A Robust Approach to Measuring Technical Efficiency in Banking: Indonesia, Malaysia, Philippines, and Thailand

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ABSTRACT

We use DEA and robust order-*m* estimators to examine the performance of banks in Indonesia, Malaysia, Philippines, and Thailand over 2000-2004 in terms of technical efficiency. Using four different models to measure inputs and outputs, we find that in Indonesia median efficiency (DEA) is higher at the end of the period and in all other countries it is unchanged. However, order-*m* results from all models indicate that median efficiency has increased over the period in all countries.

Keywords: Efficiency, DEA, order-*m*, banking, South East Asia

National financial systems and the banking sectors in particular, assume increasing importance and fluidity with the progress of economic development and the increase in economic openness. Yet, attempts to measure and formally monitor the performance of the banking sector have largely been confined to western developed economies. As a result, little concrete empirical information and evidence is available about banking productivity and efficiency in non-western countries. Accordingly, the aim of this investigation is to start filling the gap in the empirical literature relating to efficiency studies of banking in non-industrialized countries.

The paper examines the evolution and contemporary state of bank efficiency in major developing economies of South East Asia - Indonesia, Malaysia, Philippines, and Thailand - over the period 2000 to 2004. During this period the banking sectors of the sample countries experienced a process of restructuring that was often guided or even mandated by the respective governments. For example, the Indonesian government pursued a policy of consolidation, reducing the number of licensed banks by more than forty per cent during the sample period (the number of licensed banks declined from 240 to 138 by the end of 2003, involving 70 bank closures and nationalization of 13 banks by 2003). In Malaysia the number of banks was reduced by ninety percent, from 55 to

10. At the same time, cross-border mergers, mergers involving foreign firms, also increased during this period (Deloitte-Touche, 2005).

Consolidation does not necessarily improve efficiency in banking. For industrialised countries there is no robust evidence of large value or efficiency gains from bank M&As (Pilloff & Santomero, 1998; Dymski, 2002). Most cost X-efficiency studies of M&As completed by US bank during the 1980s find little or no improvement (Berger et al., 1999). This assessment is reinforced by more recent investigations (Peristiani, 1997, DeYoung, 1997, Rhoades, 1998). However, Houston et al. (2001) find evidence of improvement in operating performance of banks, while Akhavein et al. (1997) observe gains in profit X-efficiency which they attribute to enhanced opportunities for risk diversification. Evidence from Europe (Amel et al., 2004; Lang & Welzel, 1999) and Australia (Ralston et al., 2001) is consistent with these US results.

Consolidation of banks, *ceteris paribus*, inevitably changes the competitive structure of the banking sector with potential consequences for efficiency of operation. As banks combine, the number of players diminishes and concentration increases. One consequence of such consolidation is that the managers of the newly enlarged companies operate in a less competitive environment. This environment weakens the incentives to reduce costs and increase efficiency compared to more competitive conditions (Williams and Nguyen, 2005).

Changes in the governance structure of banks may also affect efficiency by increasing or reducing agency problems. For instance, moving family-owned banks into public ownership will create a different set of agency problems that may change the overall efficiency of operation. By the same token, different forms of public ownership may affect efficieny. For example, foreign banks may be more efficient than domestic banks, which, in turn, may be more efficient than state-owned banks.

The present study measures bank performance by employing Data Envelopment Analysis (DEA). We will also use order-*m* estimators proposed by Cazals, Florens, and Simar (2002). To our knowledge, robust nonparametric methods have not been applied in the context of developing countries in Asia.

We describe our methodology of estimating efficiency in the following section. Data issues are discussed in Section 3, results are presented in section 4, and concluding observations in section 5.

1. Methodology

We use Data Envelopment Analysis (DEA) and order-*m* estimators. Shephard output distance functions, comparing actual performance to the best practice in the industry (Shephard, 1970), can be used to demonstrate the

methodology. Industry best-practice is the empirical approximation of potential optimum output to which the individual firm performance can be compared. Specifically, we calculate an efficiency indicator for each bank by measuring the distance of its location in input-output space from the best practice position. This distance can be measured as the actual relative to the optimum position (in Figure 1, this distance is equal to ab/ad assuming the true technology is known).

[Figure 1]

Best practice technology is represented by the frontier that envelops all current production points. This frontier is constructed by connecting the input-output combinations achieved by the best performing banks. These banks are most efficient in the simplistic sense of achieving the highest level of output from given quantities of inputs. With Constant Returns to Scale (CRS) the position of the linear frontier is fixed by the highest point in input-output space, irrespective of firm size as measured by the quantity of inputs used. Conversely, if returns are variable (VRS), then the frontier is constructed from the set of points representing the banks that are most efficient at different levels of operation. Banks situated below or inside the frontier are considered inefficient in the sense that they produce less than the maximum potential (best-practice) output from a given quantity of inputs as indicated by the frontier.

To formalize these concepts, consider *S* banks producing *m* outputs by using *n* inputs. Let $\mathbf{x}^{i,t} = (x_1^{i,t},...,x_n^{i,t}) \in \Re_+^n$ and $\mathbf{y}^{i,t} = (y_1^{i,t},...,y_m^{i,t}) \in \Re_+^m$ denote input and output vectors, respectively, of bank *i*=1,..,S in time period t=1,…,*T*. The production possibilities set is assumed to be available to any bank, and is given by

$$\mathrm{P} = \{(\mathbf{x},\mathbf{y}) \mid \mathbf{x} \text{ can produce } \mathbf{y}\}$$

We assume that

(i) P is convex, closed, and bounded for all $\mathbf{x} \in \Re^n$;

(ii) to produce non-zero output levels, some inputs must be used;

(iii) both inputs and output are strongly disposable, that is, a bank can dispose its unwanted inputs or outputs costlessly;[1]

(iv) zero output levels are possible.

