Risk and Efficiency in East Asian Banks

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Abstract: We use a linear programming technique called Data Envelopment Analysis to estimate the inefficiencies of banks in Indonesia, Korea, Malaysia, the Philippines and Thailand. We apply this technique to the pre-crisis period 1992-96. Efficiency measures, however, are not sufficient to assess the overall performance of a bank, but risk factors should be taken into account as well. We therefore introduce a measure of bank risk-taking. We find that foreign-owned banks took little risk relative to other banks in the East Asian region, and that family-owned banks were among the most risky banks, together with company-owned banks. Our risk measure helps to predict which banks were restructured after the crisis of 1997. Restructured banks had excessive credit growth, were mostly family-owned or company-owned, and were almost never foreign-owned.

Key words: Banking, Efficiency, Risk taking, Data envelopment analysis, Ownership, East Asia

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Introduction

The financial crisis that hit the East Asian countries in 1997 revealed substantial vulnerabilities in the financial sector. It turned out that most financial institutions had a large amount of non-performing loans, which were the result of poor risk management and excessive lending to some parts of the real sector. In fact, a large number of financial institutions were insolvent and subsequently had to be either financially supported, merged or liquidated. Poor risk management was caused by weak corporate governance and limited investment in risk management technology. Excessive lending was caused to a large extent by extensive cross-ownership of banks and companies, weak enforcement of banking regulations and government-directed lending. Some banks withstood the crises better than others. This raises the question whether some segments of the East Asian banking sectors performed better than others.

Typical comparisons of bank performance use either simple aggregate bank ratios relating cost to revenues or assets, or the more sophisticated frontier technique which measures a bank's efficiency by its distance to the efficient frontier. In this paper we will use a non-stochastic frontier technique called Data Envelopment Analysis to explain differences in efficiency across East Asian banks during the pre-crisis period 1992-96. We will focus our analysis on five countries – Indonesia, Korea, Malaysia, the Philippines, and Thailand, since those countries were most affected by the financial crisis and were characterised by similar vulnerabilities in their financial sectors, namely excessive borrowing, weak regulatory and supervisory frameworks, concentrated bank ownership and family control of banks. We postulate that efficiency measures are not sufficient to assess the overall performance of a bank, but that risk factors should be taken into account as well. We therefore introduce a measure of bank risk-taking. We find that foreign-owned banks took little risk relative to other banks in the East Asian region, and that family-owned banks were among the most risky banks, together with company-owned banks. Our risk measure has explanatory power in terms of predicting which banks were to be restructured after the crisis of 1997. Not only do we find that restructured banks had excessive credit growth (indicating excessive risk-taking), but we also find that restructured banks were mostly family-owned or company-owned, and almost never foreign-owned.

The outline of the paper is as follows. Section 1 gives an overview of closely related literature and describes the most widely used methodologies to measure bank efficiency, which are Data Envelopment Analysis and Stochastic Frontier Analysis. Section 2 puts forward our

critique to using efficiency models to measure bank performance and introduces a measure of bank risk-taking. Section 3 gives a brief overview of the East Asian financial sectors. Sections 4 and 5 describe the data and methodology that we will use. Section 6 presents our empirical findings. Section 7 explores the power of our measure of risk-taking in predicting actual restructuring of banks in East Asia. Section 8 concludes.

1. Literature

The literature distinguishes two types of bank efficiency. The first is operational efficiency as introduced by Farrell (1957) to *measure* efficiency and the second is X-efficiency as introduced by Leibenstein (1966) to *explain* differences in efficiency between banks. The concept of operational efficiency is a purely technical and can be defined as the product of technical efficiency, which tells us "how far" the bank is from the isoquant, and allocative efficiency, which captures inefficiencies due to the fact that the bank picked a sub-optimal input combination given input prices. Under X-efficiency the basic problem is viewed as one that is intrinsic to the nature of human organisation. X-inefficiency may arise for reasons outside the knowledge or capability of management, including corporate governance problems and the difficulties of principal-agent relationships within organisations.

