banks can exploit greater market power and the greater the market power of banks, the less competition they face. As a result, the ESH posits a positive (negative) causality running from efficiency to market power (competition).

2.1.2. The quiet life hypothesis

The QLH was first suggested by Hicks (1935). In a first study on the link between efficiency and market structure, Hicks found that 'The best of all monopoly profits is the quiet life' (Hicks, 1935, p. 8). In other words, market power allows firms to enjoy a 'quiet life' (i.e. to have freedom from competition in a more relaxed environment), but such a life reduces firm managers' effort to maximise their firm efficiency.

Based on the pioneering study of Hicks (1935), Berger and Hannan (1998) were the first to study QLH in the banking industry. The authors suggested that managers can exercise market power of banks to gain supernormal profits without

making efforts to work or control costs toward increasing bank efficiency. Thus, increased monopoly power results in a decrease in efficiency whereas competition fosters bank efficiency.

2.1.3. The information generation hypothesis

Similar to the ESH, the IGH theorises a 'a negative relationship between competition and efficiency'. The IGH, first proposed by Marquez (2002), states that fierce competition among banks may result in lower bank efficiency. IGH is based on the view that banks are 'special' intermediaries because they can access borrowers' information to collect and analyse inside information, and thus they are able to reduce their adverse borrower selection to a minimum level, due to the ability to generate superior information compared to their peers (Koetter et al., 2008). However, in growing competitive markets, each bank owns specific information about a small pool of borrowers, so this dispersion of information can cause a decline in banks' screening capabilities, increasing the chance of having loans for low-quality borrowers, and thus increasing bank inefficiency. Moreover, when competition increases, banks will offer customers lower charges to attract them. This may lead to the easy with which customers can switch from their current bank to another bank which provides them with more benefits. Therefore, a reduction in a bank's information-gathering capacity due to customer switches also causes banks to become inefficient (Marquez, 2002). To summarise, competition among banks leads to a decline in their information-gathering capacities that results in a higher probability of adverse borrower selection and thus higher bank inefficiency.

2.2. The relationship between market concentration, competition and efficiency in banking: empirical results

The majority of the literature focused on the relationship between market concentration, bank competition and bank efficiency relates to the US and European banking.

Berger and Hannan (1998) tested the QLH in the banking industry by examining the relationship between market concentration and cost X-efficiency in the US banking system. They found that more concentrated markets reflect lower competition and cause higher cost inefficiency for banks due to poor management. Hence, the negative relationship between market concentration and bank efficiency provides evidence in support of the QLH. These authors also suggested that banks in concentrated markets can exploit market power in setting price resulting in greater costs rather than greater profits. Although managers exercise market power in pricing and allow an increase in cost rather than profit maximisation, they can still enjoy supernormal profits. Thus, if bank owners can only see the results of bank operations and not observe their managers behaviour, they may not be aware that supernormal profit results from market power rather than managers' efforts.

To explain the negative effects of market concentration, as a proxy for market power, on bank efficiency, Berger and Hannan (1998) suggested a rationale relating to manager's behaviour and monopoly power. When banks operate in a highly concentration market, they are able to set price higher than marginal cost. Thus, managers can benefit from this price and earn economic rent without expending any effort on cost minimisation. This reduces their motivation for working hard to keep expenses under control, thus causing a decrease in bank efficiency. As a result, monopoly power decreases managers' efforts in controlling costs to increase bank efficiency. Second, banks with high market power can permit their managers to pursue objectives other than profit maximisation. For example, they can outlay more costs to expand staff or utility-increasing inputs beyond cost levels for profit maximisation, or reduce risk below the level that is required by shareholder for their value maximisation. Third, bank managers may spend their resources on obtaining and maintaining market power. Although they can earn higher profits, bank costs would be increased, and thus cost efficiency would decline. Fourth, based on the price 'cushion' that is created from market power, managers can persist in their pursuit of other goals.

Koetter et al. (2008), tested two competing hypotheses, the QLH and IGH, for US banks over the period 1986–2006 using direct measures of competition including the conventional and the efficiency-adjusted Lerner. They found a significantly negative effect of competition on cost efficiency and profit efficiency. However, increasing market power precedes increasing efficiency, which implies that US banks under low competitive pressure have superior capabilities to screen their borrowers, thus supporting indirectly the IGH. Using a sample of US banks, Koetter et al. (2012) examined the relationships between competition and bank efficiency over the period 1976–2007. The authors found a negative effect of competition on cost efficiency, thus rejecting the QLH.

Maudos and de Guevara (2007), examined the relationship between bank efficiency and bank competition for 15 EU countries during 1993–2002. They found that bank competition was a significant negative determinant of cost efficiency. Several reasons were forwarded to explain their result. First, the monopolistic power of banks due to their location advantages decreases their cost of monitoring and transacting with companies. Second, banks may have cost advantages in screening borrowers due to market power obtained from geographical and technological specialisation. Third, banks with market power may enjoy higher profit so they behave prudently and select less risky activities to lower the cost of monitoring, thus increasing their cost efficiency. Fourth, greater market power allows banks to decrease their operating costs because of less pressure to enhance the quality of banking services, thereby improving their cost efficiency. Casu and Girardone (2009), investigated whether competition leads to cost efficiency using the Granger causality test for a sample of European banks over the period 2000–05. Their results suggest that a positive causality runs from market power, proxied by the Lerner index, to cost efficiency measured by both stochastic frontier analysis (SFA) and data envelopment analysis (DEA) approaches, because banks with higher market power enjoy lower financial and operating costs. The influence of monopoly power on efficiency may be positive if this power makes banks lower their costs. Casu and Girardone (2009), suggested that a positive relationship between market power and efficiency is not necessarily informative regarding their causal relationship.

The authors also examined the causality running from efficiency to competition. Granger causality tests, however, provide no proof that increases in efficiency forego increases in market power. As a result, they agreed with the findings of Casu and Girardone (2006) that the relationships between competition and efficiency are not straightforward. Schaeck and Cihak (2008) used Granger causality tests to examine the influence of competition on bank efficiency, reporting a positive influence of competition on profit efficiency for a large sample of European and US banks during 1995–2005. Additionally, their findings for the US sample show that competition increases cost efficiency. On this basis, Schaeck and Cihak (2008) suggested that banks can attain higher efficiency levels in both cost and profit under competitive pressure. Delis and Tsionas (2009), found a negative relationship between market power and efficiency in the Economic and Monetary Union banking system by establishing a framework for the joint estimation of market power and efficiency.

