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IMF Bank-Restructuring Efficiency Outcomes: Evidence from East Asia

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Abstract We report new findings on bank efficiency in East Asian countries for the pre- and post-IMF restructuring periods. We find that bank efficiency has improved, but only to the pre-IMF intervention level, and that restructured banks are not more efficient than their unrestructured counterparts. Different restructuring measures have different effects. Bank closures are economically justified, but mergers show short-term efficiency losses. Recapitalization and reprivatization of badly performing banks lead to efficiency improvement, but also increase government ownership. Ease of entry that has allowed for more foreign bank participation results in slightly improved performance of badly performing banks.

Keywords East Asian banking efficiency · IMF-supported programs · Bank restructuring · Bank re-privatization · Foreign participation

JEL classification G21 · G28 · C14 · N20

1 Introduction

In this paper, we study effects on bank performance of the IMF programs that support countries during the Asian financial crisis of 1997–1998. We create a sample of 138 commercial banks located in four of the most heavily affected East Asian economies, Indonesia, Korea, the Philippines, and Thailand. We examine the IMF restructuring effects on bank efficiency over the pre- and post-restructuring years during 1991–2005.

Since the late 1970s, 117 systemic banking crises, which we define as a widespread of banking failures that affect more than 20% of a banking system's deposits (Sheng 1996), have occurred in 93 countries. More than two-thirds of these crises happened in developing countries (Caprio and Klingebiel 2003). The IMF is charged with safeguarding the stability of the international monetary system. Thus, the central role for the IMF is to help restore

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confidence in crisis-affected economies by providing a stabilization financial package as a supported program. One of the main conditions of such programs is that the affected countries must work with the IMF to undertake a comprehensive financial sector reform. This cooperation is seen as an integral part of the crisis resolution, with the expectation that the intervention will lead to performance improvement. Countries that serve as examples of past interventions include Mexico 1994–1995, the East Asian countries in 1997–1999, Brazil in 1999, Argentina in 2001, and Turkey in 2001–2002.

A review of the literature on the IMF programs indicates that most studies of crisis intervention discuss the adoption, implementation, ownership, and impact of those programs on macroeconomic performance, but do not study the performance of the affected banking entities (see Joyce 2004). The IMF itself has used the same focus in their studies. Several studies criticize the IMF-supported programs for not achieving the set objectives, such as inflation control, mitigation of moral hazard behavior and prevention of crisis-proneness of systems (see Sen 1998; and Alper and Onis 2002). However, none of these studies has analyzed the impact that the IMF-supported programs have on the efficiency of the banks in which the IMF intervened.

There is also a growing number of studies on cross-country banking crises (see Caprio and Klingebiel 2003; and Demirgüç-Kunt and Detragiache 2005). These studies focus mainly on describing the causes, consequences, lessons, speed, and shape of general recovery (e.g., Demirgüç-Kunt and Detagiache 1998; Dell'Ariccia et al. 2005). Some researchers, such as Kaminsky and Reinhart (1998) and Bongini et al. (2001) cite the poor overall performances of banks, such as poor financial indicators and high inefficiency scores, as major causes of crises in developing countries. This causal link suggests that assessing individual bank performance in such developing countries may provide useful new findings. Yet, the performance of individual banks in developed or developing countries following crisis management by the IMF has seldom been investigated.

Moreover, although there are several cross-country studies on the effects of such factors as bank restructuring, deregulation, consolidation, and privatization on bank performance, these are largely conducted for the U.S. and European economies. Previous studies on the effects of East Asian bank restructuring on efficiency during 1991–2005 are still very limited: only seven studies (see Bongini et al. 2001; Choi and Hasan 2005; Harada 2005; Harada and Ito 2005; Williams and Nguyen 2005; Park and Weber 2006; and Brown and Skully 2006). Most such studies either use data prior to the Asian banking crisis or single-year data, and report mixed results. We fill a gap in the banking literature by using a nonparametric technique and regression analysis with more recent data that covers a longer period. These longer-term data make it possible for us to examine technical and scale efficiency (and their determinants) of the East Asian banks subject to the IMF-supported restructuring programs.

The paper is organized as follows. Section 2 outlines the related literature on bank restructuring and efficiency. In Section 3 we describe our methods. In Section 4 we discuss the empirical results. Section 5 concludes.

2 Review of the literature on bank restructuring and efficiency

A review of the bank restructuring under IMF-supported programs for the four East Asian countries indicates the use of four main restructuring measures. The first measure involves closure of banks, that is, insolvent banks are liquidated or integrated with another domestic bank that is considered to be a sound bank. The second action forces affected banks to merge with and/or acquired by healthier banks. Another measure involves nationalization

(initial recapitalization by the government with a view to future re-privatization). The fourth measure calls for private sector involvement in which capital may be sought from private owners including foreign investors.

Despite abundant literature on bank efficiency, only a handful of previous studies investigate the link between bank failures (and possibly the closures that followed) and inefficiency, most of which are on the U.S. banking markets. These studies show that banks and thrifts with low efficiency fail at greater rates than those with higher efficiency levels (Berger and Humphrey 1992a; Cebenoyan et al. 1993). Isik and Hassan (2003) provide evidence from a developing country in their study of Turkish banks during 1992–1996. These authors suggest that banks experience a substantial productivity loss in the crisis year, and that the small banks suffer the most. Two studies on East Asian banking efficiency provide further evidence on this link. Karim (2001) assesses the cost efficiency of East Asian banks during 1989–1996, and finds that banks' cost inefficiencies tend to increase during the years preceding the crisis. Williams and Nguyen (2005), in their analysis of the profit efficiency and productivity of East Asian banks, show that the closed banks have significantly lower profit efficiency scores than do other bank types. Hence, the region's bank closure decisions could be economically justified.

Previous studies on recapitalization focus on the rationale, techniques, costs, and issues of recapitalization (see, for example, Tang et al. 2000; Cheung and Liao 2005). Most recapitalized banks are then reprivatized, and thus become major state banks or fully private banks in later years. Empirical studies indicate somewhat favorable efficiency effect of bank privatization, although this conclusion varies across countries (see, for example, extensive surveys by Megginson 2005, and Clarke et al. 2005). Studies of individual nations that have gone through economic crisis and/or banking reforms, (e.g., Berger et al. 2005, on Argentina; and Bonaccorsi di Patti and Hardy 2005, on Pakistan) find that at least one bank efficiency measure (cost, profit, or revenue) improves following privatization. The empirical evidence on bank privatization in the East Asian banking markets is very limited and inconclusive. Williams and Nguyen (2005) find that East Asian state-owned banks underperform private and foreign-owned banks, and that privatized banks improve efficiency after privatization. In contrast, Harada and Ito (2005), in their study of the top ten Indonesian banks, find no evidence of such a privatization effect on bank efficiency over the period 1999–2003.

