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## IMF BANK-RESTRUCTURING EFFICIENCY OUTCOMES: EVIDENCE FROM EAST ASIA

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by

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# IMF BANK-RESTRUCTURING EFFICIENCY OUTCOMES: EVIDENCE FROM EAST ASIA


## Abstract

This paper reports new findings for the first time on bank efficiency over the pre- and post-IMF-restructuring periods for East Asia using the DEA and regression models. Bank closures that followed the IMF interventions are economically justified; but mergers and acquisitions experience short-term efficiency losses. Recapitalization and then re-privatization of bad banks have led to efficiency improvements, but still increased government ownership. Ease of entry has resulted in more foreign bank participation with improved performance; further spurts in improvements, however, may take longer time. These findings advocate bank restructuring during the crisis; but well-designed measures are vital to ensure its success. Bank mergers and acquisitions need to be scrutinized. Privatization, particularly with strategic foreign ownership, of domestic banks which should be further encouraged. To reap the potential benefits of such foreign participation, stronger economic reforms of the host countries should be further pursued.



KEY WORDS: banking efficiency; IMF-supported programs; bank restructuring.

JEL classification: G21, G28, C14, N20.

## 1. INTRODUCTION

This paper is a modest attempt to fill a gap in the developing country individual banking studies relating to the most violent of the financial crises in recent decades, the Asian financial crisis of 1997-98, by investigating the performance effects on *individual banks* resulting from the IMF-supported restructuring programs as a tool for performance enhancement. We select a sample of 138 commercial banks in four crisis-hit East Asian economies (Indonesia, Korea, the Philippines and Thailand) and examine the restructuring effects over the pre- and post-restructuring years during 1991-2005.

Since the late 1970s, 117 systemic banking crises[1] have occurred in 93 countries: more than two-thirds were 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 confidence in the economies affected by the crisis by providing a stabilization financial package (a supported program). One of the main conditionalities in this supported program is to request the receiving country to undertake a comprehensive financial sector reform with a view to crisis resolution and performance improvement. Country examples of interventions during the 1990s include Mexico 1994-1995, East Asian countries (1997-1999), Brazil in 1999, Argentina in 2001 and Turkey in 2001-02. Production efficiency as a measure of performance improvement of individual banks has yet been attempted for these cases.

Broadly, the intervention takes predictable steps. Within the IMF program's conditionality, the crisis-hit countries adopted various measures to restructure their banking systems, including closure of insolvent banks, encouraging or forcing domestic mergers, nationalization (recapitalization and re-privatization in a later stage), and allowing for foreign participation.

[1] A banking crisis is considered as "systemic" if it involves a widespread of banking failures that affect more than 20 percent of a banking system's deposits (Sheng 1996).

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, not performance of the affected entities.[2] The IMF itself undertook several studies with the same focus reported in their studies. Several studies criticized the IMF-supported programs for not achieving the set objectives such as inflation control, for mitigating moral hazard behavior and preventing crisis-prone systems and encouraging collaboration with other international financial institutions such as the World Bank.[3] None of these studies, however, analysed the impacts that the IMF-supported programs have on the intervened banking markets.

There have also been a growing number of studies on cross-country banking crises.[4] Existing studies mainly focus on describing the causes, consequences, lessons, speed and shape of general recovery (for example, Demirgüç-Kunt and Detagiache 1998, Dell'Ariccia *et al.* 2005). Banks' poor overall performances such as poor financial indicators and high inefficiency have been *claimed* as a major cause of crises in developing countries (for example, Kaminsky and Reinhart 1998, Bongini *et al.* 2001). This link suggests that assessing bank performance in such as the selected developing countries cannot be disregarded. Yet, the performance of individual banks following a crisis is seldom investigated for developing countries.

Moreover, whilst there are several cross-country studies on the effects of such factors as bank restructuring, deregulation, consolidation and privatization on bank performance, these were largely conducted for European economies.[5] Previous studies on the effects of East Asian bank restructuring on efficiency during 1991-2005 are still

[2] See Joyce (2004) for an extensive review of the IMF programs.

[3] See Sen (1998), and Alper and Onis (2002) for reviews of critics of the IMF programs.

[4] See Breuer (2004) for a review of currency and banking crises; and Caprio and Klingebiel (2003), and Demirgüç-Kunt and Detragiache (2005) for extensive surveys of systemic banking crises.

[5] See Berger and Humphrey (1997) for an extensive review of bank efficiency literature; see Berger *et al.* (1999) and Amel *et al.* (2004) for literature reviews of bank mergers and acquisitions, Megginson (2005) and Clarke *et al.* (2005) of bank privatization, and Detragiache *et al.* (2006) and Cull and Martinez-Peria (2007) of foreign bank entry.

very limited (only four studies). Most of these studies use data prior to the Asian banking crisis or single year data and report mixed results. Laeven (1999) investigates technical efficiency of East Asian banking and reported an increase in bank efficiency before the crisis, which was due to excessive risk-taking rather than a true increase in efficiency. Karim (2001), on the other hand, reports an increase in cost inefficiency of South East Asian banks during 1989-1996. Brown and Skully (2006) indicate that Asian Pacific banks in more developed financial markets enjoy higher cost efficiency in 2004. Williams and Nguyen (2005), the most comparable study to the present research, using the (parametric) stochastic frontier approach, investigated the relationship between bank profit efficiency and bank governance for South East Asian banks over 1990-2003. They suggest that private banks outperform state-owned banks, but no conclusion is made on foreign acquisition, nor of intervention dynamics. This paper attempts to fill several gaps in the existing literature by using a non-parametric technique (Data Envelopment Analysis, DEA) and regression analysis to examine technical and scale efficiency (and their determinants) of selected East Asian individual banks subjected to the IMF-supported restructuring programs.

The remainder of this paper is organized as follows. Section 2 below outlines the empirical literature on bank restructuring and efficiency. Section 3 contains a description of the methodology employed in greater detail. Section 4 discusses the empirical results, and Section 5 concludes the paper.

## 2. RELATED LITERATURE

Empirical evidence indicates two main approaches to evaluating the impact of the financial sector restructuring policies (under IMF-supported programs). The first concentrates on macroeconomic effects that are closely related to the ultimate goals of restructuring. For instance, several studies, including those by the IMF, examine the impact of supported programs on macroeconomic outcomes: growth (output), balance of

payments, unemployment, inflation, and fiscal deficits (for example, Haque and Khan 1998, Joyce 2004; and IMF 2001a,b).