[1] For inputs the formal definition is: if y can be produced from x, then y can be produced from any x*≥ x. For outputs it is: if y ∈ P(x) and y*≤ y then y* ∈ P(x) (Coelli et al.,1998, p.62).

The Shephard output distance function for bank *i* can be defined as

$$D(x^{i,t}, y^{i,t}) = \inf\{\delta^{i,t} > 0 \mid (\mathrm{x}^{\mathrm{i,t}}, \mathrm{y}^{\mathrm{i,t}} / \delta^{i,t}) \in \mathrm{P}\}.$$

Since it is not possible to observe distance functions directly, we must use approximations. Distance functions can be estimated by using Data Envelopment Analysis (DEA). We construct a country-specific frontier for each country for the entire period and assume that the variable returns to scale (VRS) assumption holds. Hence, distance functions for bank *k* can be calculated as follows:

$$\left[D^t(\mathbf{x}^{k,t}, \mathbf{y}^{k,t})\right]^{-1} = \max_{\theta,\lambda} \theta$$

$$s.t.$$

$$\theta y_m^{k,t} \le \sum_{i=1}^{S_t} \lambda^{i,t} y_m^{i,t}, \quad m = 1,..., M$$

$$\sum_{i=1}^{S_t} \lambda^{i,t} x_n^{i,t} \le x_n^{k,t}, \quad n = 1..., N$$

$$\sum_{i=1}^{S_t} \lambda^{i,t} = 1$$

$$\lambda^{i,t} \ge 0, \quad i = 1,..., S_t$$

where *t* indexes the time period. λ is a column vector of intensity variables ($\boldsymbol{\lambda} \in \Re_+^{\boldsymbol{S}}$).

DEA is a non-parametric technique that does not require the imposition of any specific structure on the production technology (Grifell-Tatje and Lovell, 1997, p.366). At the same time, its usefulness hinges on the strong assumption that there is no random error in the data since **all** observed deviations from the frontier are attributed to inefficiency. Specifically, DEA does not allow for measurement errors or chance factors that could bias the calculation of efficiency indicators. Conversely, econometric methods of estimating the production frontier, such as the Stochastic Frontier Approach (SFA), have their own structural shortcomings that potentially bias the results. They require a specific functional form (e.g. translog) and impose restrictive distributional assumptions on the joint error terms that are estimates of inefficiency and stochastic variation around the estimated frontier. These joint-distribution assumptions may not be sustained by the data.

We also use output oriented version of order-*m* estimators developed in Cazals, Florens, and Simar (2002), which are based on expected maximum output frontier. These estimators are more robust to outliers than the DEA

estimators and also do not require as much data as DEA estimators for the results to be statistically meaningful (Wheelock and Wilson, 2004). The difference between DEA and order-*m* estimators is that in DEA efficiency is measured by using the maximum feasible output for the bank, whereas in order-*m* analysis efficiency is measured "relative to the *expected maximum output* among *m* firms using input quantities *no greater than* those of the firm of interest" (Wheelock and Wilson, 2003, p.10). Order-*m* frontier can be constructed as follows (see Wheelock and Wilson, 2003 for more details):

- For bank *i*, select the firms that use the same level or less input as that bank.
- Draw *m* times, independently, with replacement, from these banks, and identify the bank that produces the maximum output
- Repeat the above step *k* times, to obtain *k* banks that produce the maximum output by using as much input or less as bank *i*. Compute the mean output of these banks.

Mean output calculated in the last step can be used as a benchmark for bank *i* to calculate its efficiency. Expected maximum output frontier is constructed by computing the means for the remaining firms. Efficiency calculations are done in the same way as DEA efficiency calculations are done, that is, output oriented order-*m* efficiency for a bank is its output level divided by the benchmark output level calculated by going through the steps above (this would be similar to ab/ac in Figure 1-with estimated VRS frontier replaced by order-*m* frontier). Note that order-*m* estimates are not bounded above by one. Order-*m* estimates greater than one indicate that the bank produces more output than expected maximum output while estimates lower than one indicate the opposite.

2. Data Issues

There are a number of alternative approaches to the specification of inputs and outputs in 'bank production'. The two most popular approaches are the production and the intermediation approaches. The activity-based production approach treats the number of accounts and transactions processed as outputs. These are produced with the application of inputs of labour and capital. The intermediation approach emphasizes the conversion by banks of loanable funds (obtained from savers) into loans and other assets. We use the intermediation approach, and estimate four alternative models. In the first three models we have the same inputs, namely total deposits, personnel expenses and fixed assets.

- Model 1 has net loans and other earning assets as outputs.
- In model 2 the nominal value of off-balance sheet activities is included in addition to the model 1 outputs.

- Model 3 drops off-balance sheet activities in favour of non-interest income.
- In model 4 we follow Sturm&Williams (2004) and Park&Weber (2005) to specify a revenue focussed model. This model has interest expense and non-interest expense as inputs and interest income and non-interest income as outputs.

Since data on quantities (number of accounts, etc.) are not available, we use reported nominal values, deflated by the GDP deflator to obtain the real values. We exclude observations before 2000 because these years were dominated by the turbulence of the financial crisis of 1997 and recession. These "shocks" are liable to introduce additional distortions into the data set. The data for the banks come from the *Bankscope* database from which we have extracted unconsolidated data. Other data, such as the GDP deflator, were obtained from the IMF *International Financial Statistics* database. The mean values of outputs and inputs used in the study are reported in Tables 1, 2, 3, and 4 for Indonesia, Malaysia, Philippines, and Thailand respectively.