There are two widely used approaches to examine a bank's input-output process. In the first, the so-called production approach, banks are treated as firms which employ capital and labour to produce different types of deposit and loan accounts. Outputs are measured by the number of deposit and loan accounts or number of transactions performed on each type of product, while total costs are the operating costs used to produce these products. The bank is viewed as a producer of two types of services: an acquirer of funds and user of funds. In the second, the so-called intermediation approach, banks are viewed as intermediators of financial services rather than producers of loan and deposit account services. Banks produce intermediation services through the collection of deposits and other liabilities and the transfer of these funds to interest-earning assets. Deposits are included as a third input along with capital and labour. As a result, operating costs, as well as interest cost, are taken into account in the production process. In this study we will use the intermediation approach. However, as Mester (1996) points out, both approaches have the disadvantage that they do not take into account risk factors. Also, both concepts assume that all banks produce the same output quality. It is likely, however, that there

are unmeasured differences in quality, because banking data do not fully capture the heterogeneity in bank output. Berger and Mester (1997) try to alleviate this problem by controlling for the ratio of nonperforming loans to total loans. However, this ratio is likely to be endogenous to each bank's efficiency.

There are two empirical ways to measure efficiency. The first is called nonparametric programming and was initiated by Charnes et al. (1978). The second is the so-called parametric stochastic frontier technique as introduced by Aigner et al. (1977). The fundamental difference between both techniques is that in the second set of techniques the research postulates a parametric frontier based on a behavioural maximisation hypothesis. This is usually a production, cost or profit frontier. In all three cases, the parametric stochastic frontier technique assumes that maximising behaviour is present and that it is exhibited by the most efficient firms in the sample. Often there do not exist any *a priori* grounds for making this assumption. In that case, as Button et al. (1992) point out, the nonparametric approach may be preferred. Another difference is that the first set of techniques only measures technical efficiencies as defined by Farrell (1957). The second set of techniques can also measure allocative efficiencies, as long as the pre-specified frontier function takes output levels as given. The most widely used nonparametric technique is called Data Envelopment Analysis (DEA) and the most widely used parametric technique is called Stochastic Frontier Analysis (SFA).

DEA constructs a convex hull of the observed input-output observations for a given set of firms or organisations, under different assumptions about returns to scale. As such, this technique constructs a frontier based simply on the distance of the best-practice firms from the rest. There is no implicit assumption of maximising behaviour on the part of any of the firms, including the best-practice firms. SFA measures technical efficiency and allocative efficiency by the size of the error between observed cost or profit performance and the sum of the parametrised maximum and a symmetrically distributed noise term.

DEA accounts for technical inefficiency in using too many inputs (input orientation) or producing too few outputs (output orientation). There are two widely used orientations in applying DEA techniques. The first, developed by Charnes et al. (1978) assumes constant returns to scale (CRS). The second, developed by Banker et al. (1984) does not assume constant returns to scale and is called the Variable Returns to Scale (VRS) orientation. The output-oriented measure of the efficiency of bank f in year t, $E_y(x^{ft}, y^{ft})$, can be computed for each bank $f = 1,\ldots, F$ and for each period $t = 1,\ldots, T$ by the following program which uses the VRS orientation:

$$\max_{l} \; q_y^{ft} = [E_y(x^{ft}, y^{ft})]^{-1} \tag{1}$$

$$\text{s.t.} \quad q_y^{ft} y_m^{ft} \le \sum_{f=1}^{F} \sum_{t=1}^{T} l^{ft} y_m^{ft}, \qquad m = 1,\ldots, M, \tag{2}$$

$$\sum_{f=1}^{F} \sum_{t=1}^{T} l^{ft} x_n^{ft} \le x_n^{ft}, \qquad n = 1,\ldots, N, \tag{3}$$

$$l^{ft} \ge 0, \qquad f = 1,\ldots, F, \quad t = 1,\ldots,T, \tag{4}$$

$$\sum_{f=1}^{F} \sum_{t=1}^{T} l^{ft} = 1, \qquad f = 1,\ldots, F, \quad t = 1,\ldots,T, \tag{5}$$

where y_m is output *m*, x_n is input *n*; and scalars are in italic, vectors are in bold, matrices are in bold capitals. The assumption of CRS is useful if by using the VRS orientation many banks turn out to be efficient. CRS is identical to VRS without restriction (5). Since the scaling is radial, any slacks remaining in the solution to the DEA envelopment problem are not incorporated into the efficiency measures. Thus the above efficiency measure may overstate technical efficiency.