An alternative approach is an analysis of specific systemic bank restructuring policies. Goldstein and Turner (1996) is the first attempt to suggest policy options for strengthening banking sectors as crisis prevention, while Sheng (1996) is the first to distill lessons from several bank restructuring programs. Other studies (see Tang *et al.* 2000, Demirgüç-Kunt and Detragiache 2005) review various lessons and policy options.

Bank restructuring under IMF-supported programs typically involves closure of insolvent banks, encouraging or forcing domestic mergers, nationalization (recapitalization and reprivatization in a later stage), and allowing for foreign participation.

With respect to the empirical evidence on *bank closures and efficiency*, a handful of previous studies mainly investigate the link between bank failures (and possibly closures to follow) and inefficiency, and a majority on the U.S. banking markets. These studies show that banks and thrifts with low efficiency fail at greater rates than institutions with higher efficiency levels (Berger and Humphrey 1992a, Hermalin and Wallace 1994, Cebenoyan *et al.* 1993). Isik and Hassan (2003) provide evidence from a developing country. The results of their study of the Turkish banks around the crisis (1992-1996) suggest that banks experience a substantial productivity loss in the crisis-year and small banks suffer the most. The two studies on South East Asian banking efficiency provide further evidence to this. Karim (2001) assesses cost efficiency of South East Asian banks during 1989-1996 and indicates that banks' cost inefficiency tend to increase over the years preceding the crisis. Similarly, Williams and Nguyen (2005), in their analysis of profit efficiency and productivity of South East Asian banks over 1990-2003, shows that the closed banks have significantly lower profit efficiency, thus the region's closure decisions can be supported on economic grounds.

On the second restructuring measure, *recapitalization*, previous studies 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 re-privatized, thus become major or fully private banks. The empirical literature somewhat indicates the favorable effect of *bank privatization* on efficiency, though varied across countries. Extensive surveys by Megginson (2005) and Clarke *et al.* (2005) document that bank privatization improves bank efficiency. Clarke *et al.* (2005) further stress that efficiency gains are greater when the government fully relinquishes control, when banks are privatized to strategic investors, when foreign banks are allowed to participate in the privatization process, and when the government does not restrict competition. Other studies of individual nations, which have gone through economic crisis and/or banking reform, including, for example, Argentina (Berger *et al.* 2005) and Pakistan (Bonaccorsi di Patti and Hardy 2005), generally find that at least one bank efficiency measure (cost, profit, revenue) improves following privatization.

The empirical evidence on bank privatization from the East Asian banking markets is limited and inconclusive. Williams and Nguyen (2005) find that South East Asian state-owned banks underperform private and foreign-owned banks, and privatized banks improve efficiency after privatization. In contrast, Harada and Ito (2005), in their study of top 10 Indonesian banks, indicate no evidence of privatization effect on bank efficiency over 1999-2003.

In respect of the impact of *bank mergers and acquisitions (M&As)* on merged banks' efficiency, the results are mainly drawn from the U.S. and European banking markets. Two extensive surveys by Berger *et al.* (1999) and Amel *et al.* (2004) indicate that bank M&As do not significantly improve cost and profit efficiency. [6] Interestingly,

[6] There is evidence for the impact of bank M&As on scale efficiency, but only up to a size well below that of the most recent large deals. Scope efficiency is hard to pin down, and there is no clear-cut evidence of their existence (Amel *et al.* 2004, p. 2504).

no evidence of the impact of bank M&As on technical efficiency is found: this issue is explored in this paper.

The evidence of the effects of East Asian bank M&As on efficiency is again very limited. The only cross-country study by Williams and Nguyen (2005) reports mixed results of the effects of bank M&As on profit and cost efficiency. Domestic M&As realize significant short-term profit efficiency gains but experience long-term profit efficiency loss, and exactly the opposite for cost efficiency. Large banks are more cost and profit efficient than small banks. Harada (2005) documents that efficiency of Korean banks deteriorates before crisis, but improves following mergers.

Previous literature 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. For example, studies by Claessens *et al* (2001), Weill (2003), Kasman *et al.* (2005) report relatively superior efficiency scores for foreign-owned banks. In contrast, studies of developed countries by DeYoung and Nolle (1996) and Berger *et al.* (2000) report contrary results.[7] There is, however, very limited evidence on the effects of foreign acquisitions (participation) on bank efficiency, and the results are mixed. While Fries and Taci (2005) report that banks with majority foreign ownerships in transition economies are most efficient, Berger *et al.* (2005) report little deterioration in efficiency associated with foreign acquisitions in Argentine banks.

Previous evidence on the relationship between *foreign ownership* and bank efficiency in the East Asian banking markets, though limited, is in line with the existing literature, which reports mixed but some favourable results for foreign ownership. Laeven (1999) indicates that foreign banks took little risk relative to other bank types in the region before the crisis. Studies by Karim (2001), Margono and Sharma (2004) and Williams and Nguyen (2005) provide evidence that private banks (domestic or foreign-

[7] See Berger (2007) for an excellent review of the cross-country banking efficiency literature.

owned) are more efficient than state-owned banks. Other studies (Harada 2005, Choi and Hasan 2005) find that higher foreign ownership improves efficiency and outperforms other bank types. In addition, financial liberalization (which includes foreign bank entry) has positive effects on domestic bank efficiency and productivity (Leightner and Lovell 1998, Park and Weber 2006). Unfortunately, very limited evidence on the effects of foreign acquisitions (participation) on the region's bank efficiency could be found. The only comparable study (Williams and Nguyen 2005) indicates that potential benefits of foreign participation may take longer to be realized.

In summary, the international empirical evidence on bank failures and efficiency generally indicates high inefficiency prior to failures, which supports closure decisions on economic grounds. The evidence on the impact of bank privatization, mergers and acquisitions, and foreign participation is somewhat mixed, although some favorable results are reported for bank privatization and foreign ownership. In the absence of guiding previous evidence and with the expectation that East Asian banks' efficiency will improve after restructuring under the IMF-supported programs, the following hypothesis is formulated:

$H_A$: *The East Asian banks' technical and scale efficiency will significantly improve after restructuring under IMF-supported programs after controlling for country-specific characteristics.*

## 3. DATA AND METHOD

The sample used consists of 138 domestic commercial banks operating in four crisis-hit East Asian countries with IMF-supported programs (Indonesia, Korea, the Philippines, and Thailand) using data over 1991-2005. Entities such as development (specialized) banks, investment banks, savings banks, regional rural banks, joint-venture banks, and wholly-owned subsidiaries and branches of foreign banks are excluded from the sample to ensure homogeneity, thus comparability of the results with other studies.

