THE ASEAN-4 BANKING SECTORS

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Abstract

Despite its severity and deep influence on both the real and financial sectors, empirical evidence on the evolution of the performance of the ASEAN-4 banking sectors since the 1997-1998 Asian financial crisis is relatively scarce. By employing the Data Envelopment Analysis (DEA) approach the present study examines for the first time the impact of the Asian financial crisis on the efficiency of the ASEAN-4 countries banking sectors. This study focuses on two major approaches vis. intermediation and revenue approaches. The empirical findings suggest that the estimates of technical efficiency are consistently higher under the revenue approach. We find that banks are relatively inefficient in a more concentrated banking market. However, when we control for countries that participate in IMF program, the concentration ratio exhibits a positive relationship with bank efficiency levels, implying that the more concentrated banking system which participates in IMF program is relatively more efficient in their intermediation function during the post crisis period.

Keywords: Efficiency, DEA, ASEAN, Regression.

JEL Classification: G21; G28

I. INTRODUCTION

The economic costs of an occurrence of banking distress to an economy could be severe. According to World Bank (2000) estimates, the fiscal costs of restructuring a banking sector to restore the intermediation functions effectively after a banking crisis or an occurrence of banking distress can be as large as a half of a country's annual GDP[1]. The total adverse economic impacts could be substantially higher than this estimate, given that banking distress may cause other crises, such as currency crises, which could further adversely affect the weakening economy[2]. In addition, any credit tightening after an occurrence of banking distress could lead to misallocation and underutilization of funds, which could undermine the potential growth of the crisis affected economy.

Table II.1
ASEAN Economies - Selected Macroeconomic Indicators

Panel A : Exchange Rates - June 1997 to May 1998

Country	US$ per 100 Local Currency 6/30/97	US$ per 100 Local Currency 6/30/97	% Δ 6/30/97 – 12/31/97	US$ per 100 Local Currency 5/8/98	% Δ 1/1/98 – 5/8/98	Cumulative % Δ 6/30/97 – 5/8/98
Thailand	4.05	2.08	-48.7	2.59	24.7	-36.0
Malaysia	39.53	45.70	-35.0	26.25	2.1	-33.6
Indonesia	0.04	0.02	-44.4	0.01	-53.0	-73.8
Philippines	3.79	2.51	-33.9	2.54	1.3	-33.0
South Korea	0.11	0.06	-47.7	0.07	21.9	-36.2
Taiwan	3.60	3.06	-14.8	3.10	1.2	-13.8
Singapore	69.93	59.44	-15.0	61.80	4.0	-11.6

Panel B: Stock Markets - June 1997 to May 1998

Country	6/30/97	12/31/97	% Δ 6/30/97 - 12/31/97	5/8/98	% Δ 1/1/98 - 5/8/98	Cumulative % Δ 6/30/97 – 5/8/98
Thailand	527.3	372.7	-29.3	386.4	3.7	-26.7
Malaysia	1,077.3	594.4	-44.8	580.1	-2.4	-46.2
Indonesia	725.0	401.7[a]	-44.6	434.7	8.2	-40.0
Philippines	2,809.0	1,869.2[b]	-33.5	2,210.0	18.2	-21.3
South Korea	745.4	376.3[b]	-49.5	373.0	-0.9	-50.0
Taiwan	9,030.0	8,187.3	-9.3	8,210.8	0.3	-9.1
Singapore	1,988.0	1,529.8	-23.0	1,420.8	-7.1	-28.5

Source: Bloomberg, IMF, Bank of International Settlements, World Bank, World Economic Outlook (various issues).
Note: a – As at 12/30/97; b – As of 12/29/97.

1 World Bank (2000) estimated the recapitalization costs of banks in the four affected countries in the Asian financial crisis ranged from 10% in Malaysia to 58% in Thailand as a share of GDP.

2 In the literature, this phenomenon is referred to as the 'twin crises'. During a banking crisis or an occurrence of banking distress, investors may re-allocate their portfolios away from domestic assets to foreign assets. A large capital outflow due to re-allocation of portfolio capital can lead to a significant run-out of foreign reserves and may encourage currency speculations.

Table II.1
ASEAN Economies - Selected Macroeconomic Indicators (continued)

Panel C: Real GDP Growth

Country	1994	1995	1996	1997	1998	1999
Thailand	9.3	9.2	5.9	-1.4	-10.5	4.4
Malaysia	9.2	9.8	10.0	7.3	-7.4	6.1
Indonesia	7.5	8.2	7.8	4.7	-13.0	0.3
Philippines	4.4	4.7	5.8	5.2	-0.6	3.4
South Korea	8.54	9.17	7.00	4.65	-6.85	9.49
Taiwan	7.90	5.00	7.27	6.79	3.31	6.60
Singapore	11.63	8.10	7.88	8.33	-1.33	7.15

Panel D: Growth of Bank Credit to the Private Sector

Country	1990 - 1994	1995	1996	End-1997
Thailand	10.0	11.1	5.8	30-40
Malaysia	3.1	10.5	13.1	30-40
Indonesia	10.4	4.4	5.7	25-30
Philippines	10.7	27.4	31.5	15-20
South Korea	2.6	2.2	-0.6	15-25
Singapore	0.8	7.8	5.7	30-40

Source: Bloomberg, IMF, Bank of International Settlements, World Bank, World Economic Outlook (various issues).
Note: a – As at 12/30/97; b – As of 12/29/97.

The Asian financial crisis, which spread from Thailand to other countries in the region during the second half of 1997, plunged the countries affected into deep recessions. The currency markets in the once fastest growing emerging Asian economies recorded huge falls ranging from 34% in the Philippines and 49% in Thailand, while the equity markets also declined abruptly from 29% in Thailand to 50% in South Korea during the second half of 1997 (Panels A and B of Table II.1). The economic growth in the region, which stood in the 6% to 8% neighbourhood prior to the crisis, fell into recession a year after the crisis stormed the East Asian region[3] (Panel C of Table II.1).

The outbreak, spread, and persistence of the crisis drew widespread attention from economists and financial analysts worldwide as the countries severely affected by the Asian financial crisis were dubbed "tiger economies" and had few of the weaknesses usually associated with countries that turn to IMF for help. These countries had fiscal surpluses, high private saving rates, and low inflation rate. Furthermore, in most cases these countries exchange rates did not seem to be out of line.

3 Frankel and Rose (1996), Sachs et al. (1996), Kaminsky et al. (1998), Corsetti et al. (1998), Eichengreen and Rose (1998), Chinn (1998), Kaminsky and Reinhart (1998), Krugman (1999), Berg and Pattillo (1999), among others examine the causes of the Asian financial crisis.

Despite the sound economic fundamentals, a few other major indicators point towards serious problems by the mid-1990s, further compounded by the weakness in the financial system. Each of the ASEAN-4 economies (Thailand, Indonesia, Malaysia, and Philippines) experienced a credit boom in the 1990s, that is the growth of bank and non-bank credit to the private sector exceeded by a wide margin the already rapid growth of real GDP (Panel D of Table II.1). The credit boom was fuelled in part by large net private capital inflows directed to the real estate and equities. As illustrated in Panel D of Table II.1, exposure to the property sector accounted for roughly 25% to 40% of total bank loans in Thailand, Indonesia, Malaysia, and Singapore[4]. This overextension and concentration of credit left the ASEAN-4 economies vulnerable to a shift in cyclical credit conditions. When the shift came, the need to raise interest rates to control overheating and to defend the faltering exchange rates resulted in property prices to fall and non-performing loans to escalate.