The most widely used concepts for measuring efficiency of financial institutions using SFA are cost efficiency, standard profit efficiency and alternative profit efficiency. Cost efficiency gives a measure of how close a bank's cost is to what a best-practice bank's cost would be for producing the same output bundle under the same conditions. Profit efficiency measures how close a bank is to producing the maximum possible profit given a particular level of input prices and output prices. In contrast to the cost function, the profit function allows for consideration of revenues that can be earned by varying outputs as well as inputs. Alternative profit efficiency, finally, measures how close a bank comes to earning maximum profits given its output levels rather than its output prices.

According to Berger and Mester (1997), the profit efficiency concept is superior to the cost efficiency concept because it accounts for errors on the output side as well as on the input side. The difference between the two profit efficiency concepts is that the standard profit efficiency concept assumes that banks are price-takers in both input and output markets, while the alternative profit efficiency concept assumes that banks are price-takers in input markets only and can set output prices. Since the input prices (i.e., interest rates on bank funding) of the East Asian banks are to a large extent determined by the oligopolistic market structures of the five banking

systems, the assumption of all banks being price takers does not seem to be a realistic one. At least the large banks are likely to have been able to influence their input prices. The assumption of price-taking in output markets seems unrealistic as well, because the loan markets in the five East Asian countries are not highly competitive.

Berger and Mester (1997) derive alternative profit efficiency from the following pre-specified profit function, in log form,

$$\ln(p + x) = f(w, y, z, e) + \ln v_p - \ln u_p \ , \qquad (6)$$

where p is the variable profits of the firm, x is a constant added to every firm's profit so that the natural log is taken of a positive number, f denotes some functional form, w is the vector of prices of variable inputs, y is the vector of quantities of variable outputs, z indicates the quantities of any fixed inputs, e is a set of environmental or market variables that may affect efficiency, u_p denotes an inefficiency factor that may lower profits below the best-practice level, and v_p denotes the random error that incorporates measurement error and luck that may temporarily give banks high or low profits. The inefficiency factor u_p incorporates both allocative inefficiencies from failing to react optimally to relative prices of inputs, and technical inefficiencies from employing too much of the inputs to produce y or setting sub-optimal output prices. As Mester (1996) points out, the profit concept assumes that all financial institutions use the same technology. This assumption seems to be a strong one, because it is likely that foreign banks use superior technology compared to domestic financial institutions.

Application of both techniques on the same banking data can lead to very different results as Ferrier and Lovell (1990) have shown. The choice of technique depends on the situation. Possible reasons to prefer SFA over DEA are plentiful. Firstly, as pointed out by Schmidt (1986), DEA estimates give only an upper bound to efficiency measures so that it is difficult to use DEA to compare efficiency among firms. Secondly, DEA does not assume statistical noise which means that all the error term in the estimation is attributed to inefficiency. This means that DEA will account for the influence of factors such as regional factor price differences, luck, bad data and extreme observations as "inefficiency". Therefore, as Schmidt (1986) has pointed out, one would expect that DEA produces greater measured levels of inefficiency than SFA. Thirdly, the estimates generated by using DEA are not very robust. As Button (1992) points out, measured DEA efficiency in small samples is sensitive to the difference between the number of firms and the sum of inputs and outputs used. This is because the small number of free dimensions

remaining increases the chance of each firm being seen as efficient. Moreover, as Greene (1993) points out, a single errant observation can have profound effects on estimates of DEA frontiers.

The major reason to prefer DEA over SFA is that DEA can be used even when conventional cost and profit functions that depend on optimising reactions to prices can not be justified. Since it is likely that regulations and other market imperfections distort prices in the East Asian banking sectors complicating the application of SFA to price and quantity data, it seems that DEA is more suitable for examining the efficiency of East Asian banks. A practical consideration to use DEA instead of SFA is that it avoids having to measure output prices, which are not available for transactions services and fee-based outputs.