The primary source of annual bank-specific data is the BANKSCOPE database, while the country-specific data were collected from International Financial Statistics, and other data sources including the IMF, World Bank, the four central banks, and Heritage Foundation and the *Wall Street Journal*. Annual cross-section and time series pooled (unconsolidated) data are used.

Of the 138 banks included in the final sample, there are 66 Indonesian, 26 Korean, 32 Filipino and 14 Thai banks. The sample accounts for asset coverage in each of the four banking markets ranging from a minimum of 68 percent in Korea to a maximum of 82 percent in Indonesia. Most banks are private-owned (91 percent of the sample), while state-owned banks were 9 percent. There are 74 listed banks (54 percent) and 64 unlisted banks (46 percent) and the study covered both.

As far as restructuring measures are concerned, only 30 percent of the banks did not experience any dramatic changes, the remainder (70 percent) underwent some form of restructuring (closure, merger and/or acquisition, recapitalization and then re-privatization, and foreign participation). Among the 97 restructured banks, 54 banks were closed (or compulsorily merged into another bank), 22 banks underwent market mergers or acquisitions and are still operational, and the other 21 banks were recapitalized by the respective governments. Nine (out of these 21 recapitalized banks) were later re-privatized. In addition, both restructured and un-restructured banks (44) had foreign bank participation in the form of acquisition or equity capital contribution. Finally, the whole sample contains 1,326 bank-year observations over 1991-2005.[8]

Firm-specific efficiency scores are calculated using parametric or nonparametric methods, and each method has its own merits and drawbacks. The nonparametric method is used in this paper for several reasons. First, the nonparametric methods such as DEA[9]

[8] A list of the sample banks with their characteristics and restructuring measures is available upon request.

[9]DEA is a nonparametric mathematical programming approach to efficiency frontier estimation, pioneered by Farrell (1957), and then developed by Charnes *et al.* (1978) who proposed a model assuming constant returns to scale, and extended by Banker *et al.* (1984) to allow for variable returns to scale. The efficiency

allow studies of jointly-produced multiple outputs, whereas the parametric methods are normally limited to focusing on a single dependent variable, such as cost, revenue or profit (Avkiran 2002, p. 50).[10] Second, price information is generally regarded as being necessary for the parametric techniques. The prices of such required inputs/outputs may be distorted due to regulations and other market imperfections in developing countries, and therefore, may complicate the measurement of cost and/or profit functions using parametric approaches (Ataullah *et al.* 2004, p. 1917). The nonparametric methods, on the other hand, can be used for efficiency assessment without this price information.

Another reason is that, as Cooper *et al.* (2000) described, in the nonparametric DEA, measurement units of different inputs and outputs do not need to be congruent, thus stock and flow variables can be dealt with in the same model. DEA thus can address both quantitative and qualitative data, and discretionary and non-discretionary variables. This became an important consideration in cross-country banking studies that incorporate environmental variables as in this paper. Fourth, the nonparametric approaches also provide meaningful scalar technical efficiency and scale efficiency measures (Favero and Papi 1995). Finally, most existing studies have already used parametric methods to examine efficiency of East Asian banks, it is therefore pertinent to see whether the DEA-based efficiency scores support the conclusions reached by those existing studies but applied to IMF cases.

DEA models commonly have either an input or output orientation. This study chooses the input-oriented model[11] since from the bank management's perspective; it is easier to control over inputs than outputs. In addition, as theory is silent as to the best

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measures generated by the technique are relative measures (indices) of efficiency, not absolute measures, ranging from zero (for the least efficient) to one (for the "best-practice" firms). See Coelli *et al.* (2005) for further details.

[10] The parametric distance functions developed by Coelli and Perelman (1999) can now be applied to multiple output technologies.

[11] An input orientation aims at reducing the input amounts as much as possible while keeping at least the present output levels, while an output orientation aims at maximizing output levels without increasing use of inputs (Cooper *et al.* 2000, p.103).

orientation to apply, this study follows the approach adopted in similar cross-country banking efficiency studies (for example, Lozano-Vivas *et al.* 2002, Kasman *et al.* 2005). The DEA model can be under either constant returns to scale (CRS, hereinafter) or variable returns to scale (VRS, hereinafter) assumptions. In this paper, both CRS and VRS assumptions are investigated, from which scale efficiency of the sample banks can be identified. In line with Coelli *et al.* (2005), the following input-oriented CRS DEA specification incorporating environmental variables is employed:

$$\underset{\theta,\lambda}{Min}\ \theta,$$

$$\text{subject to} \quad -y_i + Y\boldsymbol{\lambda} \geq 0$$

$$\theta x_i - X\boldsymbol{\lambda} \geq 0$$

$$z_i - Z\lambda \geq 0$$

$$\boldsymbol{\lambda} \geq 0 \qquad \text{(Equation 3.1)}$$

Equation 3.1 above is based on the assumption 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 (KxN) input matrix, *X*, and the (MxN) output matrix, *Y*, represent the data of all N firms. Similarly, assuming there are L environmental variables, these vectors are represented by $z_i$ for firm *i* and by (LxN) matrix Z for N firms. Parameter $\theta$ is a scalar, $\lambda$ is a (Nx1) vector of constants. The value of $\theta$ obtained is the efficiency score of firm *i*. It satisfies $\theta \leq 1$, with a value of 1 indicating a point on the frontier, and hence a technically efficient firm according to Farrell (1957) definition. With regard to the scale assumptions, Equation 3.1 represents the CRS DEA model, while the VRS DEA model is generated by Equation 3.1 plus the convexity constraint ( $N1'\lambda = 1$ ).

The calculation of scale efficiency (SE) then can be done 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 indicates existence of scale efficiency, SE. Following Coelli (1996b), the SE for firm *i* can be calculated as:

$$\mathrm{SE}_i = \frac{TE_{i,crs}}{TE_{i,vrs}} \qquad \text{(Equation 3.2)}$$

where $\mathrm{SE}_i$ is the scale efficiency, $\mathrm{TE}_{i,crs}$ is the technical efficiency score under CRS, and $\mathrm{TE}_{i,vrs}$ is the technical efficiency score under VRS assumptions.