[Tables 1-4]

3. Results

Median efficiencies calculated from the Indonesian sample range between 0.63 and 1 (see Table 5). In all models there are large increases at the end of the period compared to the beginning ranging from 6.04 percent to 24.64 percent. Mean efficiency also increases over the period for all models. The end-of-period values of variances are lower in models 2, 3, and 4; whereas in model 1 the variance increases at the end of the period.

[Table 5]

The medians of order-m estimates (m=5) for Indonesia, reported in Table 6, range over 1.26-1.40 for model 1, 1.21-1.95 for model 2, 1.35-1.87 for model 3, 1.43-2.10 for model 4. Medians are higher at the end of the period for all models. The variances and means from all models are lower at the end of the period.

[Table 6]

Medians and variances of efficiency estimates for Malaysian banks are given in Table 7. Medians from models 1, 2, and 3 are equal to one for all years, but medians obtained from model 4 are lower than one except for 2002 (in other years medians range between 0.85 and 0.94). In all models mean efficiency decreases by the end of the period by at least 1.56 percent. Dispersion or variability of efficiency estimates is higher at the end of the period than at the beginning for all models; variances obtained from model 4 are in all years lower than the variances obtained from other models.

[Table 7]

Order-*m* efficiency estimates (with *m*=5) for Malaysia show an increase in median efficiency by at least 7.99 percent (as of 2004), and end-of- period variances are higher than their beginning-of-the-period values for all models (see Table 8). Once again model 4 median efficiencies are lower than the ones obtained from the other models. It's interesting to note that contrary to what's found by using DEA, means obtained by using order-m methodology increase over the period for all models.

[Table 8]

Medians and variances from the four models applied to Philippines bank data are reported in Table 9. Medians are equal to 1 in all models in all years, except for 2004 when model 1 is used. Means from all models show increases in the range of 13.97-76.57 over the period. Variances from models 1, 3, and 4 show a decrease at the end of the period, while variances from models 3 show an increase.

[Table 9]

Medians of order-*m* efficiency estimates (*m*=5) for Philippines range from 1.51 to 3.37, and variances from 0.53-18.7 (see Table 10). These results indicate that median efficiency has increased by the end of the period, with the smallest increases indicated by model 3 medians. Means also indicate changes in the same direction over the period. Comparisons of beginning and end-of-period variances of order-*m* efficiencies indicate increases for all models.

[Table 10]

Median efficiency estimates for Thai banks and their variances are reported in Table 11. Median efficiencies for Thailand are all equal to 1 (efficiency couldn't be estimated for 2000 by using model 3 because number of observations is less than number of inputs and outputs in that year). Mean efficiency for model 1 ranges over 0.88-0.96, for models 2, 3, and 4 it ranges between 0.95 and 0.97, between 0.94 and 0.98 (over 2001-2004), between 0.94 and 0.98 respectively. Mean efficiency increases over the period in the first two models and decreases in the last two. Variances from models 1, 2, and 3 are lower at the end of the period compared to the beginning. Model 4 variance registers an increase at the end of the period.

[Table 11]

Medians and means of order *m* efficiency estimates (with *m*=5) from all models are higher compared to the median efficiencies in 2000. The same is true for variances except for model 2 variances, which indicate a decrease (see Table 12).

[Table 12]

4. Conclusions

We use Data Envelopment Analysis and order-*m* methodology to study the performance of banks in Indonesia, Malaysia, Philippines, and Thailand over 2000-2004 in terms of efficiency. During this period significant structural changes, such as domestic and cross-border mergers, nationalizations, and recapitalizations occurred in the banking sectors of the sample countries. It is a reasonable expectation that these changes might have affected the performance of banks.

We use four different models to measure inputs and outputs, and find that in Indonesia median efficiency (DEA) is higher at the end of the period and in all other countries it is unchanged (except for median efficiency in Malaysia when model 4 is used). However, order-*m* results from all models indicate that median efficiency has increased over the period in all countries. Variances obtained by using DEA and order-*m* methodologies are generally lower in Indonesia, and generally higher in Malaysia. In the Philippines and Thailand variances from DEA mostly indicate a decrease while variances from order-*m* analysis mostly indicate an increase.

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Table 1 Descriptive Statistics of Outputs and Inputs Used in the Study (in millions of national currency-deflated by the GDP deflator): **INDONESIA**