The results on the impact of bank mergers and acquisitions (M&As) on the efficiency of the merged banks are again mainly from the U.S. and European banking markets. Two extensive surveys by Berger et al. (1999) and Amel et al. (2004) show that banking M&As do not significantly improve cost and profit efficiency. The empirical evidence from East Asian banking M&As is again very limited and inconclusive. The only cross-country study (Williams and Nguyen 2005) reports mixed results of the M&A effects on profit and cost efficiency. These authors report that domestic M&As gain significant short-term profit efficiency gains, but experience long-term profit efficiency losses, a result exactly the opposite for cost efficiency. Harada (2005) documents that efficiency of Korean banks deteriorated before crisis, but improved following the mergers.

Previous studies on the association between foreign ownership and efficiency provides somewhat mixed results. But overall, there is greater evidence to support the proposition that foreign-owned banks are generally more efficient than their domestic counterparts (see, for example, Claessens et al. 2001; Weill 2003; Berger 2007). However, there is very limited evidence on the effects of foreign acquisitions (participation) on bank efficiency, and again, the results are mixed. Fries and Taci (2005) claim that majority-foreign-owned banks in transition economies are the most efficient, Berger et al. (2005) report efficiency declines associated with foreign acquisitions of Argentine banks.

Although the previous evidence on the relation between foreign ownership and bank efficiency in the East Asian banking markets is limited, it is in line with other studies that report some favorable results for foreign ownership. Laeven (1999) finds that foreign banks in the region took little risk relative to other bank types in the pre-crisis period. Studies by Karim (2001) and Williams and Nguyen (2005) show that both domestic and foreign-owned private banks are more efficient than are state-owned banks. Other studies (Harada 2005; Choi and Hasan 2005) find that higher foreign ownership is associated with higher efficiency. Thus, such banks outperform other bank types. In addition, financial liberalization, which includes foreign bank entry following deregulation, has positive effects on domestic bank efficiency (Leightner and Lovell 1998; Park and Weber 2006). There is limited evidence on the effects of foreign participation on the East Asian banking efficiency. The only study (Williams and Nguyen 2005) shows that the potential benefits of foreign participation may take a longer time to be realized.

Thus, the international empirical evidence on bank failures and efficiency generally supports bank closure (liquidation) decisions. Further, although the evidence on the impact of bank privatization, M&As, and foreign participation is somewhat mixed, there are some favorable results of improved performance for privatization and foreign ownership or participation. In the absence of guidance from previous evidence and with the expectation that East Asian banking efficiency will improve after the IMF restructuring, we formulate hypothesis 1:

H1: After controlling for country-specific characteristics, we will find that the East Asian banks' technical and scale efficiencies significantly improve after restructuring under IMF-supported programs.

As noted above, there is the expectation of improvement after restructuring. The restructured banks may catch up with their unrestructured counterparts in terms of efficiency after controlling for other bank-specific and country-specific characteristics. This argument leads to our second hypothesis.

H2: After controlling for other bank- and country-specific characteristics, we will find that there is no significant difference in technical and scale efficiencies between the East Asian restructured banks and their un-restructured counterparts.

There is no previous evidence of how recapitalization affects performance. Above, we noted the mixed results on performance from mergers and acquisitions, and favorable results for foreign participation. These arguments lead to our third and fourth hypotheses.

H3: After controlling for other bank- and country-specific characteristics, we will find that there is no significant difference in technical and scale efficiencies of the East Asian banks before and after recapitalization and mergers.

H4: After controlling for other bank- and country-specific characteristics, we will find that the technical and scale efficiencies of the East Asian banks with foreign participation significantly improve after restructuring.

3 Data and method

Our sample comprises 138 domestic commercial banks operating in the four crisis-hit East Asian countries that accepted IMF-supported programs. The data set covers the 15 years

between 1991 and 2005. To ensure homogeneity, we exclude banks such as development (specialized), investment, savings, regional rural, and joint-venture banks, and wholly-owned subsidiaries and branches of foreign banks, and thus ensure the comparability of the results inside and outside the sample.

Our primary source for the bank-specific data is the Bankscope database. We obtain the country-specific data from the International Financial Statistics (IFS) of the IMF. Other sources include the World Bank, the four central bank reports, Heritage Foundation, and the *Wall Street Journal*. These sources enable us to use annual cross-section, time-series and pooled financial data.

Of the 138 banks in the final sample, there are 66 Indonesian, 26 Korean, 32 Filipino, and 14 Thai banks. These banks account for a representative asset coverage in each of the four banking markets, ranging from a minimum of 68% in Korea to a maximum of 82% in Indonesia. Most banks are privately owned (91% of the sample), and state-owned banks account for 9%. There are 74 banks that are listed on the stock market (54%) and 64 that are not (46%). Table 1 provides summary statistics on the data.

When we examine restructuring measures, we find that only 30% of the banks did not experience any dramatic changes, since the restructuring agency and the IMF judged these banks as being sound enough to continue without interventions. The majority of banks (70%) underwent some form of restructuring: closure; merger and/or acquisition; recapitalization and then reprivatization; or foreign participation. Among the 97 restructured banks, 54 banks were closed (liquidated or forced to be taken over by another bank), 22 banks underwent mergers or acquisitions to continue operations, and the other 21 banks were recapitalized by the respective governments. Nine out of these 21 recapitalized banks were later reprivatized to both domestic and foreign investors. In addition, both the restructured and 44 unrestructured banks had foreign bank participation in the form of acquisitions or equity capital contributions, and thus became majority- or minority-owned by foreign banks. Our complete research data set, which contains 1,326 bank-year observations over the test period, is available on request.

Firm-specific efficiency scores can be calculated using either parametric or nonparametric methods, and each method has its own merits and drawbacks. In this paper, we use the nonparametric method for several reasons. First, the nonparametric methods such as

Table 1 Summary statistics of the sample banks. This table reports the summary statistics of the sample banks by ownership, listing status and restructuring measures. It also reports the representation of the banks in each country's banking sector

		Indonesia	Korea	Philippines	Thailand	Total
No. of banks		66	26	32	14	138
Ownership	State-owned	5	2	2	4	13
	Private-owned	61	24	30	10	125
Listing	Listed	24	21	21	8	74
	Unlisted	42	5	11	6	64
Restructuring	Unrestructured	21	3	17	0	41
	Restructured	45	23	15	14	97
Of restructured banks	Closed	29	14	8	3	54
	M & A	4	5	6	7	22
	Recapitalized	12	4	1	4	21
Of restructured banks	Re-privatized	6	0	0	3	9
	Foreign-participated	12	8	14	10	44
Share of assets (%)		82	68	77	75	

Data Envelopment Analysis (DEA) permit studies of jointly produced multiple outputs, but the parametric methods are normally limited to focusing on a single dependent variable, such as cost, revenue, or profits (Avkiran 2002). Second, price information is generally regarded as being necessary for inputs/outputs in the parametric techniques. These prices may be distorted due to regulations and other market imperfections in developing countries, and therefore may complicate the efficiency measurement (Ataullah et al. 2004). The nonparametric methods can be used for efficiency assessment without this price information.