There are two broad competing theories of banking service provision: the production approach and the intermediation approach. Under the production approach, banks are regarded as using labor and capital to produce deposits and loans. In contrast, the intermediation approach views banks as intermediaries with loans and other earning assets as outputs, and capital, labor and deposits as inputs (Sealey and Lindley 1977). There is also a "dual" approach which treats amounts of deposits as an output and the price of deposits as an input (Berger and Humphrey 1991).

Following Isik and Hassan (2003), and Casu *et al.* (2004), the intermediation approach is used in this study. To capture the most significant activities of banks; 3 inputs (purchased funds, labour and physical capital) and 2 outputs (loans and other earning assets) are employed in Equation 3.1.

Finally, since DEA is very sensitive to outliers (Hartman *et al.* 2001, Hughes and Yaisawarng 2004) and as a further check for the consistency of the input and output variables used, an input-oriented CRS super-efficiency model was run for each annual data set in the study to identify any units as outliers. Following Hartman *et al.* (2001), a cut-off point of 2 was used. As a result, one bank being an outlier in all years was removed from the sample; three other banks which were outliers in two or three years were removed from the sample in those years only.

Previous cross-country studies stress the importance of controlling for country-specific environmental conditions in cross-country studies (see, for instance, Dietsch and Lozano-Vivas 2000, Lozano-Vivas *et al.* 2002, Psiouras 2008b). Following these recent

developments in the cross-country banking literature, this study introduces country-specific variables directly into the DEA efficiency model.

Based on the variables identified in similar studies by Dietsch and Lozano-Vivas (2000), Lozano-Vivas *et al.* (2002), and Kasman *et al.* (2005), ten environmental variables categorized into two main groups are initially selected. The first group named "main conditions" includes measures of population density, density of demand, income per capital, interest rate level, inflation rate, and overall economic condition. The second group, "banking and financial conditions", consists of degree of concentration, depth of bank intermediation, degree of monetization, and degree of regulatory restrictions. In addition, given the choice of restructuring measures should depend on the level of difficulties that each banking system faces, a fifth variable as a proxy of average asset quality is also considered.[12] These variables characterize the structure, competition and critical problem of a banking industry. Data limitations prevented us from investigating the impact of political connections on the implementation of the restructuring measures, which could in turn influence banking efficiency during the study period.[13]

Once the eleven environmental variables are identified, the forward selection procedure (see Lozano-Vivas *et al.* 2002) is utilized. This approach helps to minimize the number of variables incorporated into the DEA model by statistically selecting only those influential environmental variables. Consequently, five out of eleven environmental variables were found to be influential and thus included in the complete model. These are: degree of monetization, density of demand, population density, overall economic condition, and average asset quality. Following Lozano-Vivas *et al.* (2002),

[12] Berger and DeYoung (1997), and Girardone, Molyneux and Gardener (2004) suggest that banking efficiency is negatively correlated to the level of non-performing loans in the US and Italian banking systems respectively.

[13] Bongini, Claessens and Ferri (2001), in their study of the political economy of distress of the East Asian banks in 1996, find that "connections" - with industrial groups or influential families - increased the probability of distress and made closure more likely. Nevertheless, the number of these company- and family-owned banks in five East Asian countries declined sharply after the crisis, from 73 in 1996 to only 9 banks in 2002 (Williams and Nguyen 2005, Table 1).

the first four variables are considered as the output-type ones (that is, the higher, the better), and thus must be introduced as inputs in the DEA model. The fifth variable, average asset quality measured by non-performing loans to total loans, is an input-type variable (the lower, the better), and thus must be included as an output, or can be transformed into a non-discretionary input by reversing its sign and translating it. We opted for the latter so that all the five environmental variables are included as inputs in the DEA model. As such, this complete model has ten variables, including three basic inputs, two basic outputs, and five environmental variables as defined in Table 3.1.

The Zhu (2003)'s DEA-Solver software allows for a single-step calculation of the technical efficiency scores under this complete model with CRS assumption. The DEA complete model with VRS assumption is also estimated so as to calculate the scale efficiency. These estimated technical and scale efficiency scores are then employed in the regression model to identify determinants of bank efficiency.

Alternative regression methods including ordinary least squares (OLS), generalized least squares (GLS), Logistic and Tobit regressions are employed in the literature for this purpose. The Tobit censored regression is used for a main reason that it can take into account the censored nature of the dependent variable (that is, efficiency scores, ranging from zero to one), thus reportedly yielding consistent estimates. To control heteroscedasticity and following Isik and Hassan (2003), we use GLS multiple regressions with White's (1980) corrections. The Tobit regression is utilized to regress the computed efficiency scores against a set of restructuring measures and other bank-specific characteristics as control variables under the following model:

$$\begin{aligned}\theta_{ijt} = {} & \beta_0 + \beta_1 RESTR_{ijt} + \beta_2 CLOSED_{ijt} + \beta_3 RECAP_{ijt} + \beta_4 RECAP\_EFF_{ijt} + \beta_5 REPRIV_{ijt} + \\ & \beta_6 M\,\&\,A_{ijt} + \beta_7 M\,\&\,A\_EFF_{ijt} + \beta_8 FOR_{ijt} + \beta_9 FOR\_EFF_{ijt} + \beta_{10} CRISIS_t + \\ & \beta_{11} DUR\_IMF_t + \beta_{12} POST\_IMF_t + \beta_{13} STATE_{ijt} + \beta_{14} LISTED_{ijt} + \beta_{15} \ln ASSETS_{ijt} + \\ & \beta_{16} ETA_{ijt} + \beta_{17} LTA_{ijt} + \beta_{18} LLRL_{ijt} + \beta_{19} TCTA_{ijt} + \beta_{20} CTI_{ijt} + \beta_{21} NIITI_{ijt} + \beta_{22} ROA_{ijt} + \\ & \beta_{23} LATA_{ijt} + \beta_{24} LTD_{ijt} + \beta_{25} INDO_j + \beta_{26} KOR_j + \beta_{27} PHIL_j + \varepsilon_{ijt}\end{aligned}$$

(Equation 3.3)

where, subscripts *i* denote individual banks, *j* countries, *t* time horizon and other variables are defined with expected signs in Table 3.1 (Panel D).