		Net Loans	Other Earning Assets	Off-balance Sheet Activities	Interest Income	Non-Interest Income	Total Deposits	Personnel Expenses	Interest Expense	Non-Interest Expense	Fixed Assets
Numb. of obs.	**2000**	48.00	48.00	44.00	48.00	42.00	47.00	46.00	47.00	46.00	48.00
Min		353.00	496.00	26.00	305.00	16.00	377.00	46.00	68.00	93.00	8.76
Max		299414.00	1917007.97	66003.00	271071.00	55926.00	1638937.03	18075.00	204931.99	80508.00	13257.00
Median		7508.50	5656.50	441.50	1368.50	227.50	9638.00	124.00	765.00	285.00	150.00
Mean		23088.26	72074.98	3144.01	10354.23	1924.11	71028.71	795.12	8168.85	2962.17	1043.70
Std. deviation		49197.97	283297.71	10143.57	39480.09	8609.14	242769.57	2685.46	30310.26	11904.87	2527.55
Numb. of obs.	**2001**	40.00	40.00	36.00	40.00	36.00	39.00	38.00	40.00	37.00	40.00
Min		65.12	301.99	15.42	336.15	6.86	514.14	32.56	211.65	93.40	5.14
Max		352741.20	1652664.95	18027.42	271754.94	24580.98	1627670.98	13665.81	208120.81	36609.25	13862.04
Median		8359.90	4910.88	850.04	1603.26	203.08	10965.72	125.11	886.89	307.63	146.53
Mean		24963.47	66755.92	2280.92	11949.84	1412.64	75838.32	795.16	9047.83	1993.27	961.30
Std. deviation		57014.35	263123.35	3882.29	43405.69	4170.59	262815.83	2278.03	33353.55	6091.49	2384.47
Numb. of obs.	**2002**	37.00	37.00	32.00	37.00	33.00	36.00	37.00	37.00	35.00	37.00
Min		90.54	497.98	25.06	385.61	13.74	1550.53	35.57	171.38	95.39	3.23
Max		167194.02	672446.26	69952.30	113128.54	9207.76	839288.60	12014.55	68869.04	24933.71	16393.69
Median		10190.78	7560.23	1748.59	1741.31	203.72	12743.73	151.17	1112.37	422.80	182.70
Mean		26072.90	47465.34	6231.27	9405.94	803.16	67927.21	883.38	6623.59	2485.14	1365.96
Std. deviation		38163.12	118227.00	13315.03	20727.63	1711.27	150036.32	2079.85	13658.82	4787.92	3098.92
Numb. of obs.	**2003**	35.00	35.00	30.00	35.00	34.00	35.00	34.00	35.00	32.00	35.00
Min		204.63	436.29	60.23	315.83	23.17	2687.26	36.29	132.05	113.51	11.58
Max		496252.50	1151848.69	230197.68	190705.03	32030.12	1449184.60	29212.36	134376.05	43684.94	40532.82
Median		13284.94	7565.25	2606.56	2073.36	311.58	15032.43	208.11	921.24	496.91	224.71
Mean		52515.24	84595.51	16132.52	16743.38	2218.06	123924.38	2181.70	10109.10	4793.81	2585.42
Std. deviation		57014.35	263123.35	3882.29	43405.69	4170.59	262815.83	2278.03	33353.55	6091.49	2384.47
Numb. of obs.	**2004**	31.00	31.00	27.00	31.00	30.00	31.00	30.00	31.00	29.00	31.00
Min		917.81	472.24	10.09	235.76	24.51	2561.64	40.37	111.03	113.91	21.63
Max		576870.21	905030.98	263051.92	129122.57	31935.83	1308302.77	16034.61	67486.66	40065.61	38142.75
Median		22107.43	12186.73	3232.16	2322.28	380.68	22313.63	308.94	896.18	1118.96	323.72
Mean		71984.73	90701.99	29037.19	15268.93	2894.90	147622.53	2449.65	7126.88	5480.49	3888.58
Std. deviation		128199.27	205075.30	62811.43	30171.18	6788.38	304916.90	4572.26	14406.33	10007.23	9198.39

Table 2 Descriptive Statistics of Outputs and Inputs Used in the Study (in millions of national currency-deflated by the GDP deflator): **MALAYSIA**

		Net Loans	Other Earning Assets	Off-balance Sheet Activities	Interest Income	Non-Interest Income	Total Deposits	Personnel Expenses	Interest Expense	Non-Interest Expense	Fixed Assets
Numb. of obs.	**2000**	27.00	29.00	28.00	27.00	27.00	29.00	27.00	26.00	25.00	29.00
Min		1.46	3.61	1.87	0.35	0.06	4.67	0.04	0.16	0.09	0.01
Max		610.04	320.91	536.71	52.50	8.31	757.61	6.24	25.73	11.15	7.92
Median		53.97	26.42	59.88	6.01	0.80	69.06	0.57	2.69	1.26	0.52
Mean		97.85	56.62	94.08	8.86	1.48	121.93	1.17	4.58	2.47	1.43
Std. deviation		132.04	72.04	118.36	11.59	1.86	162.69	1.54	5.92	2.83	1.96
Numb. of obs.	**2001**	27.00	28.00	28.00	27.00	27.00	28.00	27.00	26.00	24.00	28.00
Min		1.63	2.94	1.93	0.31	0.12	4.63	0.04	0.18	0.14	0.01
Max		768.02	333.88	699.40	59.65	11.89	922.20	8.15	28.33	14.92	10.14
Median		75.18	45.04	73.76	7.14	1.42	91.79	0.91	3.69	2.43	0.73
Mean		121.58	63.48	131.72	10.11	2.03	146.89	1.52	5.18	3.31	1.68
Std. deviation		161.27	72.71	164.77	12.46	2.46	190.23	1.88	6.03	3.53	2.30
Numb. of obs.	**2002**	28.00	29.00	29.00	29.00	28.00	29.00	29.00	28.00	27.00	29.00
Min		1.64	2.17	0.61	0.19	0.04	1.88	0.03	0.04	0.05	0.01
Max		744.12	369.24	648.87	54.87	11.00	920.34	7.80	24.97	15.25	9.69
Median		110.10	46.41	83.70	8.01	1.30	126.63	1.32	4.11	2.60	0.89
Mean		128.47	66.12	145.16	9.56	1.93	152.94	1.42	4.73	3.20	1.70
Std. deviation		157.99	79.32	181.41	11.53	2.27	188.90	1.69	5.29	3.42	2.19
Numb. of obs.	**2003**	29.00	30.00	30.00	30.00	27.00	30.00	29.00	30.00	29.00	29.00
Min		1.30	3.75	0.72	0.24	0.04	4.91	0.03	0.05	0.05	0.01
Max		767.82	400.07	709.63	62.30	11.13	947.25	8.28	23.13	16.56	9.93
Median		102.48	59.50	80.64	7.94	1.33	128.04	0.84	3.73	1.99	0.75
Mean		131.56	78.59	156.20	10.20	1.97	165.32	1.42	4.47	2.99	1.68
Std. deviation		162.32	88.50	194.37	12.60	2.29	196.14	1.78	4.86	3.64	2.20
Numb. of obs.	**2004**	27.00	28.00	27.00	28.00	27.00	28.00	27.00	28.00	26.00	27.00
Min		1.04	2.93	0.84	0.25	0.08	4.97	0.03	0.05	0.05	0.01
Max		783.37	461.82	785.09	54.20	15.44	991.65	8.80	21.69	17.94	9.37
Median		126.14	52.80	108.70	8.19	1.98	120.29	1.21	4.28	2.59	0.89
Mean		152.32	93.28	204.98	11.72	2.59	191.47	1.70	5.05	3.73	1.69
Std. deviation		179.47	106.62	225.45	13.67	3.24	225.75	2.12	5.43	4.38	2.11