Investigating the determinants of bank efficiency in the context of European countries, Delis and Papanikolaou (2009) provided evidence to support the QLH for banking systems in 10 newly acceded European Union banks during 1994- 2005, covering their banking sector reform process. The authors found a negative relationship between three-bank concentration ratios and productive efficiency scores, suggesting market concentration is a significantly negative determinant of bank efficiency.

Recent studies of banking have investigated the relationships between market concentration, bank competition and bank efficiency in developing countries. Fu and Heffernan (2009) investigated the relationship between market structure and cost X-efficiency of Chinese banks over the 1985–2002 period when various notable reforms were implemented in this sector. Following Berger and Hannan (1998), the authors employed market concentration as a proxy for market power and used the SFA approach to estimate cost X-efficiency. They found no evidence in favour of the QLH and suggested that the failure of state banks with greater market power to earn monopolistic rents was due to strict controls on interest rates rather than higher market concentration.

Chen (2009), proposed that a higher degree of bank competition pushed cost efficiency in Sub-Saharan African countries over the 2000–2007 period. Pruteanu-podpiera et al. (2008), examined the relationship and causality between bank competition and bank cost X-efficiency using data on Czech banks over the transition period of 1994–2005. Their findings indicate that greater competition reduces cost efficiency in banking due to a rise in monitoring cost and the appearance of economies of scale. Indeed, the result of Granger causality test favors a negative causality from competition to efficiency of Czech banks over the transition period. Fang et al. (2011) reported a positive association between market power and efficiency, including both cost and profit efficiency, in banking systems across six transition countries of South-eastern Europe during 1998–2008. Williams (2012) investigated the relationship between market power and efficiency of Latin American banks in different markets (loan, deposit and assets markets) during the 1985–2010 period and two sub periods including the pre-restructuring (1985–1997) and post-restructuring (1998–2010) periods. The author found significant positive associations between market power and efficiency in the assets market, however, Latin American banks seem to enjoy a "quiet life" in the deposits market in each sub-period and the full period. Kasman and Carvallo (2014) also provided strong evidence to support the "quiet life" hypothesis for commercial banks in 15 Latin American countries over the period 2001–2008 using the Granger causality technique to examine dynamic relationships between bank competition (measured by Lerner indices and Boon indicators) and both cost and revenue efficiency. Turk Ariss (2010), provided evidence of a negative (positive) relationship between market power and cost efficiency (profit efficiency) in developing countries over 1999–2005.

3. Data and methodology

3.1. Data

Bank-specific data were retrieved from the Bankscope Fitch-IBCA database for the six chosen countries for 2005–12. Country-specific data, such as growth of real gross domestic product (GDP) and inflation rate, were derived from the International Financial Statistics (IFS) data of the International Monetary Fund (IMF). After excluding banks that have missing data in more than two consecutive years and observations with negative values for total equity, interest expenses and total revenue, the data consist of 1685 observations from 212 commercial banks in emerging countries: Bangladesh (34 banks), India (50 banks), Indonesia (40 banks), Malaysia (32 banks), the Philippines (24 banks) and Vietnam (32 banks). An unbalanced panel dataset was used due to M&A, entry and exit of banks, and exclusion of inappropriate observations. The data were checked thoroughly and data problems such as missing values, inconsistencies and reporting errors were handled as appropriate.

3.2. Estimation methodology: bank efficiency and bank competition

3.2.1. Bank efficiency

To measure X-efficiency, this study uses the SFA approach, because *firstly* this method considers random fluctuation as part of the error term due to circumstances not under a bank's control and can distinguish inefficiency from random errors, which in turn may avoid biased results for inefficiency; *secondly* estimates of marginal costs, frontier estimates of profit $\left(\hat{PBT}\right)$ and total operating cost ($\hat{TOC}$) from the trans log functional form may be employed in calculating efficiency-adjusted Lerner indices; *thirdly* SFA was used in recent studies on bank efficiency using a sample of banks in developing Asian countries (see Turk Ariss, 2010; Spulbăr and Niţoi, 2014).

Table 1
Definitions of Variables for Estimating Bank Efficiency.

Variable	Definition
TOC	Total operating cost
Q (output)	Total assets
W_1 (input price of deposits)	The ratio of interest expenses to total deposits
W_2 (input price of labour)	The ratio of personnel expenditures to total assets
W_3 (input price of physical capital)	The ratio of other operating cost to fixed assets
Z_1 (fixed netput 1)	Fixed assets
Z_2 (fixed netput 2)	Total equity
Trend	Technical change
ε	Error term ($v+u$)
V	Two-sided random error term
U	One-sided non-negative inefficiency score

Both inputs and outputs of banks are specified in this study based on the intermediation approach that considers banks as financial intermediaries that collect deposits and then transfer them into loans and other earning assets (Sealey and Lindley, 1977). Total cost are expressed as a function of one output (Q), three input prices (W), two fixed netputs (Z) and technical change (trend).[1] Fixed netputs and time trend are used as control variables to account for heterogeneity across banks (Table 1).

Bank efficiency scores are estimated from the translog functional form:

$$\begin{aligned}\text{Ln TOC}_{it} &= \alpha_0 + \alpha_1 \ln Q_{it} + \frac{1}{2}\alpha_2(\ln Q_{it})^2 + \sum_{m=1}^{3}\beta_m \ln W_{mit} + \sum_{m=1}^{2}\sigma_m \ln Z_{mit} + \frac{1}{2}\sum_{m=1}^{3}\sum_{j=1}^{3}\gamma_{mj}\ln W_{mit}\ln W_{jit} \\ &+ \frac{1}{2}\sum_{m=1}^{2}\sum_{j=1}^{2}\pi_{mj}\ln\ln Z_{jit} + \sum_{m=1}^{3}\delta_m \ln Q_{it}\ln W_{mit} + \sum_{m=1}^{2}\varepsilon_m \ln Q_{it}\ln Z_{mit} + \sum_{j=1}^{3}\sum_{m=1}^{2}\theta_{mj}\ln W_{jit}\ln Z_{mit} + \varphi_1 \text{Trend} \\ &+ \frac{1}{2}\varphi_2(\text{Trend})^2 + \varphi_3 \text{Trend}\ln Q_{it} + \sum_{m=1}^{3}\mu_m \text{trend}\ln W_{mit} + \sum_{m=1}^{2}\eta_m \text{trend}\ln Z_{mit} + \varepsilon_i \end{aligned} \quad (1)$$

The study measures bank X-efficiency using the model of Battese and Coelli (1992), where the error term (ε) equals the sum of the two-sided random error term (v) and the non-negative inefficiency score (u). v_{it} is assumed to be independent and identically distributed with mean 0 and variance ${\sigma_v}^2$ as a normal distribution, $N(0, {\sigma_v}^2)$; u_i is assumed to be independent and identically distributed with mean μ and variance ${\sigma_u}^2$ as a truncated-normal distribution truncated at 0, $N^+(\mu, {\sigma_u}^2)$.