**Table 3.1** Variable Definitions (Equations 3.1 and 3.3)

| ***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*** | | |
| $\theta$ | Efficiency scores of banks *(Dependent variable)* | |
| $\beta_0$ | Constant | |
| *RESTR* | A dummy variable for restructured 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 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 | |
| $\varepsilon$ | Error term | |

The period 1998-2002 (two years after the IMF programs) is chosen for consideration in defining the variables indicating the four restructuring measures (closure, recapitalization, merger and acquisition, and foreign participation). There are two main reasons for this choice. 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 later (in 2002). Second, a three-year horizon should be sufficient for assessing such restructuring measures in their post-event period.

**Table 3.2** Banking and Environmental Variables by Country (1991-2005)

| | **Indonesia** | | **Korea** | | **Philippines** | | **Thailand** | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Std.Dev | Mean | Std.Dev | Mean | Std.Dev | Mean | Std.Dev |
| ***Panel A: Banking variables*** *(US$ millions)* | | | | | | | | |
| Purchased funds | 3686.1 | 7065.3 | 20103.4 | 23485.1 | 1842.2 | 2014.45 | 10718.5 | 9308.58 |
| Labour 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 | 2437.6 | 5213.9 | 14769.8 | 18502.4 | 1220.8 | 1309.07 | 8823.7 | 8109.39 |
| Other earning assets | 1268.4 | 2815.5 | 7166.2 | 6980.6 | 852.18 | 899.09 | 2189.3 | 2758.28 |
| ***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 | 2961.5 | 1842.4 | 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 |

This table presents the mean values and standard deviations of the means (over 1991-2005) of selected banking and environmental variables used for the efficiency assessment model. All financial variables were converted into United States dollar (US$) values (using average annual exchange rates for each year), and then adjusted for inflationary effects using each country's gross domestic product deflator (GDPD).

Table 3.2 reports the average values of the five banking variables and five environmental 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 while 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 provided US$ 2.4 billion of loans annually, while this figure of Thai banks is US$8.8 billion (Panel A).

With respect to the environmental variables, Korea is the most monetized economy with a value of 109 percent for the ratio of broad money supply to GDP (Panel B). Similarly, Korea also has the highest average density of demand (measured by total banking deposits over area) followed by Thailand, and then the Philippines. In addition, Korea also has the highest period-average GDP growth rate (5.63 percent per year). Banks in Indonesia and Thailand suffered the most level of difficulties with higher non-performing loan ratios, while Korean banks faced the least (Panel B).

## 4. DISCUSSION OF RESULTS

### *4.1 Technical Efficiency*

The average values of the computed technical efficiency scores of all the sample banks under a common frontier are reported in Table 4.1.

A preliminary observation reveals that an average efficiency score of 0.836 under the basic model (and 0.920 under the complete model) indicate that banks in the four selected East Asian countries experienced an inefficiency level of 16 percent (or 8 percent under the complete model) relative to the best-practice (fully efficient) bank during the period 1991-2005 (Table 4.1, final row). In other words, this average input-oriented efficiency level of 0.836 suggests that the East Asian banking systems could reduce by 16 percent inputs without changing outputs.

Another observation is that, average efficiency of the sample banks without controlling for environmental differences (basic model) decreased by 8 percent, from 0.855 before the IMF program to 0.776 during the IMF program, and then recovered to 0.846 after the IMF program (Table 4.1, column 2). The average efficiency when controlling for environmental differences (complete model) appeared to be more stable,

**Table 4.1** Technical Efficiency Scores: Basic and Complete Models

| | **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 Mean*** | ***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 Mean*** | ***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 Mean*** | ***0.846*** | ***0.105*** | ***0.942*** | ***0.083*** | ***73*** |
| **All-year Mean** | **0.836** | **0.118** | **0.920** | **0.088** | **88** |

This table presents the mean, standard deviation, and count of the sample banks' technical efficiency scores obtained from the estimations using the DEA input-oriented model under the CRS assumption (Equation 3.1). The Basic Model uses three inputs (purchased funds, labour 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 the five selected environmental variables (deposit density, degree of monetization, population density, overall economic condition, and asset quality).

which slightly declined (-2 percent) during the IMF program, then rose by 4 percent in the post-IMF period (column 4). These scores suggest that the negative impact of the Asian financial crisis on banking efficiency was felt deeply during the crisis.

The results also indicate that when environmental differences are taken into account, the average efficiency scores increase markedly in all three sub-periods compared to the scores from the basic model. On average, the mean efficiency scores under the complete model were 8.4 percent higher than those of the basic model (Table

4.1, final row). This finding supports the empirical evidence on cross-country banking efficiency that country-specific environmental conditions exercise remarkable influence on bank efficiency.[14] Our results, however, show narrower dispersions (standard deviations) of efficiency scores under both models (9 percent compared to 20-25 percent in those studies), suggesting a more homogeneous sample used in this study. In addition, our control of the fifth environmental variable (asset quality of the banking sector) raised the average efficiency score by 2.7 percent suggest that it is important to consider the level of difficulties that each banking system faces, particularly in their financial turmoil.

To further investigate the impact of the IMF-supported programs on bank efficiency, the computed efficiency scores are disaggregated by country (Table 4.2). As revealed, whether controlling for environmental differences or not, Thai banks, on average, were the most efficient, followed by the Filipino banks. On the other hand, Indonesian banks were the least efficient under both models.

The results (Panel A: Basic Model) also show that average efficiency decreased during the crisis (thus the IMF program). Indonesian banks were the most affected by the crisis, experiencing a reduction of 17 percent in their average efficiency scores, followed by Thai banks (6 percent), and Korean banks (4 percent). The Filipino banks, on the other hand, being not much affected by the crisis, were able to maintain their pre-IMF efficiency level of 0.85 (Panel A, Column 3). In the post-IMF period, banks (except those in the Philippines) were able to retrieve their pre-IMF efficiency level. Korean banks even obtained their efficiency level of 0.895, or 9.5 percent higher than that prior to the IMF program.

When environmental variables are taken into account, a similar trend is found for the banks in Indonesia, Thailand and Korea with their efficiency reduction of 6 percent, 2 percent and 1.5 percent respectively during the IMF program (Panel B: Complete Model). It is interesting that the average efficiency the Filipino banks even rose by 1.5

[14] See, for instance, Chaffai *et al.* (2001), Lozano-Vivas *et al.* (2002), and Kasman *et al.* (2005).