Table 3 Descriptive Statistics of Outputs and Inputs Used in the Study (in millions of national currency-deflated by the GDP deflator): **PHILIPPINES**

		Net Loans	Other Earning Assets	Off-balance Sheet Activities	Interest Income	Non-Interest Income	Total Deposits	Personnel Expenses	Interest Expense	Non-Interest Expense	Fixed Assets
Numb. of obs.	**2000**	14	14	11	14	14	14	14	14	14	14
Min		24.18	7.39	2.78	4.39	0.44	21.49	0.66	1.7	2.21	0.31
Max		1032.91	852.97	287.64	157.55	11.86	1531.54	30.76	72.75	65.89	49.53
Median		107.98	52.815	34.68	12.37	3.005	109.66	2.275	9.06	5.945	3.965
Mean		249.0379	154.9957	64.70022	33.58357	4.441429	315.7936	5.761429	19.64	14.78571	12.84786
Std. deviation		302.2533	220.6725	88.41174	41.74398	4.02375	430.6549	7.985162	22.52457	17.86625	16.14796
Numb. of obs.	**2001**	13.00	13.00	7.00	13.00	11.00	13.00	13.00	13.00	13.00	13.00
Min		3.93	0.88	5.62	0.63	0.76	3.23	0.14	0.19	0.35	0.13
Max		980.73	998.98	381.48	159.68	31.35	1617.85	31.02	111.93	69.01	146.79
Median		190.92	145.55	31.34	30.18	5.91	268.15	5.45	16.78	13.26	7.55
Mean		312.11	249.87	87.57	43.61	9.97	454.12	8.07	27.98	20.70	25.53
Std. deviation		349.70	287.73	133.76	47.56	10.80	523.73	10.03	33.15	23.47	40.03
Numb. of obs.	**2002**	17.00	17.00	11.00	17.00	16.00	17.00	17.00	17.00	17.00	17.00
Min		2.85	0.46	0.32	0.71	0.26	1.78	0.21	0.16	0.35	0.10
Max		1025.52	1068.61	725.27	133.57	42.84	1663.65	35.50	58.14	74.51	142.38
Median		97.07	53.19	31.95	10.79	4.65	100.54	1.68	4.38	5.72	4.49
Mean		259.96	239.14	171.50	28.29	12.97	401.58	6.83	14.68	17.03	19.89
Std. deviation		325.63	311.27	269.40	35.07	15.63	516.44	9.73	18.20	22.03	35.08
Numb. of obs.	**2003**	15.00	15.00	10.00	15.00	14.00	15.00	15.00	15.00	15.00	15.00
Min		2.92	0.62	0.56	0.82	0.32	2.23	0.21	0.13	0.40	0.09
Max		1092.52	1081.74	839.98	136.29	45.24	1663.15	35.93	50.94	74.18	137.93
Median		97.02	65.37	27.54	10.97	3.75	114.61	1.47	4.80	4.98	2.64
Mean		237.91	250.83	181.04	29.67	12.73	387.18	6.97	14.73	16.21	17.51
Std. deviation		322.37	335.84	324.18	39.18	15.34	525.55	10.36	18.71	21.87	35.61
Numb. of obs.	**2004**	21.00	21.00	15.00	21.00	20.00	21.00	20.00	21.00	20.00	21.00
Min		0.35	0.32	0.23	0.06	0.03	0.79	0.02	0.03	0.03	0.03
Max		1850.29	1650.79	1422.97	232.03	56.47	2896.86	45.09	118.46	113.33	127.85
Median		165.79	201.52	58.52	30.25	5.88	347.42	4.89	16.05	14.71	10.41
Mean		425.76	425.22	278.02	52.58	16.22	720.52	10.53	25.49	26.83	26.65
Std. deviation		510.99	493.16	442.60	60.50	19.53	873.58	13.51	28.50	31.67	32.81

Table 4 Descriptive Statistics of Outputs and Inputs Used in the Study (in millions of national currency-deflated by the GDP deflator): **THAILAND**

