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The Relationship between Competition and Efficiency in Southeast Asian Banking Markets

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Rossazana Ab-Rahim*
Dyg-Affizzah Awg-Marikan*
Nor-Ghani Md-Nor**

***Faculty of Economics and Business
Universiti Malaysia Sarawak

****Faculty of Economics and Management
Universiti Kebangsaan Malaysia

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Rossazana Ab-Rahim, Dyg-Affizzah Awg-Marikan and Nor-Ghani Md-Nor

ABSTRACT

This research focuses on cost efficiency measures, the decompositions of cost efficiency, and the relationship between various measures of efficiency and competition among commercial banks in five Southeast Asian countries during the period 1996-2011. This study employs a three-stage procedure. The first phase involves the calculation of cost efficiencies and its decompositions, technical and allocative efficiency, using Data Envelopment Analysis. In the second stage, the Lerner index method is employed to measure banking competition. As the second objective of this study is to investigate the relationship between banking competition and various measures of efficiency, Granger causality tests are used to achieve the objective. The results indicate competition has a positive effect on technical efficiency in all banking markets. Positive links are also found between pure technical efficiency and competition in Indonesia, Malaysia, and Thailand. In the Philippines, banking competition does not affect the efficiency performance of banks. The results also suggest that there is a negative causality running from banking competition to scale efficiency in all banking markets.

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1. INTRODUCTION

Competition is intended to foster efficiency, improve quality of provision, stimulate innovation, and boost international competitiveness (Casu and Girardone 2009). However, the relationship between efficiency and competition in banking is more complex than in other industries (Claessens and Laeven 2004).

The economic malaise at the end of 1990s triggered structural reforms in Asian banking sector profoundly. The financial crisis demonstrated the vulnerabilities of domestic banking institutions; a large number of fragile commercial banks and finance companies were revealed while insolvency and financial distress proved chaotic. Most financial institutions at the time posted high levels of non-performing loans as a result of poor risk management and excessive lending (Laeven 1999). The systemic banking crises caused many local governments to urge, or even force, failing bank institutions to merge (Shih 2003). In fact, government-led mergers had been the most popular tool in the aftermath of a banking crisis (Damar 2007).[1] Other popular tools of post-crisis restructuring include nationalizing banks, closing down ailing banks, transferring assets from weaker banks to healthier banks, removing nonperforming loans to asset management companies, and injecting capital (Williams and Nguyen 2005).

The banking reforms in Asian countries were distinct from those undertaken by other economies in the world. In developed countries and regions such as the United States and Europe, the reforms transpired mostly in domestic banks on a piecemeal basis. In the Asian region, the banking reforms allowed domestic banks to consolidate with foreign banks or merge with other local banks, while others were ordered to close down. Another notable difference between the banking reforms in Asia and those in the developed economies was that the former were undertaken in Asia following the economic crisis in the region, whereas the reform process in the latter occurred following the relaxation of regulations on geographic and product expansion.[2]

[1] Merger has been favored by local governments in the aftermath of banking crises based on three reasons. Firstly, it is believed that a merger between two weak banks will create a much healthier bank while a merger between one weak bank and one healthier bank will reduce bank failures (Shih 2003). Secondly, merger has been the useful tool to reduce the excess capacity that accumulates during a rapid economic growth prior to a crisis (Damar 2007). In addition, bank merger is seen as the most effective strategy for minimizing the social costs associated with bank failures (Bank for International Settlement 2001a) and improving the structure and enhancing the efficiency of the banking industry (Ibid 2001b).

[2] The 1997 economic crisis adversely affected the ASEAN banking sector. Authorities sought to improve the soundness of bank management by accelerating bank mergers (Okuda and Hashimoto 2004).

The Asian banking reforms were primarily a result of government interventions in the banking sector and were intended to make domestic banks more efficient and competitive. In the developed economies, bank mergers were undertaken on a voluntary merger basis.

Vander Vennet (1996) and Berger et al. (1999) said the factors inducing the consolidation process in the banking industry can be categorized as value-maximization and nonvalue maximization motives. Value maximization entails synergy, efficiency, and corporate control. Nonvalue maximization involves managerial motives, empire building, and government intervention. Government intervention in the banking sector during the Asian financial crisis was not a new phenomenon. It had previously been employed in Spain and other parts of Europe (Tortella 2001) as well as in Southeast Asia. In Indonesia, the local government had nationalized 13 banks and closed 60 banks throughout the restructuring period. By the end of 2003, the number of licensed banks in the country was reduced from 240 to 138. Bank Indonesia has consistently encouraged consolidation to reduce the number of banks in the country (Hadad et al. 2008). The Central Bank of the Philippines similarly encouraged mergers to reduce the risks of bank failures and to strengthen the banking institution (Bautista 1999).

The mergers of several groups of Malaysian domestic banks into single entities in 1999 were largely involuntary and were the direct result of a directive by the central bank, Bank Negara Malaysia. Prior to the merger announcement in April 1999, the government's policy had always been to allow market forces to dictate mergers. However, after years of calling for local bank mergers, the government's efforts proved unsuccessful. The regional financial crisis of 1997 triggered the government's decision to consolidate the Malaysian banking sector in 1999. In Thailand, bank mergers were introduced as the resolution policy to reduce the number of financial institutions. In 1998, Thai banks were taken into state ownership during the crisis to stem huge losses. Their bad assets were transferred to an asset management company. Four other banks were privatized in 1999. Efforts toward bank consolidation were seen to strengthen financial institutions.

The preceding discussion shows that bank mergers are a government-led approach pursued largely by Asian economies to strengthen capital adequacy and the financial viability of the banking industry. Theoretically, governments intervene in the market in the face of market failure. Such intervention is undertaken to correct market failure and to improve social welfare. Government intervention can also improve firms' profitability (Deardoff 2000). The uniqueness of Asian banking reforms compared with those of developed countries

offers an interesting insight on the economic justification for government interventions in the banking industry, and provides the basis for this research.

While there has been considerable research on the effects of banking reforms on banking performance, there are limited studies on efficiency and productivity in developing countries. Banks and financial institutions play important economic roles in financial intermediation and economic acceleration, and in the conversion of deposits into productive investments (Podder and Mamun 2004). Employing the data envelopment analysis method (DEA), Laeven (1999) examined the risk factors and efficiency of banks in five Southeast Asian countries (Indonesia, Korea, Malaysia, Philippines, and Thailand). The results of the study reveal that state- and foreign-owned banks as well as banks in Korea and Malaysia took less risks relative to other banks, while banks in Indonesia and the Philippines were among the highest risk takers. Utilizing stochastic frontier approach, Karim (2001) found that banks in four ASEAN (Association of Southeast Asian Nations) member countries—Thailand, Malaysia, Indonesia, Philippines—for the period 1989-1996 enjoyed increasing returns to scale. The results of the study indicated that bank mobility within the ASEAN market placed Thai and Malaysian banks at an advantage compared with their neighboring countries.

After examining seven Asian countries (Hong Kong, Indonesia, Malaysia, Philippines, Singapore, South Korea, and Thailand), Kwan (2003) found that operating costs varied significantly across countries for the period 1992-1999. Operating efficiency was found to be insignificant in the degree of openness of the banking sector. In another study, Williams and Nguyen (2005) focused on the link between bank performance and governance in five Southeast Asian countries (Indonesia, Korea, Malaysia, Philippines, and Thailand) for the period 1990-2003. The study found that as a result of domestic merger and acquisitions among banks in selected Asian countries, on average, productivity of banks increased. However, managerial performance remained indifferent. The study further suggested that policymakers should support bank privatization and reject state ownership.

Against this backdrop, a study of banking in developing economies assumes greater significance. This research seeks to examine the levels of efficiency in the banking sectors of Southeast Asian countries (specifically Malaysia, Indonesia, Singapore, Philippines, and Thailand) over the period 1996-2011. As the structural reforms target banking efficiency, the stride toward competition is inevitable. A strong and resilient banking system should support economic efficiency and stability, where efficiency is closely linked to optimal competitive structure (Northcott 2004).

As far as this research is concerned, no known studies have investigated the relationship between competition and efficiency within the Asian banking industry. With regard to structural reforms in the Asian banking industry, it would be interesting to investigate the relationship between efficiency and competition within the developing economies context. Structural reorganization in banking holds enormous promise. But it remains to be seen whether the potential gains will be realized. Questions of efficiency and the efficacy of banking competition arose following the reforms undertaken in Asian banking.

Notwithstanding the reduced number of banks resulting from banking reforms, this study aims to determine if the higher concentration of banks in the market will lead to higher or lower competition in the industry. This study also explores the relationship between banking efficiency and competition. Its main objective is to investigate the impacts of structural reforms in the Southeast Asian banking industry on efficiency gains and competitiveness.

The specific objectives of the study are, first, to assess the levels of technical efficiency and cost efficiency in the banking sectors of Southeast Asian over the period 1996-2011. Second, it aims to measure the market structure and market competition of the banking sector in the region. Finally, it seeks to test the relationship between banking efficiency and banking competition in the region.

2. LITERATURE REVIEW

2.1. Theoretical Motivation

From a static view, competition is seen as an important force for firms to operate and produce at the frontier. Those firms operating within the production frontier will do their level best to be located on the frontier while those firms on the frontier will engage in more advanced innovation and technology to remain on the frontier (Berger et al. 1999). Otherwise, restructuring in the banking industry will stimulate those firms operating inefficiently to shift to the frontier. Banks that are not allocating their resources efficiently will perish unless they increase their efficiency by producing more outputs using existing inputs. On the other hand, consolidation also leads to increased concentration, which in turn leads to negative consequences on the consumer's welfare. Therefore, it is important to develop a conceptual framework of the nexus between efficiency and competition in banking.

Most of the existing studies on the correlation between competition and efficiency in the banking industry test the structural approach, in particular the structure-conduct-performance paradigm or efficient-structure hypothesis, by taking concentration per se as a proxy for competition. As such, the theoretical foundations for the relationship between competition and efficiency in the banking industry are based on theories on market structure and efficiency, as advocated by proponents of the nonstructural approach.[3]

The rationale behind the link between market structure and efficiency originates from the quiet life hypothesis in banking. Hicks (1935) explained how monopoly power allows managers to earn monopoly rents through reduction in managerial efforts (x-inefficiency). Therefore, increased concentration will result in decreased efficiency. This proposition is known as the quiet life hypothesis. The hypothesis constitutes the structure-conduct-performance hypothesis, which postulates that banks in a concentrated market can charge higher loan rates and pay lower deposit rates, generating more profits and lower collusion costs. However, competition will decrease. Thus, the hypothesis proposes a positive correlation between competition and efficiency. That is, higher market concentration results in lower competition, which in turn leads to decreased efficiency.

Liebenstein (1966), who offered a contradictory view, argued that competition could reduce x-inefficiencies.[4] For instance, managers are aware that the only way to sustain performance in competitive markets is to cut costs and produce more. This means increasing their work efficiency. Furthermore, when competition rises, shareholders of firms tend to compare the firms' performance with that of rivals. Knowing that company owners have the power to change the management composition drives managers to increase workplace efficiency. In this context, the negative correlation of competition-efficiency comes to the fore.

[3] Based on the structural approach, competition is closely related to concentration; the concentration ratio method explains competitive performance in the banking industry by capturing the structural features of a market. The main caveats of industrial concentration are the number of banks and the distribution of bank sizes in a given market (Bikker and Haaf 2002). The structural approach has been criticized widely due to the over-emphasis on structural issues and less emphasis on the conduct of firms (Goddard et al. 2007). Such drawback has resulted in nonstructural specification models of competition. The nonstructural approach implies that market structure does not determine the competitive conduct of banks. That is, the nonstructural approach does not assume that a concentrated market is an uncompetitive market as the approach tries to measure competition empirically.

[4] Leibenstein (1966) popularized the x-efficiency concept by distinguishing it from allocative efficiency. Allocative efficiency results when price equals marginal cost; any departure from the condition would result in allocative inefficiency. In contrast, x-inefficiency occurs when a firm produces at an average cost above the minimum efficient scale point. But Stigler (1976) argued that this type of efficiency, given the negative connotation of the term "x-efficiency," can easily be integrated into the traditional theory of allocative efficiency.

Instead of viewing concentration as the cause of market power, the efficient-structure hypothesis (Demsetz 1973) contends that as a result of superior products or advancement in technology or better management, firms were more efficient relative to others that were not innovative or were poorly managed. Being more efficient means that firms incur lower costs, which allow them to capture larger market shares that in turn leas to market concentration. Given that higher market concentration lowers competition, the efficient-structure hypothesis reverses the causality running from efficiency to competition in the structure-conduct-performance paradigm.

2.2. Empirical Evidence

In general, restructuring in the banking industry could lead inefficient banks to produce more outputs using existing inputs, or to produce the same level outputs using less inputs. From the industrial organization point of view, the level market concentration determines the competitiveness level among the market players. The structure-conduct-performance paradigm posits that markets dominated by a small number of large firms (highly concentrated) are less competitive than markets with a low concentration of large firms (Mason 1939; Bain 1951). According to the efficient-structure hypothesis (ESH) the degree of market concentration is determined by the superior performance of efficient banks (Demsetz 1973; Peltzman 1977). Both SCP and ESH theories, which are known as a structural approach, postulate that market concentration determines the competitive conduct of firms in a market.

The nonstructural approach sees no clear evidence that market power is higher and competition is lower in more concentrated markets. The contestable market theory, on the other hand, states that a high-concentration market can be highly competitive even if it is dominated by a small number of firms (Baumol 1982).

The consolidation of banks in the Asian banking system by the end of the ‘90s should spur interest in the link between market concentration and competition in the banking industry. From the conservative point of view, restructuring via consolidation will lead the market to greater concentration, which in turn will spawn negative consequences on the consumer’s welfare. The preponderance of mergers has raised concerns that increased concentration is likely to intensify market power, which is believed to hinder competition, including among banks. However, this has no clear evidence from a theoretical point of view, as studies claim that mergers produce pro-competitive effects (Carletti et al. 2002; Yu 2003;

Claessens and Laeven 2004; Bikker et al. 2006a; Yildirim and Philippatos 2006; and Yeyati and Micco 2007). Mergers are generally believed to benefit competition by allowing firms to operate more efficiently. Yet other studies support the conventional view that concentration impairs competition (Bikker and Groeneveld 2000; Stennek 2000; Bikker and Haaf 2002; Corvoisier and Gropp 2002; and Demirguc-Kunt et al. 2004).

The foregoing studies highlight the importance of the link between bank competition and efficiency. Potential studies could also determine whether increased concentration hampers the realization of a competitive structure by creating market power for banks or whether increased concentration boosts competition and industrial efficiency.

Despite mounting research on market concentration and competition (De Bandt and Davis 2000; Bikker and Haaf 2002; Isik and Hassan, 2003; Angelini and Cetorelli 2003; di Patti and Hardy 2005; Williams and Nguyen 2005; Mahesh and Rajeev 2006; and Yeyati and Micco 2007), empirical evidence relating to competition and banking efficiency is rather scarce. Most of the existing studies focus on the relationship between efficiency and competition but without testing the link between the two variables. For instance, Hauner and Peiris (2005) attempted to apply the model of competition and efficiency in a study involving a low-income country such as Uganda but did not examine the link between the two. Nevertheless, the study suggested that as a result of reforms in the Ugandan banking system, both efficiency and competition recorded an improvement over the period 1999-2004. Their paper also showed that large banks and foreign banks were more efficient than smaller banks in dealing with competition. Giustiniani and Ross (2008) found that competition in Macedonia's banking industry was relatively weak and that despite improved bank efficiency, such improvement was limited. The study did not explore the relationship between efficiency and competition.

Ambitious on the causal relationship between competition and efficiency, Stennek (2000) treated both variables as endogenous, seeing that they impacted each other. The results of his study confirmed the proposition that the stiffer the competition, the higher the efficiency. His paper concluded that apart from financial constraints, which may serve as a disciplining device on the internal efficiency of a firm, an inefficient allocation of risk may bring down the x-efficiency of a firm. Vives (2001) posited that mergers between firms that served imbricate markets tended to increase efficiency by eliminating the duplication markets. But banking competition was reduced as a result.

Using the Lerner index as a proxy for competition, Angelini and Cetorelli (2003) investigated Italian banking competition during the period 1984-1997. The results

demonstrated an ideal picture of the impact of consolidation—competition did not deteriorate, bank efficiency increased, and market power was eliminated. As a final touch to the favorable picture, the findings suggested that regulatory reforms had a pro-competitive impact on Italian banks. However, this picture contrasted significantly with what emerged from the Czech banking system. Using the same measurement of competition, Pruteanu-Podpiera et al. (2008) found no improvement in competition during the period 1994-2005. In addition, the causality test taken showed a negative relationship between competition and efficiency, resulting in a higher loan rate. Thus, the quiet life hypothesis was rejected, as it was in the earlier study by Maudos and Fernández de Guevara (2007). The notion that regulation hindered competition was also acknowledged by Stiroh and Strahan (2003). Their study concluded that the earlier regulation blunted the market mechanism and hindered the competitive process in the U.S. banking industry. Thus, the deregulation that took place in the mid-1980s played a rescuer role to increase the competitiveness of the industry.

It is interesting to note that not many studies have examined or empirically tested the relationship between efficiency and competition in the banking system. A handful of studies focusing on this relationship are Yildirim and Philippatos 2006; Deltuvaite and Vaškelaitis 2007; Casu and Girardone 2006, 2009; Bolt and Humphrey 2010; Pruteanu-Podpiera et al. 2008; Schaek and Cinak, 2008; and Koetter Kolari and Spierdijk 2008.

Yildirim and Phillippatos (2006) examined the competitive conditions of the banking industries of 11 Latin American countries during the period 1993-2000. They also investigated the relationship between competition and bank performance. Apart from other measures of performance (e.g., returns on assets and ratio of overhead expenses to total assets), efficiency was measured by net interest margin while competition was determined using the Panzar-Rosse method. The results indicated that market concentration was not significantly related to competitive conduct. Additionally, a higher degree of competition in the industry was negatively correlated with bank margins and profitability. However, competition was positively associated with cost efficiency.

Applying the same methods to measure competition, Deltuvaite and Vaškelaitis (2007) examined the impact of concentration on competition and efficiency through a study set in the Lithuanian banking industry for the period 2000-2006. Return on assets and return on equities were used as efficiency indicators. The results confirmed Lithuanian banking behavior as monopolistic competition and reinforced the positive relationship between competition and efficiency.

In pursuit of the relationship between efficiency and competition, Casu and Girardone (2006) applied a modified Panzar-Rosse approach, which controlled for differences in efficiency estimates. Bank efficiency, measured by DEA, was used as one of the explanatory variables in estimating the H-statistics. The regression results did not show a clear relationship between efficiency and competition. The study further showed that the pro-competitive deregulation of the European Union (EU) banking market (1997-2003) resulted in competition growth, which eventually prompted banks to become more efficient.