**Table 4.2** Technical Efficiency Scores by Country

***Panel A:*** *Basic Model (without environmental variables)*

| Year | Indonesia | Korea | Philippines | Thailand | All-country |
|---|---|---|---|---|---|
| 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 Mean** | **0.809** | **0.825** | **0.843** | **0.879** | **0.836** |

***Panel B:*** *Complete Model (with environmental variables)*

| Year | Indonesia | Korea | Philippines | Thailand | All-country |
|---|---|---|---|---|---|
| 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 Mean** | **0.893** | **0.912** | **0.917** | **0.945** | **0.920** |

percent during the IMF program. As such, the environmental conditions exercise positive or negative effects on bank efficiency, at least during the crisis period. In the post-IMF period, while Indonesia banks were able to raise efficiency and almost regain their pre-IMF level, Korean banks made a remarkable efficiency gain of 10 percent surpassing their pre-IMF level. Efficiency of the Filipino banks slightly deteriorated to just 1

percent higher than that prior to the IMF program. A very slight improvement in efficiency was found for Thai banks in this post-IMF period, but still 1 percent lower than that in the pre-IMF period.

To further investigate the impact of the IMF-supported programs on bank efficiency, the sample banks' period-mean efficiency scores by ownership types, listing status, and restructuring measures are reported in Table 4.3.

**Table 4.3** Technical Efficiency Scores by Bank Ownership and Restructuring Measures

***Panel A:*** *Technical Efficiency by Ownership Characteristics and Listing Status*

| | **Ownership** | | | **Listing** | | **Restructuring** | |
|---|---|---|---|---|---|---|---|
| | State | Private | Foreign | Listed | Unlisted | Restructured | Un-restructured |
| **Basic Model** | 0.848 | 0.829 | 0.835 | 0.834 | 0.832 | 0.832 | 0.837 |
| **Complete Model** | 0.916 | 0.909 | 0.932 | 0.921 | 0.905 | 0.922 | 0.917 |

***Panel B:*** *Technical Efficiency by Restructuring Measures*

| | **Recapitalized** | | | **Merged** | | **Foreign-participated** | |
|---|---|---|---|---|---|---|---|
| | Before | After | After re-privatized | Before | After | Before | After |
| **Basic Model** | 0.839 | 0.827 | 0.858 | 0.863 | 0.843 | 0.829 | 0.849 |
| **Complete Model** | 0.915 | 0.939 | 0.960 | 0.922 | 0.898 | 0.919 | 0.926 |

In respect of performance by ownership, when environmental factors are not taken into account, there seems to have no distinctive differences among the three banking groups (state, private, and foreign-participated). This finding might not be consistent with the literature, particularly on positive effects of foreign ownership or participation. This phenomenon, however, is understandable in this case as these four East Asian countries have recently opened their banking sectors to further foreign ownership which has increased rapidly since 2002, their positive impact therefore, if any, may not have been realized. When environmental differences are controlled for, foreign-participated banks and listed banks then could obtain a slightly higher technical efficiency score than their state-owned and unlisted counterparts respectively. There

seems to be no distinctive differences in technical efficiency performance among the banks which whether or not underwent restructuring (Table 4.3, Panel A).

On efficiency performance by specific restructuring measures[15] (Table 4.3, Panel B), the efficiency level of the recapitalized and merged banks was below their pre-restructuring level (Basic Model). There are some reasons for this. First, these banks had to strictly meet the governments' various conditions when they were recapitalized or merged. One of the conditions was to take over the (good and bad) liabilities and assets from other compulsorily merged or nationalized banks. Another condition was to clean up their balance sheets, meaning write-off or sell their bad debts. These could have negative effects on their efficiency performance in the short-run.

However, when environmental variables are considered, efficiency of the recapitalized banks was 2.5 percent higher than their pre-event level. In addition, nine recapitalized banks have been re-privatized since 2002, and their efficiency score (0.960) in the post-event period was 4 percent higher than their pre-event level under the complete model. Domestic mergers and acquisitions, on the other hand, experienced short-term efficiency loss. Technical efficiency of foreign-participated banks, on the other hand, slightly improved whether or not environmental differences are considered.

## *4.2 Scale Efficiency*

If there appears a difference between the technical efficiency scores under the constant returns to scale (CRS) and variable returns to scale (VRS) assumptions, the bank has scale inefficiency. Scale efficiency thus could be obtained if the bank is operating at the optimal scale (or CRS), that is, where there are neither increasing returns to scale nor decreasing returns to scale. Scale efficiency (SE) thus can be calculated by

[15] We also conducted an evaluation of the efficiency performance of the closed banks prior to their closures. The results - available with the authors - indicated that their pre-closure performance was significantly worse than their unclosed counterparts, suggesting that the closure decisions were supported on economic grounds.

comparing the differences in technical efficiency (TE) scores generated under the CRS and VRS specifications. Table 4.4 displays the SE under both basic and complete models.

**Table 4.4** Scale Efficiency Scores: Basic and Complete Models

| | **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 Mean*** | ***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 Mean*** | ***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 Mean*** | ***0.884*** | ***0.071*** | ***0.930*** | ***0.086*** | ***73*** |
| **All-year Mean** | ***0.892*** | **0.068** | **0.925** | **0.087** | **88** |

The average scale efficiency of the sample banks for the whole period 1991-2005 was 0.892 (basic model) or 0.925 (complete model). This means the sample banks deviated on average 11 percent or 7.5 percent from their efficient size of scale in both models respectively. Since the overall efficiency is a power of technical efficiency and scale efficiency, the relative sizes of these scores provide evidence on the source of inefficiency. When environmental factors are ignored, the overall period-mean technical

efficiency score (0.836) was 6 percent below the period-mean scale efficiency (0.892), suggesting that the technical factor in the sample banks was a relatively more important inefficiency source than the scale factor. However, when the environmental variables are taken into account, the difference in efficiency between the technical factor and scale factor was no longer present (Tables 4.1 and 4.4, final rows).

With this scale efficiency specification, however, it is not clear whether the sample banks were operating in an area of increasing or decreasing returns to scale. To determine this and following Coelli (1996), an additional DEA problem with non-increasing returns to scale (NIRS) imposed was run, and the scores under this NIRS assumption were compared with those under the VRS assumption. The results from these two assumptions on average were all different, suggesting that most sample banks on average were operating in increasing returns to scale regions.[16] One implication is that these East Asian banks could achieve significant cost savings and efficiency gains by increasing their scale of operations, which could be done via internal growth or continued consolidation in the sector. Consolidation exercises that had gone on after the crisis thus could be supported based upon this scale efficiency analysis.