As each country has different economic structure, different economic measures were ensued. For example, Thailand and Indonesia experienced harsh stock market collapse, skyrocketing interest rates, and abrupt depreciation of the Baht and Rupiah respectively, asked the IMF for relief financing and took massive structural reshuffle as requested by the IMF. On the other hand, although Malaysia also experienced depreciation of the Ringgit and a depressed stock market, the countermeasures for the crisis were quite different from Thailand and Indonesia. Malaysia refused help from the IMF and reacted to the Asian financial crisis by adopting a strong capital control policy and a fixed exchange rate regime in order to stabilize the exchange rate and boost the financial sector.

The role of the IMF in dealing with the Asian financial crisis has been a subject of sharp criticisms on many fronts. Among others, Radelet and Sachs (1998) argued that some of the conditions imposed by the IMF on the crisis affected countries for financial assistance have exaggerated, rather than alleviated the panic. They suggest that the crisis affected countries were merely victims of a negative shift of sentiments on the part of international investors. The IMF is criticized for being too intrusive by making detailed recommendations on financial sector reform, recommending high interest rates, bank closures, tight fiscal policy, and on the ground of moral hazard argument.

In addressing this issue, a large number of studies have been undertaken to examine the impact of the IMF program on the crisis affected countries economies. Aside from this type of

4 Goldstein and Hawkins (1998) find that in Thailand, Indonesia, and Malaysia, this exposure was compounded by high (80% to 100%) loan to collateral ratios. Also, most of banks' exposure to the property market reflects exposure to property developers rather than to homeowners.

analysis, virtually nothing has been published on the impact of the Asian financial crisis on the efficiency of the ASEAN-4 banking sectors. In the light of these knowledge gaps, this paper seeks to examine the impact of the Asian financial crisis on the efficiency of the ASEAN-4 banking sectors. The present paper also attempts to compare the difference in the efficiency of the banking sectors which participated in the IMF program and the one that that decides against the IMF program. We differentiate this paper from previous ones that focus on the ASEAN-4 banking sectors and add insights in several respects discussed below.

First, unlike previous studies on the ASEAN-4 banking sectors, this paper attempts to contribute to the existing literature by providing new empirical evidence on the impact of the Asian financial crisis on the ASEAN-4 banking sectors' efficiency. Given that banks are the dominant financial institution in the ASEAN-4 economies, their health is very critical to the general economy at large, as demonstrated during the Asian financial crisis, which left many financial institutions in distress. Although it is has been contended that efficiency and productivity analysis can be used to assess the impact of major economic events such as economic crisis or financial liberalization on the performance of banking firms (seenFukuyama, 1995; Humphrey and Pulley, 1997; Leightner and Lovell, 1998; Isik and Hassan, 2003), the impact of the Asian financial crisis on the ASEAN-4 banking sectors' efficiency has not been critically studied yet.

Second, we compare the results obtained from the intermediation approach that has been followed in most recent studies of banks' efficiency with the revenue or profit approach that was recently proposed by Drake et al. (2006). This allows us to observe if different input and output definitions affect efficiency scores.

Finally, we run multivariate regression analysis to examine factors that influence the efficiency of the ASEAN-4 banking sectors during the post Asian financial crisis period. We analyze how different bank characteristics, such as capitalization, problem loans ratio, and size, influences the efficiency estimates, while controlling for other macroeconomic and market structure variables. We also examine whether countries that participated in the IMF program exhibits a higher efficiency level compared to the one which refused IMF help.

This paper is set out as follows: In the next section we provide reviews of the main literature. In section III we outline the approaches to the measurement of efficiency change as well as the method for the estimation of the determinants of bank efficiency. Section IV discusses the results, and finally we conclude in section V.

II. THEORY

The literature examining the efficiency of financial institutions with parametric and/or non-parametric frontier techniques has expanded rapidly in recent times. The issues examined are among others the impact of risk on bank efficiency (e.g. Drake and Hall, 2003), the impact of off-balance sheet activities on bank efficiency (e.g. Lozano-Vivas and Pasiouras, 2008), the relationship between bank efficiency and share prices (e.g. Pasiouras et al. 2008), the impact of mergers on bank efficiency (e.g. Al-Sharkas et al. 2008). The comparison of efficiency between foreign and domestic banks has also been studied extensively (e.g. Bhattacharyya et al. 1997; Isik and Hassan, 2002; Ataullah and Le, 2006).

A large body of literature spanning a half-century exists on banking efficiency in the United States (see surveys in Berger et al. 1993; Berger and Humphrey, 1997; Berger, 2007 and references therein). However, empirical evidence on the Asian countries is relatively scarce. Among the earliest to employ frontier technique to examine the performance of Asian banks is Fukuyama (1993) who considers the efficiency of 143 Japanese banks in 1990. The results suggest that banks of different organizational status perform differently in respect to all efficiency measures and that scale efficiency is positively but weakly associated with bank size.

Single country studies focusing on the East Asian banking sectors have mainly concentrated on the comparison between the foreign and domestic banks' performance. Generally, the empirical evidence showed that foreign banks have succeeded in capitalizing on their advantages and exhibit a higher level of efficiency than their domestic bank peers. Leightner and Lovell (1998) find that the average Thai bank experienced falling total factor productivity growth (TFP), while the average foreign bank experienced increasing TFP. Unite and Sullivan (2003) suggests that the entry of foreign banks in the Philippines has resulted in the reduction of interest rate spreads and bank profits of the domestic banks that are affiliated with family business groups. In a study on the Malaysian banking sector, Matthews and Ismail (2005) suggests that foreign banks in Malaysia have exhibited a higher level of technical efficiency. They also suggest that the productivity of the domestic banks is more susceptible to macroeconomic shocks than their foreign bank counterparts.

The South Asian banking sectors have also been studied extensively. Sathye (2003) and Shanmugam and Das (2004) find that the public and foreign owned banks in India have exhibited a higher level of technical efficiency compared to their privately owned bank peers. Iimi (2004) suggest that privatized banks in Pakistan are the most efficient, followed by foreign and private banks, while the public banks are the least efficient. Hardy and Patti (2001) investigate the effects of financial reforms on profitability, cost, and revenue efficiency of the Pakistan banking sector during 1981-1998. They show that financial liberalization has positive impact on banks'

performance. Subsequently, Patti and Hardy (2005) examine the cost and profit efficiency of Pakistan commercial banks during the period 1981-2002. They find that financial liberalization lead to higher bank profitability, but only during the first round of financial reform of 1991-1992.

Kwan (2003) is among the few studies that have analyzed the efficiency of the East Asian banking sectors in a multi-country setting. He studied the operating performance efficiency of banks among seven Asian economies over the period 1992 to 1999 failed to find any positive relationship between operating efficiency and the degree of openness of the banking sector. More recently, Williams and Nguyen (2005) examined the impact of changes in bank ownership on banking sectors' performance in Indonesia, Malaysia, Thailand, Korea, and the Philippines during the period 1990-2003. They suggest that bank privatization lead to higher bank performance.