To estimate time-varying cost inefficiency, u_{it} is calculated as $u_{it} = u_i(\exp[-\eta(t - T_i)])$ (Battese and Coelli, 1992) where $t = 1,..., T_i$; T_i is the last period for bank i; and η is the decay parameter. If $\eta > 0$, the inefficiency of bank $i$tends to decrease over time. If $\eta < 0$, the inefficiency of bank $i$tends to increase over time. If $\eta = 0$, the inefficiency of bank $i$is unchanged with time.

Some conditions are suggested for the translog cost function that is linearly homogeneous in input price:

$$\sum_{m=1}^{3}\beta_m = 1, \sum_{m=1}^{3}\gamma_{mj} = 0\,(j = 1, 2, 3), \sum_{m=1}^{3}\delta_m = 0, \sum_{m=1}^{3}\mu_m = 0,$$
$$\sum_{j=1}^{3}\theta_{mj} = 0\,(m = 1, 2)$$

By symmetry of the Hessian, $\gamma_{mj} = \gamma_{jm}$, $\pi_{mj} = \pi_{jm}$.

Total costs and input prices are normalised by input price of physical capital (W_3) to impose linear homogeneity in input prices. The translog cost function is rewritten as follows:

$$\begin{aligned}\text{Ln}\left(\text{TOC}_{\text{it}}/\text{W}_{3\text{it}}\right) &= \alpha_0 + \alpha_1 \ln \text{Q}_{\text{it}} + \frac{1}{2}\alpha_2(\ln \text{Q}_{\text{it}})^2 + \sum_{m=1}^{2}\beta_m \ln\left(\text{W}_{\text{mit}}/\text{W}_{3\text{it}}\right) + \sum_{m=1}^{2}\sigma_m \ln \text{Z}_{\text{mit}} \\ &+ \frac{1}{2}\sum_{m=1}^{2}\sum_{j=1}^{2}\gamma_{mj}\ln\left(\text{W}_{\text{mit}}/\text{W}_{3\text{it}}\right)\ln\left(\text{W}_{\text{jit}}/\text{W}_{3\text{it}}\right) + \frac{1}{2}\sum_{m=1}^{2}\sum_{j=1}^{2}\pi_{mj}\ln \text{Z}_{\text{mit}}\ln \text{Z}_{\text{jit}} \\ &+ \sum_{m=1}^{2}\delta_m \ln \text{Q}_{\text{it}}\ln\left(\text{W}_{\text{mit}}/\text{W}_{3\text{it}}\right) + \sum_{m=1}^{2}\varepsilon_m \ln \text{Q}_{\text{it}}\ln \text{Z}_{\text{mit}} + \sum_{j=1}^{2}\sum_{m=1}^{2}\theta_{mj}\ln\left(\text{W}_{\text{jit}}/\text{W}_{3\text{it}}\right)\ln \text{Z}_{\text{mit}} \\ &+ \varphi_1 \text{ Trend} + \frac{1}{2}\varphi_2(\text{Trend})^2 + \varphi_3 \text{ Trend ln Q}_{\text{it}} + \sum_{m=1}^{2}\mu_m \text{ trend ln}\left(\text{W}_{\text{mit}}/\text{W}_{3\text{it}}\right) \\ &+ \sum_{m=1}^{2}\eta_m \text{ trend ln Z}_{\text{mit}} + \varepsilon_{\text{i}} \end{aligned} \quad (2)$$

[1] The trend variable ranges from 1 to 8, with 1 for the year 2005 and 8 for the year 2012.

According to Berger and Mester (1997), X-efficiency measures how close a bank's costs are to a best-practice bank's costs for producing an identical output bundle under the same conditions. Therefore, the X-efficiency of bank i is calculated as the ratio of the estimated minimum costs that would be used by the best-practice bank in the sample to produce the same output bundle under the same exogenous conditions to the estimated actual cost of bank i.

Bank-specific X-efficiency is measured as follows:

$$\text{X} - \text{Eff}_i = \frac{\hat{C}_{min}}{\hat{C}_i} = \frac{\exp\left[\hat{f}\left(Q_i, w_i, Z_i, trend\right)\right]\exp\left(ln\hat{u}_{min}\right)}{\exp\left[\hat{f}\left(Q_i, w_i, Z_i, trend\right)\right]\exp\left(ln\hat{u}_i\right)} = \frac{\hat{u}_{min}}{\hat{u}_i} \tag{3}$$

X-efficiency ranges between 0 and 1, and equals 1 for the most efficient bank (the best-practice bank) in the sample. X-efficiency shows the percentage of cost the bank uses efficiently compared to the costs of the best-practice bank in the sample under the same conditions.

3.2.2. Bank competition

Consistent with studies by Turk Ariss (2010), Koetter et al. (2008, 2012) and Williams (2012) on the relationship between competition and efficiency in banking, the competition at bank level was estimated here using the Lerner index approach.[2] As for the conventional Lerner index, banks are assumed to be fully efficient. Unlike the conventional Lerner index, the efficiency-adjusted Lerner index can account for endogeneity bias via simultaneous estimation of both market power degree and efficiency from a single structural model. Therefore, for the robustness check of the results for competition, both the conventional Lerner index and the efficiency-adjusted Lerner index are used to measure bank competition.

The conventional Lerner index is calculated as:

$$L = \frac{p - MC}{p} = \frac{AR - MC}{AR} \tag{4}$$

Here, price (p) is defined as average revenue (AR), which is measured as the ratio of total revenue to total asset, whereas total revenue equals sum of profit before tax (PBT) and total operating cost (TOC). Marginal cost (MC) is derived from the translog cost function by taking derivatives with respect to total asset (Q). Marginal cost is calculated as follows:

$$MC = \frac{TOC_{it}}{Q_{it}}\left[\alpha_1 + \alpha_2 ln\, Q_{it} + \sum\nolimits_{m=1}^{3}\delta_m ln\, W_{mit} + \sum\nolimits_{m=1}^{3}\varepsilon_m ln\, Z_{mit} + \varphi_3 Trend\right] \tag{5}$$

For calculating marginal cost, the coefficients of Equation (2) are estimated using Ordinary Least Squares (OLS) regression.