Another reason is that, as Cooper et al. (2000) describe, in the nonparametric DEA, measurement units of different inputs and outputs do not need to be congruent, so stock and flow variables can be dealt with in the same model. Thus, DEA can address both quantitative and qualitative data, and discretionary and non-discretionary variables. This consideration is important in cross-country studies such as ours, which incorporates country-banking environmental variables. Further, the nonparametric approaches also provide meaningful scalar technical efficiency and scale efficiency measures (Favero and Papi 1995). Finally, most studies have already used parametric methods to examine the efficiency of East Asian banks. Therefore, it is pertinent to see whether the DEA-based efficiency scores, which we consider in our unique IMF-supported cases, can support the conclusions reached by other studies.

DEA models commonly have either an input or output orientation. For this study, we choose the input-oriented modeling since, from the bank management perspective; it is easier to have control over inputs than outputs. The DEA model can be tested under either constant returns to scale (CRS) or variable returns to scale (VRS) assumptions. In this paper, we investigate both CRS and VRS assumptions from which we can identify scale efficiencies. Following Coelli et al. (2005), we use the following input-oriented CRS DEA specification, which incorporates environmental variables. (We note that we suppress the time subscript in the equation):

$$\begin{aligned} &\mathrm{Min}_{\theta,\lambda}\theta, \\ \text{subject to } &-y_i + Y\lambda \geq 0 \\ &\theta x_i - X\lambda \geq 0 \\ &z_i - Z\lambda \geq 0 \\ &\lambda \geq 0 \end{aligned} \tag{1}$$

In Eq. 1 we assume that there are K inputs and M outputs for each of N firms. For firm i, these vectors are represented by x_i and y_i respectively. The $(K \times N)$ input matrix, X, and the $(M \times N)$ output matrix, Y, represent the data of all N firms. We also assume that there are L environmental variables. These vectors are represented by z_i for firm i and by $(L \times N)$ matrix $\boldsymbol{Z}$ for N firms. Parameter θ is a scalar, and λ is a $(N \times 1)$ vector of constants. The value of θ is the efficiency score of firm i. It satisfies $\theta \leq 1$, with a value of one indicating a point on the frontier, and hence a technically efficient firm.

For the scale assumptions, Eq. 1 represents the CRS DEA model. The VRS DEA model is generated by Eq. 1 plus the convexity constraint ($N1'\lambda = 1$). We can calculate the scale efficiency (SE) by comparing the differences in technical efficiency (TE) scores generated by the CRS and VRS DEA models. If there is a difference in the two efficiency scores, then this difference indicates the existence of scale inefficiency. Following Coelli (1996b), we calculate the SE for firm i as:

$$\mathrm{SE}_i = \frac{\mathrm{TE}_{i,\mathrm{crs}}}{\mathrm{TE}_{i,\mathrm{vrs}}} \tag{2}$$

where SE_i is the scale efficiency, $TE_{i,crs}$ is the technical efficiency score under CRS, and $TE_{i,vrs}$ is the technical efficiency score under VRS assumptions.

There are two competing theories of banking service provision: the production and the intermediation approaches. Under the production approach, banks are regarded as using labor and capital to produce deposits and loans. The intermediation approach views banks as intermediaries that use loans and other earning assets as outputs, and capital, labor, and deposits as inputs (Sealey and Lindley 1977). Following Isik and Hassan (2003), and Casu et al. (2004), we use the intermediation approach. To capture the most significant banking activities, we use three inputs (purchased funds, labor and physical capital) and two outputs (loans and other earning assets) in Eq. 1.

In addition, since DEA is very sensitive to outliers (Hartman et al. 2001; Hughes and Yaisawarng 2004), we run an input-oriented CRS super-efficiency model for each annual data set to identify any units as outliers. Following Hartman et al. (2001), we use two as our cut-off point. As a result, we remove one bank that we identified as an outlier in all years. Three other banks that were outliers in 2 or 3 years were removed from the sample for only those years.

Recent cross-country studies stress the importance of controlling for country-specific environmental conditions (see, for instance, Dietsch and Lozano-Vivas 2000; Lozano-Vivas et al. 2002; Carbo-Valverde et al. 2007; Psiouras 2008). Following these recent developments, we introduce country-specific variables directly into the DEA efficiency model.

Based on the variables identified in similar studies (for instance, Dietsch and Lozano-Vivas 2000; Lozano-Vivas et al. 2002), we initially select ten environmental variables, which we categorize into two main groups. The first group, which we label "main conditions," comprises measures of population density, density of demand, income per capita, interest rate level, inflation rate, and overall economic condition. The second group, which we label "banking and financial conditions," consists of degree of concentration, depth of bank intermediation, degree of monetization, and degree of regulatory restrictions. In addition, given that the choice of restructuring measures should depend on the level of difficulties that each banking system faces, we also consider a fifth variable as a proxy of asset quality. These variables characterize the structure, competition, and critical problem of a banking industry. Data limitations prevent us from investigating the impact of political connections on the implementation of the restructuring measures, which may in turn influence banking efficiency during the study period.

Once we identify the eleven environmental variables, we follow the forward selection procedure (see Lozano-Vivas et al. 2002). This approach helps to minimize the number of variables incorporated into the DEA model by statistically selecting only those influential environmental variables. We find that five out of eleven environmental variables are influential. Thus, we include the following variables: degree of monetization, density of demand, population density, overall economic condition, and average asset quality. Following Lozano-Vivas et al. (2002), we consider that the first four variables are the output type, i.e., the higher, the better; and therefore should be introduced as inputs in the DEA model. The fifth variable, average asset quality measured by non-performing loans (NPLs) to total loans, is an input-type variable, i.e., the lower, the better. Thus, we should include this variable as an output, or else transform it into a non-discretionary input by reversing its sign and translating it. We opt for the latter solution, so that we use all five environmental variables as inputs in the DEA model. The complete model has ten variables: three inputs, two outputs, and five environmental variables. We define these variables in Table 2.