III. METHODOLOGY

III.1. Data Envelopment Analysis

The non-parametric Data Envelopment Analysis (DEA) is employed with variable return to scale (VRS) assumption to measure the input-oriented technical efficiency of the ASEAN-4 banks. DEA involves constructing a non-parametric production frontier based on the actual input-output observations in the sample relative to which efficiency of each bank in the sample is measured (Coelli, 1996). Let us give a short description of the DEA. Assume that there is data on K inputs and M outputs for each N bank. For ith bank these are represented by the vectors x_i and y_i respectively. Let us call the K x N input matrix – X and the M x N output matrix – Y. To measure the efficiency for each bank we calculate a ratio of all inputs, such as $(u'y_i/v'x_i)$ where u is an M x 1 vector of output weights and v is a K x 1 vector of input weights. To select optimal weights we specify the following mathematical programming problem:

$$\min_{u,v} (u'y_i/v'x_i),$$

$$u'y_i/v'x_i \leq 1, \qquad j = 1, 2, \ldots, N,$$

$$u, v \geq 0 \qquad \text{(II.1)}$$

The above formulation has a problem of infinite solutions and therefore we impose the constraint $v'x_i = 1$, which leads to:

$$\min_{\mu,\varphi} (\mu'y_i),$$

$$\varphi' x_i = 1$$

$$\mu' y_i - \varphi' x_j \leq 0 \qquad j = 1, 2, \ldots, N,$$

$$\mu, \varphi \geq 0 \qquad \text{(II.2)}$$

where we change notation from u and v to μ and φ, respectively, in order to reflect transformations. Using the duality in linear programming, an equivalent envelopment form of this problem can be derived:

$$\min_{\theta, \lambda} \theta,$$

$$y_i + Y\lambda \geq 0$$

$$\theta x_i + X\lambda \geq 0$$

$$\lambda \geq 0 \qquad \text{(II.3)}$$

where θ is a scalar representing the value of the efficiency score for then i th bank which will range between 0 and 1. λ is a vector of N x 1 constants. The linear programming has to be solved N times, once for each bank in the sample. In order to calculate efficiency under the assumption of VRS, the convexity constraint ($N1'\lambda = 1$) will be added to ensure that an inefficient bank is only compared against banks of similar size, and therefore provides the basis for measuring economies of scale within the DEA concept.

III.2 Multivariate Regression Analysis

Data Envelopment Analysis, in the context of the study of the influence of contextual variables, has the drawback of relying on two stage statistical procedures, where efficiencies computed in the first stage are modeled via a regression model in the second stage. These pose technical problems since efficiency measurements will be correlated. If the contextual variables are exogenous to the production process, Simar and Wilson (2007), Souza and Staub (2007) and Banker and Natarajan (2008) show that the two stage analysis is viable and under certain error conditions, may even capture nonparametric stochastic efficiency results. Banker and Natarajan (2008) provide proof that the use of a two-stage procedure involving DEA followed by an OLS regression yields consistent estimators of the regression coefficients. Furthermore, McDonald (2009) provide statistical foundation that that the use of DEA and OLS is a consistent estimator, and if White's (1980) heteroskedastic consistent standard errors are calculated, large sample tests can be performed which are robust to heteroskedasticity and the distribution of the disturbances.

Motivated by these recent results on DEA, following among others Saranga and Phani (2009), and Chang et al. (2008), the second stage regressions in this study are estimated by using the ordinary least square (OLS) method, where the standard errors are calculated by using White's (1980) cross-section tests to adjust for cross section heteroskedasticity.

To test the relationship between the efficiency of the ASEAN-4 banking sectors and other bank specific traits, macroeconomic, and market specific factors, the following regression model is estimated:

$$\theta_{jt} = \beta_0 + \beta_1 \Sigma Characteristics + \beta_2 \Sigma Econ + \varepsilon_{jt} \quad \text{(II.4)}$$

where, θ_{jt} is the technical efficiency of the *j* th bank in period t obtained from DEA intermediation and revenue approaches, *Characteristics* is a set of bank specific characteristics, *Econ* is a vector of economic and market conditions.

Extending Eq. (II.4) to reflect the variables as described in Table II.3, the model is formulated as follows:

$$\theta_{jt} = \delta_t + \alpha_{jt} (EQASS_{jt} + LNTA_{jt} + LLP/TL_{jt} + NIE/TA_{jt} + NII/TA_{jt} + ROAA_{jt})$$
$$+ \alpha_{it} (LNGDP_t + INFL_t + CR\_3 + IMF) + \varepsilon_{jt} \quad \text{(II.5)}$$

III.3 Specification of Bank Inputs, Outputs, and Data

It is commonly acknowledged that the choice of variables in efficiency studies significantly affects the results. The problem is compounded by the fact that variable selection is often constrained by the paucity of data on relevant variables. The cost and output measurements in banking are especially difficult because many of the financial services are jointly produced and prices are typically assigned to a bundle of financial services. The role of the commercial banks is generally defined as collecting the savings of households and other agents to finance the investment needs of firms and consumption needs of individuals. Three approaches dominate the literature: the production approach, the intermediation approach and more recently, the revenue or profit oriented approach. The first two approaches apply the traditional microeconomic theory of the firm to banking and differ only in the specification of banking activities. The third approach goes a step further and incorporates some specific activities of banking into the classical theory and thereby modifies it.

Under the production approach, pioneered by Benston (1965), a financial institution is defined as a producer of services for account holders, that is, they perform transactions on deposit accounts and process documents such as loans. According to this approach, the number

of accounts or its related transactions is the best measure for output, while the number of employees and physical capital are considered as inputs. This approach has primarily been employed in studying the efficiency of bank branches (Berger and Humphrey, 1992). The intermediation approach on the other hand assumes that financial firms act as an intermediary between savers and borrowers and posits total loans and securities as outputs, whereas deposits along with labour and physical capital are defined as inputs. More recently, Drake et al. (2006) proposed the revenue approach in DEA. The revenue approach (or income based approach) views banks as business units with the final objective of generating revenue from the total cost incurred for running the business. Accordingly, it defines banks' output as total revenue (interest and non-interest income) and inputs as the total expenses (interest and non-interest expenses).

The appropriateness of each approach varies according to the circumstances. However, based on practical considerations and to examine the robustness of the estimated efficiency

Table II.2
Descriptive Statistics for Inputs and Outputs

	Loans (Y1)	Investments (Y2)	Interest Income (Y3)	Non-Interest Income (Y4)	Total Deposits (X1)	Capital (X2)	Interest Expenses (X3)	Non-Interest Expense (X4)
Panel A : Malaysia								
Min	304.7	82.4	16.2	11.7	82.0	0.3	11.1	10.5
Mean	36,336.2	4,793.8	2,931.9	622.3	37,596.5	552.3	1,485.2	873.7
Max	126,005.2	29,846.6	9,616.5	2,424.9	131,068.0	1,528.1	6,148.5	2,938.8
S.D	28,568.9	5,321.0	2,211.2	521.7	29,328.8	402.1	1,149.0	634.8
Panel B : Thailand								
Min	3,482.4	4.4	1,144.7	23.8	26,069.1	103.1	1,172.1	404.9
Mean	374,592.3	53,087.3	21,954.4	5,692.1	432,377.4	12,392.7	12,244.4	12,337.9
Max	978,372.5	256,903.8	67,114.3	21,461.2	1,195,366.5	35,233.7	57,771.8	40,623.8
S.D	282,301.1	54,578.8	17,716.0	5,382.3	334,933.7	10,322.5	11,021.3	10,123.9
Panel C : Indonesia								
Min	45,172.3	17.8	27,708.3	270.4	13,906.1	162.6	10,313.8	5,591.6
Mean	10,778,081.4	12,088,763.3	3,179,087.0	553,364.6	24,125,755.3	569,425.8	2,319,251.4	1,005,351.5
Max	106,693,088.0	150,770,000.0	31,474,380.0	7,690,285.0	206,289,664.0	5,483,628.0	35,552,660.0	17,351,460.0
S.D	18,710,265.5	25,326,765.6	5,710,159.2	1,158,807.1	41,960,002.4	996,137.5	4,736,490.6	2,022,434.2
Panel D : Philippines								
Min	10.1	0.8	8.6	4.4	242.3	44.9	4.7	19.3
Mean	52,104.4	21,298.5	7,251.5	2,350.4	83,673.6	6,812.9	4,202.6	3,780.8
Max	270,006.5	141,583.0	38,307.5	11,895.4	424,248.0	42,282.5	25,078.5	18,864.4
S.D	67,672.8	28,168.8	9,103.2	2,899.3	105,816.0	10,385.7	5,081.0	4,638.5