The efficiency-adjusted Lerner index is calculated as follows:

$$L_{adjusted} = \frac{\left(\frac{\widehat{PBT}}{Q} + \frac{\widehat{TOC}}{Q}\right) - \widehat{MC}}{\left(\frac{\widehat{PBT}}{Q} + \frac{\widehat{TOC}}{Q}\right)} \tag{6}$$

Here, frontier estimates of PBT $\left(\widehat{PBT}\right)$ and of TOC $\left(\widehat{TOC}\right)$ are derived from the alternative profit and TOC function, respectively. $\widehat{MC}$ is marginal cost derived from the translog cost function using SFA, and Q is Total asset.

The alternative profit function is similar to the cost function in Equation (1) with TOC replaced by PBT as the dependent variable and the error term (ε) being equal to $v - u$. Average revenues are calculated as the sum of average profits and average costs. As for the countries that have negative values of PBT, a constant (φ) is added to the PBT of each bank to ensure that values of PBT are positive before taking their logarithm. Following Berger and Mester (1997), a constant (φ) equals the absolute minimum value of PBT divided by the input price of physical capital (W_3) in the same year for all banks plus 1; that is, $\varphi = |(\text{PBT}/W_3)_{\min}| + 1$. A calculation for φ is carried out for each country in the sample.

3.3. Model specifications and methodology

The study examines the relationship between market concentration, bank competition and bank efficiency in emerging Asian countries using the baseline model:

$$\text{X-efficiency} = f(\text{Marketconcentration, bankcompetition, bank-specificcharacteristics, macroeconomicconditions})$$

Here, the dependent variable, X-efficiency, measures the X-efficiency of banks i at time t. Two main independent variables are market concentration and bank competition. Market concentration is calculated as the ratio of the total assets of the four largest banks to the total assets of all the banks in a given year. Bank competition is measured by the two specifications of Lerner, the conventional Lerner (Lerner) and the efficiency-adjusted Lerner (Lerner-adj). A higher (lower) Lerner index is

[2] Lerner indices reflect the degree of market power; therefore, the higher the Lerner index value, the lower the degree of competition.

Table 2
Average Revenue and Marginal Cost on Average by Country.

Country	Average Revenue		Marginal Cost	
	p	$\left(\widehat{PBT}+\widehat{TOC}\right)/Q$	MC-OLS	MC-SFA
Bangladesh	0.107	0.196	0.076	0.077
India	0.080	0.074	0.063	0.062
Indonesia	0.097	0.121	0.070	0.073
Malaysia	0.052	0.096	0.033	0.034
Philippines	0.075	0.097	0.042	0.060
Vietnam	0.088	0.068	0.070	0.071

Source: Author's calculations.
Note: Price (p) is calculated as the ratio of total revenues to total assets, and total revenue is the sum of PBT and TOC. $\widehat{PBT}$ and $\widehat{TOC}$ are frontier estimates of PBT and TOC. Q is total assets. Marginal cost is derived from the translog cost function using OLS (MC-OLS) and SFA (MC-SFA).

related to a lower (higher) competition level. Bank-specific characteristics include bank size, credit risk and liquidity risk. Bank size is measured by a natural logarithm of total assets. Bank risk includes credit risk (measured as a ratio of loans to assets) and liquidity risk (measured as a ratio of deposits to assets). Macroeconomic conditions are used to account for the effects of economic development (proxied by GDP growth) and economic stability (proxied by inflation rate) on efficiency.

According to Kumbhakar and Lovell (2000), when the value of a dependent variable lies between 0 and 1, this variable must be transformed before estimation, or Tobit regression must be used to estimate a limited dependent variable. Greene (2005) supported the suggestion that a Tobit model should be applied in the case of a dependent variable obtained from a first-stage regression. Consistent with banking literature on efficiency and competition (e.g. Coccorese and Pellecchia, 2010; Koetter et al., 2008; Turk Ariss, 2010), a Tobit regression model, also called a censored regression model, is used here to examine the relationship between concentration, competition and bank efficiency in the context of emerging Asian countries.

First, the Tobit regression is estimated to account for the censored nature of the dependent variable, X-efficiency. Due to the probability of 'reverse causation' under the efficient structure paradigm, meaning that bank efficiency may affect market concentration and bank competition, the Wald test is employed to test for the exogeneity of market concentration and/or competition. The null hypothesis is that market concentration and competition (measured by the Lerner index) are exogenous variables. For each country, industry size measured by total assets of the banking system is used as an instrumental variable for market concentration. Since market concentration is calculated as the ratio of total assets of the biggest four banks and total assets of all banks, market concentration is negatively associated with industry size. An increase in industry size may be due to an increase in the number of banks and an increase in size of banks in the system. Therefore, it is difficult for the biggest banks to increase their market share in a more crowded market and larger banking system. This may explain the negative relationship between market concentration and industry size. In addition, industry size does not affect bank efficiency directly so it satisfies the conditions for an instrumental variable. Following Koetter et al. (2008, 2012) and Williams (2012), one-period lags of Lerner are used as instrumental variables for Lerner indices. If the Wald test statistic is significant, the null hypothesis of exogeneity is rejected, suggesting that concentration and competition (measured by the Lerner index) are treated as endogenous variables. In this case, Tobit estimation can cause a bias. The instrumental variables technique (2SLS) is used here to address any endogeneity problems and avoid associated bias. The presence of multicollinearity is determined using the variance inflation factor (VIF). Multicollinearity is confirmed when the VIF of a variable is >10.

4. Empirical results

4.1. Estimation results for X-efficiency and bank competition

The Lerner index was calculated based on two components, average revenue and marginal cost, as shown in Table 2. Estimates of the conventional Lerner index rely on price (p) and marginal cost derived from the translog cost function using OLS (MC-OLS). The specification of the efficiency-adjusted Lerner index is based on average revenue $\left[\left(\widehat{PBT}+\widehat{TOC}\right)/Q\right]$ and marginal cost (MC-SFA) derived from the translog cost function using SFA. The figures in Table 2 indicate the differences between the averaged values of marginal cost estimated by OLS and SFA regressions for the six Asian countries are not significant.