The Zhu (2003) DEA-Solver software allows for a single-step calculation of the technical and then scales efficiency scores under this complete model. We use these

Table 2 Variable definitions (Eqs. 1 and 3). This table defines the variables used in the DEA and regression models. We also include expected signs (third column from left), with "+" indicating positive and "–" indicating negative effects

Variable	Definition	Expected sign
Panel A: inputs		
Purchased funds	Customer deposits, money market funding & other funds	
Labor	Personnel expenses	
Physical capital	Book value of fixed assets	
Panel B: outputs		
Net loans	Total customer loans minus loan loss reserves	
Other earning assets	Placements with other banks, securities and investments	
Panel C: environmental variables		
Degree of monetization	Broad money (M2) divided by GDP (%)	
Density of demand	Total deposits of banking sector divided by area (km^2)	
Population density	Number of inhabitants per km^2	
Overall economic condition	GDP growth rate (%)	
Average asset quality	Total non-performing loans to total loans	
Panel D: Tobit regression variables		
θ	Efficiency scores of banks (dependent variable)	
β_0	Constant	
RESTR	A dummy variable for restructured banks during 1998–2002	+/–
CLOSED	A dummy variable for closed banks during 1998–2002	–
RECAP	A dummy variable for recapitalized banks during 1998–2002	+/–
RECAP_EFF	A dummy variable for the years following the recapitalization	+/–
REPRIV	A dummy for recapitalized banks which were later reprivatized during 1998–2002	+/–
M&A	A dummy variable for a domestic bank that underwent at least one domestic merger or acquisition during 1998–2002	+/–
M&A_EFF	A dummy variable for the years following the M or A	+/–
FOR	A dummy variable for a bank that underwent at least one foreign acquisition or participation during 1998–2002	+
FOR_EFF	A dummy variable for the years following foreign acquisition or participation during 1998–2002	+
DUR_IMF	A dummy variable for the years during IMF program (1998–2000)	+/–
POST_IMF	A dummy variable for the years following IMF program	+/–
STATE	A dummy variable for state-owned banks during 1991–2005	–
LISTED	A dummy variable for listed banks during 1991–2005	+/–
LnASSETS	Natural logarithm of total assets	+/–
ETA	Total equity to total assets	+
LTA	Gross loans to total assets	
LLRL	Loan loss reserves to total loans	–
CTI	Cost to income	–
NIITI	Non-interest income to total income	+
ROA	Profits before tax to total assets	+
LATA	Liquid assets to total assets	+/–
LTD	Gross loans to total deposits and money market funding	+/–
INDO, KOR, PHIL	A dummy for Indonesia, Korea, and Philippines, respectively	
ε	Error term	

efficiency scores in the regression model to identify determinants of bank efficiency. Other studies use alternative regression methods, including ordinary least squares (OLS), generalized least squares (GLS), logistic, and Tobit regressions for this purpose. We use the Tobit censored regression because it can account for the censored nature of the dependent variable, that is, the efficiency scores, thus yielding reportedly consistent estimates. To control for heteroskedasticity, and following Isik and Hassan (2003), we also use GLS regressions with White's (1980) corrections. We regress the efficiency scores against restructuring measures and other bank-specific characteristics under the following Tobit regression model:

$$\begin{aligned}\theta_{ijt} = {} & \beta_0 + \beta_1 RESTR_{ijt} + \beta_2 CLOSED_{ijt} + \beta_3 RECAP_{ijt} + \beta_4 RECAP\_EFF_{ijt} + \beta_5 REPRIV_{ijt} \\ & + \beta_6 M\&A_{ijt} + \beta_7 M\&A\_EFF_{ijt} + \beta_8 FOR_{ijt} + \beta_9 FOR\_EFF_{ijt} + \beta_{10} DUR\_IMF_t \\ & + \beta_{11} POST\_IMF_t + \beta_{12} STATE_{ijt} + \beta_{13} LISTED_{ijt} + \beta_{14} \ln ASSETS_{ijt} + \beta_{15} ETA_{ijt} + \beta_{16} LTA_{ijt} \\ & + \beta_{17} LLRL_{ijt} + \beta_{18} TCTA_{ijt} + \beta_{19} CTI_{ijt} + \beta_{20} NIITI_{ijt} + \beta_{21} ROA_{ijt} + \beta_{22} LATA_{ijt} + \beta_{23} LTD_{ijt} \\ & + \beta_{24} INDO_j + \beta_{25} KOR_j + \beta_{26} PHIL_j + \varepsilon_{ijt}\end{aligned} \tag{3}$$

In Eq. 3, we define subscripts i as individual banks, j countries, t time horizon, and other variables with the expected signs, as in Table 2, Panel D.

We choose 1998–2002, i.e., the 2years after the IMF programs, to consistently define the variables that indicate the four restructuring measures (closure, recapitalization, M&As, and foreign participation). We do so because first, although a majority of banks underwent at least one of the four restructuring measures during 1998–2000, several banks were recapitalized, consolidated, or reprivatized in 2002; and second, because a 3-year horizon after that final restructuring year should be sufficient for assessing such restructuring measures in their post-event period.

Table 3 reports the average values of the variables disaggregated by country. There are significant variations in the banking variables among the four countries. Korean banks appear to dominate in all banking inputs and outputs, followed by Thai banks. The Filipino banks have the smallest values in these variables. For example, with respect to inputs, the average purchased funds vary from US$1.8 billion in the Philippines to US$20 billion in Korea. On the outputs, while Indonesian banks provide US$2.4 billion of loans annually, this figure for Thai banks is US$8.8 billion (see Panel A).

When we examine the environmental variables, we find that Korea is the most monetized economy, with a value of 109% for the ratio of broad money supply to GDP (as in Panel B). As measured by total banking deposits over area, Korea also has the highest average density of demand, followed by Thailand, and then the Philippines. In addition, Korea also has the highest period-average GDP growth rate (5.6% per year). Banks in Indonesia and Thailand suffer the highest level of difficulties with higher nonperforming loan ratios, and Korean banks face the lowest (Panel B).

4 Discussion of results

We now turn to discuss the results on technical and scale efficiencies obtained from the DEA model, and determinants of efficiency from the regression.

Table 3 Banking and environmental variables by country (1991–2005). This table presents the mean values and standard deviations (over 1991–2005) of selected banking and environmental variables that we use for the efficiency assessment model. We convert all financial variables into United States dollar (US$) values, using average annual exchange rates for each year, and then adjust for inflationary effects, using each country's gross domestic product deflator (GDPD)

	Indonesia		Korea		Philippines		Thailand	
	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev
Panel A: banking variables (US$ million)								
Purchased funds	3,686.1	7,065.3	20,103.4	23,485.1	1,842.2	2,014.45	10,718.5	9,308.58
Labor expense	47.73	88.87	218.44	239.87	31.85	35.04	90.34	86.69
Fixed assets	74.48	130.8	580.22	532.94	76.92	104.48	403.85	360.75
Net loans	2,437.6	5,213.9	14,769.8	18,502.4	1,220.8	1,309.07	8,823.7	8,109.39
Other earning assets	1,268.4	2,815.5	7,166.2	6,980.6	852.18	899.09	2,189.3	2,758.28
Panel B: selected environmental variables								
Broad money to GDP (%)	51.73	6.46	109.32	18.98	53.35	9.28	90.20	11.99
Banking deposits over area (km^2) (US$'000)	41.57	9.99	2,961.5	1,842.4	112.66	34.89	225.38	40.17
Number of inhabitants per km^2	106.69	5.96	462.99	15.66	242.60	21.74	116.93	5.18
GDP growth rate (%)	3.94	5.74	5.63	4.07	3.76	2.09	4.70	5.15
NPLs to total loans (%)	13.77	14.43	6.23	4.19	9.16	4.95	14.67	11.25

4.1 Technical efficiency

Table 4 reports the average values of the computed technical efficiency scores of all the sample banks, under a common efficiency frontier.