Note: Y1: Loans (includes loans to customers and other banks), Y2: Investments (includes dealing and investment securities), Y3: Interest Income, Y4: Non-Interest Income (defined as fee income and other non-interest income, which among others consist of commission, service charges and fees, guarantee fees, and foreign exchange profits), X1: Total Deposits (includes deposits from customers and other banks), X2: Capital (measured by the book value of property, plant, and equipment), X3: Interest Expenses, X4: Non-Interest Expense.
Source: Banks Annual Reports and authors own calculations

scores under various alternatives, the present study focuses on two major approaches: intermediation approach and revenue approach. Under the intermediation approach, we assume deposits (X1), capital (X2) and, non-interest expense (X4) as inputs for producing loans (Y1) and investments (Y2). Under the revenue approach, interest expense (X5) and non-interest expense (X4) are used as inputs producing outputs like interest income (Y3) and non-interest income (Y4).

We use annual bank level and macroeconomic data of ASEAN-4 commercial banks over the period 1999-2005. The variables are obtained from published balance sheet information in annual reports of each individual bank, while the macro data is collected from the World Bank World Development Indicators (WDI). The final sample accounts for more than 80% of Malaysia, 90% of Thailand, 74% of Philippines, and 35% of Indonesia banking sectors' total assets respectively. Table II.2 presents summary statistics of the output and input variables used to construct the DEA model.

Several bank and industry specific attributes may influence a particular bank's efficiency level. We use an array of bank specific variables to control banks' production technologies, the input and product market share they are facing, and other factors that might confound the empirical relationship between bank characteristics and efficiency. The independent variables used to explain bank efficiency are grouped under two main characteristics. The first represent bank specific attributes, while the second encompass economic conditions and market specific factors during the period examined. The bank specific variables included in the regressions are, EQASS, LNTA, LLP/TL, NIE/TA, NII/TA, and ROAA. To measure the relationship between economic and market specific factors and bank efficiency, LNGDP, INFL, IMF, and CR_3 are used. The

Table II.3
Descriptive of the Variables Used in the Regression Models

Variable	Description	HypothesizedRelation ship With Efficiency
	Bank Characteristics	
EQASS	Total book value of shareholders equity over total assets	+/-
LNTA	Natural logarithm of total assets	+/-
LLP/TL	Loan loss provisions over total loans	-
NIE/TA	Non-interest expense over total assets	-
NII/TA	Non-interest income over total assets	+
ROAA	Return on average assets	+
	Economic Conditions / Market Specific	
LNGDP	Natural logarithm of gross domestic products	+/-
INFL	Inflation rate.	+/-
CR_3	Proxy for the concentration in terms of assets of the three largest banks.	+/-
IMF	Dummy variable that takes a value of 1 for banks in countries which resort to IMF, 0 otherwise	+/-

independent variables and their hypothesized relationship with bank efficiency are detailed in Table II.3.

IV. RESULT AND ANALYSIS

In this section, we will discuss the technical efficiency (TE) change of the ASEAN-4 banking sectors, measured by the DEA method and its decomposition into pure technical efficiency (PTE) and scale efficiency (SE) components. The efficiency of banks is first examined by applying the DEA method for each year under investigation. The results are classified into two broad heads. First, we describe the estimates of technical efficiency under two alternative approaches. To substantiate the results under the DEA approach, a multivariate regression framework is employed to relate bank efficiency level to a set of bank characteristics and other macroeconomic and market specific factor variables.

IV.1 Efficiency of the ASEAN-4 Banking Sectors

The summary results of technical efficiency estimates for the Malaysian, Indonesian, Philippines, and Thailand banking sectors under the intermediation and revenue approaches are presented in Tables II.4 and II.5 respectively. The average technical efficiency estimate (M) represents the average of all optimal values obtained from Constant Returns to Scale (CRS) model for each commercial bank. The empirical results suggest a large asymmetry between banks regarding their technical efficiency scores. In particular, different approaches of measuring inputs and outputs of banks produce divergent sets of efficiency estimates. In general, the estimates of technical efficiency are observed to be consistently higher under revenue approach.

On the other hand, under the intermediation approach, banks are characterized by relatively low level of technical efficiency. Illustratively, in year 1999, only one bank in Malaysia and Philippines and two banks in Indonesia and Thailand are found to be efficient under the intermediation approach and the average technical efficiency of banks in Malaysia, Indonesia, Philippines, and Thailand stood at 50.7%, 45.7%, 67.2%, and 71.7% respectively. On the other hand, under revenue approach, the number of efficient banks is higher. The average efficiency levels are also markedly higher. In sum, during the period of 1999-2005, there has been no perceptible change in the number of efficient banks under both approaches for the ASEAN-4 banking sectors.

The dispersion of technical efficiency scores as measured by its standard deviation roughly depicts declining trends across the ASEAN-4 banking sectors. On the other hand, the percentage

Table II.4
Average Technical Efficiency - Intermediation Approach

Year	# of Banks	# of Efficient Banks	Average Efficiency (M)	Standard Deviation (σ)	Interval		(%) of Banks in I	(%) of Banks 1Std. Dev. Be low Mean
					(I=M -σ)	(I=M +σ)		
Panel A : Malaysia								
1999	12	1	0.507	0.171	0.336	0.678	91.67	0.00
2000	10	1	0.627	0.153	0.474	0.780	80.00	10.00
2001	9	1	0.724	0.158	0.566	0.882	55.56	22.22
2002	9	2	0.823	0.130	0.693	0.953	66.67	11.11
2003	9	2	0.827	0.118	0.709	0.945	66.67	11.11
2004	9	2	0.823	0.125	0.698	0.948	66.67	11.11
2005	9	4	0.895	0.122	0.773	1.017	77.78	22.22
Panel B : Thailand								
1999	13	2	0.717	0.236	0.481	0.953	76.92	7.69
2000	13	2	0.701	0.215	0.486	0.916	76.92	7.69
2001	11	1	0.724	0.118	0.606	0.842	81.82	9.09
2002	11	2	0.886	0.095	0.791	0.981	63.64	18.18
2003	11	3	0.876	0.115	0.761	0.991	63.64	9.09
2004	10	2	0.851	0.102	0.749	0.953	50.00	20.00
2005	10	2	0.867	0.105	0.762	0.972	40.00	30.00
Panel C : Indonesia								
1999	28	2	0.457	0.258	0.199	0.715	71.43	14.29
2000	26	2	0.545	0.256	0.289	0.801	57.69	23.08
2001	25	1	0.360	0.195	0.165	0.555	76.00	12.00
2002	25	1	0.544	0.220	0.324	0.764	68.00	16.00
2003	28	2	0.586	0.236	0.350	0.822	67.86	17.86
2004	25	4	0.702	0.228	0.474	0.930	76.00	16.00
2005	25	3	0.743	0.204	0.539	0.947	68.00	16.00
Panel D : Philippines								
1999	20	1	0.672	0.157	0.515	0.829	65.00	15.00
2000	20	2	0.650	0.177	0.473	0.827	75.00	10.00
2001	20	2	0.768	0.173	0.595	0.941	60.00	15.00
2002	18	3	0.749	0.185	0.564	0.934	50.00	27.78
2003	18	3	0.724	0.187	0.537	0.911	55.56	22.22
2004	16	1	0.609	0.181	0.428	0.790	75.00	18.75
2005	16	2	0.624	0.218	0.406	0.842	75.00	12.50

of banks wherein technical efficiency lies within the interval of one standard deviation around the mean hovered around 40% to 92% in Malaysia, Indonesia, Philippines, and Thailand banking sectors. These numbers are higher under the revenue approach. As the technical efficiency estimates is time varying, these proportions do not necessarily corroborate the degree of (in) efficiency of the banking systems. For example, under the intermediation approach around 92.0%, 77%, and 71% of banks exhibit technical efficiency within the interval of one standard