Table 3 provides the yearly average estimates of the degree of market power based on the two Lerner specifications for the six focal countries' banking systems. A higher (lower) Lerner index is associated with a lower (higher) bank competition level. The figures in Table 3 indicate that annual averaged values of Lerner indices are between 0 and 1, so banks in Bangladesh, India, Indonesia, Malaysia and the Philippines seem to have operated under monopolistic competition over the 2005–12 period. In the case of Vietnam, the annual average values of the conventional Lerner index also lie between 0 and 1, but the annual average values of the efficiency-adjusted Lerner index are negative for the year 2008 and during 2010–12. This suggests that with respect to endogeneity bias due to interrelatedness of bank competition and efficiency for Vietnamese

Table 3
Estimation results for the Lerner indices and X-efficiency.

Country	Conventional Lerner (Lerner)	Efficiency-adjusted Lerner (Lerner-adj)	X-efficiency
Bangladesh	0.264	0.456	0.863
India	0.203	0.153	0.902
Indonesia	0.286	0.365	0.910
Malaysia	0.364	0.453	0.924
Philippines	0.445	0.524	0.972
Vietnam	0.221	−0.011	0.863

Source: Author's calculations.
Note: A higher (lower) Lerner index is associated with a lower (higher) bank competition level. X-efficiency lies between 0 and 1, and equals 1 for the most efficient bank (i.e. the best-practice bank) in the sample.

Table 4
The Relationship between Market Concentration, Bank Competition and Bank X-efficiency across Six Emerging Asian Countries.

	Dependent variable: X-efficiency									
	Tobit					2SLS				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Concentration	0.002***	–	–	0.002***	0.002***	0.005***	–	–	0.001***	0.005***
Lerner	–	0.008	–	−0.002	–	–	0.144***	–	0.134***	–
Lerner-adj	–	–	0.138***	–	0.138***	–	–	0.151***	–	0.131***
Size	0.014***	0.004***	0.010***	0.014***	0.020***	0.024***	0.008***	0.008***	0.010***	0.028***
Credit risk	−0.006	−0.014	−0.0003	−0.007	0.008	0.010	0.002	−0.016	0.011	0.018
Liquidity risk	−0.060***	−0.045**	0.004	−0.060***	−0.011	−0.090***	−0.097***	0.017	−0.088***	−0.009
GDP growth	0.004 ***	0.004***	0.003***	0.004***	0.003***	0.004***	0.001*	0.002***	0.002***	0.002***
Inflation	−0.002***	−0.003***	−0.001***	−0.002***	−0.0004	−0.002***	−0.003***	−0.0002	−0.002***	0.001*
Constant	0.723***	0.902***	0.763***	0.724***	0.581***	0.546***	0.891***	0.779	0.807***	0.391***
Wald test										
Chi^2 (2)	38.40	17.72	12.29	56.04	37.61					
Prob>chi^2	0.000	0.001	0.001	0.000	0.000					

Source: Author's calculation.
*, ** and *** denote statistical significance at the 10, 5 and 1% levels, respectively.

banks, their marginal cost seems to be higher than price, possibly due to non-optimising behaviour of banks in the system in 2008 and 2010–12.

Table 3 reports the annual averaged estimates of bank X-efficiency scores for the six focal countries over 2005–12 using the SFA approach. Averaged X-efficiency scores for banking systems in all countries of the sample are rather high. These scores are highest for the Philippines (0.972), followed by Malaysia (0.924), Indonesia (0.910) and India (0.902). Bangladesh and Vietnamese banking systems achieve the same averaged X-efficiency score of 0.863. These results suggest that banks in the six emerging Asian countries operate quite efficiently compared to their best-practice bank for producing the same outputs under the same conditions.

4.2. The relationship between market concentration, bank competition and X-efficiency for the full sample

Table 4 provides the Tobit regression and 2SLS regression test results for the relationship between market concentration, bank competition and bank X-efficiency in the full dataset. The Wald tests show that exogeneity for market concentration and bank competition is rejected at the 1% level for all models. Therefore, Tobit estimation seems to be less appropriate than instrumental variable estimation (2SLS). This result is consistent with the finding of Koetter et al. (2008) that the instrumental variables technique should be used. The relationships between market concentration, bank competition and bank X-efficiency are analysed in detail below.

The values in Table 4 indicate that market concentration has a significant influence on X-efficiency across all models. Indeed, the coefficients for market concentration are significantly positive at the 1% level for both Tobit and 2SLS estimations. This shows that an increase in market concentration results in an increase in bank X-efficiency, thus arguing against the QLH in these Asian countries. Thus, an increasing market concentration level can help banks in the system to improve their quality of management in terms of both allocative and technical efficiency. These findings are in line with those for EU banking in the loans market but contrast with results for the deposits market reported by Maudos and de Guevara (2007), and also are not consistent with those for banking in Sub-Saharan Africa reported by Kirkpatrick et al. (2008).

According to the results from Tobit regressions, the relationship between the conventional Lerner index and X-efficiency is positive (but not significantly so) when excluding market concentration from the research model (Model 2) but is negative (but not significantly so) when considering concentration and competition as key variables of interest (Model 4). The association between the conventional Lerner index and X-efficiency is significantly positive for both Models 2 and 4 using 2SLS regression. These findings suggest rejection of the QLH, which postulates that banks require less effort to maximise their

Table 5
The Relationship between Market Concentration, Bank Competition and Bank X-efficiency by Country: Tobit and 2SLS Estimations.

	Bangladesh		India		Indonesia		Malaysia		Philippines		Vietnam	
	Tobit	2SLS	Tobit	2SLS	Tobit	2SLS	Tobit	2SLS	Tobit	2SLS	Tobit	2SLS
Concentration	−0.015***	−0.017***	0.011***	0.011***	−0.005***	−0.006***	0.006***	0.034***	0.012***	0.086***	0.003***	0.005***
Lerner-adj	−0.033***	−0.049***	0.040***	0.077***	−0.010	−0.033*	0.072***	−0.001	−0.022	0.001	0.109***	0.127***
Size	0.010***	−0.004	−0.0004	0.004**	0.015***	0.014***	−0.011***	0.021***	0.031***	0.004**	−0.001	0.0002
Credit risk	−0.014	−0.042***	−0.010	−0.016*	0.028**	0.026*	0.036**	−0.037	0.003	0.001	−0.001	0.009
Liquidity risk	−0.117***	−0.228***	−0.007	−0.010	−0.032**	−0.054***	0.030*	−0.096***	−0.161***	−0.124***	0.008	−0.023
GDP Growth	−0.027***	−0.027***	0.0003***	−3.73e − 06	−0.006***	−0.007***	−0.001*	−0.0002	−0.002***	−0.010***	0.015***	0.008***
Inflation	0.009***	0.009***	0.002***	0.002***	−0.001***	−0.001***	0.004***	0.006***	−0.001	−0.003***	0.001***	0.001***
Constant	1.586***	1.859***	0.519***	0.474***	1.162***	1.241***	0.657***	−0.910***	0.180**	−3.942***	0.561***	0.513***
Wald test												
Chi^2 (2)	87.07		243.7		10.21		134.42		83.91		1745.14	
Prob>chi^2	0.000		0.000		0.006		0.000		0.000		0.000	

Source: Author's calculations.
*, ** and *** denote statistical significance at the 10, 5 and 1% levels, respectively.

efficiency in a more relaxed environment and thus that increasing competition fosters X-efficiency of banks in the system. The significantly negative association between competition and X-efficiency supports the IGH.