Our preliminary observation shows that an average efficiency score is 0.836 under the basic model and 0.920 under the complete model. This result indicates that the banks experience an inefficiency level of 16% (or 8% under the complete model) relative to the best-practice (fully efficient) bank during 1991–2005 (final row in Table 4). In other words, the average input-oriented efficiency level of 0.836 suggests that the East Asian banks could reduce inputs by 16% without affecting outputs (on an assumption of zero slacks).

A second observation is that when we do not control for environmental differences (basic model), we see that the average efficiency of the sample banks decreases by 8% from 0.855 before the IMF program to 0.776 during the IMF program, and then recovers to 0.846 after the IMF program (Table 4, column 2). When we control for environmental differences (complete model), the average efficiency appears to be more stable, with the result showing a slight decline (−2%) during the IMF program, then a rise of 4% in the post-IMF period (Table 4, column 4). These scores suggest that the negative impact of the Asian financial crisis on bank efficiency was felt deeply during the crisis.

The results also indicate that on average, the mean efficiency scores under the complete model are 8.4% higher than those of the basic model (final row in Table 4). This finding is supported by the empirical evidence (e.g., Chaffai et al. 2001; Lozano-Vivas et al. 2002;

Table 4 Technical efficiency scores: basic and complete models. This table presents the mean, standard deviation, and count of the sample banks' technical efficiency scores, which we obtain from the DEA input-oriented model under the CRS assumption. The basic model uses three inputs (purchased funds, labor costs, and physical capital), and two outputs (net loans and other earning assets). The complete model uses the same inputs and outputs, but also incorporates five environmental variables (deposit density, degree of monetization, population density, overall economic condition, and asset quality)

	Basic model (without environmental variables)		Complete model (with environmental variables)		
Year	Mean	Standard deviation	Mean	Standard deviation	No. of observations
1991	0.886	0.089	0.952	0.055	44
1992	0.873	0.076	0.933	0.073	78
1993	0.881	0.078	0.925	0.071	102
1994	0.858	0.088	0.885	0.082	114
1995	0.854	0.090	0.888	0.094	119
1996	0.797	0.127	0.925	0.088	120
1997	0.836	0.097	0.923	0.087	111
Pre-IMF	0.855	0.092	0.919	0.078	98
1998	0.784	0.152	0.900	0.110	94
1999	0.798	0.156	0.904	0.101	90
2000	0.746	0.162	0.894	0.145	87
Dur-IMF	0.776	0.157	0.899	0.119	90
2001	0.829	0.118	0.939	0.100	83
2002	0.808	0.123	0.939	0.101	81
2003	0.875	0.096	0.937	0.078	76
2004	0.853	0.096	0.945	0.075	72
2005	0.864	0.093	0.952	0.061	55
Post-IMF	0.846	0.105	0.942	0.083	73
All-year	0.836	0.118	0.920	0.088	88

Kasman et al. 2005) on cross-country banking efficiency, that country-specific environmental conditions exercise remarkable influence on bank efficiency. However, our results show narrower dispersions (standard deviations) of efficiency scores under both models (9% compared to 20% to 25% in other studies), suggesting that our sample might be more homogeneous than samples in other studies. In addition, our control of the fifth environmental variable (asset quality) raises the average efficiency score by 2.7%, suggesting that it is important to consider the level of difficulties that each banking system faces, particularly in a period of financial turmoil (also, see Berger and DeYoung 1997).

To investigate the varied impacts of the IMF-supported programs on bank efficiency, in Table 5 we disaggregate the computed efficiency scores by country. The statistics show that whether or not we control for environmental differences, Thai banks, on average, are the most efficient, followed by the Filipino banks. On the other hand, the results from both models suggest that the Indonesian banks are the least efficient.

The results in Panel A (basic model), also show that average efficiency decreases during the crisis period (thus, during the IMF program). Indonesian banks are the most affected by the crisis, experiencing a reduction of 17% in their average efficiency scores, followed by Thai banks (6%), and Korean banks (4%). The Filipino banks, being less affected by the crisis, are able to maintain their pre-IMF efficiency level of 0.85 (Panel A, Column 3). In the post-IMF period, banks (excepting those in the Philippines) regain efficiency to their pre-IMF level. Korean banks even obtain their efficiency of 0.895, or 9.5% higher than that prior to the IMF program.

Table 5 Technical efficiency scores by country. This table presents the mean and standard deviation of the sample banks' technical efficiency scores by country. We obtain the efficiency scores from the DEA input-oriented model under the CRS assumption (Eq. 1). The basic model uses three inputs (purchased funds, labor costs, and physical capital), and two outputs (net loans and other earning assets). The complete model uses the same inputs and outputs, but also incorporates five environmental variables (deposit density, degree of monetization, population density, overall economic condition, and asset quality)

Year	Indonesia	Korea	Philippines	Thailand	All-country
Panel A: basic model (without environmental variables)					
1991	0.861	0.879	0.838	0.930	0.886
1992	0.865	0.825	0.863	0.928	0.873
1993	0.883	0.826	0.876	0.891	0.881
1994	0.877	0.789	0.844	0.911	0.858
1995	0.868	0.783	0.855	0.907	0.854
1996	0.793	0.723	0.810	0.890	0.797
1997	0.835	0.780	0.857	0.876	0.836
Pre-IMF	0.855	0.801	0.849	0.905	0.855
1998	0.672	0.745	0.883	0.890	0.784
1999	0.683	0.801	0.876	0.851	0.798
2000	0.693	0.754	0.788	0.799	0.746
Dur-IMF	0.683	0.767	0.849	0.847	0.776
2001	0.809	0.857	0.826	0.847	0.829
2002	0.767	0.886	0.810	0.833	0.808
2003	0.864	0.921	0.854	0.876	0.875
2004	0.846	0.893	0.825	0.863	0.853
2005	0.821	0.915	0.842	0.891	0.864
Post-IMF	0.822	0.895	0.831	0.862	0.846
All-year	0.809	0.825	0.843	0.879	0.836
Panel B: complete model (with environmental variables)					
1991	0.926	0.972	0.946	0.962	0.952
1992	0.928	0.893	0.940	0.970	0.933
1993	0.914	0.880	0.944	0.962	0.925
1994	0.904	0.841	0.866	0.929	0.885
1995	0.915	0.822	0.887	0.930	0.888
1996	0.904	0.925	0.913	0.960	0.925
1997	0.897	0.899	0.931	0.963	0.923
Pre-IMF	0.912	0.891	0.918	0.954	0.919
1998	0.844	0.893	0.940	0.923	0.900
1999	0.874	0.849	0.934	0.958	0.904
2000	0.841	0.883	0.925	0.928	0.894
Dur-IMF	0.853	0.875	0.933	0.936	0.899
2001	0.905	0.945	0.952	0.945	0.939
2002	0.898	0.967	0.941	0.939	0.939
2003	0.903	0.977	0.926	0.929	0.937
2004	0.910	0.983	0.918	0.958	0.945
2005	0.952	0.978	0.908	0.958	0.952
Post-IMF	0.913	0.970	0.929	0.946	0.942
All-year	0.893	0.912	0.917	0.945	0.920

When we consider the environmental variables, we find a similar trend for the banks in Indonesia, Thailand, and Korea, which have efficiency reductions of 6%, 2%, and 1.5%, respectively. The efficiency of Filipino banks actually rises by 1.5% during the IMF program (Panel B, Complete Model). Thus, we see that the environmental conditions

exercise either positive or negative effects on bank efficiency, at least during the crisis period. In the post-IMF period, we see that while Indonesian banks are able to raise their average efficiency and almost regain efficiency to their pre-IMF level, Korean banks make a remarkable 10% gain, surpassing their pre-IMF level. The Filipino banks' efficiency deteriorates slightly. We find a very slight improvement in efficiency for Thai banks in the post-IMF period, but it is still 1% lower than that in the pre-IMF period.