Table II.5
Average Technical Efficiency - Revenue Approach

Year	# of Banks	# of Efficient Banks	Average Efficiency (M)	Standard Deviation (σ)	Interval		(%) of Banks in I	(%) of Banks 1Std. Dev. Be low Mean
					(I=M -σ)	(I=M +σ)		
Panel A : Malaysia								
1999	12	2	0.745	0.141	0.604	0.886	66.67	16.67
2000	10	3	0.899	0.108	0.791	1.007	80.00	20.00
2001	9	2	0.778	0.181	0.597	0.959	55.56	22.22
2002	9	4	0.944	0.089	0.855	1.033	77.78	11.11
2003	9	3	0.877	0.141	0.736	1.018	77.78	22.22
2004	9	3	0.817	0.168	0.649	0.985	55.56	11.11
2005	9	3	0.874	0.125	0.749	0.999	55.56	33.33
Panel B : Thailand								
1999	13	5	0.918	0.088	0.830	1.006	92.31	15.38
2000	13	3	0.902	0.098	0.804	1.000	84.62	15.38
2001	11	2	0.782	0.120	0.662	0.902	81.82	0.00
2002	11	3	0.859	0.125	0.734	0.984	54.55	18.18
2003	11	3	0.823	0.129	0.694	0.952	54.55	18.18
2004	10	4	0.958	0.063	0.895	1.021	80.00	20.00
2005	10	4	0.939	0.085	0.854	1.024	90.00	10.00
Panel C : Indonesia								
1999	29	5	0.736	0.197	0.539	0.933	62.07	17.24
2000	27	5	0.788	0.150	0.638	0.938	59.26	18.52
2001	26	4	0.685	0.206	0.479	0.891	57.69	19.23
2002	26	7	0.783	0.165	0.618	0.948	57.69	15.38
2003	29	6	0.787	0.165	0.622	0.952	62.07	13.79
2004	26	6	0.830	0.138	0.692	0.968	61.54	15.38
2005	25	6	0.886	0.103	0.783	0.989	64.00	12.00
Panel D : Philippines								
1999	20	4	0.785	0.176	0.609	0.961	60.00	15.00
2000	19	5	0.810	0.180	0.630	0.990	52.63	21.05
2001	20	6	0.872	0.171	0.701	1.043	85.00	15.00
2002	18	6	0.839	0.156	0.683	0.995	55.56	11.11
2003	18	3	0.811	0.149	0.662	0.960	72.22	11.11
2004	16	2	0.798	0.136	0.662	0.934	68.75	18.75
2005	14	3	0.843	0.117	0.726	0.960	57.14	21.43

deviation around the mean in 1999 compared to around 78%, 40%, and 68% in Malaysia, Thailand, and Indonesia respectively during 2005. Yet banks are relatively more efficient in 2005 than in 1999.

As against the changing benchmark of comparison, these proportions quantify the number of banks that are close to the average over time and thus merely capture the kurtosis of the efficiency distribution. For instance, in the case of the Malaysian banking sector, the efficiency

scores displays a leptokurtic distribution i.e. the efficiency scores has a high peak with a small variance, suggesting that a lot of scores fall in the center of the distribution. On the other hand, the efficiency of the Philippines banking sector seem to follow a mesokurtic distribution i.e. the efficiency scores displays a moderate peak with gradual curves suggesting a normal number of scores in the middle range of the distribution.

Overall, the findings presented in Tables II.4 and II.5 clearly bring forth the high degree of inefficiency of several banks in each country during the sample period. Most of the inefficiency stemmed from the under utilization of resources (waste of inputs). Finally, considering the evolution of efficiency over time, a clear temporal pattern does not emerge from these different approaches. However, especially under the intermediation approach, inefficiency exists in the production of banking services and appears to be an important determinant of banks' costs. Therefore, any empirical examination of the performance of the ASEAN-4 banking sectors would need to take cognizance of the presence of inefficiency.

Once technical efficiency is estimated using the VRS model, scale efficiency is derived by dividing the technical efficiency by pure technical efficiency. These estimates are presented in Tables II.6 -II.9. It is observed that over the sample period, both pure technical and scale efficiency measures, especially under intermediation approach, displays significant variation and did not achieve sustained efficiency gains across the ASEAN-4 banking sectors. The estimates of pure technical efficiency under the intermediation approach vary from a low of 71.1% in 1999 to a high of 95.3% in 2005 in the case of Malaysia, 86.7% in 1999 to 95.2% in 2001 in the case of Thailand, 60.2% in 1999 to 80.4% in 2005 in the case of Indonesia, and 77.8% in 2004 to 87.9% in 2001 in the case of the Philippines banking sector. The percentage of banks whose pure technical efficiency falls within the interval of one standard deviation around the mean fluctuated around 42% to 89% in Malaysia, 46% to 91% in Thailand, 48% to 88% in Indonesia, and 78% to 85% in the Philippines under the intermediation approach. On the other hand, under the revenue approach, the figures remained fairly stable across the ASEAN-4 banking sectors over the years.

It is observed from Tables II.8 to II.9 that the number of efficient banks under CRS (technical efficiency) and VRS (pure technical efficiency) differs markedly, irrespective of the choice of various inputs and outputs. This clearly demonstrates the existence of sizable scale inefficiency among the ASEAN-4 banking sectors. Under the intermediation approach, for example, Tables 8 reveals that 20% to 60% of banks have been efficient under VRS, whereas only 10% to 20% banks are efficient under CRS across the ASEAN-4 banking sectors during the period under study. This indicates that the remaining 80% to 90% banks failed to reach the CRS frontier