Nevertheless, it is assumed that by regressing the efficiency scores on the competition measures, the findings will only disclose the effects of efficiencies relating to competition. The causation and magnitude of the nexus will remain unanswered. In a recent study, Casu and Girardone (2009) revealed the causality of the relationship by employing Granger causality tests. The study confirmed its earlier findings on the negative link between efficiency and competition in selected EU countries (France, Germany, Italy, Spain, and the United Kingdom) between 2000 and 2005. This study, however, used a different methodology by investigating the relationship between competition and efficiency at the firm level using the Lerner index as the proxy instead of H-statistics.

Moreover, notwithstanding the fact that the primary objective of Pruteanu-Podpiera et al.'s (2008) study was to investigate the effects of banking competition on efficiency measures in the Czech Republic between 1994 and 2005, the Granger causality test taken unleashed the reverse causality of the variables. The results affirmed the negative relationship between cost efficiency scores and banking competition. Yet the link was found to be insignificant. However, the Granger causality test confirmed that negative relationship between competition and efficiency, resulting in a higher loan rate. Thus, the quiet life hypothesis was rejected, as it was in the earlier study by Maudos and Fernández de Guevara (2007).

By pointing out the gap in the literature of the link between competition and bank soundness, Schaeck and Čihák (2008) employed efficiency measures as the possible transmission mechanism by which higher competition might have contributed to increased bank soundness in European and U.S. markets during the period 1995-2005. Employing the Lerner index as the measure of competition and cost and profit efficiency measured using the stochastic frontier method, the study applied Granger causality tests to examine the link between competition and efficiency. The negative running causality from cost efficiency to competition was confirmed in both markets. Yet, the running causality of 'competition-cost efficiency' yielded different signs—a positive link in the U.S. and the reverse in the European

market. The study offered support to pro-competition policies by suggesting that competitive banks were able to allocate resources more efficiently to bank customers. The testimony was further confirmed in Koetter at al.'s (2008) study of the U.S. banking market between 1986 and 2005.

The majority of previous studies have focused on the link between market concentration and banking competition. Findings are mixed. Some believe that concentrated market will not necessarily lead to low competition in the market, while advocates support the conventional wisdom that the higher the market concentration, the lower the competition. As yet, empirical evidence relating to the competitiveness of the market and banking efficiency is rather scarce. Competition and efficiency are closely entwined in banking. However, many previous studies on banking competition neglected the relationship between bank competition and efficiency.

This research departs from the foregoing studies by investigating the nexus between efficiency and competition with respect to cost efficiency and profit efficiency. Apart from that, there are no known studies that have investigated the relationship between competition and efficiency within the Southeast Asian banking industry.

3. DATA AND METHODOLOGY

3.1. Data Collection

This research sample covers 1,541 observations. The largest number of banks covered by the study comes from Indonesia (520), followed by Malaysia (321), the Philippines (320), Thailand (257), and Singapore (123). To maintain consistency across countries, the analysis included only commercial banks. All financial variables reported are in nominal values (million US dollar) to facilitate comparison over time. All the variables are transformed into their real values using each country's price deflator and 2000 as the base year.

3.2. Input and Output Variables

The definition and measurement of input and output in banking function remains a contentious issue among researchers. In the banking theory literature, there are two main approaches competing with each other in this regard: the production and intermediation approaches (Sealey and Lindley 1977). Based on the production approach, a financial institution is defined as a producer of services for account holders; it performs transactions on deposit accounts and process documents such as loans. The intermediation approach, on the

other hand, assumes that financial firms act as an intermediary between savers and borrowers and deems total loans and securities as outputs, whereas deposits along with labor and physical capital are seen as inputs. The input price variables—i.e., the price of labor (the ratio of total personnel expenses to total assets), the price of capital (the ratio of non-interest expenses to fixed assets), and the price of deposit—are calculated as the ratio of interest expenses to total deposits.

This research covers the period 1996-2011 and focuses on commercial banks in the banking sector in selected Southeast Asian countries. The bank-level data used were taken from BankScope spreadsheets published by Bureau Van Dijk (BVD), which publishes corporate information and business intelligence reports. All financial variables reported are in nominal values of US dollar (million) to facilitate comparison over time; all the variables are deflated by the consumer price index to obtain real values, with 2000 as the base year.

3.3. Methodology

3.3.1. Measuring Efficiency

The main nonparametric method, DEA, was introduced by Charnes et al. (1978) and is an analytical tool used to measure relative efficiency of firms throughout the process of transforming inputs into outputs. The following presents two types of envelopment surfaces, referred to as the constant returns to scale (CRS) and variable returns to scale (VRS) models. The DEA procedures are adopted from Coelli et al. (2000).

DEA efficiency score is obtained by taking the maximum ratio of weighted outputs to weighted inputs. This measurement allows multiple outputs and inputs to be reduced to single "virtual" input (x_i) and single "virtual" output (y_i) by optimal weighs.

$$\begin{aligned} &\max_{u,v} && (u' y_i / v' x_i) \\ &\text{subject to (s.t.)} && u' y_j / v' x_j \leq 1 \qquad j = 1, 2, \ldots, n \\ & && u, v \geq 0, \end{aligned} \tag{1}$$

The vectors x_i and y_i indicate the $K \times N$ inputs matrix and $K \times M$ outputs matrix for ith decisionmaking units (DMUs), respectively. In addition, the vector represents the ratio of all outputs over all inputs, where u is an $M \times 1$ vector of output weighs and v is a $K \times 1$ vector of

input weighs. The efficiency for the *i*th DMU is maximized by finding values for *u* and *v*; next, a constant constraint is imposed on Equation (1).

$$\begin{aligned} &\max_{u,v} && (\mu' y_i), \\ &\text{s.t.} && \rho' x_i = 1 \\ & && \mu' y_j - \rho' x_j \leq 0 \qquad j = 1, 2, \ldots, n \\ & && \mu, \rho \geq 0, \end{aligned} \tag{2}$$

The efficiency measure is thus a function of multipliers of the "virtual" input-output combination, as in Equation (2). The notations and indicate the transformation of *u* and *v*. The envelopment form is seen below as:

$$\begin{aligned} &\min_{\theta,\lambda} && \theta, \\ &\text{s.t.} && -y_i + Y\lambda \geq 0, \\ & && \theta x_i - X\lambda \geq 0 \\ & && \lambda \geq 0, \end{aligned} \tag{3}$$

where is a scalar and is an *N 1* vector of constants. The value of is the efficiency score for the *i*th DMU, and it should be solved *n* times. If the value is equal to 1, the particular DMU is technically efficient.

By relaxing the constant returns-to-scale assumption (Banker et al. 1984), the efficiency is assessed on the assumption of variable returns to scale; the convexity constraint is applied to Equation (3).

$$\begin{aligned} &\min_{\theta,\lambda} && \theta, \\ &\text{s.t.} && -y_i + Y\lambda \geq 0, \\ & && \theta x_i - X\lambda \geq 0 \\ & && N1'\lambda = 1 \\ & && \lambda \geq 0, \end{aligned} \tag{4}$$

To account for allocative efficiency, the vector of input prices w_i is inserted in Equation (4), as shown below:

$$\begin{aligned} &\min_{\lambda,xi^*} && w_i' x_i^*, \\ &\text{s.t.} && -y_i + Y\lambda \geq 0, \\ & && x_i^* - X\lambda \geq 0, \\ & && N1'\lambda = 1, \end{aligned} \tag{5}$$

$$\lambda \qquad \geq \quad 0,$$

where is the cost-minimizing vector of input quantities for the *i*th DMU, given the input prices w_i and the output levels y_i. The total cost efficiency or overall efficiency of the *i*th DMU is calculated as:

$$CE= \frac{w_i' x_i^*}{w_i' x_i} \qquad (6)$$

3.3.2. Measuring Market Structure

To measure market share in an industry, a market concentration ratio is used. Specifically, this study employs a bank concentration index of the highest two (CR_2), three (CR_3) and four (CR_4) banks' total assets, total deposits, and total loans. CR_k is computed as the sum of the *k* largest firms' market shares in the market, which takes the following form:

$$CR_k = \sum_i^k s_i \qquad (7)$$

As market concentration signals market behavior that is determined by a small number of large firms, the index ignores the competitive behavior of smaller-sized firms that may influence the overall market behavior. Thus, the Herfindahl–Hirschman Index (HHI) is utilized to capture the general features of market structure. HHI includes information on the distribution of market shares as well as the number of firms in the industry.[5]

HHI refers to the sum of the squared market shares of all banks in the market, where the market shares are considered weights. The formula is as follows:

$$HHI = \sum_i^n s_i^2 \qquad (8)$$

where s_i^2 the sum of squared market shares of the *i*th individual firm and *n* is the number of firms in the market.

3.3.3. Measuring Market Competition

[5] Please read Bikker and Haaf (2002) for a full understanding of the comprehensive merits and demerits of both CR_k and HHI.

The Lerner index of monopoly power is a nonstructural indicator of the degree of market competition developed in the context of industrial economics. The computation of the index, which provides measures of competition at the firm level, allows the investigation of the causality between efficiency and competition at the firm level to be carried out. The Lerner index has been computed in several empirical studies on banking competition (e.g., Angelini and Cetorelli 2003; Maudos and Fernández de Guevara 2007; Fernández de Guevara et al. 2005.). It is defined as the difference between price (calculated as the ratio of total costs to total assets) and marginal cost (expressed as a percentage of prices) divided by price.

The Lerner index measures the degree to which firms can mark up output prices over the marginal cost of production. It can be approximated empirically using the translog functional form with three inputs and a single bank output (Shaffer 1993; and Berg and Kim 1994). It is assumed that the flow of goods and services by banks is proportional to its assets; the price of assets is computed as total interest income divided by total assets. To derive the marginal cost, a translog cost function with one output and three input prices was estimated. Cost functions were derived based on three subperiods to allow coefficients of the cost function to evolve over these periods.

The econometric model is applied to a pooled sample of banks to evaluate the competitive structure, as the heterogeneity is controlled in the domestic banking industry. Standard symmetry restrictions of linear homogeneity in input prices are imposed by normalizing total costs and input prices by one input price (P_D) to correct for heteroskedasticity and scale biases. The cost function adopted from Pruteanu-Podpiera, Weil and Schobert (2008) is specified as follows:

$$ln\left(\frac{TC}{P_D}\right) = \alpha_0 + \alpha_1 ln\, Q + \frac{1}{2}\alpha_2 (ln\, Q)^2 + \alpha_3 ln\left(\frac{P_L}{P_D}\right) + \alpha_4\, ln\left(\frac{P_K}{P_D}\right) + \alpha_5\, ln\left(\frac{P_L}{P_D}\right) * \ln\left(\frac{P_K}{P_D}\right)$$
$$+ \frac{1}{2}\alpha_6 \left(ln\left(\frac{P_L}{P_D}\right)\right)^2 + \frac{1}{2}\alpha_7 \left(ln\left(\frac{P_L}{P_D}\right)\right)^2 + \alpha_8 lnQ\, ln\left(\frac{P_L}{P_D}\right) + \alpha_9 lnQ\, ln\left(\frac{P_K}{P_D}\right) + \varepsilon \qquad (9)$$

Bank costs (*TC*) are functioned to output or total assets (*Q*), the input prices, which are P_L as the price of labor, P_K as the price of physical capital, and P_D as the price of borrowed funds; while *= 1, 2, ..., 9* are parameters to be estimated, and is the error term. Indices for each bank have been dropped in the presentation for simplicity. Once the parameters are estimated, the marginal cost of banking can be computed. The cost function is estimated using a common frontier and allows the derivation of marginal costs (*MC*), as in Equation (10). The formula for Lerner index is as shown in Equation (11):

$$MC_{it} = \frac{TC_{it}}{Q_{it}} \left(\alpha_1 + \alpha_2 \ln Q_{it} + \alpha_3 \ln Q_{it} + \alpha_{24} \ln Q_{it} + \varepsilon_{it}\right) \quad (10)$$

$$LI = \frac{p_i - MC_{it}}{p_i} \quad (11)$$

where p_i is the price of production output Q total assets and is calculated as total revenue (interest plus non-interest income) divided by total assets. *LI* stands for Lerner index, *LI = 0* indicates perfect competition, so firm has no market power, while *LI*, being closer to 1, indicates relatively weak price competition, which means the firm has market power.

3.3.4. Testing the Relationship between Efficiency and Competition

The standard procedure for Granger causality test is as follows:

$$y_{it} = \alpha_0 + \sum_{l=1}^{m} \alpha_l^y y_{it-l} + \sum_{l=1}^{m} \delta_l^y x_{it-l} + f_i^y + u_{it}^y \quad (12)$$

$$x_{it} = \beta_0 + \sum_{l=1}^{m} \alpha_l^x x_{it-l} + \sum_{l=1}^{m} \delta_l^y y_{it-l} + f_i^x + u_{it}^x \quad (13)$$

where *y* represents efficiency, *x* competition, and *f* the bank's individual effect. Moreover, *i* and *t* represent indices for the bank and the time period involved, respectively. The error terms in Equations (12) and (13) are assumed to be normally distributed, with mean zero and constant variance. Each dependent variable is regressed on its yearly lags and on those of the other variable.

The dependent variable in Equation (12) is the estimated efficiency scores, or the efficiency scores of bank *i* relative to its peers in year *t*, or how close the bank is to the estimated industry-wide best practice cost frontier in a particular year. The second dependent variable in Equation (13) measures the competition indexes of the individual firms. The right-hand side variables include lagged values of the dependent variables *y* (efficiency) and *x* (competition) as a standard procedure for Granger-causality models.

4. RESULTS AND DISCUSSION

This research focuses on commercial banks in five countries in Southeast Asia, namely, Indonesia, Malaysia, Philippines, Singapore, and Thailand. The bank data used were extracted from BankScope spreadsheets published by Bureau Van Dijk database and covered the period 1996-2011. The bank data included unbalanced panel data on individual commercial banks in Southeast Asia. Thus, investment banks, savings banks, and Islamic

banks were excluded. All financial variables are reported in US$. To facilitate a comparison over time, the consumer price index was used to deflate all variables to obtain their values using 2000 as base year. [6]

Input variables consist of total personnel expenses (i.e., total expenditure on employees such as salaries, employee benefits, and reserves for retirement pay), total fixed assets (i.e., the book value of premises and fixed assets), and total deposits (including short-term funding), while security portfolios, total loans and advances, and off-balance sheet items represent the output variables. Total personnel expenses variable is a proxy for labor input, while the total fixed assets are a proxy for capital input. Input prices are calculated as price of labor (i.e., total personnel expenses divided by total assets), price of capital (i.e., other non-interest expenses divided by total fixed assets), and price of deposits (i.e., total interest expenses divided by total deposits and short-term funding).

Table 1. Market Share in Southeast Asia Banking (million USD)

COUNTRY		TOTAL ASSETS	TOTAL LOANS	TOTAL DEPOSITS
Indonesia	Mean	4, 017.28	1, 961.18	3, 209.41
	Min	27.43	1.25	2.17
	Max	60, 861.46	33, 327.37	48, 162.20
Malaysia	Mean	9, 883.03	5, 898.31	8, 260.31
	Min	13.28	4.34	5, 002.63
	Max	136, 387.59	84, 084.22	107, 322.33
Philippines	Mean	3, 307.98	1, 425.35	2, 688.77
	Min	47.59	7.67	53.02
	Max	24, 980.63	14, 701.06	20, 518.49
Singapore	Mean	36, 043.66	17, 684.21	26, 662.37
	Min	137.60	28.88	33.06
	Max	262, 062.00	149, 361.90	200, 578.10
Thailand	Mean	12, 849.37	8, 811.48	10, 652.55
	Min	18.81	3.33	2.84

[6] The consumer price index was the preferable deflator for studies in the banking sector (Khumbakar et al. 2001, Dogan and Fausten 2003, and Detragiache and Gupta 2004). According to Okuda and Hashimoto (2004) when using panel data, it is necessary to use a deflator to keep output from various years comparable.

	Max	66, 482.56	43, 855.11	55, 227.51
Min		13.28	1.25	2.17
Max		262, 062.00	149, 361.90	200, 578.10

Table 1 shows that the Singapore banking market had the largest share in total assets (US$36,043 million), total loans (US$17,684 million), and total deposits (US$26, 662 million). Singapore's banking sector also recorded the highest total assets (US$262,062 million) as well as total loans (US$149,361 millions) and total deposits (US$200,578). The Thai banking sector had the second largest market share in terms of total assets (US$12,849), total loans (US$8, 811), and total deposits ($US10, 652).

4.1. Banking Efficiency in Southeast Asia

This section shows the banking efficiency performance in five Southeast Asian countries. Table 2 shows the yearly and average levels of efficiency during the period 1996-2011 across all commercial banks in these countries. Essentially, five types of efficiencies are generated, namely, the overall cost efficiency and its decomposition, technical efficiency, pure technical efficiency, scale efficiency, and allocative efficiency. The DEA constant returns-to-scale model yields technical efficiency scores, while pure technical efficiency is generated by the DEA variable returns-to-scale model. Additionally, scale efficiency is the ratio of technical efficiency to pure technical efficiency.

Table 2. Summary of Efficiency Scores (1996-2011)

Year	TE	PTE	SE	CE	AE
1996	0.6281	0.7663	0.8395	0.7627	0.8431
1997	0.6043	0.6723	0.9045	0.6686	0.9079
1998	0.6013	0.6712	0.9075	0.6600	0.9160
1999	0.6555	0.7159	0.9137	0.7067	0.9246
2000	0.6368	0.6892	0.9296	0.6593	0.9620
2001	0.6371	0.6795	0.9395	0.6503	0.9782
2002	0.6742	0.7281	0.9281	0.6853	0.9832
2003	0.6838	0.7642	0.9004	0.7120	0.9607

2004	0.6467	0.7453	0.8739	0.6983	0.9247
2005	0.6856	0.7731	0.8840	0.7385	0.9234
2006	0.6594	0.7486	0.8822	0.7272	0.9045
2007	0.6170	0.7385	0.8458	0.7000	0.8879
2008	0.5967	0.7256	0.8263	0.6803	0.8885
2009	0.6166	0.7538	0.8248	0.6983	0.8909
2010	0.6589	0.8461	0.7846	0.7744	0.8583
2011	0.6468	0.8492	0.7758	0.7939	0.8346
Mean	0.6405	0.7417	0.8725	0.7072	0.9118

In Table 2, TE represents technical efficiency, PTE and SE stand for pure technical efficiency and scale efficiency, respectively, CE refers to cost efficiency, and AE is allocative efficiency. Table 2 shows that the highest efficiency scores are seen in allocative efficiency (82 percent), followed by scale efficiency (78 percent), and pure technical efficiency (67 percent) categories. Cost efficiency (64 percent) and technical efficiency (52 percent) are fourth and fifth, respectively. The results are presented graphically in Figure 1.