4.2 Scale efficiency (SE)

We calculate SE by comparing the differences in TE scores generated under the CRS and VRS specifications. Table 6 summarizes the SE of the sample banks under both the basic and complete models.

The banks' period average SE is 0.892 for the basic model and 0.925 for the complete model. This result suggests that on average, and assuming zero slacks, the banks deviate 11% (basic model) or 7.5% (complete model) from their potential efficiency score. Since the overall efficiency depends on both technical efficiency and scale efficiency, the relative sizes of these scores provide us with evidence about the sources of inefficiency. When we ignore environmental factors, then the overall period-mean TE score (0.836) is about 6% below the period-mean SE (0.892), suggesting that the technical factor is a relatively more important inefficiency source than the scale factor. However, when we include the

Table 6 Scale efficiency scores: basic and complete models. This table presents the mean, standard deviation, and count of the sample banks' scale efficiency scores, which we obtain from the calculations of the differences between the scores under the constant returns to scale (CRS) and those under the variable returns to scale (VRS) assumptions (Eq. 2). The basic model uses three inputs (purchased funds, labor costs, and physical capital), and two outputs (net loans and other earning assets). The complete model uses the same inputs and outputs, but also incorporates five environmental variables (deposit density, degree of monetization, population density, overall economic condition, and asset quality)

	Basic model (without environmental variables)		Complete model (with environmental variables)		
Year	Mean	Standard deviation	Mean	Standard deviation	No. of observations
1991	0.908	0.061	0.948	0.060	44
1992	0.926	0.042	0.943	0.063	78
1993	0.934	0.037	0.940	0.060	102
1994	0.936	0.033	0.917	0.070	114
1995	0.940	0.031	0.924	0.075	119
1996	0.859	0.092	0.917	0.088	120
1997	0.918	0.063	0.936	0.079	111
Pre-IMF	0.917	0.051	0.932	0.071	98
1998	0.860	0.097	0.911	0.115	94
1999	0.863	0.092	0.922	0.094	90
2000	0.811	0.114	0.906	0.151	87
Dur-IMF	0.845	0.101	0.913	0.120	90
2001	0.868	0.077	0.936	0.106	83
2002	0.855	0.097	0.929	0.107	81
2003	0.903	0.059	0.917	0.079	76
2004	0.891	0.065	0.930	0.071	72
2005	0.904	0.060	0.937	0.066	55
Post-IMF	0.884	0.071	0.930	0.086	73
All-year	0.892	0.068	0.925	0.087	88

environmental variables, the difference in efficiency between the technical factor and scale factor is no longer present (Tables 4 and 6, final rows).

However, with this SE specification, it is not clear whether the banks are operating in an area of increasing or decreasing returns to scale. To determine this and following Coelli (1996b), we run an additional DEA test with non-increasing returns to scale (NIRS) imposed, and compare these NIRS scores with those under the VRS assumption. On average, the results from these tests are all different. This finding suggests that most banks are operating in the region of increasing returns to scale. One implication is that the banks might achieve significant cost savings and efficiency gains by increasing their scale of operations, which they might be able to do via internal growth or continued consolidation in the sector. Consolidation exercises that take place after the crisis could thus be justified based on this SE analysis.

Table 7 reports the SE scores by country. When we do not consider environmental differences, we find that on average, the Thai banks are the most scale efficient (0.925) and Indonesian banks the least (0.876). Although the SE of Korean banks declines slightly over time, it still surpasses that of Thai banks when we take the environmental factors into account. Although the SE of the banks in Indonesia and the Philippines are slightly higher (2%) under the complete model, the SE of Indonesian banks is the lowest (0.88–0.9), whether or not we consider environmental factors.

When we consider changes in efficiency by period, the results under the basic model indicate that the average SE of all sample banks decreases by 7% (from 0.917 to 0.845) during the IMF program. However, these banks (except for those in the Philippines) could almost reach their pre-IMF level in the post-IMF period. The SE of the Filipino banks, on the other hand, is 4% lower than that in the pre-IMF period. But when we control for environmental differences, although the SE of Thai banks declines by 2% during the IMF program, it remains unchanged in the post-IMF period. The SE of Indonesian banks decreases the most, by 7%, during the IMF program, and then recovers to the pre-IMF level in the post-IMF period. The SE of Korean banks declines slightly over time, but that of Filipino banks increases during the IMF program, after which it declines in the post-IMF period, ending at the same level as their pre-IMF positions (Table 7, Panel B).

4.3 Determinants of bank efficiency

Due to the censored nature of the efficiency scores, we use the Tobit censored regression. We also run GLS multiple regressions as robustness tests. Following Baltagi (2005), we conduct tests for identifying multicollinearity (the Variance Inflation Factor test) and autocorrelation (the Durbin–Watson test). The test results enable us to confirm the normality of the data set. Since the results from the Tobit and GLS regressions are similar, with the majority of the coefficients being statistically significant and the coefficients having the same sign, we report on and discuss only the pooled Tobit regression results. These results serve as robustness tests of the previous discussion.