		Net Loans	Other Earning Assets	Off-balance Sheet Activities	Interest Income	Non-Interest Income	Total Deposits	Personnel Expenses	Interest Expense	Non-Interest Expense	Fixed Assets
Numb. of obs.	**2000**	10	10	10	10	5	10	10	10	10	10
Min		82.88	94.2	0.47	14.65	0.74	210.34	1.76	11.19	5.21	14.14
Max		4658.98	5510.29	4608.24	420.95	85.86	8827.03	72.9	284.01	200.34	349.6
Median		1664.46	462.385	308.825	82.325	51.91	2122.425	11.74	95.145	36.215	115.37
Mean		1978.411	1218.365	1066.706	166.667	40.322	2987.988	22.636	116.3	71.772	143.159
Std. deviation		1857.909	1717.051	1695.21	169.8519	36.08952	3077.354	25.6124	104.6473	75.6183	132.5987
Numb. of obs.	**2001**	13	13	13	13	11	13	13	13	13	13
Min		149.6474	76.22919	0.254652	12.11557	3.24192	173.9275	1.782566	6.973555	3.565132	13.19295
Max		4305.024	5013.555	3814.731	386.7189	59.04995	8786.327	70.25465	209.8629	192.5759	331.1166
Median		1278.511	282.5465	467.1792	62.50735	10.92067	2008.629	11.35162	70.8619	35.88639	140.2547
Mean		1889.754	997.7842	1076.715	139.5984	23.98273	2765.236	21.15272	87.09033	62.84864	143.2984
Std. deviation		1677.248	1463.422	1434.914	139.4431	22.15172	2786.567	22.55829	74.07315	65.52593	124.5726
Numb. of obs.	**2002**	16	16	15	16	14	16	16	16	16	17
Min		107.5802	2.789116	0.262391	0.194363	0.019436	63.85811	0.058309	0.068027	0.126336	0.009718
Max		6621.254	4583.703	5782.682	507.1817	120.7969	10523.04	80.79689	290.2138	235.7046	623.4208
Median		1071.633	256.3022	609.8639	61.66667	16.54519	1717.711	11.14674	45.84062	32.48785	136.2099
Mean		1959.543	1202.997	1536.163	144.1284	34.79314	3033.021	21.26701	79.77102	62.14286	159.8577
Std. deviation		2099.891	1622.443	1907.175	155.3664	36.08582	3388.007	24.00895	83.89895	69.89843	168.4642
Numb. of obs.	**2003**	16	16	16	16	14	16	16	16	16	16
Min		0.869981	0.382409	0.181644	0.00956	0.669216	4.894837	0.210325	0.00956	0.478011	0.363289
Max		6830.899	5093.489	6210.096	459.5889	118.8432	10949.36	80.68834	224.847	199.7801	557.5908
Median		996.4006	338.3078	622.1941	51.50096	22.98757	1718.924	11.07553	35.46845	31.43881	138.1166
Mean		2108.702	1173.919	1398.105	133.7327	41.09055	3099.247	22.22036	61.10062	60.0251	157.3446
Std. deviation		2380.312	1557.528	1918.602	146.8743	41.29328	3567.469	24.8453	67.20495	64.08869	163.6438
Numb. of obs.	**2004**	16	16	16	16	15	16	16	16	16	16
Min		6.074074	0.601852	0.101852	0.194444	0.018519	15.31481	0.37037	0.148148	0.898148	0.583333
Max		7636.815	4177.981	6633.472	446.7222	161.5463	11240.49	82.43519	143.8426	236.7963	568.6759
Median		2026.875	392.2083	849.9583	97.0787	21.00926	2690.014	15.46296	44.03704	33.99537	149.2407
Mean		2681.586	924.1927	1625.799	141.1476	42.7716	3428.734	26.73958	44.4919	69.52431	183.9045
Std. deviation		2617.739	1139.616	2135.052	145.0808	49.87151	3516.79	27.47473	43.64674	73.94969	179.3203

Table 5 Summary Statistics for Efficiency Estimates (DEA): **INDONESIA**

	2000	2001	2002	2003	2004
Model 1					
Numb. of obs.	45.00	37.00	36.00	34.00	30.00
Minimum	0.30	0.44	0.50	0.18	0.32
Maximum	1.00	1.00	1.00	1.00	1.00
Median	0.77	0.81	0.95	0.70	0.82
Mean	0.73	0.80	0.86	0.70	0.77
Variance	0.06	0.04	0.03	0.08	0.06
Model 2					
Numb. of obs.	43.00	35.00	32.00	29.00	26.00
Minimum	0.31	0.44	0.58	0.52	0.59
Maximum	1.00	1.00	1.00	1.00	1.00
Median	0.78	0.92	1.00	1.00	0.97
Mean	0.75	0.82	0.92	0.90	0.90
Variance	0.06	0.04	0.02	0.02	0.02
Model 3					
Numb. of obs.	39.00	33.00	32.00	33.00	30.00
Minimum	0.30	0.44	0.50	0.18	0.32
Maximum	1.00	1.00	1.00	1.00	1.00
Median	0.78	0.93	0.97	0.75	0.93
Mean	0.76	0.82	0.87	0.73	0.80
Variance	0.06	0.04	0.03	0.08	0.06
Model 4					
Numb. of obs.	40.00	33.00	32.00	31.00	29.00
Minimum	0.45	0.35	0.26	0.28	0.47
Maximum	1.00	1.00	1.00	1.00	1.00
Median	0.73	0.63	0.67	0.68	0.82
Mean	0.76	0.69	0.68	0.68	0.81
Variance	0.04	0.06	0.08	0.06	0.04