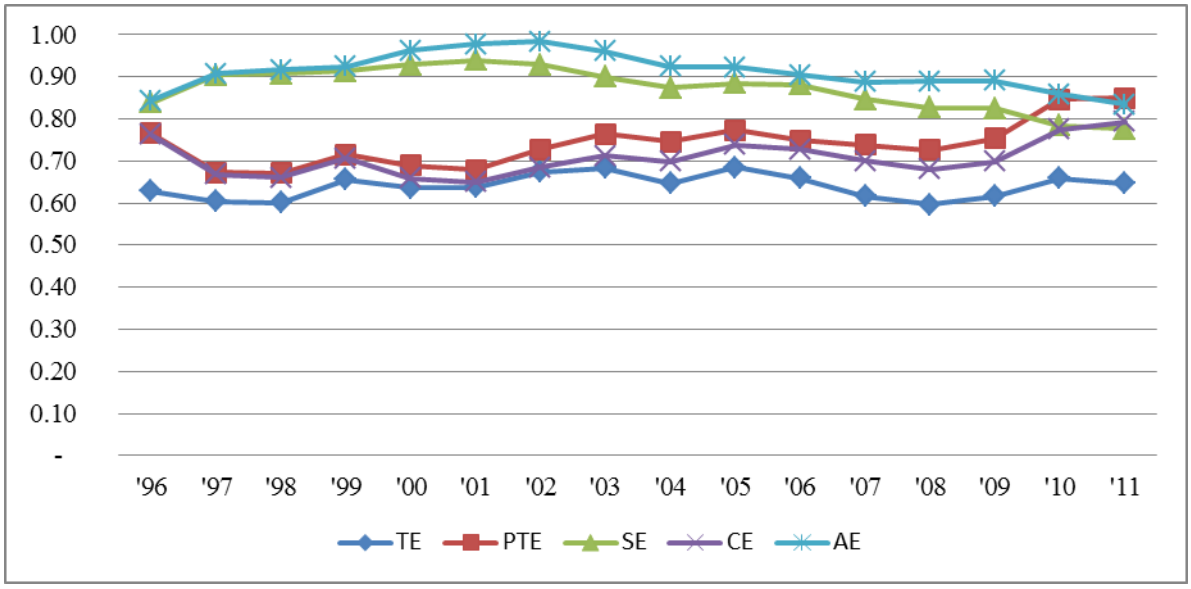


Figure 1. Efficiency scores with respect to five types of efficiencies

Figure 1 presents the trend in efficiency scores covering the period 1996-2011. Basically, all types of efficiencies show a mixed trend. For instance, technical efficiency

performance declined between 1996 and 1998, and from 1999 to 2001. However, the efficiency scores registered an increase from 2001 to 2003 as well as from 2008 to 2010, but declined in 2011. The same pattern of steady increase followed by a decline applied to pure technical efficiency and cost efficiency. However, other types of efficiency, namely. Scale efficiency and allocative efficiency, showed a different trend. From 1996 to 2002, scale efficiency and allocative efficiency registered an increasing trend. However, from 2003 onwards, both types of efficiency followed a declining trend.

Table 3 and Figure 2 present the mean efficiency scores of commercial banks in selected five Southeast Asian countries, namely, Indonesia, Malaysia, Philippines, Singapore, and Thailand.

Table 3. Summary of Bank Efficiency Scores by Country (1996-2011)

Country	TE	PTE	SE	CE	AE
Indonesia	0.3141	0.4694	0.7207	0.4478	0.7482
Malaysia	0.5977	0.7627	0.8036	0.7263	0.8394
Philippines	0.6641	0.7947	0.8261	0.7727	0.8552
Singapore	0.4881	0.8237	0.6064	0.7605	0.6789
Thailand	0.6406	0.7445	0.8693	0.70874	0.9101

The results in Table 3 above illustrate that the overall cost efficiency (77 percent) of all commercial banks in Philippines over the period 1996-2011 was relatively higher than those of other countries, with the major source of cost efficiency coming from allocative efficiency (86 percent) and technical efficiency (66 percent).

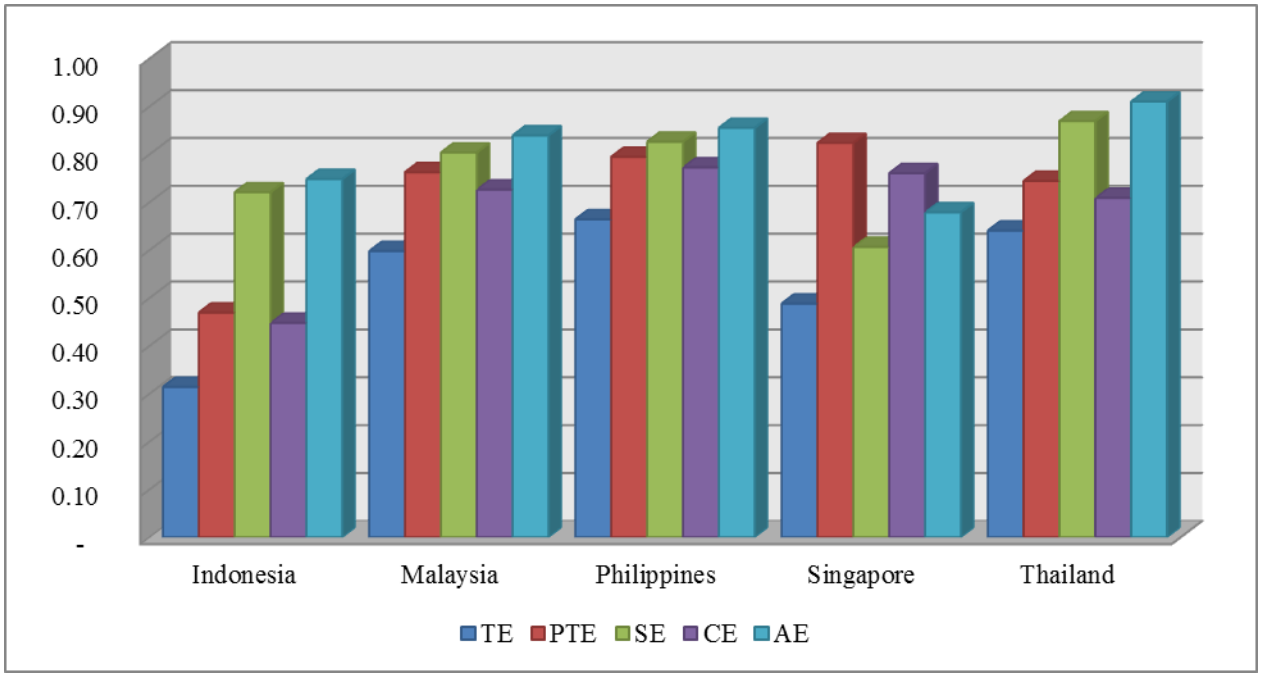


Figure 2a. Types of efficiency scores with respect to countries

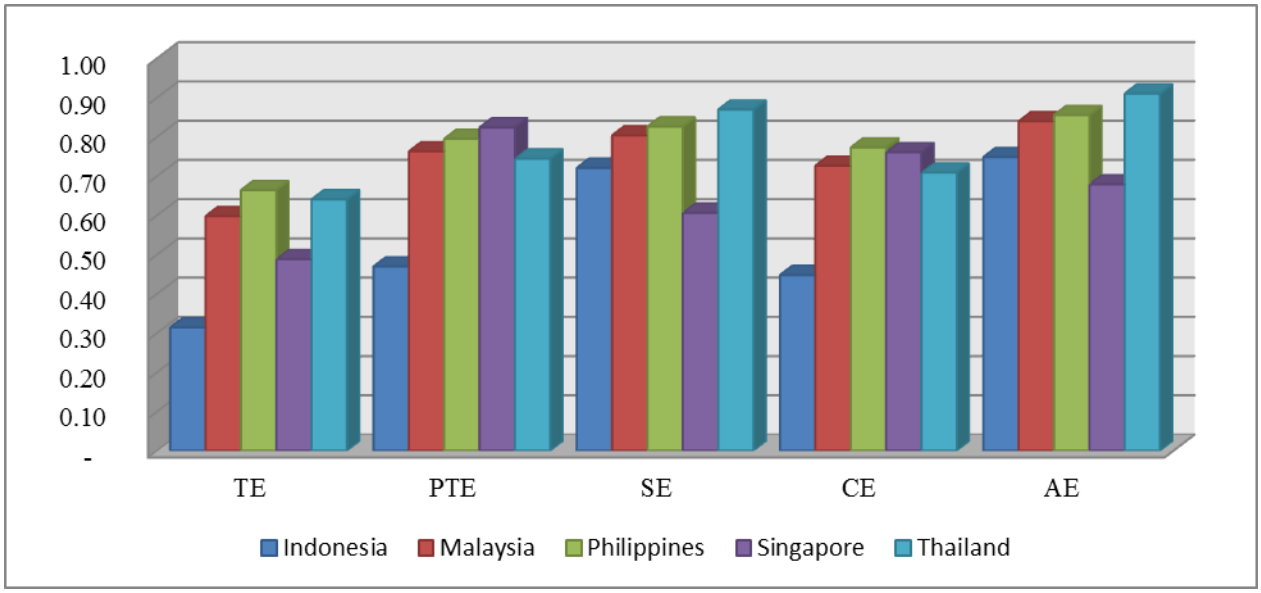


Figure 2b. Efficiency scores by country

From a quick glance at Figure 2a, the Thai banking sector led in terms of overall efficiency performance. The Philippine and Malaysian banking markets placed second and third, respectively, followed by Singapore and Indonesia. Figure 2b shows the Thai banking sector's average scores for scale efficiency (86 percent) and allocative efficiency (91 percent) were the highest relative to its counterparts. Meanwhile, Philippine banks dominated two

types of efficiency, technical efficiency (66 percent) and cost efficiency (77 percent). The average pure technical efficiency scores were highest (82 percent) in Singapore.

The discussion of efficiency performance for commercial banks in Southeast Asian banking markets is carried out based on the results presented in Table 4, which shows the mean efficiency scores across five types of efficiency among with respect to the five banking markets.

Table 4a. Summary of Bank Efficiency Scores in Indonesia (1996-2011)

Year	TE	PTE	SE	CE	AE
1996	0.4027	0.6334	0.6978	0.5858	0.7265
1997	0.4339	0.6374	0.7261	0.6002	0.7690
1998	0.3859	0.4892	0.7830	0.4616	0.8423
1999	0.4000	0.4627	0.8301	0.4442	0.8828
2000	0.4003	0.4517	0.8523	0.4368	0.8950
2001	0.3378	0.4107	0.8036	0.3877	0.8640
2002	0.3014	0.3806	0.8174	0.3626	0.8465
2003	0.2975	0.3848	0.8021	0.3757	0.8244
2004	0.2960	0.4238	0.7758	0.3993	0.7806
2005	0.2842	0.4145	0.7307	0.3997	0.7607
2006	0.2755	0.4199	0.7183	0.4083	0.7334
2007	0.2576	0.4383	0.6802	0.4283	0.6797
2008	0.2679	0.4773	0.6462	0.4563	0.6664
2009	0.2667	0.4954	0.6151	0.4786	0.6307
2010	0.2514	0.5141	0.5693	0.4863	0.5822
2011	0.2640	0.5657	0.5303	0.5297	0.5535
Mean	0.3202	0.4750	0.7236	0.4526	0.7524

Table 4b. Summary Statistics of Efficiency Scores of Malaysian Banks (1996-2011)

Year	TE	PTE	SE	CE	AE
1996	0.6403	0.7596	0.8541	0.7347	0.8791
1997	0.6008	0.7028	0.8679	0.6811	0.8912
1998	0.6440	0.7587	0.8596	0.7389	0.8792
1999	0.6129	0.7422	0.8431	0.6950	0.8864
2000	0.6034	0.7463	0.8257	0.7106	0.8582
2001	0.6264	0.7630	0.8361	0.7503	0.8475
2002	0.6464	0.8092	0.8172	0.7835	0.8403

2003	0.6089	0.7823	0.8030	0.7395	0.8421
2004	0.6164	0.7753	0.8138	0.7448	0.8443
2005	0.5910	0.7658	0.7898	0.7243	0.8306
2006	0.5893	0.7708	0.7816	0.7267	0.8260
2007	0.5619	0.7408	0.7710	0.6933	0.8201
2008	0.5879	0.7868	0.7684	0.7429	0.8081
2009	0.5635	0.7718	0.7524	0.7190	0.8059
2010	0.5404	0.7519	0.7524	0.7043	0.8052
2011	0.5458	0.7652	0.7524	0.7271	0.7888
Mean	0.5987	0.7620	0.8055	0.7260	0.8408

Table 4c. Summary of Bank Efficiency Scores in the Philippines (1996-2011)

Year	TE	PTE	SE	CE	AE
1996	0.7636	0.9050	0.8215	0.8738	0.8581
1997	0.7627	0.8740	0.8491	0.8471	0.8833
1998	0.6814	0.8231	0.8149	0.7742	0.8745
1999	0.6623	0.7938	0.8165	0.7583	0.8605
2000	0.6707	0.7933	0.8298	0.7645	0.8670
2001	0.6686	0.7763	0.8463	0.7595	0.8752
2002	0.6629	0.7789	0.8407	0.7605	0.8698
2003	0.6605	0.7772	0.8372	0.7588	0.8673
2004	0.6822	0.8149	0.8283	0.7957	0.8573
2005	0.6550	0.7779	0.8300	0.7662	0.8584
2006	0.6040	0.7299	0.8205	0.7148	0.8543
2007	0.6256	0.7571	0.8169	0.7405	0.8469
2008	0.6869	0.8121	0.8337	0.7926	0.8600
2009	0.6350	0.7788	0.8177	0.7607	0.8309
2010	0.6267	0.7876	0.8037	0.7683	0.8120
2011	0.6203	0.7766	0.8145	0.7630	0.8162
Mean	0.6668	0.7973	0.8263	0.7749	0.8557

Table 4d. Summary of Bank Efficiency Scores in Singapore (1996-2011)

Year	TE	PTE	SE	CE	AE
1996	0.3039	0.6534	0.5280	0.5586	0.6573
1997	0.3416	0.7226	0.5275	0.6293	0.6486
1998	0.4737	0.7569	0.6447	0.6788	0.7527
1999	0.4424	0.7166	0.6106	0.6781	0.6446

2000	0.4636	0.7365	0.6056	0.7131	0.6276
2001	0.4402	0.7210	0.6594	0.6725	0.6868
2002	0.5134	0.8537	0.6162	0.8000	0.6695
2003	0.5648	0.9285	0.6107	0.9000	0.6417
2004	0.5408	0.8854	0.6176	0.8600	0.6521
2005	0.5178	0.8844	0.5865	0.8371	0.6480
2006	0.5347	0.8799	0.6184	0.8200	0.6862
2007	0.5492	0.8696	0.6426	0.8225	0.7065
2008	0.5036	0.8640	0.5977	0.7775	0.7040
2009	0.5168	0.8700	0.6022	0.7688	0.7187
2010	0.4973	0.8487	0.6214	0.7606	0.7170
2011	0.5873	0.9909	0.5909	0.8886	0.6878
Mean	0.4869	0.8239	0.6050	0.7603	0.6781

Table 4e. Summary of Efficiency Scores in Thailand (1996-2011)

Year	TE	PTE	SE	CE	AE
1996	0.6281	0.7663	0.8395	0.7627	0.8431
1997	0.6043	0.6723	0.9045	0.6686	0.9079
1998	0.6013	0.6712	0.9075	0.6600	0.9160
1999	0.6555	0.7159	0.9137	0.7067	0.9246
2000	0.6368	0.6892	0.9296	0.6593	0.9620
2001	0.6371	0.6795	0.9395	0.6503	0.9782
2002	0.6742	0.7281	0.9281	0.6853	0.9832
2003	0.6838	0.7642	0.9004	0.7120	0.9607
2004	0.6467	0.7453	0.8739	0.6983	0.9247
2005	0.6856	0.7731	0.8840	0.7385	0.9234
2006	0.6594	0.7486	0.8822	0.7272	0.9045
2007	0.6170	0.7385	0.8458	0.7000	0.8879
2008	0.5967	0.7256	0.8263	0.6803	0.8885
2009	0.6166	0.7538	0.8248	0.6983	0.8909
2010	0.6589	0.8461	0.7846	0.7744	0.8583
2011	0.6468	0.8492	0.7758	0.7939	0.8346
Mean	0.6406	0.7417	0.8725	0.7072	0.9118

The results presented in Table 4as and 4e are illustrated graphically in Figures 3a to 3e.