Most bank efficiency studies look at the US or other developed countries. Bhattacharyya et al. (1997) have applied such techniques to Indian banks in the first study using data of a developing country. The only bank efficiency studies so far that have used East Asian banking data are Leightner and Lovell (1997), Leightner (1997), Gilbert and Wilson (1998) and Hao et al. (1999). Leightner and Lovell (1997) use linear programming techniques and Thai banking data to show that Thai banks experienced high growth rates in production during the years of 1990-94. They argue that these high growth rates indicate an unusual level of success of the banking system. Leightner (1997) uses identical linear programming techniques on data between 1990-95 for Thailand's finance and securities companies. He shows that, although the finance and security companies enjoyed tremendous profitability and rapid growth, these firms were not fully efficient, i.e. that profits could have been increased even more by changing the output and/or input mix. He also finds strong economies of scale and argues that the finance and security companies are too small to compete with the larger banks. Gilbert and Wilson (1998) use linear programming techniques to investigate the effects of privatisation and deregulation on the productivity of Korean banks over the years 1980-94. They find that Korean banks responded to privatisation and deregulation by altering their mix of inputs and outputs, yielding large changes in productivity. Hao et al. (1999) use the stochastic frontier approach to explain differences in efficiency scores for 19 Korean banks over the period 1985-95. They find that banks with faster growth rates, banks with a countrywide branch network, and banks which made extensive use of deposits in funding their assets were most efficient.

2. Efficiency and Risk-Taking

In the previous section we have already pointed out that bank efficiency models have the disadvantage that they do not take into account risk factors. Firstly, they assume that all banks are risk neutral. Secondly, they ignore risk-taking by banks. Efficiency models, for example, assume that book values of net loans equal market values of gross loans. In most cases, however, there is a discrepancy between the market and book value of loans. A particular case is when loan data are distorted by inadequately reported nonperforming loans. Application of such distorted data to efficiency models might lead to incorrect conclusions, because banks with excessive loan growth will show high technical efficiency (ceteris paribus), while they take on excessive risks. Inadequately reported nonperforming loans are most likely to be a large factor of data distortion in emerging markets with weak enforcement of banking regulation. In such countries a bank efficiency model might estimate a bank to be in better shape that they actually are. In fact, the most efficient banks of a banking system as measured by a bank efficiency model are not necessarily the least risky banks. In the case of East Asia it seems likely than inadequate loan loss provisions were a large factor of data distortion as well, because, until 1997, loans were not classified as nonperforming loans until no payments were made for over one year, leading to underreporting of bad loans to regulators.

The extremely high loan growths in the five East Asian countries during the period 1992-96 (up to 151% for the Philippines – see Appendix, Table 4) suggest excessive risk taking behaviour of the East Asian banks. Since the technical efficiency measure does not take into account that excessive loan growth can indicate excessive risk taking instead of increased bank performance, technical bank efficiency measures are not a perfect indicator for bank performance, but are merely an indicator for how well banks are in transforming their inputs into loans, both bad and good loans. Especially in countries where poor regulatory frameworks and weak enforcement of banking regulations enable banks to take excessive risks, technical efficiency measures will provide a misleading insight in the performance of banks.

The earlier mentioned studies by Leightner and Lovell (1997), Leightner (1997), Gilbert and Wilson (1998) and Hao et al. (1999) on Thai and Korean banking data use traditional bank efficiency measures to assess the bank performance. We argue that their results are misleading. Leightner and Lovell (1997), for example, find that Thai banks experienced high loan growth rates during the period 1990-94 and argue that high growth rates indicate an unusual level of success of the banking system. For Korea, Hao et al. (1999) find that banks with faster loan growth rates were most efficient during the period 1985-95. Although these high loan growths do indicate a

success in terms of generating loans one cannot draw general conclusions on the success of the banking system without looking at the risk of these loans. Ex-post we know that high loan growth of Thai and Korean banks was a sign of excessive lending, not of excellent performance.