Table 6 Summary Statistics for Efficiency Estimates (Order-*m*): **INDONESIA**

	2000	2001	2002	2003	2004
Model 1					
Numb. of obs.	45.00	37.00	36.00	34.00	30.00
Minimum	0.60	0.89	0.99	0.50	0.83
Maximum	83.36	66.04	19.48	55.77	18.81
Median	1.26	1.53	1.63	1.45	1.40
Mean	4.96	4.63	3.32	4.97	3.28
Variance	167.78	119.23	13.26	107.98	17.16
Model 2					
Numb. of obs.	43.00	35.00	32.00	29.00	26.00
Minimum	0.68	0.90	1.00	0.90	1.00
Maximum	123.02	29.50	29.11	76.83	25.86
Median	1.21	1.68	1.95	1.65	1.81
Mean	7.12	3.77	4.36	6.95	4.69
Variance	372.90	28.69	30.83	240.13	39.36
Model 3					
Numb. of obs.	39.00	33.00	32.00	33.00	30.00
Minimum	0.89	1.00	1.00	0.52	1.00
Maximum	168.81	59.29	24.64	61.74	31.37
Median	1.35	1.87	1.85	1.67	1.58
Mean	7.77	5.21	4.27	5.62	4.78
Variance	737.31	108.78	25.49	130.23	51.05
Model 4					
Numb. of obs.	40.00	33.00	32.00	31.00	29.00
Minimum	0.96	0.48	0.41	0.37	0.62
Maximum	109.27	51.61	16.90	34.13	19.85
Median	1.74	1.43	1.58	1.56	2.10
Mean	5.72	4.26	2.99	4.44	4.22
Variance	292.84	81.93	11.29	47.07	26.01

Table 7 Summary Statistics for Efficiency Estimates (DEA): **MALAYSIA**

	2000	2001	2002	2003	2004
Model 1					
Numb. of obs.	27	27	28	28	26
Minimum	0.82	0.8	0.84	0.82	0.77
Maximum	1	1	1	1	1
Median	1	1	1	1	1
Mean	0.98	0.96	0.96	0.97	0.96
Variance	0.002	0.004	0.003	0.003	0.005
Model 2					
Numb. of obs.	27	27	28	28	25
Minimum	0.82	0.8	0.85	0.82	0.77
Maximum	1	1	1	1	1
Median	1	1	1	1	1
Mean	0.98	0.96	0.96	0.97	0.97
Variance	0.002	0.004	0.003	0.003	0.006
Model 3					
Numb. of obs.	27	27	28	26	26
Minimum	0.82	0.8	0.85	0.86	0.77
Maximum	1	1	1	1	1
Median	1	1	1	1	1
Mean	0.99	0.96	0.97	0.98	0.97
Variance	0.002	0.004	0.003	0.002	0.005
Model 4					
Numb. of obs.	25	23	25	26	25
Minimum	0.58	0.6	0.7	0.62	0.53
Maximum	1	1	1	1	1
Median	0.94	0.9	1	0.89	0.85
Mean	0.91	0.87	0.94	0.87	0.83
Variance	0.015	0.013	0.008	0.016	0.029

Table 8 Summary Statistics for Efficiency Estimates (Order-*m*): **MALAYSIA**

	2000	2001	2002	2003	2004
Model 1					
Numb. of obs.	27.00	27.00	28.00	28.00	26.00
Minimum	1.00	1.00	1.00	1.00	1.00
Maximum	3.87	4.48	5.24	5.61	5.49
Median	2.11	2.21	2.82	2.68	2.36
Mean	2.12	2.11	2.67	2.64	2.38
Variance	0.73	0.85	1.81	1.57	1.28
Model 2					
Numb. of obs.	27.00	27.00	28.00	28.00	25.00
Minimum	1.00	1.00	1.00	1.00	1.00
Maximum	6.35	8.17	18.92	14.95	10.79
Median	2.61	2.79	3.40	3.10	2.82
Mean	2.68	2.79	4.35	4.01	3.62
Variance	1.85	2.93	13.11	9.29	7.92
Model 3					
Numb. of obs.	27.00	27.00	28.00	26.00	26.00
Minimum	1.00	1.00	1.00	1.00	1.00
Maximum	5.38	5.25	5.81	4.72	6.10
Median	2.48	2.33	3.05	2.49	2.87
Mean	2.54	2.27	2.99	2.59	2.84
Variance	1.40	1.04	2.13	1.23	1.84
Model 4					
Numb. of obs.	25.00	23.00	25.00	26.00	25.00
Minimum	1.00	1.00	1.00	1.00	1.00
Maximum	4.37	3.67	3.58	4.13	3.74
Median	1.72	1.71	1.87	2.06	2.01
Mean	1.88	1.72	1.93	2.04	2.08
Variance	0.55	0.36	0.36	0.56	0.58

Table 9 Summary Statistics for Efficiency Estimates (DEA): **PHILIPPINES**

	2000	2001	2002	2003	2004
Model 1					
Numb. of obs.	14.00	13.00	17.00	15.00	20.00
Minimum	0.78	0.81	0.57	0.66	0.64
Maximum	1.00	1.00	1.00	1.00	1.00
Median	1.00	1.00	1.00	1.00	0.97
Mean	0.95	0.97	0.93	0.94	0.91
Variance	0.005	0.005	0.018	0.010	0.013
Model 2					
Numb. of obs.	11.00	7.00	11.00	10.00	14.00
Minimum	0.85	1.00	0.72	0.86	0.73
Maximum	1.00	1.00	1.00	1.00	1.00
Median	1.00	1.00	1.00	1.00	1.00
Mean	0.96	1.00	0.97	0.98	0.98
Variance	0.004	0.000	0.007	0.003	0.005
Model 3					
Numb. of obs.	14.00	11.00	16.00	14.00	19.00
Minimum	0.78	0.82	0.70	0.80	0.64
Maximum	1.00	1.00	1.00	1.00	1.00
Median	1.00	1.00	1.00	1.00	1.00
Mean	0.97	0.97	0.95	0.98	0.92
Variance	0.005	0.005	0.011	0.004	0.013
Model 4					
Numb. of obs.	14.00	11.00	16.00	14.00	19.00
Minimum	0.66	0.79	0.67	0.63	0.62
Maximum	1.00	1.00	1.00	1.00	1.00
Median	1.00	1.00	1.00	1.00	1.00
Mean	0.95	0.94	0.94	0.93	0.93
Variance	0.011	0.008	0.010	0.013	0.013