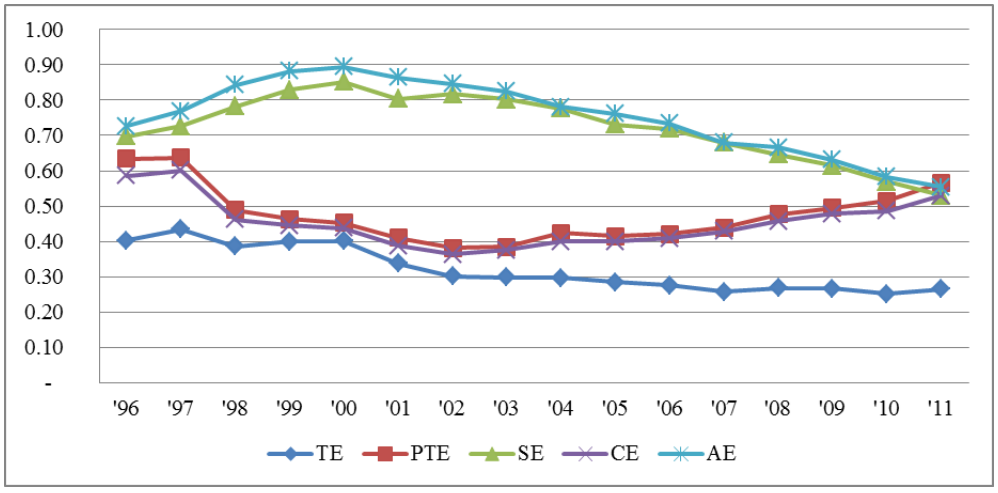


Figure 3a. Trend in bank efficiency scores in Indonesia

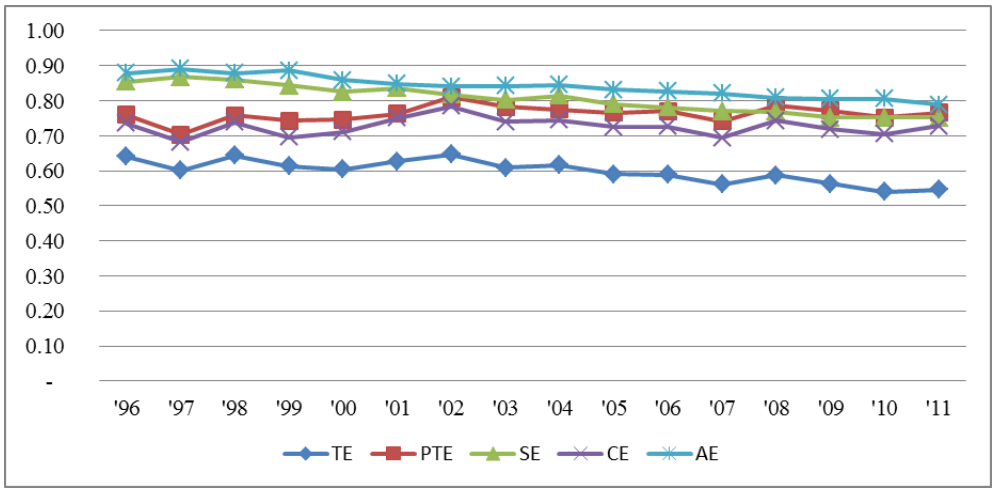


Figure 3b. Trend in bank efficiency scores in Malaysia

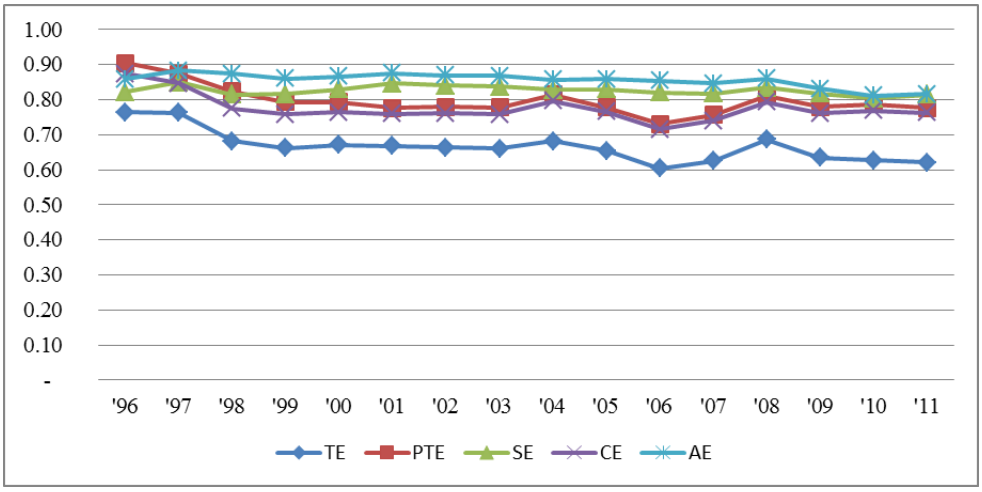


Figure 3c. Trend in bank efficiency scores in the Philippines

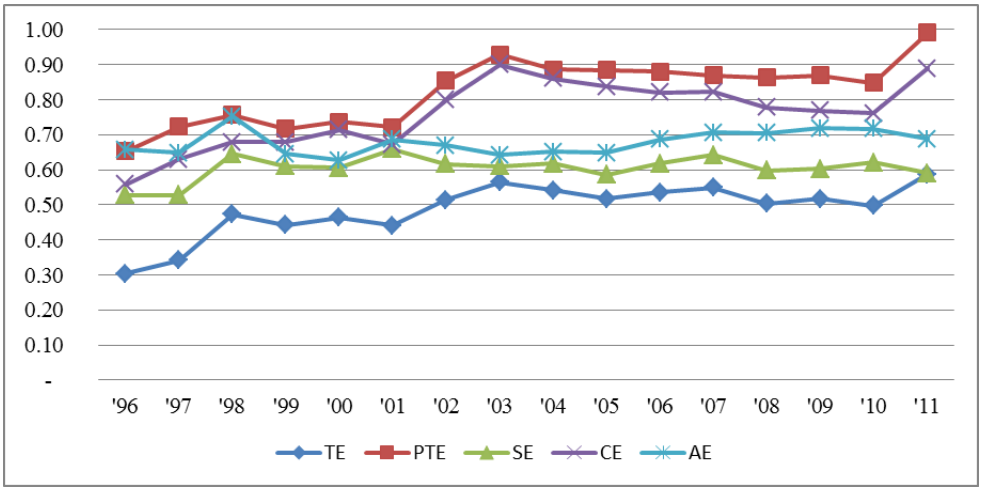
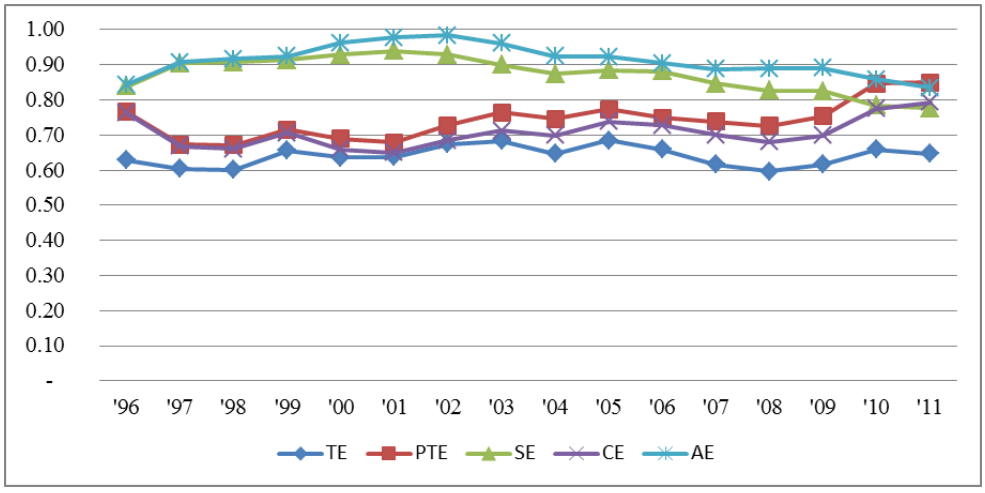


Figure 3d. Trend in bank efficiency scores in Singapore



1. *Figure 3e. Trend in bank efficiency scores in Thailand*

4.2. Bank Market Structure in Southeast Asia

This study employs a widely used bank concentration index—a two-bank concentration ratio (CR_2), three-bank concentration ratio (CR_3), and four-bank concentration ratio (CR_4) as well as Hirschman-Herfindahl Index (HHI) vis-à-vis total assets, total deposits, and total loans. Market concentration indices corresponding to the five Southeast Asian countries and which are based on CR and HHI during the period 1996-2011 are shown in Table 5.

Table 5. Bank Market Concentration in Southeast Asia (1996-2011)

Year	Total Assets				Total Deposits				Total Loans			
	CR_2	CR_3	CR_4	HHI	CR_2	CR_3	CR_4	HHI	CR_2	CR_3	CR_4	HHI
1996	0.48	0.56	0.63	1,669.21	0.45	0.53	0.60	1,592.97	0.48	0.57	0.64	1,655.95
1997	0.51	0.60	0.66	2,044.18	0.50	0.59	0.65	1,981.35	0.52	0.61	0.67	2,072.63
1998	0.43	0.54	0.61	1,450.74	0.44	0.53	0.60	1,524.60	0.43	0.53	0.61	1,444.68
1999	0.42	0.54	0.64	1,370.84	0.43	0.55	0.63	1,439.06	0.42	0.54	0.64	1,360.36
2000	0.41	0.52	0.62	1,345.09	0.42	0.54	0.63	1,419.04	0.41	0.51	0.61	1,328.96
2001	0.40	0.51	0.61	1,336.25	0.42	0.53	0.63	1,396.71	0.41	0.52	0.61	1,372.65
2002	0.40	0.52	0.61	1,319.55	0.41	0.52	0.62	1,340.59	0.40	0.52	0.61	1,318.01
2003	0.37	0.47	0.57	1,163.16	0.37	0.49	0.59	1,215.84	0.36	0.46	0.56	1,156.99
2004	0.37	0.48	0.58	1,161.27	0.38	0.50	0.60	1,216.60	0.37	0.47	0.58	1,154.81
2005	0.36	0.47	0.58	1,126.86	0.38	0.49	0.59	1,190.79	0.36	0.47	0.57	1,114.28
2006	0.37	0.50	0.60	1,149.46	0.38	0.52	0.61	1,201.72	0.37	0.50	0.60	1,140.57
2007	0.38	0.52	0.60	1,169.77	0.39	0.53	0.61	1,229.23	0.38	0.51	0.60	1,157.48
2008	0.39	0.52	0.60	1,194.45	0.41	0.54	0.63	1,289.31	0.39	0.52	0.60	1,190.35
2009	0.39	0.54	0.62	1,229.68	0.41	0.56	0.65	1,306.87	0.39	0.53	0.62	1,207.07
2010	0.37	0.51	0.62	1,188.27	0.39	0.52	0.62	1,225.54	0.37	0.51	0.61	1,175.54
2011	0.41	0.51	0.60	1,284.44	0.42	0.52	0.61	1,343.32	0.39	0.52	0.62	1,240.73

The five banking markets are considered moderately concentrated, with HHI scores ranging from 1,126 to 2,072 relative to total assets, total loans, and total deposits (Table 5). In 1997, the HHI scores were highest across all categories—total assets (2,044), total deposits (1,981), and total loans (2,072). After 1997 and onwards, the HHI estimates were found to have declined. For instance, the HHI scores based on total assets decreased to 1,450 (from 2,044 in 1997), which were reinforced by a decline in the HHI of total loans in year 1998 to 1,444 from 2,072 in 1997. This pattern could be attributed to the immediate banking reforms implemented by the local authorities in the five banking markets to cushion the impacts of the economic crisis in late 1997. Figure 4 further illustrates the market concentration in the five Southeast Asian banking sectors.

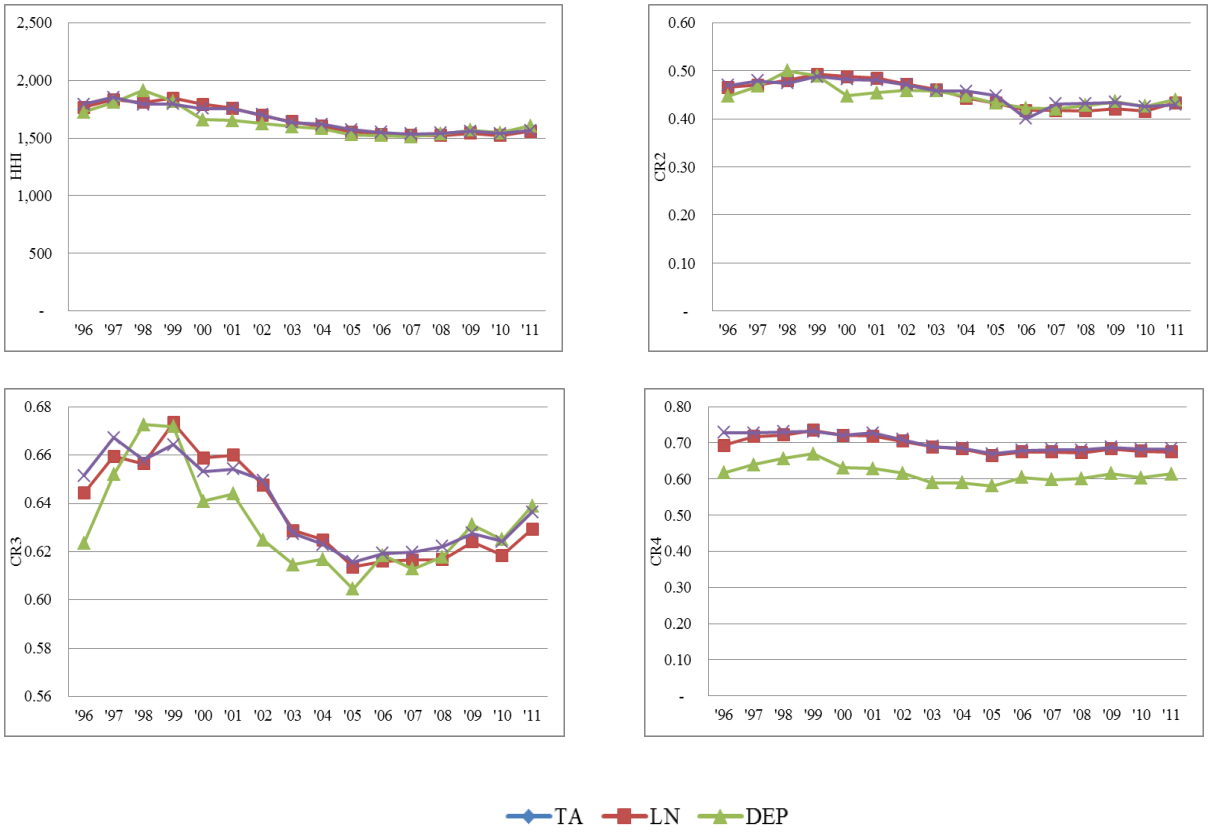


Figure 4. Banking market structure in Southeast Asia (1996-2011)

Bank market structure data with respect to the five Southeast Asian banking markets are presented in Tables 6a to 6e. The findings are illustrated graphically in Figures 5a to 5e.

Table 6a. Bank Market Concentration in Indonesia (1996-2011)

Year	Total Assets				Total Deposits				Total Loans			
	CR_2	CR_3	CR_4	HHI	CR_2	CR_3	CR_4	HHI	CR_2	CR_3	CR_4	HHI
1996	0.39	0.55	0.67	1,338.07	0.37	0.52	0.66	1,306.67	0.41	0.56	0.69	1,449.26
1997	0.40	0.59	0.69	1,397.15	0.40	0.59	0.70	1,426.79	0.44	0.62	0.70	1,530.89
1998	0.49	0.65	0.74	1,698.32	0.57	0.72	0.78	2,178.85	0.46	0.66	0.76	1,637.70
1999	0.51	0.67	0.77	1,952.83	0.50	0.66	0.76	1,837.75	0.49	0.65	0.73	1,716.66
2000	0.50	0.63	0.72	1,771.87	0.38	0.55	0.66	1,236.58	0.46	0.62	0.72	1,611.67
2001	0.49	0.63	0.69	1,677.01	0.39	0.55	0.62	1,197.06	0.45	0.59	0.70	1,548.94
2002	0.46	0.61	0.68	1,541.64	0.41	0.50	0.60	1,182.09	0.46	0.62	0.69	1,557.00
2003	0.45	0.60	0.68	1,496.65	0.41	0.51	0.60	1,185.22	0.46	0.61	0.68	1,495.36
2004	0.42	0.57	0.66	1,344.38	0.38	0.49	0.59	1,128.49	0.43	0.57	0.67	1,347.51
2005	0.38	0.52	0.62	1,194.96	0.32	0.43	0.54	956.20	0.39	0.53	0.63	1,221.10
2006	0.36	0.50	0.62	1,133.48	0.33	0.45	0.55	970.01	0.37	0.51	0.64	1,168.20
2007	0.35	0.49	0.61	1,101.79	0.31	0.43	0.54	932.16	0.37	0.50	0.63	1,143.89
2008	0.34	0.48	0.60	1,069.06	0.32	0.44	0.55	943.77	0.36	0.50	0.62	1,116.37
2009	0.36	0.50	0.61	1,093.30	0.35	0.46	0.56	991.66	0.36	0.51	0.63	1,124.20
2010	0.35	0.49	0.59	1,039.97	0.34	0.45	0.54	952.05	0.36	0.50	0.60	1,070.50
2011	0.35	0.48	0.58	1,018.76	0.33	0.45	0.54	934.99	0.35	0.49	0.60	1,043.76

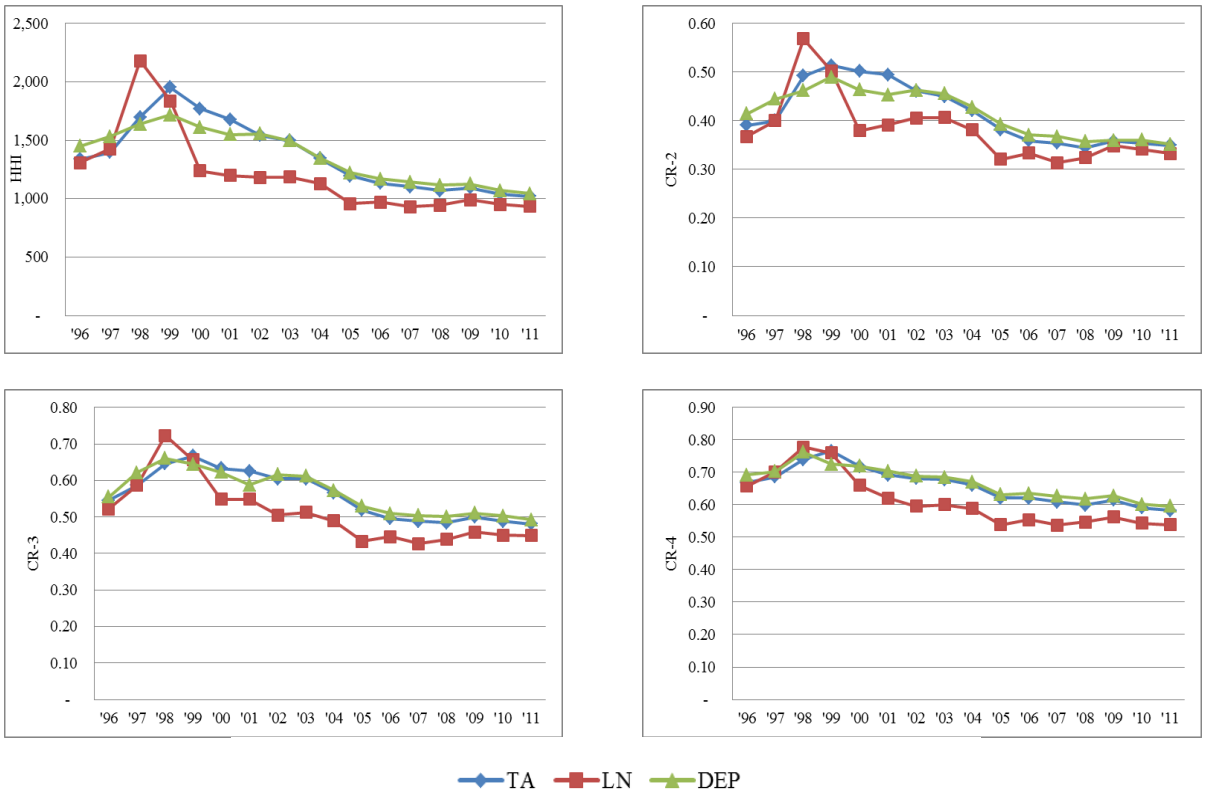


Figure 5a. Bank market structure in Indonesia (1996-2011)