4.3.1 Bank restructuring and efficiency

The effects of the bank restructuring measures on efficiency are expressed by the estimated coefficients in Table 8, Panel A. To capture the overall effect of the IMF-supported bank restructuring programs, we use a dummy, Restructured, for determining if the restructured banks outperform their non-restructured counterparts. The reported positive but nonsignificant coefficient indicates that the restructured banks are not significantly more efficient

Table 7 Scale efficiency scores by country. This table presents the mean and standard deviation of the sample banks' scale efficiency scores by country. We obtain the efficiency scores from the calculations of the differences between the scores under the constant returns to scale (CRS) and those under the variable returns to scale (VRS) assumptions (Eq. 2). The basic model uses three inputs (purchased funds, labor costs, and physical capital), and two outputs (net loans and other earning assets). The complete model uses the same inputs and outputs, but also incorporates five environmental variables (deposit density, degree of monetization, population density, overall economic condition, and asset quality)

Year	Indonesia	Korea	Philippines	Thailand	All-country
Panel A: basic model (without environmental variables)					
1991	0.913	0.878	0.897	0.936	0.908
1992	0.912	0.909	0.926	0.949	0.926
1993	0.928	0.914	0.933	0.949	0.934
1994	0.930	0.928	0.934	0.934	0.936
1995	0.933	0.935	0.941	0.927	0.940
1996	0.886	0.853	0.843	0.922	0.859
1997	0.912	0.895	0.924	0.929	0.918
Pre-IMF	0.916	0.902	0.914	0.935	0.917
1998	0.826	0.801	0.889	0.925	0.860
1999	0.812	0.855	0.887	0.929	0.863
2000	0.787	0.780	0.822	0.857	0.811
Dur-IMF	0.808	0.812	0.866	0.904	0.845
2001	0.857	0.878	0.844	0.904	0.868
2002	0.816	0.893	0.848	0.910	0.855
2003	0.879	0.917	0.893	0.937	0.903
2004	0.878	0.887	0.882	0.918	0.891
2005	0.869	0.922	0.896	0.940	0.904
Post-IMF	0.860	0.899	0.873	0.922	0.884
All-year	0.876	0.883	0.891	0.925	0.892
Panel B: complete model (with environmental variables)					
1991	0.951	0.961	0.925	0.957	0.948
1992	0.933	0.955	0.919	0.964	0.943
1993	0.919	0.956	0.923	0.964	0.940
1994	0.909	0.959	0.845	0.955	0.917
1995	0.920	0.955	0.866	0.954	0.924
1996	0.909	0.921	0.892	0.945	0.917
1997	0.902	0.946	0.947	0.948	0.936
Pre-IMF	0.920	0.950	0.902	0.955	0.932
1998	0.839	0.953	0.915	0.936	0.911
1999	0.869	0.946	0.928	0.943	0.922
2000	0.836	0.944	0.924	0.923	0.906
Dur-IMF	0.848	0.948	0.922	0.934	0.913
2001	0.910	0.964	0.942	0.930	0.936
2002	0.903	0.959	0.931	0.924	0.929
2003	0.908	0.929	0.916	0.914	0.917
2004	0.915	0.935	0.908	0.963	0.930
2005	0.957	0.930	0.898	0.963	0.937
Post-IMF	0.918	0.943	0.919	0.939	0.930
All-year	0.896	0.947	0.915	0.943	0.925

Table 8 Tobit regression results on determinants of bank efficiency (1991–2005). This table presents results on the determinants of bank efficiency using the Tobit censored regression model (Eq. 3). The dependent variables are the calculated TE and SE scores (under the complete model, i.e., controlling for environmental differences). The independent variables are as defined in Table 2. Adjusted R^2 taken from the GLS using the same data set

Dependent variable	Technical efficiency			Scale Efficiency		
	Coefficient	Std.Error	*t*-statistic	Coefficient	Std. Error	*t*-statistic
Constant	0.4651	0.0489	9.22***	0.3686	0.0406	9.18**
Panel A: restructuring measures						
Restructured	0.0079	0.0115	0.69	0.0132	0.0102	1.32
Recap	−0.0168	0.0092	−1.83*	−0.0105	0.0082	−1.29
Recap_Eff	0.0271	0.0100	2.71***	0.0177	0.0089	2.02**
Reprivatized	0.0162	0.0195	1.72*	0.0150	0.0174	1.69*
M&A	0.0019	0.0083	1.23	0.0004	0.0073	0.06
M&A_Eff	−0.02658	0.011304	−2.37**	−0.01879	0.0099	−1.89*
Foreign	0.0012	0.0105	0.82	0.0048	0.0094	0.52
Foreign_Eff	0.0152	0.0099	1.07	0.0137	0.0087	1.09
Panel B: IMF-programs						
Dur_IMF	−0.051	0.020	−2.52**	−0.0219	0.0141	−1.57
Post_IMF	0.0114	0.0186	0.62	0.0051	0.0166	0.32
Panel C: bank (CAMEL-based) characteristics						
State	−0.0003	0.0079	−0.05	0.0025	0.0069	0.82
Listed	0.0021	0.0067	1.10	0.0058	0.0060	0.98
LnAssets	0.0345	0.0020	11.37***	0.0263	0.0018	14.99***
ETA	0.0042	0.0005	9.03***	0.0038	0.0004	9.31***
LTA	0.0001	0.0002	0.81	0.0002	0.0001	1.47
LLRL	−0.0047	0.0005	−8.62***	−0.0040	0.0005	−8.35***
TCTA	−0.0001	0.0003	−0.33	−0.0006	0.0002	−0.04
CTI	−0.0002	0.0001	−2.60***	−0.0018	0.0001	−0.27
NIITI	0.0058	0.0003	1.09	0.0017	0.0003	0.66
ROA	0.0019	0.0017	1.71*	0.0017	0.0016	1.13
LATA	0.0002	0.0002	0.95	0.0003	0.0002	1.46
LTD	0.0002	0.0001	2.13**	0.0001	0.0001	1.29
Panel D: country dummies						
Indonesia	−0.0361	0.0089	−4.34***	−0.0281	0.0079	−3.58***
Korea	−0.0222	0.0104	−2.89***	0.0004	0.0092	0.05
Philippines	−0.0211	0.0102	−2.48***	−0.0304	0.0091	−3.39***
Diagnostics						
Log likelihood function		1,253.70		1,630.36		
LR test		660.85		654.67		
Adjusted R^2 with year dummies		0.398		0.387		
Without year dummies		0.375		0.371		
Number of cross-sections	138					
Number of time periods	15					
Total (pooled, unbalanced) observations	1,326					

*p=0.10; **p=0.05; ***p=0.01

than the non-restructured ones. This result supports Hypothesis H_2. Our finding is in line with that reported by Williams and Nguyen (2005), who find no significant difference in the profit efficiency of the restructured and other domestic private banks in either the short or the long term.

To examine the performance effects of specific restructuring measures,[1] we capture the recapitalization effect by using three dummies. We apply the first dummy, Recap, to assess whether the recapitalized banks are efficient relative to the un-recapitalized ones over the restructuring period (1998–2002). We use the second dummy, Recap_Eff, to evaluate a short-term effect, i.e., we wish to determine if these banks become more efficient after recapitalization. The third dummy, Reprivatized, assesses the short-term efficiency effect on those banks that are initially recapitalized, but reprivatized in later years. The coefficient of the dummy Recap is negative, and statistically significant at the 5% level for the TE. This finding suggests that these recapitalized banks are significantly less efficient than their un-recapitalized counterparts during the entire test period. However, bank recapitalization and then re-privatization yield short-term efficiency gains, which is evidenced by the positive and significant coefficients of Recap_Eff and Reprivatized.