The scale efficiency scores by country are reported in Table 4.5. As it appears, when environmental differences are not considered (basic model), Thai banks on average were the most scale efficient (0.925) and Indonesian banks the least (0.876). Although the scale efficiency of Korean banks has slightly declined over time, it still could surpass that of Thai banks when environmental factors are taken into account (complete model). While the scale efficiency of the banks in both Indonesia and the Philippines was slightly (2 percent) higher under the complete model, that of Indonesian banks was the lowest (0.88-0.90) whether or not environmental factors were considered.

[16] A detailed investigation of the scale efficiency region for each individual bank is beyond the research objective of this paper; but this could be an interesting area for future research.

When changes in efficiency by period are considered, the results under the basic model indicate that the average scale efficiency of all sample banks decreased by 7 percent (from 0.917 to 0.845) during the IMF program, in line with their average technical efficiency. These banks (except those in the Philippines), however, could

**Table 4.5** Scale Efficiency Scores by Country

***Panel A:*** *Basic Model (without environmental variables)*

| Year | Indonesia | Korea | Philippines | Thailand | All- country |
|---|---|---|---|---|---|
| 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)*

| Year | Indonesia | Korea | Philippines | Thailand | All-country |
|---|---|---|---|---|---|
| 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** |

obtain almost their pre-IMF scale efficiency level in the post-IMF period. The scale efficiency of the Filipino banks, on the other hand, was 4 percent lower than that in the pre-IMF period. However, when environmental differences are controlled for, while the scale efficiency of Thai banks declined by 2 percent during the IMF program, then remained unchanged in the post-IMF period, that of Indonesian banks decreased the most by 7 percent during the IMF-program then recovered to their pre-IMF level in the post-IMF period. The scale efficiency of Korean banks has slightly declined over time, that of Filipino banks, on the other hand, increased during the IMF program, and then declined in the post-IMF period, resulting in the same level as their pre-IMF positions (Table 4.5, Panel B).

With regard to effects of bank ownership, listing status and restructuring measures on scale efficiency, when environmental differences are not considered (Basic Model), there seems no distinctive differences in scale efficiency between banks of different ownership forms, listing and restructuring status (Table 4.6, Panel A).

**Table 4.6** Scale Efficiency Scores by Bank Ownership and Restructuring Measures

***Panel A:*** ***Scale Efficiency by Ownership Characteristics and Listing Status***

| | **Ownership** | | | **Listing** | | **Restructuring** | |
|---|---|---|---|---|---|---|---|
| | State | Private | Foreign | Listed | Un-listed | Re-structured | Un-restructured |
| **Basic Model** | 0.890 | 0.895 | 0.887 | 0.887 | 0.907 | 0.895 | 0.891 |
| **Complete Model** | 0.939 | 0.919 | 0.912 | 0.928 | 0.896 | 0.927 | 0.903 |

***Panel B:*** ***Scale Efficiency by Restructuring Measures***

| | **Recapitalized** | | | **Merged** | | **Foreign-participated** | |
|---|---|---|---|---|---|---|---|
| | Before | After | After re-privatized | Before | After | Before | After |
| **Basic Model** | 0.881 | 0.869 | 0.892 | 0.893 | 0.918 | 0.893 | 0.899 |
| **Complete Model** | 0.896 | 0.925 | 0.939 | 0.912 | 0.921 | 0.911 | 0.919 |

Nevertheless, when environmental factors are controlled for (Complete Model), state-owned banks, which are typically large in size, appear to have capitalized on their size advantage, resulting in superior scale efficiency. Listed and restructured banks also

slightly outperformed their unlisted and unrestructured counterparts in scale efficiency**.** This could be due to the market discipline effect for the listed banks, and size advantage for the restructured banks which have typically become larger after restructuring.

On the effect of restructuring measures (Table 4.6, Panel B), there seems no restructuring effect on scale efficiency for the recapitalized and foreign-participated banks under both models. The banks which underwent mergers and/or domestic acquisitions appear to have capitalized on their size advantage in the post-event period.

### *4.3. Determinants of Bank Efficiency*

Due to the censored nature of the efficiency scores, the Tobit censored regression was used. In addition, GLS multiple regressions were also run, and consistent estimates of the covariance matrix allowing for heteroscedasticity were also computed following the White (1980) procedure as a robustness check, and for getting the explanatory power of the model. Following Baltagi (2005), tests for identifying multicollinearity (the Variance Inflation Factor test) and autocorrelation (the Durbin-Watson test) were conducted, and were able to confirm the normality of the dataset. Since the results from the Tobit and GLS regressions are quite similar with the majority of the coefficients being statistically significant and of the same sign, only the pooled Tobit regression results are reported and discussed. Its results are summarized in Table 4.7.

#### *4.3.1 Bank Restructuring and Efficiency*

The effects of the bank restructuring measures on efficiency are expressed by the estimated coefficients shown in Table 4.7 (Panel A). To capture the overall effect of the bank restructuring programs with IMF support, a *Restructured* dummy was used for determining if the restructured banks outperformed their unrestructured counterparts during 1991-2005. The reported positive but insignificant coefficient indicates that the restructured banks are not significantly more efficient than the unrestructured ones. This

**Table 4.7** Tobit Regression Results on Determinants of Bank Efficiency (1991-2005)

| **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 | | 1253.70 | | 1630.36 | | |
| 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 | | 1326 | | | | |

This table presents results on the determinants of bank efficiency using the Tobit censored regression model (Equation 3.3). The dependent variables are the calculated technical efficiency and scale efficiency scores (under the complete model, i.e., controlling for environmental differences). The independent variables are as defined in Table 3.1. Adjusted $R^2$ taken from the generalized least squares using the same dataset. ***, ** and * indicate statistical significance at 1%, 5% and 10% levels, respectively.

finding is in line with that reported by Williams and Nguyen (2005) who find no significant difference in profit efficiencies of the restructured and other domestic private banks in either short or long-term.