Table 6b. Bank Market Concentration in Malaysia (1996-2011)

Year	Total Assets				Total Deposits				Total Loans			
	CR_2	CR_3	CR_4	HHI	CR_2	CR_3	CR_4	HHI	CR_2	CR_3	CR_4	HHI
1996	0.48	0.56	0.63	1,669.21	0.45	0.53	0.60	1,592.97	0.48	0.57	0.64	1,655.95
1997	0.51	0.60	0.66	2,044.18	0.50	0.59	0.65	1,981.35	0.52	0.61	0.67	2,072.63
1998	0.43	0.54	0.61	1,450.74	0.44	0.53	0.60	1,524.60	0.43	0.53	0.61	1,444.68
1999	0.42	0.54	0.64	1,370.84	0.43	0.55	0.63	1,439.06	0.42	0.54	0.64	1,360.36
2000	0.41	0.52	0.62	1,345.09	0.42	0.54	0.63	1,419.04	0.41	0.51	0.61	1,328.96
2001	0.40	0.51	0.61	1,336.25	0.42	0.53	0.63	1,396.71	0.41	0.52	0.61	1,372.65
2002	0.40	0.52	0.61	1,319.55	0.41	0.52	0.62	1,340.59	0.40	0.52	0.61	1,318.01
2003	0.37	0.47	0.57	1,163.16	0.37	0.49	0.59	1,215.84	0.36	0.46	0.56	1,156.99
2004	0.37	0.48	0.58	1,161.27	0.38	0.50	0.60	1,216.60	0.37	0.47	0.58	1,154.81
2005	0.36	0.47	0.58	1,126.86	0.38	0.49	0.59	1,190.79	0.36	0.47	0.57	1,114.28
2006	0.37	0.50	0.60	1,149.46	0.38	0.52	0.61	1,201.72	0.37	0.50	0.60	1,140.57
2007	0.38	0.52	0.60	1,169.77	0.39	0.53	0.61	1,229.23	0.38	0.51	0.60	1,157.48
2008	0.39	0.52	0.60	1,194.45	0.41	0.54	0.63	1,289.31	0.39	0.52	0.60	1,190.35
2009	0.39	0.54	0.62	1,229.68	0.41	0.56	0.65	1,306.87	0.39	0.53	0.62	1,207.07
2010	0.37	0.51	0.62	1,188.27	0.39	0.52	0.62	1,225.54	0.37	0.51	0.61	1,175.54
2011	0.41	0.51	0.60	1,284.44	0.42	0.52	0.61	1,343.32	0.39	0.52	0.62	1,240.73

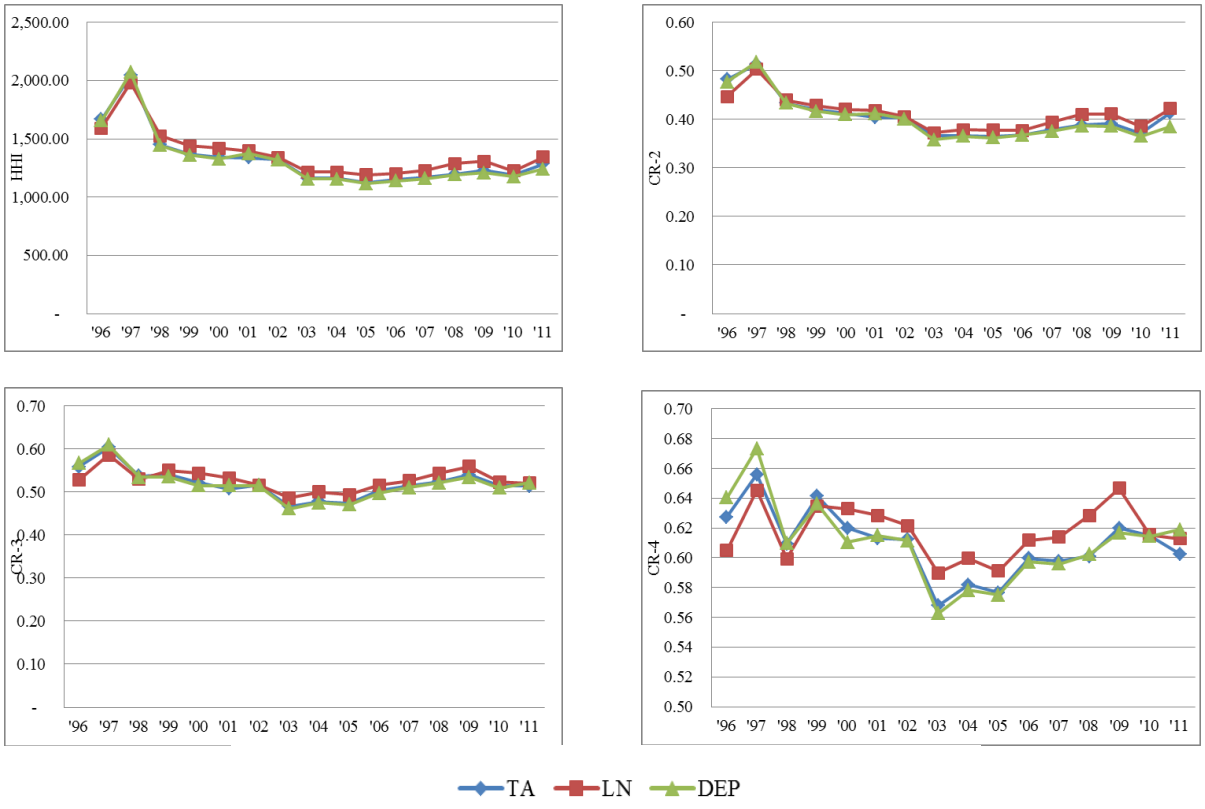


Figure 5b. Bank market structure in Malaysia (1996-2011)

Table 6c. Bank Market Concentration in the Philippines (1996-2011)

Year	Total Assets				Total Deposits				Total Loans			
	CR_2	CR_3	CR_4	HHI	CR_2	CR_3	CR_4	HHI	CR_2	CR_3	CR_4	HHI
1996	0.35	0.50	0.61	1,134.05	0.33	0.48	0.59	1,098.08	0.36	0.51	0.62	1,154.29
1997	0.34	0.48	0.58	1,074.15	0.34	0.47	0.57	1,064.44	0.35	0.48	0.59	1,090.10
1998	0.33	0.48	0.59	1,107.50	0.35	0.47	0.59	1,119.56	0.33	0.48	0.60	1,117.98
1999	0.42	0.52	0.63	1,237.89	0.41	0.51	0.61	1,230.97	0.41	0.53	0.64	1,251.86
2000	0.41	0.52	0.61	1,222.81	0.41	0.51	0.60	1,224.42	0.41	0.52	0.62	1,240.63
2001	0.43	0.55	0.64	1,320.44	0.44	0.54	0.64	1,326.25	0.43	0.55	0.65	1,351.20
2002	0.40	0.51	0.60	1,184.67	0.43	0.53	0.63	1,286.02	0.39	0.51	0.60	1,186.86
2003	0.38	0.49	0.57	1,089.22	0.41	0.52	0.58	1,213.30	0.37	0.48	0.56	1,081.38
2004	0.37	0.48	0.57	1,074.34	0.42	0.53	0.58	1,226.77	0.38	0.48	0.56	1,083.88
2005	0.38	0.49	0.57	1,103.53	0.44	0.54	0.61	1,284.37	0.40	0.50	0.58	1,148.37
2006	0.34	0.50	0.60	1,094.36	0.38	0.57	0.65	1,258.40	0.35	0.51	0.60	1,118.69
2007	0.35	0.50	0.60	1,106.96	0.38	0.56	0.64	1,244.98	0.36	0.52	0.61	1,133.49
2008	0.35	0.50	0.60	1,097.85	0.37	0.54	0.63	1,196.95	0.36	0.51	0.61	1,124.98
2009	0.35	0.49	0.60	1,087.75	0.39	0.55	0.64	1,237.98	0.35	0.51	0.60	1,105.64
2010	0.35	0.51	0.61	1,115.16	0.40	0.57	0.65	1,292.67	0.35	0.52	0.62	1,142.57
2011	0.40	0.56	0.62	1,243.52	0.45	0.62	0.69	1,492.77	0.40	0.57	0.63	1,274.47

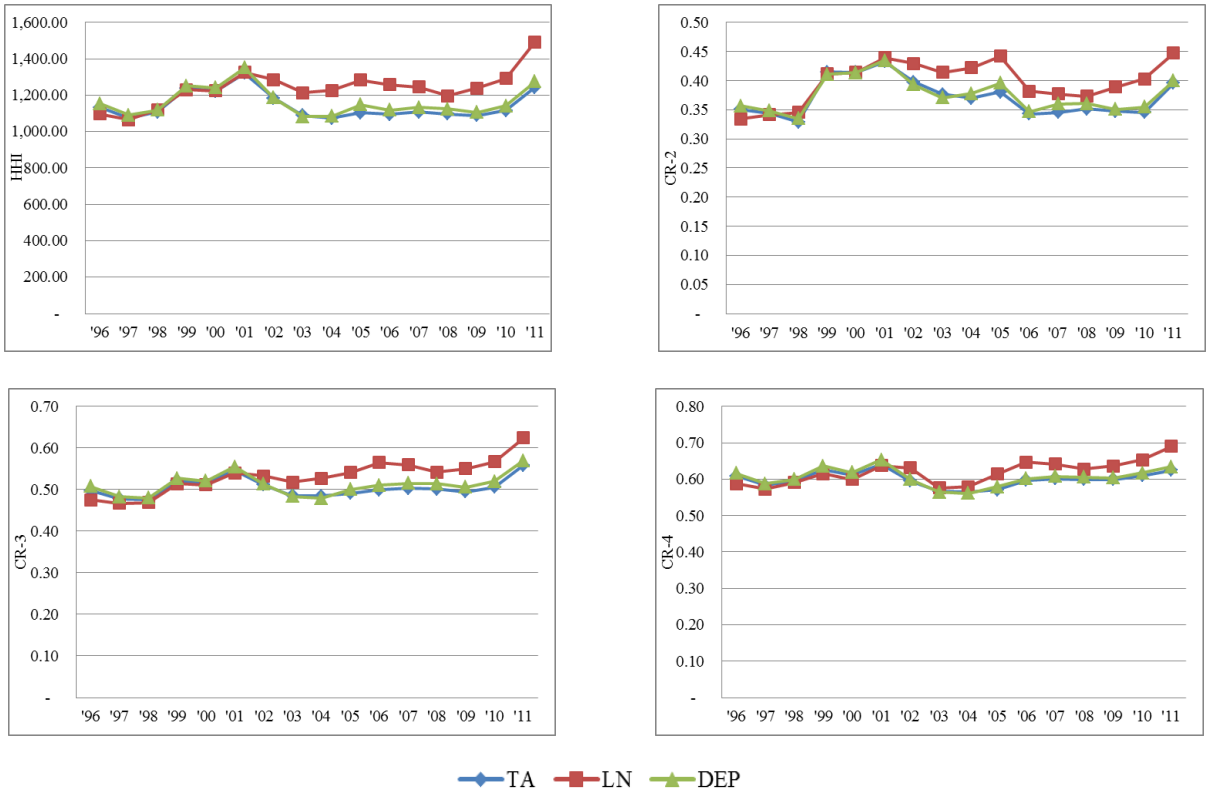


Figure 5c. Bank market structure in the Philippines (1996-2011)

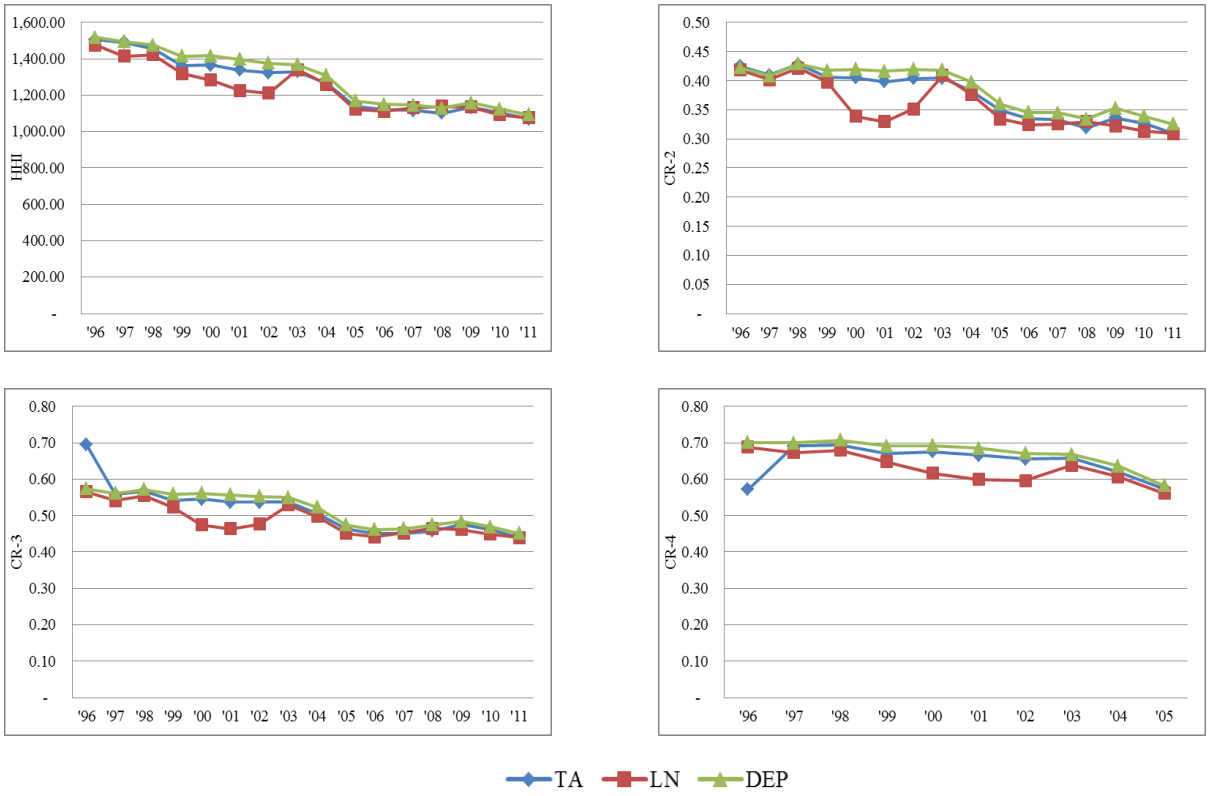
Table 6d. Bank Market Concentration in Singapore (1996-2011)

Year	Total Assets				Total Deposits				Total Loans			
	CR_2	CR_3	CR_4	HHI	CR_2	CR_3	CR_4	HHI	CR_2	CR_3	CR_4	HHI
1996	0.68	0.98	0.99	3,182.24	0.67	0.97	0.99	3,147.66	0.68	0.98	0.99	3,188.70
1997	0.68	0.97	0.97	3,154.03	0.69	0.97	0.97	3,158.44	0.67	0.95	0.97	3,064.03
1998	0.72	0.97	0.97	3,333.40	0.73	0.97	0.97	3,317.69	0.71	0.96	0.97	3,292.06
1999	0.71	0.96	0.97	3,310.47	0.71	0.97	0.98	3,261.15	0.70	0.95	0.97	3,226.64
2000	0.71	0.96	0.98	3,254.61	0.68	0.96	0.98	3,135.86	0.70	0.95	0.97	3,182.87
2001	0.69	0.96	0.98	3,122.39	0.69	0.95	0.99	3,117.37	0.69	0.96	0.98	3,112.18
2002	0.69	0.96	0.98	3,108.37	0.70	0.95	0.98	3,100.86	0.68	0.95	0.97	3,066.90
2003	0.70	0.96	0.98	3,131.86	0.69	0.94	0.97	3,039.03	0.69	0.95	0.97	3,076.73
2004	0.68	0.97	0.99	3,158.79	0.68	0.95	0.98	3,080.21	0.72	0.97	0.98	3,201.46
2005	0.69	0.97	0.98	3,192.97	0.69	0.95	0.98	3,080.31	0.73	0.96	0.98	3,201.85
2006	0.68	0.97	0.98	3,158.87	0.69	0.95	0.97	3,063.93	0.72	0.96	0.98	3,161.42
2007	0.67	0.96	0.98	3,135.14	0.69	0.94	0.97	3,028.68	0.70	0.95	0.97	3,101.07
2008	0.68	0.96	0.97	3,149.12	0.70	0.95	0.97	3,102.45	0.72	0.95	0.97	3,146.25
2009	0.67	0.96	0.98	3,160.39	0.71	0.96	0.97	3,166.31	0.72	0.96	0.98	3,203.74
2010	0.68	0.97	0.98	3,157.81	0.69	0.96	0.97	3,162.97	0.70	0.96	0.98	3,174.21
2011	0.70	0.96	0.98	3,174.55	0.69	0.96	0.98	3,175.85	0.68	0.96	0.98	3,167.80

Figure 5d. Bank market structure in Singapore (1996-2011)

Table 6e. Bank Market Concentration in Thailand (1996-2011)

Year	Total Assets				Total Deposits				Total Loans			
	CR_2	CR_3	CR_4	HHI	CR_2	CR_3	CR_4	HHI	CR_2	CR_3	CR_4	HHI
1996	0.42	0.69	0.57	1,505.65	0.42	0.57	0.69	1,475.99	0.42	0.57	0.70	1,517.15
1997	0.41	0.56	0.69	1,490.17	0.40	0.54	0.67	1,414.85	0.41	0.56	0.70	1,494.64
1998	0.43	0.57	0.69	1,456.37	0.42	0.55	0.68	1,423.52	0.43	0.57	0.71	1,474.81
1999	0.41	0.54	0.67	1,361.52	0.40	0.52	0.65	1,319.00	0.42	0.56	0.69	1,413.65
2000	0.41	0.54	0.68	1,365.99	0.34	0.47	0.62	1,283.60	0.42	0.56	0.69	1,415.88
2001	0.40	0.54	0.67	1,338.70	0.33	0.46	0.60	1,225.29	0.42	0.56	0.69	1,397.07
2002	0.40	0.54	0.66	1,324.24	0.35	0.48	0.60	1,210.89	0.42	0.55	0.67	1,376.24
2003	0.40	0.54	0.66	1,329.55	0.41	0.53	0.64	1,340.36	0.42	0.55	0.67	1,367.13
2004	0.38	0.51	0.62	1,266.94	0.38	0.50	0.61	1,260.05	0.40	0.52	0.64	1,309.26
2005	0.35	0.46	0.57	1,136.77	0.33	0.45	0.56	1,122.14	0.36	0.47	0.58	1,169.28
2006	0.33	0.45	0.58	1,121.23	0.32	0.44	0.57	1,111.45	0.35	0.46	0.59	1,151.00
2007	0.33	0.45	0.59	1,116.77	0.33	0.45	0.59	1,130.24	0.35	0.46	0.60	1,145.14
2008	0.32	0.46	0.59	1,101.59	0.33	0.46	0.60	1,138.82	0.33	0.47	0.60	1,128.91
2009	0.34	0.48	0.61	1,133.63	0.32	0.46	0.60	1,136.02	0.35	0.48	0.61	1,158.20
2010	0.33	0.46	0.59	1,102.57	0.31	0.45	0.58	1,093.81	0.34	0.47	0.60	1,125.47
2011	0.31	0.44	0.58	1,070.42	0.31	0.44	0.58	1,075.87	0.33	0.45	0.59	1,092.07



2. Figure 5e. Bank market structure in Thailand (1996-2011)

4.3. Results on Correlation between Bank Efficiency and Competition

This section presents the results of Granger causality test on bank efficiency and competition. The Lerner index is employed to compute the individual measures of competition for each sample in bank while DEA measured efficiency of each bank.