The next restructuring measure, which involves domestic bank mergers and acquisitions, is captured by the two binary dummies, M&A and M&A_Eff. The M&A dummy assesses the efficiency of the banks that undergo any domestic mergers and/or acquisitions between 1998 and 2002. The M&A_Eff dummy evaluates if these banks become more efficient after their mergers and/or acquisitions. The estimated coefficients of M&A are positive, but not significant, for both technical and scale efficiencies. This finding suggests that the efficiency performance of the banks that experience mergers and/or acquisitions is not significantly different from their non-M&A counterparts. However, domestic mergers and acquisitions experience significant short-term efficiency losses. This result could be partly due to their unsuccessful alignments of corporate culture and management practices in the initial post-merger period. Our finding is consistent with Shih (2003), who finds that two merging banks weakened by the Asian financial crisis or even merging one weak into a healthier one, in many cases results in one weaker bank. Hence, we find mixed results for Hypothesis H_3.

We examine the outcome of the final restructuring measure, foreign participation, via two dummies, Foreign and Foreign_Eff. We use the Foreign dummy to evaluate the efficiency of the banks that undergo any foreign acquisition or participation between 1998 and 2002, and the Foreign_Eff dummy to see if these banks become more efficient after their foreign acquisitions. The coefficients in the table suggest that banks that undergo foreign acquisitions have no significantly higher technical and scale efficiencies compared to those that do not. We find similar results for the short-term effect. Thus, we find only marginal support for Hypothesis H_4. These results support the observation by Williams and Nguyen (2005), who find no evidence of "cherry-picking" by foreign banks in the East Asian banking markets during 1990–2003. Our results also suggest that efficiency gains associated with foreign participation might take a longer time to be realized.

During the IMF program period, the efficiency of the sample banks is significantly lower than during the pre-IMF period, which suggests that the crisis has a negative effect on bank efficiency. These banks are able to recover their efficiency levels in the post-IMF period, but the difference is not significant when compared with their pre-IMF level. This result

[1] We also conducted an evaluation of the efficiency performance of the closed banks prior to their closures. The results, which are available on request, indicate that their pre-closure performance is significantly worse than their unclosed counterparts, suggesting that the closure decisions are supported on economic grounds.

suggests that the Asian financial crisis has created long-term negative effects. However, to the extent that the efficiency losses during the crisis period, i.e., during the intervention period, are reversed and that the banking sectors regain their pre-crisis levels of efficiency, we could argue that there is an improvement. This interpretation of the results supports Hypothesis H_1.

4.3.2 Bank characteristics and efficiency

Table 8 (Panel C) provides the findings on the influences of bank-specific characteristics (ownership, listing status, and CAMEL-based measures)[2] on efficiency. The results indicate that there is no significant difference in efficiency between state-owned banks and domestic private-owned ones. Banks with foreign participation have insignificantly higher technical and scale efficiencies compared to the state-owned and other private-owned banks. This finding confirms our earlier estimated results. We observe no significant impact of stock exchange listing on efficiency. This could be due to the fact that market discipline might not exert significant effects on efficiency in crisis-hit economies, especially in those countries in which 46 of the sample banks are not listed. This finding is broadly in line with Laeven (1999), who reports an insignificant relation between a stock market listing and efficiency of Asian banks during the pre-crisis years.

Concerning the influence of CAMEL-based measures on efficiency, the coefficients in Table 8 (Panel C) suggest that bank size, capitalization, earnings, and liquidity have a significant positive effect on bank efficiency. These results confirm our earlier finding of large banks' superior scale efficiency. The significantly positive coefficient for capitalization (ETA) is consistent with the argument that banks with high efficiency will have higher profits and hence will be able to retain more earnings as capital (Carvallo and Kasman 2005). The positive coefficient for earnings (ROA) suggests that the more profitable banks are also more efficient. The coefficient for liquidity, when measured by loans to deposits, LTD, is significantly positive in terms of TE, indicating that higher fund utilization relative to fund-raising is important for banks to improve efficiency. However, this lending capability however is two-sided, since increased loans may lead to more credit risks, and to higher nonperforming loans and higher operating costs if a good risk management system is not in place. This result explains why other financial measures (loan loss reserves to loans, LLRL; and cost to income, CTI) have significantly negative influences on bank efficiency.

4.3.3 Geographical location and bank efficiency

The coefficients of the country dummies in Table 8 (Panel D), show that Indonesian and Filipino banks are significantly less efficient than Thai banks in both technical and scale efficiencies (at the 1% level). On the other hand, we see that Korean banks are significantly less efficient than Thai banks in technical efficiency only. This result suggests that on average, Thai banks are the most efficient among those in the four selected countries.

When we include the year dummies (except those years that are covered by the dummy Dur-IMF) in the regression, the adjusted *R*-squared statistic increases by only 2.3 in the TE model, and by1.6 in the SE model, indicating only a marginal impact of the time trend on efficiency (*Diagnostics* in Table 8). A closer look at each year-dummy shows that during 3years (1995, 1996, and 1998), a significantly negative trend prevails for bank efficiency, suggesting a downward trend in efficiency before and during the crisis years.

[2] CAMEL stands for Capital, Asset Quality, Management, Earnings, and Liquidity. This framework has been used as a regulatory tool for banks in the United States, India, and the four countries in this study.

5 Conclusion

In this paper we examine the effect of the IMF-supported restructuring programs on the efficiency of banks subject to intervention. We sample 138 commercial banks from four crisis-hit East Asian economies (Indonesia, Korea, the Philippines, and Thailand) and examine the effects over the pre- and post-restructuring years. We investigate these effects by using individual bank data and aggregating the test results across the sample and subsamples.

To obtain robust results, we use both nonparametric and regression models. First, we use the nonparametric DEA to estimate technical and then scale efficiencies, incorporating environmental or control variables of each country. Second, we regress these estimated efficiency scores on four bank restructuring measures, IMF programs, and other bank-specific variables, using the Tobit and GLS regressions.

Our main results indicate that, overall, East Asian banking efficiency improves in the post-IMF period, but their recovery reaches only to their pre-IMF level. The restructured banks are not significantly more efficient than their unrestructured counterparts, and different restructuring measures have significantly different effects on bank efficiency. Bank recapitalization (and then reprivatization in certain cases) yields significant short-term efficiency gains. Mergers and acquisitions, on the other hand, experience significant short-term efficiency losses. There are positive but insignificant effects of foreign participation on efficiency, which suggests that the potential benefits of foreign ownership, may accrue over a longer time than we can test here.

This paper may suggest some policy implications. Bank restructuring during a financial crisis is required and justified on efficiency restoration grounds; but importantly, well-designed measures are vital to ensure its success. Regulators must scrutinize bank mergers and acquisitions as they might have only long-term implications. The normal gains in mergers are absent in the tested period in East Asia. Recapitalization and reprivatization are supported as a means for performance improvement. Foreign participation should be encouraged, although its potential benefits may also take longer time to be fully realized. To reap these benefits, regulators should pursue stronger economic reforms, especially regarding competition, in crisis-hit countries.

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