Table 10 Summary Statistics for Efficiency Estimates (Order-*m*): **PHILIPPINES**

	2000	2001	2002	2003	2004
Model 1					
Numb. of obs.	14.00	13.00	17.00	15.00	20.00
Minimum	1.00	1.00	1.00	1.00	1.00
Maximum	4.06	3.75	8.18	6.29	20.92
Median	1.51	1.93	3.00	3.37	2.66
Mean	1.98	2.04	3.57	3.26	3.93
Variance	1.18	0.53	4.43	2.51	18.70
Model 2					
Numb. of obs.	11.00	7.00	11.00	10.00	14.00
Minimum	1.00	1.00	1.00	1.00	1.00
Maximum	4.31	5.59	20.75	11.07	9.61
Median	1.33	1.50	2.42	2.17	2.56
Mean	2.11	1.98	4.48	3.11	4.18
Variance	1.66	2.70	31.37	9.78	11.35
Model 3					
Numb. of obs.	14.00	11.00	16.00	14.00	19.00
Minimum	1.00	1.00	1.00	1.00	1.00
Maximum	4.39	3.25	7.24	8.11	26.95
Median	1.72	1.58	3.25	2.94	3.62
Mean	2.12	1.78	3.63	3.30	4.95
Variance	1.38	0.62	4.25	3.99	33.77
Model 4					
Numb. of obs.	14.00	11.00	16.00	14.00	19.00
Minimum	0.94	1.00	1.00	1.00	1.00
Maximum	2.91	2.74	3.58	5.48	6.98
Median	1.58	1.49	2.24	1.74	2.25
Mean	1.73	1.58	2.14	2.23	2.50
Variance	0.50	0.36	0.85	1.72	1.86

Table 11 Summary Statistics for Efficiency Estimates (DEA): **THAILAND**

	2000	2001	2002	2003	2004
Model 1					
Numb. of obs.	10.00	13.00	16.00	16.00	16.00
Minimum	0.42	0.45	0.41	0.40	0.82
Maximum	1.00	1.00	1.00	1.00	1.00
Median	1.00	1.00	1.00	1.00	1.00
Mean	0.88	0.92	0.92	0.92	0.96
Variance	0.038	0.025	0.026	0.028	0.004
Model 2					
Numb. of obs.	10.00	13.00	15.00	16.00	16.00
Minimum	0.77	0.76	0.66	0.70	0.88
Maximum	1.00	1.00	1.00	1.00	1.00
Median	1.00	1.00	1.00	1.00	1.00
Mean	0.95	0.96	0.95	0.96	0.97
Variance	0.009	0.006	0.011	0.008	0.002
Model 3					
Numb. of obs.	NA	11.00	14.00	14.00	15.00
Minimum	NA	0.77	0.55	0.51	0.86
Maximum	NA	1.00	1.00	1.00	1.00
Median	NA	1.00	1.00	1.00	1.00
Mean	NA	0.98	0.94	0.95	0.98
Variance	NA	0.005	0.017	0.018	0.002
Model 4					
Numb. of obs.	5.00	11.00	14.00	14.00	15.00
Minimum	0.90	0.60	0.69	0.75	0.65
Maximum	1.00	1.00	1.00	1.00	1.00
Median	1.00	1.00	1.00	1.00	1.00
Mean	0.98	0.91	0.95	0.94	0.92
Variance	0.002	0.022	0.009	0.010	0.013

Table 12 Summary Statistics for Efficiency Estimates (Order-*m*): **THAILAND**

	2000	2001	2002	2003	2004
Model 1					
Numb. of obs.	10.00	13.00	16.00	16.00	16.00
Minimum	0.96	0.98	0.73	0.81	1.00
Maximum	4.29	5.12	7.00	9.93	6.22
Median	1.79	2.13	2.42	2.97	2.53
Mean	2.06	2.29	2.77	3.37	2.74
Variance	1.37	1.96	3.49	5.43	2.14
Model 2					
Numb. of obs.	10.00	13.00	15.00	16.00	16.00
Minimum	1.00	1.00	1.00	1.00	1.00
Maximum	12.68	6.75	8.33	86.10	9.91
Median	2.47	3.30	3.21	7.41	4.90
Mean	3.66	3.21	3.52	16.11	5.40
Variance	12.55	4.30	4.92	502.70	7.63
Model 3					
Numb. of obs.	NA	11.00	14.00	14.00	15.00
Minimum	NA	1.00	0.76	1.00	1.00
Maximum	NA	4.63	25.73	6.39	7.15
Median	NA	2.02	3.45	3.06	2.39
Mean	NA	2.36	6.66	2.98	2.68
Variance	NA	1.70	54.69	2.53	1.97
Model 4					
Numb. of obs.	5.00	11.00	14.00	14.00	15.00
Minimum	1.00	0.82	1.00	1.00	1.00
Maximum	2.85	2.48	22.80	3.87	6.79
Median	1.17	1.64	1.98	1.94	1.84
Mean	1.47	1.62	5.65	2.08	2.38
Variance	0.61	0.37	61.44	0.71	2.12

Figure 1 Illustration of Distance Functions