4.3.1. Lerner Index

It may be recalled that the Lerner index of monopoly power is a nonstructural indicator of the degree of market competition. This index refers to the difference between price (calculated as the ratio of total costs to total assets) and marginal cost (expressed as a percentage of prices divided by price). Studies by Angelini and Cetorelli (2003), Maudos and Fernández de Guevara (2007), Pruteanu-Podpiera et al. (2008), and Casu and Girardone (2009) have all employed the Lerner index as a measurement of banking competition.

A Lerner index that is close to 0 indicates that a firm has no market power. In contrast, a firm enjoys greater market power when the index is closer to 1. A higher market

power implies a higher price cost margin. The Lerner index is an inverse measure of competition, and therefore a greater Lerner index means lower competition. The yearly Lerner indices are shown in Table 7.

Table 7. Lerner Indices Per Year by Country (1996-2011)

Year	Indonesia	Malaysia	Philippines	Singapore	Thailand	Mean
1996	0.67	0.61	0.71	0.76	0.32	0.62
1997	0.67	0.62	0.73	0.76	0.33	0.62
1998	0.69	0.61	0.75	0.79	0.22	0.61
1999	0.78	0.65	0.76	0.86	0.23	0.65
2000	0.82	0.68	0.74	0.84	0.41	0.70
2001	0.80	0.64	0.76	0.84	0.44	0.70
2002	0.76	0.65	0.76	0.83	0.44	0.69
2003	0.76	0.68	0.77	0.81	0.44	0.69
2004	0.76	0.68	0.79	0.81	0.51	0.71
2005	0.73	0.69	0.82	0.83	0.47	0.71
2006	0.74	0.70	0.82	0.82	0.43	0.70
2007	0.74	0.72	0.81	0.80	0.44	0.70
2008	0.71	0.70	0.80	0.83	0.46	0.70
2009	0.61	0.70	0.82	0.82	0.45	0.68
2010	0.64	0.69	0.83	0.79	0.51	0.69
2011	0.64	0.67	0.81	0.79	0.47	0.68
Mean	0.72	0.67	0.78	0.81	0.41	

Table 7 shows that the Lerner index is found highest in the Singapore banking market (81 percent), followed by the Philippines (78 percent), Indonesia (72 percent), Malaysia (67), and Thailand (41. It must be noted that the Singapore banking market is the largest market relative to the other countries. As the yearly Lerner index is computed by taking the average Lerner index scores of all banks in the five banking markets covered by this study, the trend in Lerner indices during the post-period of banking reform is not too visible. Yet in 1999, which is considered as the post-period of the reform, the Lerner index decreased in all countries. For instance, the Lerner index for Indonesia jumped from 0.69 in 1998 to 0.78 in 1999. This could be due to the immediate effect of the consolidation policy enforced in 1998. Figure 6 illustrates the trend in banking competition in the five Southeast Asian markets.

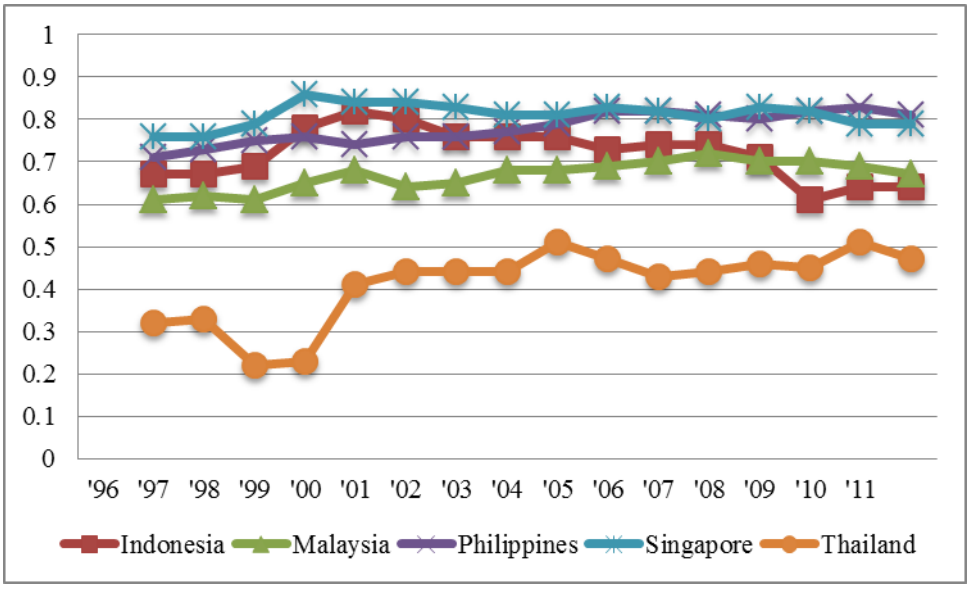


Figure 6. Trends in Lerner indices in Southeast Asia (1996-2011)

Figure 6 shows banking competition increased during the entire review period. Following the improvement in banking competition during the early years, banking competition in all countries (except Thailand) decreased considerably between 2000 and 2005 and increased steadily from 2005 onwards.

4.3.2. Competition and Market Concentration

Table 8. Concentration Ratios and Competition Indices (1995-2005)

Year	HHI	CR_2	CR_3	CR_4	Lerner Index
Total Assets		0.47	0.64	0.69	

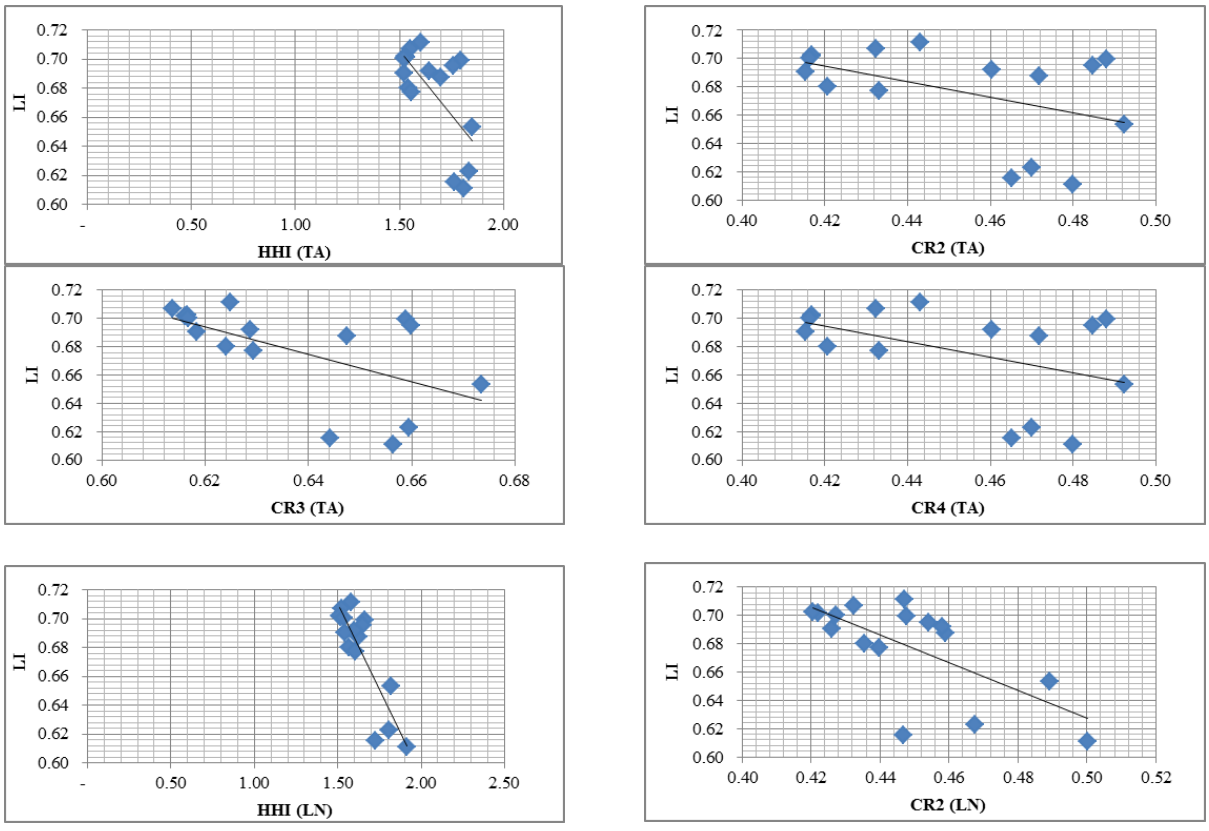
1996	1,765.84				0.62
1997	1,831.94	0.47	0.66	0.72	0.62
1998	1,809.26	0.48	0.66	0.72	0.61
1999	1,846.71	0.49	0.67	0.73	0.65
2000	1,792.07	0.49	0.66	0.72	0.70
2001	1,758.96	0.48	0.66	0.72	0.70
2002	1,695.69	0.47	0.65	0.70	0.69
2003	1,642.09	0.46	0.63	0.69	0.69
2004	1,601.15	0.44	0.62	0.68	0.71
2005	1,551.02	0.43	0.61	0.67	0.71
2006	1,531.48	0.42	0.62	0.68	0.70
2007	1,526.09	0.42	0.62	0.68	0.70
2008	1,522.42	0.42	0.62	0.67	0.70
2009	1,540.95	0.42	0.62	0.68	0.68
2010	1,520.76	0.42	0.62	0.68	0.69
2011	1,558.34	0.43	0.63	0.67	0.68
Total Loans					
1997	1,724.27	0.45	0.62	0.62	0.62
1997	1,809.17	0.47	0.65	0.64	0.62
1998	1,912.84	0.50	0.67	0.66	0.61
1999	1,817.59	0.49	0.67	0.67	0.65
2000	1,659.90	0.45	0.64	0.63	0.70
2001	1,652.54	0.45	0.64	0.63	0.70
2002	1,624.09	0.46	0.62	0.62	0.69
2003	1,598.75	0.46	0.61	0.59	0.69
2004	1,582.42	0.45	0.62	0.59	0.71
2005	1,526.76	0.43	0.60	0.58	0.71
2006	1,521.10	0.42	0.62	0.60	0.70
2007	1,513.06	0.42	0.61	0.60	0.70
2008	1,534.26	0.43	0.62	0.60	0.70
2009	1,567.77	0.44	0.63	0.62	0.68
2010	1,545.41	0.43	0.62	0.60	0.69
2011	1,604.56	0.44	0.64	0.61	0.68
Deposits					
1996	1,793.07	0.47	0.65	0.73	0.62
1997	1,850.46	0.48	0.67	0.73	0.62
1998	1,793.45	0.47	0.66	0.73	0.61
1999	1,793.84	0.49	0.66	0.73	0.65
2000	1,756.00	0.48	0.65	0.72	0.70
2001	1,756.41	0.48	0.65	0.73	0.70
2002	1,701.00	0.47	0.65	0.71	0.69
2003	1,635.52	0.46	0.63	0.69	0.69
2004	1,619.39	0.46	0.62	0.69	0.71
2005	1,570.98	0.45	0.62	0.67	0.71
2006	1,547.97	0.40	0.62	0.68	0.70
2007	1,536.21	0.43	0.62	0.68	0.70
2008	1,541.37	0.43	0.62	0.68	0.70
2009	1,559.77	0.43	0.63	0.69	0.68
2010	1,537.66	0.42	0.62	0.68	0.69
2011	1,563.77	0.43	0.64	0.68	0.68

Table 8 shows an average concentration index based on HHI, CR_2, CR_3, and CR_4, and the Lerner indices over the sample period 1996-2011 vis-à-vis total assets, total loans, and total deposits. The results are mixed with respect to the relationship between market concentration and market competition. On total assets, during the initial years of the study

period, the HHI index rose from 1,765 (1996) to 1,846 (1999). Between 1996 and 201, the Lerner index rose from 0.62 to 0.70.

The resulting Lerner indices indicate that market concentration is inversely related to market competition. Figure 7 shows a scatter diagram of various measures of market concentration and Lerner indices, in addition to the estimated linear regression line.

Based on Figure 7, the slightly downward-sloping regression line predicts the negative link between market concentration and market power. It suggests that a higher concentration leads to a lower degree of market power. Such linkage, however, is not statistically significant. As Figure 7 also shows, even if the banking market is highly concentrated, it does not lead to anticompetitive conduct, as suggested by the traditional structure-conduct-performance hypothesis. Since the competitive analyses in the previous section consistently reject the existence of collusive behavior, the linear regression in this section does not yield any significant relationship between concentration and competition. As the relationship between concentration ratios and competition is not statistically tested, this link is further explored in the next section.



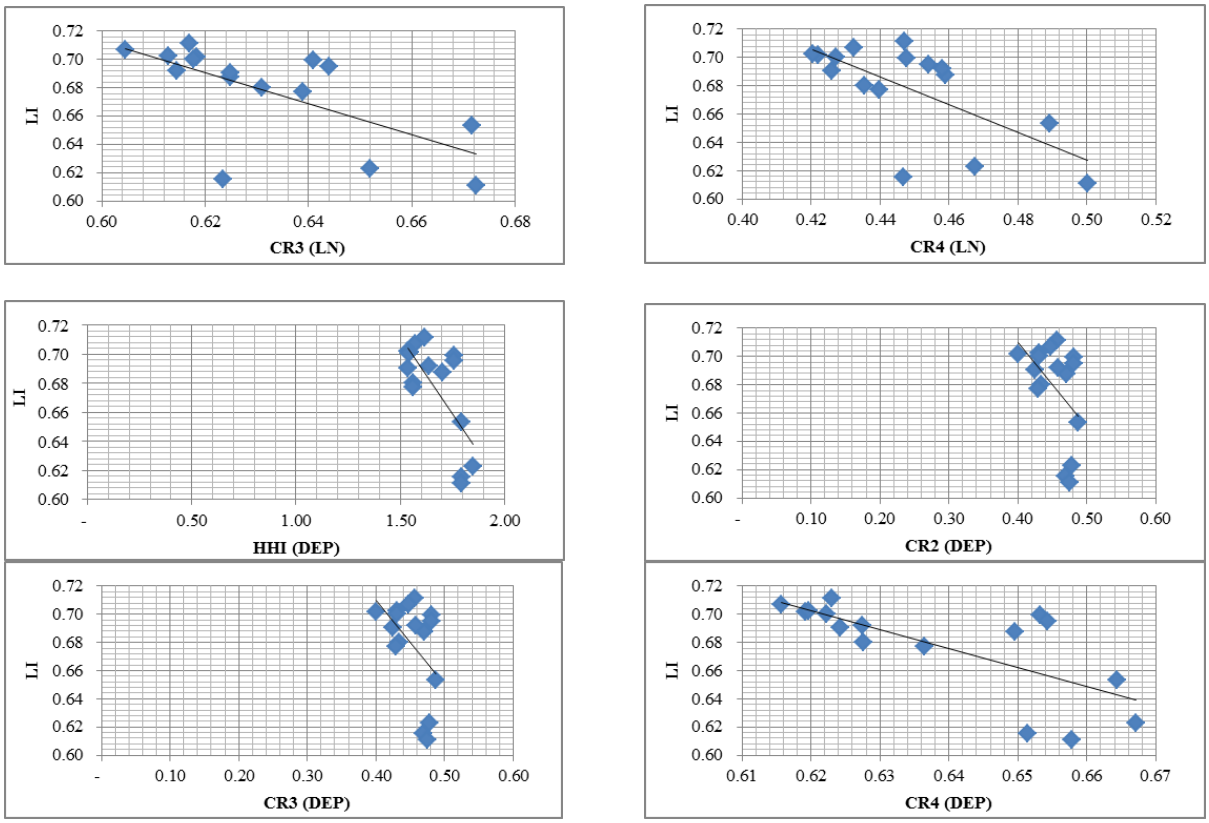


Figure 7. Scatter diagrams of concentration ratios and Lerner index (all countries)

4.3.3. Empirical Results: Efficiency and Competition

This section presents the results of the causality tests between efficiency and competition. To investigate the causality running from competition to efficiency and from efficiency to competition, Granger causality tests are employed. Following Berger and DeYoung (1997), Williams (2004), and Pruteanu-Podpiera et al. (2009), the model specifications include four lags of the dependent and independent variables. Tests are carried out based on various types of efficiency.

The Granger causality tests are performed to determine technical efficiency, pure technical efficiency, and scale efficiency, thus facilitating an examination of the relationship between efficiency and competition within the five Southeast Asian banking markets. As the main concerns are the coefficients of the independent variable lag, the joint hypothesis are equal to zero. The joint hypothesis shows whether the variable Granger yielded the dependent variable. The sum of these coefficients, which gives an overall measure of the effect on the dependent variables, is also computed.

While Panel A reports the causality running from efficiency to competition, the results of the causality running from competition to efficiency are reported in Panel B (see Tables 9 to 13).[7] Tables 9a-9c present the results for the Indonesian banking market; Tables 10a-10c for Malaysia; Tables 11a-11c for the Philippines; Tables 12a-12c for Singapore; and Tables 13a-13c for Thailand. These tables report the coefficients of dependent variable lags as well as the coefficients of the independent variable lags.