Table II.6
Average Pure Technical Efficiency - Intermediation Approach

Year	# of Banks	# of Efficient Banks	Average Efficiency (M)	Standard Deviation (σ)	Interval		(%) of Banks in I	(%) of Banks 1Std. Dev. Be low Mean
					(I=M -σ)	(I=M +σ)		
Panel A : Malaysia								
1999	12	4	0.711	0.239	0.472	0.950	41.67	25.00
2000	10	3	0.755	0.198	0.557	0.953	50.00	20.00
2001	9	3	0.802	0.180	0.622	0.982	44.44	22.22
2002	9	4	0.899	0.122	0.777	1.021	88.89	11.11
2003	9	4	0.917	0.104	0.813	1.021	66.67	33.33
2004	9	4	0.912	0.117	0.795	1.029	77.78	22.22
2005	9	6	0.953	0.081	0.872	1.034	88.89	11.11
Panel B : Thailand								
1999	13	5	0.867	0.118	0.749	0.985	46.15	15.38
2000	13	6	0.921	0.083	0.838	1.004	84.62	15.38
2001	11	5	0.952	0.067	0.885	1.019	72.73	27.27
2002	11	4	0.922	0.083	0.839	1.005	90.91	9.09
2003	11	3	0.886	0.109	0.777	0.995	63.64	9.09
2004	10	3	0.885	0.083	0.802	0.968	60.00	10.00
2005	10	5	0.928	0.096	0.832	1.024	80.00	20.00
Panel C : Indonesia								
1999	28	6	0.602	0.298	0.304	0.900	57.14	21.43
2000	26	11	0.780	0.286	0.494	1.066	80.77	19.23
2001	25	6	0.728	0.248	0.480	0.976	60.00	12.00
2002	25	8	0.734	0.253	0.481	0.987	48.00	20.00
2003	28	6	0.680	0.251	0.429	0.931	57.14	21.43
2004	25	7	0.753	0.231	0.522	0.984	60.00	16.00
2005	25	5	0.804	0.197	0.607	1.001	88.00	12.00
Panel D : Philippines								
1999	20	7	0.826	0.186	0.640	1.012	80.00	20.00
2000	20	9	0.874	0.174	0.700	1.048	80.00	20.00
2001	20	11	0.879	0.176	0.703	1.055	85.00	15.00
2002	18	9	0.849	0.193	0.656	1.042	77.78	22.22
2003	18	8	0.834	0.206	0.628	1.040	77.78	22.22
2004	16	5	0.778	0.247	0.531	1.025	81.25	18.75
2005	16	4	0.782	0.251	0.531	1.033	81.25	18.75

owing to scale inefficiencies. Therefore, scale inefficiency appears to be a serious problem across the ASEAN-4 banking sectors. In general, average scale efficiency estimates of the ASEAN-4 banking sectors have been low for most of the years under the intermediation approach (Table II.8). Thus, with respect to their current scale of operations, banks in the ASEAN-4 countries are likely to lose sizeable output.

Table II.7
Average Pure Technical Efficiency - Revenue Approach

Year	# of Banks	# of Efficient Banks	Average Efficiency (M)	Standard Deviation (σ)	Interval		(%) of Banks in I	(%) of Banks 1Std. Dev. Be low Mean
					(I=M -σ)	(I=M +σ)		
Panel A : Malaysia								
1999	12	6	0.901	0.133	0.768	1.034	83.33	16.67
2000	10	5	0.929	0.090	0.839	1.019	80.00	20.00
2001	9	5	0.912	0.106	0.806	1.018	77.78	22.22
2002	9	5	0.959	0.063	0.896	1.022	77.78	11.11
2003	9	6	0.922	0.122	0.800	1.044	77.78	22.22
2004	9	5	0.889	0.163	0.726	1.052	77.78	11.11
2005	9	6	0.925	0.117	0.808	1.042	77.78	33.33
Panel B : Thailand								
1999	13	7	0.964	0.051	0.913	1.015	76.92	23.08
2000	13	7	0.935	0.094	0.841	1.029	84.62	15.38
2001	11	3	0.840	0.128	0.712	0.968	72.73	0.00
2002	11	5	0.900	0.114	0.786	1.014	81.82	18.18
2003	11	6	0.905	0.124	0.781	1.029	72.73	27.27
2004	10	8	0.996	0.010	0.986	1.006	90.00	10.00
2005	10	7	0.952	0.087	0.865	1.039	90.00	10.00
Panel C : Indonesia								
1999	29	16	0.876	0.170	0.706	1.046	89.66	10.34
2000	27	16	0.910	0.127	0.783	1.037	81.48	18.52
2001	26	10	0.826	0.187	0.639	1.013	76.92	23.08
2002	26	13	0.885	0.160	0.725	1.045	84.62	15.38
2003	29	13	0.871	0.153	0.718	1.024	86.21	13.79
2004	26	12	0.900	0.132	0.768	1.032	76.92	23.08
2005	25	11	0.920	0.095	0.825	1.015	88.00	12.00
Panel D : Philippines								
1999	20	5	0.813	0.165	0.648	0.978	60.00	15.00
2000	19	8	0.865	0.167	0.698	1.032	78.95	21.05
2001	20	7	0.905	0.152	0.753	1.057	75.00	25.00
2002	18	7	0.873	0.157	0.716	1.030	77.78	22.22
2003	18	6	0.866	0.168	0.698	1.034	88.89	11.11
2004	16	5	0.836	0.150	0.686	0.986	50.00	18.75
2005	14	4	0.871	0.118	0.753	0.989	50.00	21.43

Table II.8
Average Scale Efficiency - Intermediation Approach

Year	# of Banks	# of Efficient Banks	Average Efficiency (M)	Standard Deviation (σ)	Interval		(%) of Banks in I	(%) of Banks 1Std. Dev. Be low Mean
					(I=M -σ)	(I=M +σ)		
Panel A : Malaysia								
1999	12	1	0.748	0.184	0.564	0.932	66.67	16.67
2000	10	1	0.847	0.134	0.713	0.981	50.00	30.00
2001	9	1	0.909	0.075	0.834	0.984	66.67	11.11
2002	9	2	0.918	0.085	0.833	1.003	77.78	22.22
2003	9	2	0.903	0.088	0.815	0.991	55.56	22.22
2004	9	2	0.906	0.096	0.810	1.002	88.89	11.11
2005	9	4	0.939	0.100	0.839	1.039	88.89	11.11
Panel B : Thailand								
1999	13	2	0.836	0.245	0.591	1.081	92.31	7.69
2000	13	2	0.767	0.229	0.538	0.996	76.92	7.69
2001	11	1	0.761	0.106	0.655	0.867	81.82	9.09
2002	11	2	0.960	0.029	0.931	0.989	63.64	18.18
2003	11	3	0.988	0.011	0.977	0.999	54.55	18.18
2004	10	2	0.960	0.041	0.919	1.001	90.00	10.00
2005	10	2	0.936	0.082	0.854	1.018	90.00	10.00
Panel C : Indonesia								
1999	28	2	0.766	0.177	0.589	0.943	64.29	17.86
2000	26	2	0.709	0.199	0.510	0.908	73.08	11.54
2001	25	1	0.522	0.233	0.289	0.755	64.00	8.00
2002	25	1	0.745	0.158	0.587	0.903	68.00	16.00
2003	28	3	0.874	0.153	0.721	1.027	82.14	17.86
2004	25	4	0.934	0.095	0.839	1.029	92.00	8.00
2005	25	4	0.926	0.107	0.819	1.033	80.00	20.00
Panel D : Philippines								
1999	20	1	0.830	0.144	0.686	0.974	55.00	20.00
2000	20	2	0.753	0.161	0.592	0.914	65.00	10.00
2001	20	3	0.879	0.111	0.768	0.990	70.00	10.00
2002	18	3	0.890	0.126	0.764	1.016	77.78	22.22
2003	18	3	0.883	0.139	0.744	1.022	77.78	22.22
2004	16	1	0.807	0.138	0.669	0.945	68.75	6.25
2005	16	2	0.810	0.133	0.677	0.943	50.00	25.00