A negative relationship between competition and bank efficiency is strongly supported when considering the effect of the efficiency-adjusted Lerner index on X-efficiency. The coefficients for the efficiency-adjusted Lerner index are all significantly positive at the 1% level using both Tobit and 2SLS regression. This suggests that banks with higher competition levels cannot reduce costs to attain higher levels of X-efficiency. Therefore, the findings lead to rejection of the QLH, as discussed above, whereas they provide evidence in support of the IGH, which proposes that bank competition decreases bank efficiency. These findings are in line with those reported by Maudos and de Guevara (2007) and Schaeck and Cihak (2008) for Europe; Pruteanu-podpiera et al. (2008) for the Czech Republic; and Fang et al. (2011) for six transition countries in South-eastern Europe. There are two possible reasons to explain this result. First, competition among banks results in an increased mobilizing interest rates. The banking systems in these emerging countries concentrate mainly on two traditional activities: capital mobilising activity and credit activity. Banks compete fiercely to capture market share and attract bank depositors by increasing their mobilising interest rates, thus increasing costs and decreasing X-efficiency. Second, in more competitive markets, bank can increase costs for monitoring and treating non-performing loans. As suggested by the IGH, when competition increases, the screening and information-gathering capacities of banks can decrease due to a dispersion of information about their borrowers; thus low-quality borrowers have more chance to acquire bank loans, and banks' probability of adverse borrower selection increases. To prevent non-performing loans, banks need to expend more resources (e.g. personnel) for monitoring their borrowers and dealing with non-performing loans. As a result, bank X-efficiency can decrease. Therefore, competition can result in lower bank X-efficiency.

The values in Table 4 indicate that bank size has a highly significant effect on X-efficiency. The coefficients for bank size are significantly positive for all models by Tobit regression and 2SLS regression. Thus larger banks are able to attain higher levels of X-efficiency. This finding is in line with the result for developing countries reported by Turk Ariss (2010).

Turning to bank risk variables, although the signs of the coefficients for credit risk vary between research models, the coefficients for this variable are insignificant for all models. The coefficients for liquidity risk are not significant in models considering the efficiency-adjusted Lerner index as a measure of competition. The significantly negative relationship between liquidity risk and X-efficiency holds for Models 1, 2 and 4 by both Tobit and 2SLS regression. This suggests that liquidity risk has a significant negative effect on allocative and technical efficiency of the banking systems of the six study countries over 2005–12. Therefore, banks in these countries may decrease their liquidity risk to improve their X-efficiency.

Macroeconomic conditions have significant effects on X-efficiency for banks in the sample. The coefficients for economic development (GDP growth) are significantly positive across all models by Tobit regressions and 2SLS regressions. Therefore, economic development is positively related to X-efficiency. This indicates that banks can improve their allocative and technical efficiency levels when they operate under conditions of more rapid growth in GDP. Moreover, the effect of economic stability (inflation) on X-efficiency is negative across all models by Tobit regression, although the signs of the coefficients for inflation vary among models with 2SLS regression. The coefficients for inflation by 2SLS are significantly positive for only Model 5 when considering the efficiency-adjusted Lerner and concentration as key variables of interest but they are negative for the remaining models. Therefore, the influence of inflation on allocative and technical efficiency in these emerging Asian countries is not clear.

4.2.1. The relationship between market concentration, bank competition and X-efficiency by country

Exogeneity in concentration and bank competition are rejected at the 1% level for all countries in the sample based on the Wald test results. This suggests it is necessary to perform the instrumental variables technique. Therefore, both Tobit and 2SLS regression are used here.

Table 5 reports the relationships between market concentration, bank competition and bank X-efficiency by Tobit and 2SLS regression for each country in the dataset. Banking systems in Bangladesh and Indonesia show evidence to support the QLH whereas this hypothesis is rejected for the other banking systems over the study period.

4.2.2. Evidence to support the quiet life hypothesis: Bangladesh and Indonesia

In Bangladesh banking, market concentration and the efficiency-adjusted Lerner index are highly significantly and negatively related to X-efficiency. This finding seems to support the QLH, which posits that banks with higher market power require less effort to maximise efficiency in a relaxed environment. Therefore, increasing competition can result in an improvement of X-efficiency in the Bangladesh banking system. Bangladesh banks had a tendency to improve their X-efficiency over the period of 2005–2012. This improvement in the quality of management of banks may be attributed to financial reforms in banking such as legal, policy and institutional reforms. A series of reforms were undertaken to improve financial intermediation processes and enhance the competitiveness of the private sector, thus increase efficiency of financial resource allocation. The growth of total assets held by the four largest banks (~14%) is lower than the growth of total assets for the whole banking system (~20%) over 2005–2012,[3] thus the banking system became less concentrated. This is due to the competition between commercial banks to grab market shares from largest banks. It is also the reason that makes Bangladesh banks became more efficient.

The relationship between bank size and X-efficiency indicated by the Tobit regression results is positive and highly significant at the 1% level, suggesting that larger banks can achieve higher X-efficiency levels. The coefficients for credit risk and liquidity risk are negative but only insignificant so for credit risk by Tobit regression. Hence, banks in Bangladesh are able to reduce their credit risk and liquidity risk to gain higher X-efficiency. In addition, the effects of macroeconomic conditions (including GDP growth and inflation) on X-efficiency are highly significant (1% level). GDP growth has a negative relationship with X-efficiency whereas inflation is positively related to X-efficiency.

The Indonesian banking system also seems to fit the QLH. The association between market concentration and X-efficiency is negative and highly significant for all regressions. Moreover, the relationships between Lerner indices and X-efficiency are negative and only significant for 2SLS estimations. The banking system in Indonesia was rather highly concentrated. The four largest banks owned over half of the total market share of whole system during the period of 2005–2012. Although State-owned banks dominated the banking system with the largest assets, joint ventures and private banks have captured market share by providing additional services and product variety over the studied period. Therefore, a decrease in market concentration along with competitive pressures may result in an increase in bank efficiency. The coefficients for bank size and credit risk are significantly positive whereas those for liquidity risk, GDP growth and inflation are significantly negative for all regressions. Thus, banks with larger size and credit risk can achieve higher X-efficiency. In contrast, a higher liquidity risk for banks can reduce their X-efficiency. Macroeconomic conditions such as GDP growth and inflation have negative effects on X-efficiency.