4.3.3.1. Indonesian Banking Market

Table 9a. Granger-causality—Lerner index (LI) and Technical Efficiency (TE)

Variable	**PANEL A: Dependent – LI**		**PANEL B: Dependent – TE**	
	Coefficient	**s.e.**	**Coefficient**	**s.e.**
Intercept	0.2515	0.0502*	0.1814	0.0437*
LI_{t-1}	0.6929	0.0636*	0.0642	0.0303**
LI_{t-2}	-0.0201	0.0574	-0.0226	0.0383
LI_{t-3}	0.0982	0.0362*	-0.2300	0.0205*
LI_{t-4}	-0.1324	0.0419*	0.1309	0.0278*
$LI_{t-1} = LI_{t-2} = LI_{t-3} = LI_{t-4}=0$	λ^2 (4) = 0.64*		λ^2 (4) = 0.5112*	
Σ coefficients:	-0.0543	0.0574	-0.0576	0.1169*
TE_{t-1}	0.0552	0.0233**	0.6192	0.0491
TE_{t-2}	-0.0522	0.0170*	-0.1315	0.0637
TE_{t-3}	0.0016	0.0126	0.0412	0.0429
TE_{t-4}	0.0364	0.0114*	-0.0176	0.0374
$TE_{t-1}=TE_{t-2}=TE_{t-3}=TE_{t-4}=0$	λ^2 (4) = 0.04**		λ^2 (4) = - 0.05***	
Σ coefficients:	-0.0142	0.0126	0.5113	0.1931

Note: *; **; *** Significant at 1 percent, 5 percent, 10 percent significance level

Table 9b. Granger-causality—Lerner index (LI) and Pure Technical Efficiency (PTE)

Variable	**PANEL A: Dependent – LI**		**PANEL B: Dependent – PTE**	
	Coefficient	**s.e.**	**Coefficient**	**s.e.**
Intercept	0.2848	0.0444*	0.4913	0.0352*
LI_{t-1}	0.7003	0.0654	-0.2304	0.0621*
LI_{t-2}	-0.0288	0.0535	0.0509	0.0514
LI_{t-3}	0.1009	0.0492	-0.2761	0.0613*
LI_{t-4}	-0.1432	0.0397	0.1181	0.0428*
$LI_{t-1} = LI_{t-2} = LI_{t-3} = LI_{t-4}=0$	λ^2 (4) = -0.031*		λ^2 (4) = -0.33*	

[7] Most of the results are based on the fixed effect model, with generalized least square estimators and are White corrected except for the Philippine banking market, where the fixed effect model with generalized least square estimators were used.

Σ coefficients:	0.6291	0.2078	-0.3376	0.2176
PTE_{t-1}	-0.0220	0.0157	0.5345	0.0554*
PTE_{t-2}	-0.0442	0.0161*	-0.0382	0.0404
PTE_{t-3}	-0.0036	0.0145	0.0488	0.0276***
PTE_{t-4}	0.0387	0.0091*	-0.0465	0.0370
$PTE_{t-1} = PTE_{t-2} = PTE_{t-3} = PTE_{t-4} = 0$	λ^2 (4) = 0.63*		λ^2 (4) = 0.49*	
Σ coefficients:	-0.0310	0.0554	0.4985	0.1604

Note: *; **; *** Significant at 1 percent, 5 percent, 10 percent significance level

Table 9c. Granger-causality—Lerner index (LI) and Scale Efficiency (SE)

Variable	**PANEL A: Dependent – LI**		**PANEL B: Dependent – SE**	
	Coefficient	**s.e.**	**Coefficient**	**s.e.**
Intercept	0.2261	0.0381*	-0.0236	0.0681
LI_{t-1}	0.6390	0.0475*	0.2252	0.0823*
LI_{t-2}	-0.0164	0.0413	-0.1102	0.0516**
LI_{t-3}	0.1322	0.0456*	-0.0216	0.0559
LI_{t-4}	-0.1178	0.0345*	0.1333	0.0677**
$LI_{t-1} = LI_{t-2} = LI_{t-3} = LI_{t-4} = 0$	λ^2 (4) = 0.64*		λ^2 (4) = 0.22*	
Σ coefficients:	0.6369	0.1688	0.2267	0.2575
SE_{t-1}	0.0846	0.0172*	0.9391	0.0298*
SE_{t-2}	-0.0176	0.0157	-0.0696	0.0357***
SE_{t-3}	-0.0401	0.0232***	-0.0057	0.0400
SE_{t-4}	0.0283	0.0143**	-0.0984	0.0301*
$SE_{t-1} = SE_{t-2} = SE_{t-3} = SE_{t-4} = 0$	λ^2 (4) = 0.05*		λ^2 (4) = 0.76*	
Σ coefficients:	0.0551	0.0704	0.7654	0.1355

Note: *; **; *** Significant at 1 percent, 5 percent, 10 percent significance levels.

Panel A in Table 9a shows a negative Granger coefficient, thus indicating that efficiency positively Granger-causes competition, i.e., an increase in bank efficiency Granger-causes increase in competition. The link is significant at 1 percent significance level and, therefore, the null hypothesis that efficiency does not Granger-cause competition is rejected. Panel B shows the results for the causality running from Lerner index to efficiency. The results suggest that efficiency at time *t* is highly affected by previous years' competition.

Furthermore, the negative signs of the coefficients indicate a positive link between competition and efficiency. That is, as the coefficients of the lags of the Lerner index increase, the competition measures decrease and as a result, the technical efficiency scores decrease. The joint hypothesis confirms that the Granger causality running from competition to efficiency is highly significant at 1 percent, with the summation of coefficients at 0.5.

Table 9b shows the results of the causality running tests between pure technical efficiency and competition. The negative Granger coefficient demonstrates that the efficiency negatively Granger-causes the Lerner index. Thus, the efficiency positively Granger-causes competition. In addition, the summation of coefficients is 0.03. Panel B shows that the Granger causality running from competition to efficiency is significant at 1 percent, with the summation of coefficients at 0.3. The negative sign of the summation of coefficients indicates a positive link between competition and efficiency. As the coefficients of the lags of Lerner index increase, the competition measures decrease and as a result, the pure technical efficiency scores decrease.

Based on the results in Panel A of Table 9c, the scale efficiency positively Granger-causes the Lerner index, which means that efficiency negatively Granger-causes competition. The Granger coefficient is also positive in Panel B—an indication that as the competition measures decrease, the scale efficiency scores increase. Nevertheless, the link found is relatively weak at 10 percent of significance, with the summation of coefficients at 0.02.

The aforementioned results presented in Table 9 highlight the positive causality running from competition to efficiency, in the case of technical efficiency and pure technical efficiency. On the reverse running flow, the link is only found negative in the case of scale efficiency.

4.3.3.2. Malaysian Banking Market

Table 10a. Granger-causality—Lerner index (LI) and Technical Efficiency (TE)

Variable	PANEL A: Dependent – LI		PANEL B: Dependent – TE	
	Coefficient	**s.e.**	**Coefficient**	**s.e.**
Intercept	0.2872	0.0438*	0.8073	0.1698*
LI_{t-1}	0.6153	0.0638*	-0.3413	0.1238*
LI_{t-2}	-0.1738	0.0751**	0.3190	0.1254**
LI_{t-3}	0.2120	0.0593*	-0.3499	0.1034*
LI_{t-4}	-0.0862	0.0403**	-0.0250	0.1113
$LI_{t-1} = LI_{t-2} = LI_{t-3} = LI_{t-4}=0$	λ^2 (4) = 146.28*		λ^2 (4) = 19.88*	
Σ coefficients:	0.0155	0.0697	-0.3973	0.4641
TE_{t-1}	0.0024	0.0144	0.3453	0.0722*
TE_{t-2}	-0.0186	0.0196	0.0827	0.0635
TE_{t-3}	0.0306	0.0163***	-0.1816	0.0581*
TE_{t-4}	0.0011	0.0194	-0.1619	0.0835***
$TE_{t-1} = TE_{t-2} = TE_{t-3} = TE_{t-4} =0$	λ^2 (4) = 2.57		λ^2 (4) = 39.10*	
Σ coefficients:	0.0155	0.0697	0.0845	0.2774

Note: *; **; *** Significant at 1 percent, 5 percent, 10 percent significance levels.

Table 10b. Granger-causality—Lerner index (LI) and Pure Technical Efficiency (PTE)

Variable	PANEL A: Dependent – LI		PANEL B: Dependent –PTE	
	Coefficient	s.e.	Coefficient	s.e.
Intercept	0.2826	0.0424*	0.7899	0.1792*
LI_{t-1}	0.6220	0.0696*	-0.3427	0.1658**
LI_{t-2}	-0.1939	0.0585*	0.2268	0.1257***
LI_{t-3}	0.2261	0.0830*	-0.2258	0.1309***
LI_{t-4}	-0.0916	0.0337*	0.0167	0.0990
$LI_{t-1} = LI_{t-2} = LI_{t-3} = LI_{t-4}=0$	λ^2 (4) = 155.62*		λ^2 (4) = 10.31**	
Σ coefficients:	0.5625	0.2448	-0.3250	0.5214
PTE_{t-1}	0.0114	0.0142	0.3161	0.1083*
PTE_{t-2}	-0.0285	0.0163***	0.0537	0.0631
PTE_{t-3}	0.0291	0.0196	-0.0918	0.0899
PTE_{t-4}	0.0106	0.0187	-0.0254	0.0745
$PTE_{t-1} = PTE_{t-2} = PTE_{t-3} = PTE_{t-4} =0$	λ^2 (4) = 6.96		λ^2 (4) = 23.03*	
Σ coefficients:	0.0226	0.0687	0.2527	0.3358

Note: *; **; *** Significant at 1 percent, 5 percent, 10 percent significance levels.

Table 10c. Granger-causality—Lerner index (LI) and Scale Efficiency (SE)

Variable	PANEL A: Dependent – LI		PANEL B: Dependent – SE	
	Coefficient	s.e.	Coefficient	s.e.
Intercept	0.3457	0.0657*	0.1409	0.0308*
LI_{t-1}	0.5693	0.0638*	-0.0247	0.0078*
LI_{t-2}	-0.0894	0.0696	0.0333	0.0178***
LI_{t-3}	0.1467	0.0688**	0.0025	0.0178
LI_{t-4}	-0.0771	0.0572	-0.0085	0.0146
$LI_{t-1} = LI_{t-2} = LI_{t-3} = LI_{t-4}=0$	λ^2 (4) = 129.27*		λ^2 (4) = 13.08**	
Σ coefficients:	0.5495	0.2594	0.0025	0.0581
SE_{t-1}	-0.1209	0.0535**	0.6879	0.0700*
SE_{t-2}	0.0737	0.0608	0.0810	0.0700
SE_{t-3}	0.0996	0.0511***	0.0154	0.0487
SE_{t-4}	-0.0990	0.0460**	0.0251	0.0381
$SE_{t-1} = SE_{t-2} = SE_{t-3} = SE_{t-4} =0$	λ^2 (4) = 12.19**		λ^2 (4) = 504.73*	
Σ coefficients:	-0.0466	0.2113	0.8095	0.2267

Note: *; **; *** Significant at 1 percent, 5 percent, 10 percent significance levels.

Panel A in Table 10a shows that the Granger coefficient is positive, thus indicating that efficiency negatively Granger-causes competition, i.e., an increase in bank efficiency Granger-causes a decrease in competition. However, the link is not significant; therefore, the

null hypothesis that efficiency does not Granger-cause competition, could not be rejected. On the other hand, Panel B shows the results for the causality running from Lerner index to efficiency.

The significance of the coefficients for all lags of Lerner index suggests that efficiency at time *t* is highly affected by previous years' competition. Furthermore, the negative signs of the coefficients indicate a positive link between competition and efficiency. Thus, as the coefficients of the lags of the Lerner index increase, the competition measures decline and as a result, the technical efficiency scores decrease.

Table 10b shows the results of the causality running tests between pure technical efficiency and competition. As shown in Panel A, the positive Granger coefficient demonstrates that the efficiency negatively Granger-causes competition. However, the link is also not significant as the results for technical efficiency case. Panel B shows that the Granger causality running from competition to efficiency is negative. The negative sign of the summation of coefficients indicates the positive link between competition and efficiency. As the coefficients of the lags of Lerner index increase, the competition measures decrease and as a result, the pure technical efficiency scores decrease.

Based on the results in Panel A of Table 10c, the scale efficiency negatively Granger-causes the Lerner index, which means that efficiency positively Granger-causes competition. The joint test is significant at 1 percent, thus rejecting the null hypothesis that efficiency does not Granger-cause competition. The Granger coefficient is positive in Panel B and, therefore, as the competition measures decrease, the scale efficiency scores increase.

The aforementioned results presented in Tables 10 highlight the positive causality running from competition to efficiency, in the case of technical efficiency and pure technical efficiency. On the reverse running flow, the link is found positive only in the case of scale efficiency.

4.3.3.3. Philippine Banking Market

Table 11a. Granger-causality—Lerner index (LI) and Technical Efficiency (TE)

Variable	**PANEL A: Dependent – LI**		**PANEL B: Dependent – TE**	
	Coefficient	**s.e.**	**Coefficient**	**s.e.**
Intercept	0.3021	0.0737*	0.3945	0.0504*
LI_{t-1}	0.6709	0.0363*	-0.0837	0.0268*
LI_{t-2}	-0.0586	0.0722	0.0075	0.0238
LI_{t-3}	0.0362	0.0773	0.0701	0.0292**
LI_{t-4}	-0.0287	0.0638	-0.0354	0.0190***

$LI_{t-1} = LI_{t-2} = LI_{t-3} = LI_{t-4}=0$	λ^2 (4) = 542.25*		λ^2 (4) = 16.12*	
Σ coefficients:	0.6198	0.2496	-0.0415	0.0989
TE_{t-1}	0.0370	0.0332	0.5305	0.0940*
TE_{t-2}	0.0374	0.0406	-0.0071	0.1051
TE_{t-3}	-0.0593	0.0312***	-0.0081	0.0770
TE_{t-4}	-0.0076	0.0258	-0.0783	0.0664
$TE_{t-1} = TE_{t-2} = TE_{t-3} = TE_{t-4} = 0$	λ^2 (4) = 11.93*		λ^2 (4) = 72.89*	
Σ coefficients:	0.0075	0.1307	0.4370	0.3424

Note: *; **; *** Significant at 1 percent, 5 percent, 10 percent significance levels.

Table 11b. Granger-causality—Lerner index (LI) and Pure Technical Efficiency (PTE)

Variable	**PANEL A: Dependent – LI**		**PANEL B: Dependent –PTE**	
	Coefficient	**s.e.**	**Coefficient**	**s.e.**
Intercept	0.1332	0.0259*	-0.0456	0.0950
LI_{t-1}	0.7236	0.0685*	0.2447	0.1263***
LI_{t-2}	0.0662	0.0607	-0.2321	0.1502
LI_{t-3}	0.1278	0.0527**	0.0437	0.1350
LI_{t-4}	-0.0448	0.0362	0.0420	0.0892
$LI_{t-1} = LI_{t-2} = LI_{t-3} = LI_{t-4}=0$	λ^2 (4) = 1251.56*		λ^2 (4) = 4.24	
Σ coefficients:	0.8727	0.2182	0.8337	0.1170
PTE_{t-1}	-0.0480	0.0242**	0.1635	0.0825*
PTE_{t-2}	0.0047	0.0323	-0.0992	0.0597**
PTE_{t-3}	0.0412	0.0218***	0.0600	0.0675***
PTE_{t-4}	-0.0316	0.0151**	0.0644	0.0689
$PTE_{t-1} = PTE_{t-2} = PTE_{t-3} = PTE_{t-4} = 0$	λ^2 (4) = 114.12*		λ^2 (4) = 538.60*	
Σ coefficients:	-0.0337	0.0933	0.9579	0.3267

Note: *; **; *** Significant at 1 percent, 5 percent, 10 percent significance levels.

Table 11c. Granger-causality—Lerner index (LI) and Pure Technical Efficiency (PTE)

Variable	**PANEL A: Dependent – LI**		**PANEL B: Dependent – SE**	
	Coefficient	**s.e.**	**Coefficient**	**s.e.**
Intercept	0.1093	0.0461**	0.0327	0.0268
LI_{t-1}	0.7898	0.0668*	0.0311	0.1061
LI_{t-2}	0.0354	0.0583	0.0182	0.0879
LI_{t-3}	0.1229	0.0526**	0.0012	0.0724
LI_{t-4}	-0.0759	0.0394***	-0.0073	0.0612
$LI_{t-1} = LI_{t-2} = LI_{t-3} = LI_{t-4}=0$	λ^2 (4) = 523.88*		λ^2 (4) = 3.81	
Σ coefficients:	0.8723	0.2171	0.0432	0.3278
SE_{t-1}	0.0632	0.0404	0.9549	0.0763
SE_{t-2}	-0.0293	0.0709	0.0280	0.1032
SE_{t-3}	0.0431	0.0615	0.1036	0.0927
SE_{t-4}	-0.0803	0.0308*	-0.1728	0.0602
$SE_{t-1} = SE_{t-2} = SE_{t-3} = SE_{t-4} = 0$	λ^2 (4) = 12.11**		λ^2 (4) = 4148.11*	

Σ coefficients:	-0.0032	0.2036	0.9137	0.3324

Note: *; **; *** Significant at 1 percent, 5 percent, 10 percent significance levels.

Panel A in Table 11a shows that the Granger coefficient is positive, thereby indicating that efficiency negatively Granger-causes competition. The summation of coefficients is at 0.0075, and this link is significant at 1 percent, thus belying the null hypothesis that efficiency does not Granger-cause competition. These results reveal that only three years of lag appear to be significant. On the other hand, Panel B shows that the significance of the coefficients for all lags of Lerner index (except two years lag), suggests that efficiency at time *t* is highly affected by previous years' competition. However, the negative signs of the coefficients indicate a positive link between competition and efficiency. Therefore, as the coefficients of the lags of the Lerner index increase, the competition measures decrease alongside the technical efficiency scores.

Table 11b shows the results of the causality running tests between pure technical efficiency and competition. As can be seen from Panel A, three annual lags are significant and the joint hypothesis confirms the link at 1 percent significance level. The negative Granger coefficient demonstrates that the efficiency negatively Granger-causes the Lerner index; therefore the efficiency positively Granger-causes competition. Panel B shows that the Granger causality running from competition to efficiency is insignificant. This means that the efficiency at time *t* is not affected at all by the previous competition.

This link is further confirmed in Panel B, Table 11c, which indicates that banking competition does not Granger-cause scale efficiency. However, Panel A of Table 11c reveals that the scale efficiency positively Granger-causes the competition. The joint test is significant at 1 percent, thus rejecting the null hypothesis that efficiency does not Granger-cause competition.