Table II.9
Average Scale Efficiency - Revenue Approach

Year	# of Banks	# of Efficient Banks	Average Efficiency (M)	Standard Deviation (σ)	Interval		(%) of Banks in I	(%) of Banks 1Std. Dev. Be low Mean
					(I=M -σ)	(I=M +σ)		
Panel A : Malaysia								
1999	12	2	0.837	0.153	0.684	0.990	58.33	25.00
2000	10	4	0.966	0.049	0.917	1.015	80.00	20.00
2001	9	2	0.848	0.158	0.690	1.006	77.78	22.22
2002	9	4	0.982	0.032	0.950	1.014	77.78	11.11
2003	9	3	0.950	0.065	0.885	1.015	88.89	11.11
2004	9	3	0.922	0.104	0.818	1.026	88.89	11.11
2005	9	3	0.948	0.090	0.858	1.038	88.89	11.11
Panel B : Thailand								
1999	13	6	0.952	0.082	0.870	1.034	84.62	15.38
2000	13	3	0.966	0.057	0.909	1.023	84.62	15.38
2001	11	2	0.938	0.098	0.840	1.036	90.91	9.09
2002	11	3	0.957	0.082	0.875	1.039	81.82	18.18
2003	11	3	0.913	0.105	0.808	1.018	81.82	18.18
2004	10	5	0.962	0.064	0.898	1.026	80.00	20.00
2005	10	4	0.987	0.019	0.968	1.006	90.00	10.00
Panel C : Indonesia								
1999	29	5	0.845	0.157	0.688	1.002	82.76	17.24
2000	27	5	0.870	0.125	0.745	0.995	62.96	18.52
2001	26	4	0.833	0.166	0.667	0.999	69.23	15.38
2002	26	8	0.890	0.116	0.774	1.006	76.92	23.08
2003	29	6	0.904	0.094	0.810	0.998	62.07	17.24
2004	26	6	0.926	0.098	0.828	1.024	84.62	15.38
2005	25	8	0.963	0.057	0.906	1.020	84.00	16.00
Panel D : Philippines								
1999	20	4	0.962	0.050	0.912	1.012	85.00	15.00
2000	19	6	0.937	0.089	0.848	1.026	73.68	26.32
2001	20	7	0.960	0.067	0.893	1.027	90.00	10.00
2002	18	10	0.963	0.061	0.902	1.024	83.33	16.67
2003	18	3	0.942	0.060	0.882	1.002	66.67	33.33
2004	16	3	0.957	0.047	0.910	1.004	75.00	25.00
2005	14	3	0.968	0.036	0.932	1.004	85.71	14.29

IV.2 The Determinants of Banks' Efficiency

Regression results focusing on the relationship between bank efficiency and the explanatory variables are presented in Tables II.10 and II.11. The equations are based on 446 (intermediation approach) and 451 (revenue approach) bank year observations during the 1999-2005 period. To conserve space, the full regression results, which include bank, country, and time-specific random effects, are not reported in the paper. In models II.2 to II.4 regressions, when we add the other macroeconomic and market specific variables to the baseline specification that include

Table II.10
Multivariate Regression Analysis

$$BANKEFF_{jt} = \alpha + \beta_1 EQASS + \beta_2 LNTA + \beta_3 LLP/TL + \beta_4 NIE/TA + \beta_5 NII/TA + \beta_6 ROAA + \beta_7 LNGDP + \beta_8 INFL + \beta_9 CR\_3 + \beta_{10} IMF + \varepsilon_j$$

The dependent variables are bank's technical efficiency score derived from the DEA Intermediation approach. EQASS is a measure of bank capitalization measured by total shareholders equity divided by total assets. LNTA is the size of the bank measured as the natural logarithm of total assets. LLP/TL is a measure of risk calculated as the ratio of total loan loss provisions divided by total loans. NIE/TA is a measure of management quality calculated as total non-interest expenses divided by total assets. NII/TA is a proxy measure for diversification towards non-interest income, calculated as total non-interest income divided by total assets. ROAA is a proxy measure for profitability calculated as profit after tax divided by average total assets. LNGDP is natural logarithm of gross domestic product. INFL is the inflation rate. CR_3 is the 3-bank concentration ratio. IMF is a binary variable that takes a value of 1 for banks in countries, which resort to IMF, 0 otherwise.
Values in parentheses are standard errors.
***, **, and * indicate significance at 1, 5 and 10% levels.

	Intermediation Approach			
	Model 1	**Model 2**	**Model 3**	**Model 4**
CONSTANT	0.503437**	1.580559***	0.594610***	1.695365***
	(2.358402)	(4.672162)	(2.842828)	(5.343458)
Bank Characteristics				
EQASS	0.250131**	0.287396***	0.261460**	0.300683***
	(2.089644)	(2.729242)	(2.430087)	(3.244123)
LNTA	0.029413*	0.012249	0.024415	0.006847
	(1.780343)	(0.735875)	(1.517362)	(0.456302)
LLP/TL	0.095700**	0.098050**	0.109337**	0.112911**
	(2.172619)	(2.359470)	(2.152538)	(2.221143)
NIE/TA	1.497771***	0.953848***	1.552629***	1.007398***
	(3.133859)	(3.687442)	(2.962891)	(3.571843)
NII/TA	1.031242	0.790387	1.385434	1.177958
	(0.786325)	(0.746605)	(1.089119)	(1.171814)
ROAA	-0.043997	-0.247660	-0.014038	-0.218282
	(-0.148513)	(-1.195330)	(-0.049738)	(-1.137707)
Economic Conditions/ Market Specific Factors				
LNGDP	-0.027093***	-0.014913	-0.039542***	-0.028605*
	(-3.268134)	(-1.206479)	(-4.225010)	(-1.765998)
INFL	-0.006849***	0.001548	-0.006453***	0.002133
	(-3.058988)	(0.614152)	(-3.000705)	(0.827924)
CR_3		-1.762961***		0.160129***
		(-6.318397)		(2.663158)
IMF			0.145644***	-1.791752***
			(3.087752)	(-6.781625)
R^2	0.151956	0.215611	0.161088	0.226527
Adj. R^2	0.136431	0.199419	0.143771	0.208746
F-statistics	9.787938***	13.31627***	9.302306***	12.73982***
No. of Observations	446	446	446	446

the bank specific attribute variables, the coefficients of the baseline variables stay mostly the same: they keep the same sign, the same order of magnitude, they remain significant as they are so in the baseline regressions (albeit sometimes at different levels), and with few exceptions, do not become significant if they are not in the baseline regressions. Therefore, for models II.2 to II.4 regressions, we will only discuss the results of the new variables added to the baseline specification.

EQASS exhibits positive relationship in all regression models under both the intermediation and revenue approaches. The empirical findings seem to suggest that the more managerially efficient banks, *ceteris paribus*, use less leverage (more equity) compared to their less efficient peers. The findings may also imply that the more efficient banks are involved in riskier operations and in the process tend to hold more equity, voluntarily or involuntarily, i.e. the reason may be due to deliberate efforts by banks to increase the safety cushions.

The coefficient of LLP/TL entered all intermediation approach regression models with a positive sign, which is in consonance with Berger and DeYoung's (1997) *skimping* hypothesis. To recap, Berger and DeYoung (1997) suggests that under the *skimping* hypothesis, a bank maximizing the long run profits may rationally choose to have lower costs in the short run by skimping on the resources devoted to underwriting and monitoring loans, but bear the consequences of greater loan performance problems. On the other hand, it is observed from Table II.11 that LLP/TL exhibits a negative relationship with bank efficiency under the revenue approach.

It is observed from Table II.10 that NIE/TA has a positive and significant impact on bank efficiency under the intermediation approach and is statistically significant at the 1% level. The results suggest that the more efficient banks (in terms of intermediation function) may have engaged in expense preference behavior. A plausible explanation is that the more highly qualified and professional management may require a higher remuneration packages and thus a positive relationship with efficiency measure is natural (Sathye, 2003). On the other hand, under the revenue approach the variable exhibits a negative sign, which is in accordance with the *bad management* hypotheses of Berger and DeYoung (1997). The empirical findings imply that the ASEAN-4 banking sectors would be more efficient in generating revenues by having an efficient cost management. Likewise, NII/TA exhibits a negative relationship with bank efficiency and is statistically significant at the 5% level under the revenue approach. The empirical findings seem to suggest that banks that have a high proportion of income from non-interest sources are relatively inefficient particularly during the post crisis periods.