4.2.3. Evidence to reject the quiet life hypothesis: India, Malaysia, Philippines and Vietnam

4.2.3.1. India. In contrast to the cases of Bangladeshi and Indonesian banking, significantly positive coefficients for concentration and Lerner indices in both Tobit and 2SLS regressions provide evidence against the QLH and seem to support the IGH for the Indian banking system. The financial sector reforms have allowed the entry of new private commercial banks and foreign banks since 1992. The establishment of new private banks became liberalised, thus the banking became less concentrated and more competitive. The competition between banks pushed the interest rates. The growth of credit and deposit had a tendency to increase, however, high interest rates along with lower economic growth weaken borrowers' repayment capacity, thus increasing non-performing assets and decrease bank efficiency

The coefficients for bank size estimated by Tobit and 2SLS regression vary in sign, but are significant only for 2SLS estimation. Results estimated by 2SLS regression indicate that Indian banks with larger TA can achieve higher X-efficiency. Credit risk and liquidity risk have negative effects on X-efficiency, but only significantly so for 2SLS estimates for the relationship between credit risk and bank efficiency. The signs and significance of the coefficients for GDP growth from Tobit and 2SLS regressions are contrasting: they are positive and significant for Tobit regression but negative and insignificant for 2SLS regression. The coefficients for inflation are significantly positive for all regressions, suggesting that inflation has a positive impact on X-efficiency.

4.2.3.2. Malaysia. For Malaysian banking, the coefficients for market concentration are positive and significant at the 1% level for all regressions. In addition, the coefficient for the efficiency-adjusted Lerner index is significantly positive for the Tobit estimate (although negative and insignificant for the 2SLS regression estimate). The apparent positive relationship between concentration and X-efficiency argues against the QLH in Malaysian banking. Market concentration decreased slightly over 2006–11. The banking sector has undergone consolidation that has led to a reduction in number of domestic commercial banks, merges of finance companies into commercial banking groups, and merges of discount houses and securities firms to become investment banks. Around half of market share of the whole system owned by four largest banks. In other hand,

[3] Source: Authors' calculation based on Bankscope data.

increased competition between banks has caused an increase in deposit interest rates over 2009–2012, thus, banks may cannot control cost efficiently and become less efficient.

The influence of bank size on X-efficiency is significantly negative for Tobit regression. Nevertheless, the coefficient for size by 2SLS regression is significantly positive, suggesting that larger banks in Malaysia are more efficient than their smaller peers. Both liquidity risk and credit risk are significantly positively related to X-efficiency for Tobit estimates. However, the 2SLS results indicate that the coefficient for credit risk is insignificantly negative and that for liquidity risk is negative and significant at the 1% level. Therefore, banks with higher liquidity risk may be less efficient. In addition, both the Tobit and 2SLS estimates suggest that GDP growth has a negative influence on X-efficiency, although only the Tobit coefficients are significant. X-efficiency of banks under effects of higher inflation can be improved for Malaysian banks.

4.2.3.3. The Philippines. For the Philippines banking system, the results for both Tobit and 2SLS regressions indicate that concentration is significantly and positively related to X-efficiency, providing evidence to reject the QLH. Market concentration generally followed a slight upward trend from 56% in 2005 to nearly 59% in 2012[4] due to a decline in the number of operating banks over this period. During this period, banks in Philippines focused on strengthening their capital. They did not participate in the race in deposit interest rate but they concentrated on the loan quality as well as providing greater access to financial services via the use of various electronic banking channels. A decrease in the deposit interest rates and funding cost ratios along with low non-performing loans ratios in spite of expansion in lending may result in improvement of bank efficiency of the system.

The relationship between bank size and X-efficiency are significantly positive; thus banks with larger size can achieve higher X-efficiency. Both liquidity risk and GDP growth have significant negative effects on X-efficiency. All coefficients for inflation are negative but significantly so only with 2SLS regression. This suggests that higher inflation can decrease X-efficiency of banks in the Philippines. The coefficients for Lerner indices and credit risk are not statistically significant; therefore, bank competition and credit risk have no significant effect on X-efficiency in the Philippines.

4.2.3.4. Vietnam. The coefficients for concentration and Lerner-adj are positive and significant at the 1% level, suggesting that the QLH be rejected for Vietnamese banking. The Vietnamese banking system has witnessed a dramatic increase in the number of banks, mainly due to a remarkable increased presence of foreign banks, especially since 2007 when Vietnam became a member of the World Trade Organization (WTO). Due to the global integration of Vietnam and its WTO commitments, the banking system is now more open to foreign investment, and has removed many barriers to foreign banks. Since 1 January 2011, the playing field for both domestic and foreign banks has been levelled because of the similar treatment of foreign banks' branches as domestic banks, for example with respect to deposit and lending rules and provision of the same services (Ho and Baxter, 2011). An increase in the participation of foreign banks along with a strong competition between banks in the system to capture market share led to a dramatic decrease in concentration levels and a race to hike deposit interest rates between banks in the system. In addition, a liquidity shortage of banks also pressurises deposit interest rates. Therefore, deposit interest rates increased sharply from 8.4% to 11.5% over 2005–2012, especially this rates increased to around 13.5% in 2008 and 13.0% in 2011.[5] Higher deposit interest rates may increase bank costs, thus decreasing the X-efficiency of banks in Vietnam. The effects of macroeconomic conditions on X-efficiency are highly significant (1% level). The coefficients for GDP growth and inflation are significantly positive, indicating that higher GDP growth and higher inflation rates can improve X-efficiency of Vietnamese banks. Size, credit risk and liquidity risk have insignificant effects on X-efficiency.

4.3. Tests for multicollinearity

Multicollinearity was tested for the models using Variance Inflation Factor (VIF). The figures in Table 6 show that VIF is highest for the efficiency-adjusted Lerner index in Model 5 (1.42) and lowest for size in Model 2 (1.05). Therefore, multicollinearity is not a concern in all models when examining the relationship between competition, market concentration and X-efficiency for full sample.