4.3.3.4. Singapore Banking Market

Table 12a. Granger-causality—Lerner index (LI) and Technical Efficiency (TE)

Variable	**PANEL A: Dependent – LI**		**PANEL B: Dependent – TE**	
	Coefficient	**s.e.**	**Coefficient**	**s.e.**
Intercept	0.3388	0.1110*	0.7523	0.3954***
LI_{t-1}	0.6234	0.1113*	-0.7790	0.3966***
LI_{t-2}	0.2361	0.1206***	-1.1559	0.4298*
LI_{t-3}	-0.1279	0.1301	1.9489	0.4634*

LI_{t-4}	-0.1559	0.1154	-0.3621	0.4110
$LI_{t-1} = LI_{t-2} = LI_{t-3} = LI_{t-4}=0$	λ^2 (4) =	50.58*	λ^2 (4) =	8.02***
Σ coefficients:	0.5757	0.4774	-0.3481	1.7008
TE_{t-1}	0.0109	0.0309	0.2603	0.1099***
TE_{t-2}	0.0867	0.0443***	-0.0170	0.1577
TE_{t-3}	-0.0796	0.0529	0.1253	0.1885
TE_{t-4}	-0.0099	0.0399	-0.3012	0.1421**
$TE_{t-1} = TE_{t-2} = TE_{t-3} = TE_{t-4} = 0$	λ^2 (4) = 6.97		λ^2 (4) =	119.85*
Σ coefficients:	0.0080	0.1679	0.0675	0.5981

Note: *; **; *** Significant at 1 percent, 5 percent, 10 percent significance levels.

Table 12b. Granger-causality—Lerner index (LI) and Pure Technical Efficiency (PTE)

Variable	**PANEL A: Dependent – LI**		**PANEL B: Dependent –PTE**	
	Coefficient	**s.e.**	**Coefficient**	**s.e.**
Intercept	0.2669	0.0729*	0.0627	0.3149
LI_{t-1}	0.7481	0.1304***	-0.0566	0.3213
LI_{t-2}	0.0040	0.1067	-0.8891	0.3781**
LI_{t-3}	-0.0053	0.1166	1.7039	0.4321*
LI_{t-4}	-0.1180	0.1185**	-0.0622	0.3770
$LI_{t-1} = LI_{t-2} = LI_{t-3} = LI_{t-4}=0$	λ^2 (4) =	96.67*	λ^2 (4) =	8.02***
Σ coefficients:	0.6289	0.4721	0.6961	1.5084
PTE_{t-1}	0.0516	0.0303*	0.2388	0.1021**
PTE_{t-2}	0.0024	0.0370	-0.0030	0.1670
PTE_{t-3}	0.0181	0.0256	0.0421	0.1855
PTE_{t-4}	-0.0328	0.0149	0.0227	0.1242
$PTE_{t-1} = PTE_{t-2} = PTE_{t-3} = PTE_{t-4} = 0$	λ^2 (4) = 23.53*		λ^2 (4) =	119.85*
Σ coefficients:	0.0393	0.1078	0.3006	0.5788

Note: *; **; *** Significant at 1 percent, 5 percent, 10 percent significance levels.

Table 12c. Granger-causality—Lerner index (LI) and Scale Efficiency (SE)

Variable	**PANEL A: Dependent – LI**		**PANEL B: Dependent – SE**	
	Coefficient	**s.e.**	**Coefficient**	**s.e.**
Intercept	0.5369	0.1334*	0.3552	0.4134
LI_{t-1}	0.4576	0.1174*	-0.0828	0.3639
LI_{t-2}	0.2171	0.1176***	-0.2930	0.3642
LI_{t-3}	-0.0784	0.1153	0.7917	0.3571**
LI_{t-4}	-0.2003	0.1052***	-0.5951	0.3260***
$LI_{t-1} = LI_{t-2} = LI_{t-3} = LI_{t-4}=0$	λ^2 (4) =	36.09*	λ^2 (4) =	5.35
Σ coefficients:	0.3960	0.4555	-0.1791	1.4112
SE_{t-1}	-0.0318	0.0437	0.8811	0.1355*
SE_{t-2}	0.1010	0.0562***	-0.2638	0.1742
SE_{t-3}	-0.1045	0.0493**	0.1978	0.1528
SE_{t-4}	-0.0421	0.0398	-0.1867	0.1234
$SE_{t-1} = SE_{t-2} = SE_{t-3} = SE_{t-4} = 0$	λ^2 (4) = 11.48**		λ^2 (4) =	56.85**

Σ coefficients:	-0.0773	0.1891	0.6285	0.5860

Note: *; **; *** Significant at 1 percent, 5 percent, 10 percent significance levels.

Panel A in Table 12a shows that the Granger coefficient is positive, thereby indicating that efficiency negatively Granger-causes competition, i.e., an increase in bank efficiency Granger-causes a decrease in competition. However, such linkage is not significant.

Panel B shows that the causality running from Lerner index to efficiency is negative. The significance of the coefficients for all lags of Lerner index suggests that efficiency at time *t* is highly affected by previous years' competition. Furthermore, the negative signs of the coefficients indicate a positive link between competition and efficiency. Hence, as the coefficients of the lags of the Lerner index increase, the competition measures decrease and so do the technical efficiency scores.

The negative link between technical efficiency and competition is also found in the case of pure technical efficiency as in Panel A, Table 12b. However, the link is significant at 1% significance level. Results in Panel B show that the Granger causality running from competition to efficiency is weakly significant at 10 percent, with the summation of coefficients at 0.69. The positive sign of the summation of coefficients indicates the negative link between competition and efficiency. As the coefficients of the lags of Lerner index increase, the competition measures decrease, resulting in increased pure technical efficiency scores.

Based on Panel A of Table 12c, the scale efficiency negatively Granger-causes the Lerner index, which means that efficiency positively Granger-causes competition. The joint test is significant at 5 percent, which disproves the null hypothesis that efficiency does not Granger-cause competition. However, the Granger coefficient (negative) in Panel B is found insignificant. Thus, banking competition does not Granger-cause scale efficiency.

4.3.3.5. Thai Banking Market

Table 13a. Granger-causality—Lerner index (LI) and Technical Efficiency (TE)

Variable	**PANEL A: Dependent – LI**		**PANEL B: Dependent – TE**	
	Coefficient	**s.e.**	**Coefficient**	**s.e.**
Intercept	0.1444	0.0760***	0.3397	0.0796*
LI_{t-1}	0.7114	0.0904*	-0.0309	0.0511
LI_{t-2}	-0.1563	0.0805***	0.0419	0.0406
LI_{t-3}	0.1968	0.0896**	-0.1438	0.0488*

LI_{t-4}	-0.1423	0.0607**	0.0945	0.0449**
$LI_{t-1} = LI_{t-2} = LI_{t-3} = LI_{t-4}=0$	λ^2 (4) =	87.15*	λ^2 (4) =	13.31*
Σ coefficients:	0.6096	0.3212	-0.0383	0.1853
TE_{t-1}	0.1400	0.0791***	0.5975	0.0551*
TE_{t-2}	-0.0872	0.0478***	-0.1379	0.0350*
TE_{t-3}	0.0413	0.0621	0.0790	0.0753
TE_{t-4}	-0.0677	0.0725	-0.0700	0.0519
$TE_{t-1} = TE_{t-2} = TE_{t-3} = TE_{t-4} = 0$	λ^2 (4) =	9.37***	λ^2 (4) =	207.71*
Σ coefficients:	0.0265	0.2615	0.4686	0.2173

Note: *; **; *** Significant at 1 percent, 5 percent, 10 percent significance levels.

Table 13b. Granger-causality—Lerner index (LI) and Pure Technical Efficiency (PTE)

Variable	**PANEL A: Dependent – LI**		**PANEL B: Dependent –PTE**	
	Coefficient	**s.e.**	**Coefficient**	**s.e.**
Intercept	0.3314	0.0771*	0.4893	0.1278*
LI_{t-1}	0.7026	0.0757*	-0.2119	0.0670*
LI_{t-2}	-0.1989	0.0925**	0.0219	0.0955
LI_{t-3}	0.1885	0.0880**	-0.2379	0.0700*
LI_{t-4}	-0.1625	0.0808**	0.1428	0.0520*
$LI_{t-1} = LI_{t-2} = LI_{t-3} = LI_{t-4}=0$	λ^2 (4) =	113.32*	λ^2 (4) =	20.72*
Σ coefficients:	0.5296	0.3371	-0.2852	0.2846
PTE_{t-1}	-0.0318	0.0526	0.6693	0.0580*
PTE_{t-2}	-0.1576	0.0688**	-0.1064	0.0817
PTE_{t-3}	0.0891	0.0680	0.0409	0.0935
PTE_{t-4}	-0.0900	0.0520***	-0.0971	0.0775
$PTE_{t-1} = PTE_{t-2} = PTE_{t-3} = PTE_{t-4} = 0$	λ^2 (4) =	12.32**	λ^2 (4) =	88.87*
Σ coefficients:	-0.1904	0.2415	0.5067	0.3107

Note: *; **; *** Significant at 1 percent, 5 percent, 10 percent significance levels.

Table 13c. Granger-causality—Lerner index (LI) and Scale Efficiency (SE)

Variable	**PANEL A: Dependent – LI**		**PANEL B: Dependent – SE**	
	Coefficient	**s.e.**	**Coefficient**	**s.e.**
Intercept	-0.1305	0.0818	0.0748	0.0754
LI_{t-1}	0.5676	0.0774*	0.0293	0.0161***
LI_{t-2}	-0.2467	0.0590*	-0.0102	0.0387
LI_{t-3}	0.2065	0.0574*	0.1014	0.0194*
LI_{t-4}	-0.1516	0.0645**	-0.0631	0.0288**
$LI_{t-1} = LI_{t-2} = LI_{t-3} = LI_{t-4}=0$	λ^2 (4) =	63.99*	λ^2 (4) =	63.37*
Σ coefficients:	0.3757	0.2583	0.0574	0.1030
SE_{t-1}	0.3672	0.0323*	1.0578	0.0706*
SE_{t-2}	0.2057	0.0501*	-0.0577	0.0998
SE_{t-3}	-0.2069	0.0632*	-0.0786	0.0913
SE_{t-4}	0.0898	0.0687	-0.0485	0.1098

$SE_{t-1} = SE_{t-2} = SE_{t-3} = SE_{t-4} = 0$	λ^2 (4) = 214.65*		λ^2 (4) = 441.45*	
Σ coefficients:	0.4558	0.2142	0.8731	0.3715

Note: *; **; *** Significant at 1 percent, 5 percent, 10 percent significance levels.

Panel A in 13a shows that the Granger coefficient is positive, thereby indicating that efficiency negatively Granger-causes competition, that is, an increase in bank efficiency Granger-causes a decrease in competition. Panel B shows the results for the causality running from banking competition to efficiency is positive. In other words, as the coefficients of the lags of the Lerner index increase, the competition measures decline while the technical efficiency scores drop. The joint hypothesis confirms that the Granger causality running from competition to efficiency is significant at 1 percent, with the summation of coefficients at 0.03.

Table 13b shows that the causality running tests between pure technical efficiency and competition suggest that the link is positive in both ways. The negative Granger coefficient demonstrates that the efficiency positively Granger-causes competition. The negative sign of the summation of coefficients between Lerner index and pure technical efficiency indicates the positive link between competition and efficiency.

Based on Panel A of Table 13c, the scale efficiency positively Granger-causes the Lerner index, which means that efficiency negatively Granger-causes competition. The Granger coefficient is also found positive in Panel B and, therefore, as the competition measures decrease, the scale efficiency scores decrease.

5. **CONCLUSION**

The investigation of the running causality from competition to banking efficiency and from banking efficiency to competition in five Southeast Asian banking markets is done by employing the Granger causality tests. Table 14 presents a summary of the results of the running causality. The left panel represents types of efficiency variables, namely, technical efficiency, pure technical efficiency, and scale efficiency. The top panel corresponds to banking competition as the independent variable. Thus, efficiency variables serve as dependent variable and in the case of banking competition acts as dependent variable, and efficiency variables become independent variables.

Table 14. Summary of Relationships between Banking Efficiency and Competition

	Indonesia		Malaysia		Philippines		Singapore		Thailand	
	DV	IV	DV	IV	DV	IV	DV	IV	DV	IV
TE	+	+	-*	+	-	+	-	+	-	+
PTE	+	+	-	+	+	-*	-	-	+	+
SE	-	-	+	-	+	-*	+	+	-	-

Note: * insignificant
+ positive
- negative
DV – competition serves as the dependent variable
IV - competition serves as the independent variable

In general, the results of the causality test suggest a positive link between banking efficiency and banking competition. However, these results should be examined further. For instance, technical efficiency decreases banking competition in all banking markets except Indonesia. The signs of the running causality from efficiency to competition are mixed across efficiency types. The negative relationship between efficiency and competition are found within the context of technical efficiency, which corroborates the efficient-structure (Demsetz 1973; Peltzman 1977; and Smirlock 1985) and the quiet-life hypotheses (Hicks 1935).

The efficient-structure hypothesis postulates that banks with superior management strategies, better technologies, and highly skilled personnel harnessed those attributes to maximize profit. Efficient banks increased their market share at the expense of inefficient banks. Similarly, efficient banks also benefit from economies of scale due to increased bank size. As the market becomes concentrated, banks can exploit their market power with a resultant trade-off between efficiency and competition. The noncompetitive market permits bank managers to enjoy a "quiet life," where costs are not kept under control. This results in decreased competition.

These results run parallel to findings of previous studies such as Pruteanu-Podpiera et al. (2008); Yildirim and Philippatos (2006); Casu and Girardone (2006; 2009); and Koetter et al. (2008). By incorporating efficiency scores, as one of the independent variables, Casu and Girardone (2006) found that increased efficiency does not result in higher competition within the EU banking system. In a separate paper, Casu and Girardone (2009) revealed the causality of relationships by employing Granger-causality tests. Their study confirmed the earlier findings on the negative link between efficiency and competition within selected EU countries—France, Germany, Italy, Spain, and the United Kingdom—between 2000 and 2005.

Pruteanu-Podpiera et al. (2008) investigated the effects of banking competition on efficiency measures in the Czech Republic between 1994 and 2005, and found that the Granger-causality test showed reverse causality in the two variables. Their results supported the negative relationship between cost efficiency scores and banking competition. This means cost efficiency had negative effects on banking competition; a negative running causality from competition to efficiency was also detected.

A similar study by Schaeck and Čihák (2008) focused on efficiency as a possible mechanism by which competition could contribute to banking soundness within European and U.S. markets between 1995 and 2005. The negative running causality from cost efficiency to competition was found in both markets.[8] A study by Koetter et al. (2008) of the US banking market between 1986 and 2005 and Yildirim and Philippatos (2006) yielded a similar finding. In the latter study, however, net interest margin acted as the proxy for efficiency and H-statistic represented competition measures.

Nonetheless, in the case of pure technical efficiency, the positive relationship between efficiency and competition in Indonesian, Philippine, and Thai banking markets appears to be due to the nature of the efficiency itself. Pure technical efficiency is defined as the ability of the bank managers to avoid the wastage of bank resources. Managerial efficiency means bank managements exert their best efforts to produce efficiently. This kind of behavior has positive spillovers on banking competition. It is unfortunate, though, that the positive outcome in the three banking markets cited earlier could not be compared with previous studies since none of these investigated the relationship between efficiency and banking competition.

Schaeck and Čihák (2008) also showed that in the case of running causality from banking competition to efficiency, banking competition has positive impacts on technical efficiency in all banking markets. The positive link between competition and efficiency affirms the quiet-life hypothesis. Hicks (1935) said, "The best of all monopoly profits is a quiet life," which suggests that banks with more market power are not exposed to competition and, therefore, they are unable to reduce costs to attain higher efficiency.

This proposition is supported by previous studies. For instance, Berger and Hannan (1998) discovered that the quiet-life hypothesis prevailed in the US banking sector during the 1980s. They also argued that in a highly concentrated market, bank managers do not work hard to control costs. On the contrary, they pursue objectives other than profit maximization.

[8] Nevertheless, the findings are only valid in cost efficiency context, whereas the profit efficiency proves otherwise. Profit efficiency is found to be positively linked with competition in European market and negative in the US market.

In this kind of environment, managers are able to exercise market power by setting prices above marginal costs. As a result, the costs of production increase, social welfare is hampered, and cost efficiency is eventually halted.

In developing countries, Hughes et al. (2003) noted that superior banks may show their market power by having large and sophisticated offices and spending excessively on technological innovations. This tack could eventually lead to substantial efficiency loses.

Indeed, greater banking competition may hamper the efficiency of banks, which could result in higher loan rates. As emphasized in banking literature, the negative effect of competition on efficiency, as found in the scale efficiency of all banking markets, shows that reduced competition permits banks to benefit from scale economies in terms of sustained customer relationships and lower monitoring costs.

In light of market power, other objectives such as fostering company and employee growth and managing labor conflicts have replaced profit maximization as the ultimate objective (Maudos and Fernández de Guevara 2006). Berger and Hannan (1998) affirmed this positive relationship between market power and inefficiency. However, their study employs market concentration as proxy for market power. Several studies express concern on the limitations of market concentration as an indicator of market competition (Berger et al. 2004; Maudos and Fernández de Guevara 2006; Claessens and Laeven 2004; and Fernández de Guevara et al. 2005).

Meanwhile, findings indicating a negative link between competition and efficiency complement previous studies by Berger (1995); Goldberg and Rai (1996); Weill (2004); Schaeck and Čihák (2008); Pruteanu-Podpiera et al. (2008); and Koetter et al. (2008). According to Maudos and Fernández de Guevara (2007), banks with more market power can achieve higher cost efficiency levels within the EU banking sector. Berger (1995) and Goldberg and Rai (1996) measured the competition based on market concentration or market share indices, while Weill (2004) did the same using the Panzar-Rosse model.

The remaining studies employed the Lerner index-based approach to measuring competition. Koetter et al. (2008) are particularly noteworthy for investigating the link between competition and two types of efficiency, namely, cost efficiency and profit efficiency. Their study confirmed the negative effect of competition on cost efficiency and the positive effect of competition on profit efficiency. The study, however, stands out for its estimation of the link between competition and the five types of efficiency. Its results appear to be consistent with the efficient-structure hypothesis, where the best-managed firms have the lowest costs and the largest market shares, which in turn, lead to higher concentration.

Overall, this study presents important evidence on the link between banking competition and banking efficiency in developing countries, particularly in five Southeast Asian markets. Theoretically, intense competition compels firms to put more effort in improving their efficiency. With little or no competition, firms tend to enjoy the quiet life by taking customers for granted and making no effort to enhance their efficiency and productivity. By ensuring only the most competitive and innovative firms stay in the market, competition improves consumer welfare. Competition benefits customers by making firms more efficient and inducing them to compete on price, improve the quality of their services, and innovate more. Nevertheless, the impact of competition depends on many factors such as the nature and structure of the industry. Additionally, this study offers evidence that the impact of competition on banking efficiency varies by type of bank efficiency at work in the banking industry.

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