It is observed from Table II.11 that when we control for the 3-bank concentration ratio in the revenue approach regression models, the variable ROAA reveals a negative relationship

with bank efficiency levels. The results suggest that banks are relatively inefficient in generating revenues and subsequently become less profitable in a more concentrated banking system. LNGDP exhibits negative relationship in most of the regression models under both intermediation and revenue approaches. Likewise, INFL entered the intermediation approach regression models II.1 and II.3 with a negative sign.

The concentration measure CR_3 has a negative relationship with bank efficiency under both intermediation and value added approaches. The results suggest that the more concentrated

Table I.11
Multivariate Regression Analysis

$$BANKEFF_{jt} = \alpha + \beta_1 EQASS + \beta_2 LNTA + \beta_3 LLP/TL + \beta_4 NIE/TA + \beta_5 NII/TA + \beta_6 ROAA + \beta_7 LNGDP + \beta_8 INFL + \beta_9 CR\_3 + \beta_{10} IMF + \varepsilon_j$$

The dependent variables are bank's technical efficiency score derived from the DEA Revenue approach. EQASS is a measure of bank capitalization measured by total shareholders equity divided by total assets. LNTA is the size of the bank measured as the natural logarithm of total assets. LLP/TL is a measure of risk calculated as the ratio of total loan loss provisions divided by total loans. NIE/TA is a measure of management quality calculated as total non-interest expenses divided by total assets. NII/TA is a proxy measure for diversification towards non-interest income, calculated as total non-interest income divided by total assets. ROAA is a proxy measure for profitability calculated as profit after tax divided by average total assets. LNGDP is natural logarithm of gross domestic product. INFL is the inflation rate. CR_3 is the 3-bank concentration ratio. IMF is a binary variable that takes a value of 1 for banks in countries, which resort to IMF, 0 otherwise.
Values in parentheses are standard errors.
***, **, and * indicate significance at 1, 5 and 10% levels.

	Intermediation Approach			
	Model 1	**Model 2**	**Model 3**	**Model 4**
CONSTANT	0.821179***	1.443167***	0.843351***	1.470880***
	(6.028475)	(7.606450)	(5.730668)	(8.958449)
Bank Characteristics				
EQASS	0.098430**	0.116046***	0.103161**	0.121491***
	(2.079216)	(2.812624)	(2.498129)	(3.300976)
LNTA	0.015102	0.006278	0.013988	0.004921
	(1.026364)	(0.529969)	(0.888992)	(0.396981)
LLP/TL	-0.029456**	-0.028605**	-0.025272	-0.023782
	(-2.201320)	(-2.166050)	(-1.450427)	(-1.489032)
NIE/TA	-1.083486*	-1.412780**	-1.066088*	-1.394950**
	(-1.738295)	(-1.993855)	(-1.756050)	(-2.027612)
NII/TA	-1.938439**	-2.058388**	-1.827336**	-1.930232**
	(-2.364464)	(-2.533576)	(-2.102631)	(-2.247243)
ROAA	-0.204223	-0.312806***	-0.198186	-0.306202**
	(-1.546343	)(-2.709183)	(-1.480874)	(-2.569217)
Economic Conditions/ Market Specific Factors				
LNGDP	-0.014512**	-0.007894	-0.017976***	-0.011694**
	(-1.995446)	(-1.051472)	(-3.926218)	(-2.471931)
INFL	-0.001858	0.003071	-0.001706	0.003266
	(-1.497101)	(1.149538)	(-1.493551)	(1.236520)
CR_3		-1.034231***		-1.038241***
		(-3.386801)		(-3.340021)
IMF			0.038637	0.043094
			(0.543625)	(0.714016)
R2	0.153864	0.192086	0.155271	0.193905
Adj. R2	0.138550	0.175598	0.138031	0.175584
F-statistics	10.04686***	11.65002***	9.006755***	10.58412***
No. of Observations	451	451	451	451

banking system is likely to be less efficient in their intermediation function as well as in generating revenues. However, when the binary variable IMF is introduced to the intermediation approach regression model 4, the sign of the CR_3 coefficient turns positive. The empirical findings seem to suggest that countries that participate in the IMF program have a more concentrated banking system. Finally, the binary variable IMF has a positive relationship with bank efficiency under the intermediation approach. The empirical findings seem to suggest that banking systems of countries which participate in the IMF program have been relatively more efficient in their intermediation function. It is also interesting to note that after controlling for banking sector's concentration, the coefficient of the IMF variable exhibits a negative sign. The empirical findings suggest that banks in a more concentrated banking system which countries participate in the IMF program are relatively more efficient in their intermediation function.

V. CONCLUSION

Despite its severity and deep influence on both the real and financial sectors, empirical evidence on is relatively scarce. The present study investigates the evolution of the performance of the ASEAN-4 banking sectors since the 1997-1998 Asian financial crisis. The efficiency estimates of individual banks are evaluated by using the Data Envelopment Analysis (DEA) approach. Two different approaches vis. intermediation approach and revenue approach have been employed to differentiate how efficiency scores vary with changes in inputs and outputs. A multivariate regression analysis is also performed to examine the relationship between the efficiency scores derived from the DEA to a set of explanatory variables i.e. capitalization, size, risk, profitability, and market structure.

The estimates of technical efficiency are observed to be consistently lower under the intermediation approach compared to the revenue approach. On the other hand, under the revenue approach, banks are characterized by relatively higher technical efficiency and the number of efficient banks is also higher. The dispersion of efficiency scores depicts declining trends across the ASEAN-4 banking sectors. The empirical findings suggest that the percentage of banks wherein technical efficiency lies within the interval of one standard deviation around the mean is higher during the earlier year. Despite that, the results suggest that banks are more efficient during the later year, which may be explained by the kurtosis of the efficiency distribution.

During the period under study, the empirical findings suggest that the number of efficient banks under the CRS and VRS differs markedly. The results imply that scale inefficiency is a serious problem across the ASEAN-4 banking sectors. The average scale efficiency of banks was low for most of the years, particularly under the intermediation approach. If anything

could be delved from the results, banks in the ASEAN-4 countries are likely to lose a sizable output with respect to their current scale of operations.

The results from the multivariate regression analysis suggest that the more efficient banks hold a higher level of equity, which could be due to the involvement of these banks in riskier operations. The empirical findings suggest that under the intermediation approach the proxy measure for risk is positively related to bank efficiency, thus supporting Berger and DeYoung's (1997) *skimping* hypothesis. During the period under study, the empirical findings suggest that banks that engaged in the expense preference behavior are relatively more efficient in their intermediation function. On the other hand, under the revenue approach, the results seem to support Berger and DeYoung's (1997) *bad management* hypothesis, whereby the more efficient banks are the one that efficiently controls their operating costs. Likewise, we find that banks that have a low proportion of income from non-interest sources to be relatively efficient under the revenue approach.

During the period under study, the results suggest that banks are relatively inefficient and subsequently becoming less profitable in a more concentrated banking system. The concentration ratio measured by CR_3 exhibits a negative relationship with bank efficiency under both the intermediation and revenue approaches, implying that the less concentrated banking market is relatively more efficient. However, when we control for countries that participate in the IMF program, the concentration ratio exhibits a positive relationship with bank efficiency levels. This implies that the more concentrated banking sectors which participate in the IMF program are relatively more efficient in their intermediation function during the post crisis period.

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