With regards to performance effects of specific restructuring measures, the recapitalization effect is captured by the use of three dummies. The first dummy *Recap* was applied to assess whether the recapitalized banks were efficient relative to the un-recapitalized ones over the restructuring period (1998-2002). The second dummy *Recap_Eff* was used to evaluate a short-term effect, that is, if these banks have become more efficient after recapitalization. The third one, *Reprivatized, w*as aimed at assessing a short-term efficiency effect on those banks which were initially recapitalized, but reprivatized in later years. The reported coefficients of the first dummy *Recap* are negative, and statistically significant at 5 percent level for technical efficiency suggesting that these recapitalized banks were significantly less efficient than their un-recapitalized counterparts during the whole period analyzed. Bank recapitalization and reprivatization, however, yielded short-term efficiency gains as evidenced by the positive and significant coefficients of *Recap_Eff* and *Reprivatized.*

The next restructuring measure which involved domestic bank mergers and acquisitions is captured by the two binary dummies, *M&A* and *M&A_Eff*. The first dummy *M&A* was to assess efficiency of the banks which underwent any domestic mergers and/or acquisitions between 1998 and 2002, while the second dummy *M&A_Eff* was to evaluate if these banks have become more efficient after their mergers and/or acquisitions. The reported coefficients of *M&A* are positive, but insignificant for both technical and scale efficiencies suggesting that the efficiency performance of the banks that experienced mergers and/or

acquisitions was not significantly different from their non-M&A counterparts. Domestic mergers and acquisitions, however, experienced significant short-term efficiency loss. This could be due to their unsuccessful alignments of corporate culture and management practices in the initial post-merger period. This finding is consistent with Shih (2003) that merging two banks weakened by the Asian financial crisis or even merging one weak into a healthier one in many cases would result in a weaker bank (p. 31).

The outcome of the final restructuring measure which involved foreign acquisition is examined via two other dummies, *Foreign* and *Foreign_Eff*. The first dummy *Foreign* was employed to evaluate efficiency of the banks which underwent any foreign acquisition or participation between 1998 and 2002, while the second one *Foreign_Eff* was used to see if these banks have become more efficient after their foreign acquisitions. The reported coefficients show that banks which underwent foreign acquisitions had insignificantly higher technical and scale efficiency compared to those which did not, and similar results for the short-term effect. This finding again supports the observation by Williams and Nguyen (2005) who report no evidence of "cherry-picking" of foreign banks in the South East Asian banking markets during 1990-2003, and also suggest that efficiency gains associated with foreign ownership might take longer time to be realized.

During the IMF program period (1998-2000), the sample banks' efficiency was significantly lower than that in the pre-IMF period (1991-1997), suggesting the negative crisis effect (thus the IMF programs). These banks were able to recover their efficiency level in the post-IMF period, but insignificantly different from their pre-IMF level. This suggests that the Asian financial crisis has created long-term negative effect and bank efficiency gains associated with the IMF programs might have taken longer time to be realized.

***Bank Characteristics and Efficiency***

Table 4.7 (Panel C) provides the findings on the influences of bank-specific characteristics (ownership, listing status, and CAMEL-based measures) on efficiency. The results indicate that there was no significant difference in efficiency between state-owned banks and domestic private-owned ones. Foreign-participated banks, as indicated in section 4.3.1, had insignificantly higher technical and scale efficiency compared to the state-owned and other private-owned banks. No significant impact of stock exchange listing on efficiency was observed. This could be due to the fact that market discipline might not exert effects on efficiency in developing and crisis-hit economies as in this study, especially where 46 percent of the sample banks are not listed. This finding is broadly in line with Laeven (1999) which reports a statistically insignificant relationship between stock market listing and efficiency of East Asian banks during 1992-1996.

With regard to the influence of CAMEL-based measures on efficiency, the coefficients in Table 4.7 (Panel C) suggest that bank size, capitalization, earnings, and liquidity significantly and positively affected bank efficiency. These results confirm large banks' scale efficiency as previously discussed in Section 4.2. 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, p. 70). The positive coefficient for earnings (*ROA*) suggests that more profitable banks were also more efficient. The coefficient for liquidity (when measured by loans to deposits, *LTD*) is significantly positive in terms of technical efficiency, indicating that higher fund utilization relative to fund-raising was important for banks to improve efficiency. This lending capability, however, is two-sided since increased loans

may lead to more credit risks, thus higher non-performing loans and higher operating costs if a good risk management system is not in place. This can explain why other financial measures (loan loss reserves to loans, *LLRL;* and cost to income, *CTI*) significantly and negatively influenced bank efficiency.

### *4.3.3 Geographical Location and Bank Efficiency*

The coefficients of the country dummies in Table 4.7 (Panel D) show that Indonesian and Filipino banks were significantly less efficient than Thai banks in both technical and scale efficiency (at 1 percent level). Korean banks, on the other hand, were significantly less efficient than Thai banks in technical efficiency only. This suggests that Thai banks on average were the most efficient among those in the four selected countries.

Finally, when the year dummies (except those years which were covered by the dummy *Dur-IMF*) were included into the regression, the adjusted R-squared statistic increased by only 2.3 percent (technical efficiency model) and 1.6 percent (scale efficiency model), indicating very marginal impact of the time trend on efficiency (*Diagnostics* in Table 4.7). A closer look at each of the year dummies reveals that three years (1995, 1996, and 1998) had a significantly negative influence on bank efficiency, suggesting some downward trend in efficiency before and during the crisis.

## 5. CONCLUSION

This paper examined the efficiency performance of banks over the pre- and post-restructuring periods in four crisis-hit East Asian economies subjected to the IMF-supported restructuring programs. We selected a sample of 138 commercial banks in the four crisis-hit

East Asian economies (Indonesia, Korea, the Philippines and Thailand) and examined the restructuring effects over the pre- and post-restructuring years during 1991-2005.

To achieve this objective, both nonparametric and regression models were employed. First, the nonparametric DEA was used to estimate technical efficiency and then scale efficiency, incorporating environmental (country) differences. Second, these estimated efficiency scores were regressed on bank restructuring measures, IMF programs and bank-specific control variables, using the Tobit and generalized least squares (GLS) regressions.

The results indicate that, overall, East Asian banks' efficiency improved in the post-IMF period, but only reached their pre-IMF levels. The restructured banks were not significantly more efficient than their unrestructured counterparts, and different restructuring measures had significantly different effects on bank efficiency. Specifically, bank recapitalization (and then re-privatization in certain cases) yielded significant short-term efficiency gains; mergers and acquisitions, on the other hand, experienced significant short-term efficiency losses; and positive but insignificant effects of foreign participation on efficiency, which suggests that any potential benefits of foreign ownership may take longer time to be realized.

Some policy implications can therefore be drawn from this paper. Bank restructuring during the financial crisis is required; but importantly, well-designed measures are vital to ensure its success. Bank mergers and acquisitions need to be scrutinized. Recapitalization and re-privatization are supported as a means for performance improvement. Foreign participation should be encouraged, although its potential benefits may take longer time to be realized. To reap these potential benefits, stronger economic reforms of the host countries should be further pursued.

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