Table 7 shows that VIF for bank concentration is highest for India (6.84) and VIF for credit risk is lowest for Philippines (1.04). Overall, multicollinearity is not a concern when examining the relationship between competition, market concentration and X-efficiency by country in the sample.

5. Conclusions and policy recommendations

This paper analysed the relationships between market concentration, bank competition and bank efficiency for the six emerging Asian countries pre- and post-GFC. Our results indicate that market concentration has a significantly positive effect on X-efficiency, providing evidence against the QLH for these six Asian countries. On the other hand, there appears to be a significantly positive association between Lerner indices and X-efficiency, suggesting that competition is negatively associated with X-efficiency, in line with the IGH. Two possible reasons for this are that banks compete fiercely to capture

[4] Source: Authors' calculation based on Bankscope data.
[5] Source: Asian Development Bank (The Key Indicators for Asia and the Pacific 2013).

Table 6
Variance Inflation Factor (VIF): Checking for Multicollinearity for the Full Sample.

	VIF				
	(1)	(2)	(3)	(4)	(5)
Concentration	1.28	–	–	1.32	1.29
Lerner	–	1.15	–	1.18	–
Lerner-adj	–	–	1.41	–	1.42
Size	1.21	1.05	1.12	1.21	1.29
Credit risk	1.16	1.13	1.12	1.16	1.16
Liquidity risk	1.12	1.15	1.17	1.15	1.17
GDP growth	1.09	1.06	1.07	1.09	1.10
Inflation	1.08	1.15	1.31	1.15	1.33
Mean VIF	1.15	1.11	1.20	1.18	1.25

Source: Author's calculation.

Table 7
Variance Inflation Factor (VIF): Checking for Multicollinearity for Each Country.

	VIF					
	Bangladesh	India	Indonesia	Malaysia	Philippines	Vietnam
Concentration	2.41	6.84	3.38	1.05	1.34	3.06
Lerner-adj	1.81	2.11	1.82	1.29	1.89	1.79
Size	2.52	1.21	1.18	1.95	1.71	1.82
Credit risk	1.10	1.42	1.14	2.11	1.04	1.06
Liquidity risk	1.10	1.33	1.85	1.52	1.60	1.34
GDP growth	1.30	1.29	1.85	1.17	1.18	2.69
Inflation	1.35	5.48	2.09	1.17	1.36	1.14
Mean VIF	1.66	2.81	1.90	1.47	1.45	1.84

Source: Author's calculation.

market share and attract bank depositors by increasing their mobilising interest rates, thus increasing costs and decreasing X-efficiency; and second in more competitive markets, banks' probability of adverse borrower selection increases and they need to expend more resources to monitor their borrowers and treat non-performing loans, thus decreasing X-efficiency.

Bank size has a highly significant positive effect on X-efficiency, suggesting that larger banks are able to attain higher levels of X-efficiency. Liquidity risk is significantly negatively related to X-efficiency, thus banks with higher liquidity risk experience decreased X-efficiency. Economic development (GDP growth) positively influences bank X-efficiency, suggesting that banks can improve their allocative and technical efficiency levels under conditions of rapid GDP growth. However, the effect of economic stability (inflation) on X-efficiency is unclear. Inflation is significantly positively related to X-efficiency only for Model 5, which considers the efficiency-adjusted Lerner and concentration as key variables of interest; the relationship is negative in the remaining models. Credit risk has no significant effect on X-efficiency in all research models.

The study also examined the relationship between market concentration, bank competition and bank X-efficiency for each country in the research sample. Here we found that the QLH is supported for the banking in Bangladesh and Indonesia but this hypothesis is rejected and the IGH is supported for banking in India, Malaysia, the Philippines and Vietnam.

On the basis of the empirical findings, some recommendations can be made for increasing bank efficiency in the context of emerging countries.

For governments and policymakers, several policy implications arise from the study. First, policy on M&A need to encourage M&A of small and weak banks as a means to improve their financial strength and soundness. Second, as demonstrated by some previous studies (e.g. Claessens and Laeven, 2004; Jeon et al., 2011; Yeyati and Micco, 2007; Yildirim and Philippatos, 2007; Wu et al., 2010), foreign bank entry be promoted as this enhances competition by restructuring domestic banking sectors and encouraging troubled local banks to change their governance as well as decreasing the state's role in banking markets. Generally, further encouragement of foreign bank penetration and divestiture of state ownership in banking can heighten competitive pressures in the banking sector. Thus, the main policy lessons drawn from the study are that competitive conditions may be further enhanced by easing regulatory impediments and, in the long run, allowing more foreign bank participation in an attempt to spur competitive conduct in banking.

Some policy recommendations are also suggested for banks to increase their X-efficiency. The negative relationship between competition and efficiency may be explained by the fact that banks compete fiercely to capture market share from their peers. They raise their mobilising interest rates and invest more in banking promotions and bonuses to attract new customers to sign up for new accounts and to retain existing customers, thus increasing their costs and decreasing X-efficiency. Further, when bank competition increases, a bank's probability of adverse borrower selection increases. Therefore, banks experience increased costs of monitoring their borrowers and treating non-performing loans, thus decreasing X-efficiency. Thus, to increase bank X-efficiency, banks aim to diversify their activities and income (e.g. net interest income and non-interest income) rather than continuing to rely largely on traditional activities (e.g. capital mobilisation and credit activities) and net interest incomes, to avoid a race to increase interest among banks. Additionally, banks consider establishing

better customer information systems to access, collect, store and transmit customer information to their peers. In this way, they can assess repayment capacity of their customers before lending, to avoid adverse borrower selection. Banks also need to thoroughly examine sub-prime lending and relationship-based lending.

The second important recommendation arises from the results which indicate that bank size has a positive effect on X-efficiency. Therefore, to increase bank X-efficiency, banks aim to increase their size and total assets via privatisation, attracting capital from shareholders and investors through the securities market. Banks are encouraged to attract deposits from customers and other banks by diversifying their deposit products and introducing new products to their existing and potential clients as well as supplying the best quality of service to their customers. Small and weak financial banks may be able to increase their size via M&A to improve their financial strength and X-efficiency.

The third recommendation for banks is that they can increase their X-efficiency by reducing their liquidity risk. Banks can raise liquidity of their assets by increasing their liquid assets and matching cash-flows of both assets and liabilities. Moreover, it is necessary to build very close cooperation and strong relationships among banks in the system, so that a bank facing the risk of a funding crisis or a sudden demand for liquid funds can receive prompt support from its peers. In addition, banks endeavour to strengthen customer belief and build customer loyalty to promote a strong relationship between them and their customers.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.ribaf.2016.07.012.

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