Since the technical bank efficiency measure cannot distinguish between excessive risk taking and increased bank performance we will develop in this section a measure of excessive loan growth that can be used as a proxy for bank risk taking. Excessive loan growth will be defined as being growth above the level of loans that a bank would have provided if it would have put its inputs at use as efficiently as in a defined base year. In the previous section we have argued that DEA might be most suitable for examining the efficiency of East Asian banks, because it can be used even if regulations and other market imperfections distort prices, as is likely to be the case in the East Asian banking sector. We therefore decide to use the DEA technique to measure efficiency, which is an input for our measure of excessive credit growth.

Taking model (1)-(5) in section 2 as a starting point, let y_1^{ft} be the amount of loans of bank f in base year t and $y_1^{f(t+T)}$ the amount of loans of bank f in year $t+T$. Let q_y^{ft} be the inverse of the output-oriented measure of efficiency of bank f in year t calculated using DEA. We will assume that slacks are zero. Then the efficient level of loans for bank f in year t given its inputs in year t would be $q_y^{ft} y_1^{ft}$ and the efficient level of loans for bank f in year $t+T$ given its inputs in year $t+T$ would be $q_y^{f(t+T)} y_1^{f(t+T)}$. However, with T small, there is no *a priori* reason to assume a major change in efficiency, hence in q_y^f, between year t and $t+T$. Therefore, one would expect a loan level in year $t+T$ of $\frac{q_y^{f(t+T)} y_1^{f(t+T)}}{q_y^{ft}}$ instead of the actual level $y_1^{f(t+T)}$. The difference between $y_1^{f(t+T)}$ and $\frac{q_y^{f(t+T)} y_1^{f(t+T)}}{q_y^{ft}}$ can be classified as the amount of excessive loans. We will thus define excessive loan growth as $\frac{y_1^{f(t+T)} - \frac{q_y^{f(t+T)} y_1^{f(t+T)}}{q_y^{ft}}}{y_1^{ft}}$ or as $\frac{y_1^{f(t+T)}}{y_1^{ft}}\left[1 - \frac{q_y^{f(t+T)}}{q_y^{ft}}\right]$.

Taking the year 1992 as the base year and the 1992 efficiency figures as the benchmark and assuming a constant efficiency over 5 years we define the following as a measure of bank

risk-taking for the purpose of our application to East Asian banking data for the period 1992-96 in the following section

$$R_y^f(q_y^{f,1992}, q_y^{f,1996}) = \frac{y_1^{f,1996}}{y_1^{f,1992}}\left[1 - \frac{q_y^{f,1996}}{q_y^{f,1992}}\right] \tag{7}$$

where $y_1^{f,1992}$ and $y_1^{f,1996}$ are loan levels of bank f in 1992 and 1996 respectively, and $q_y^{f,1992}$ and $q_y^{f,1996}$ are the inverse of the output-oriented measure of efficiency of bank f calculated using DEA in year 1992 and 1996 respectively. Our measure of risk-taking focuses on excessive loan growth and does not take into account that banks also made excessive investments in securities. However, in comparison to their lending operations East Asian banks invested a relatively small amount in securities (see Appendix, Table 4). It is likely that in 1992, banks already took excessive risks. Our risk measure, however, does not include the risk acquired until 1992, and thus only measures additional risk taken during 1992-96.

3. Overview of the East Asian Financial Sectors

The financial systems of Indonesia, Korea, Malaysia, Philippines and Thailand have long been dominated by commercial banks. In all countries the commercial banking sector is dominated by a few large domestic commercial banks with extensive branch networks. Foreign banks, which are often disadvantaged by a number of restrictions, account for a relatively small amount of bank assets and mostly provide trade finance to multinational firms. Other large groups of financial institutions are the finance companies in Malaysia and Thailand, and the merchant banks in Korea.

Finance companies and merchant banks faced more restrictions and engaged in different activities than commercial banks. Thai finance companies, for example, were not allowed to mobilise demand or time deposits, but were only permitted to issue fixed-term promissory notes and certificates of deposits to fund their businesses. In view of these restrictions, Thai finance companies could not effectively compete for most of the commercial bank mainstream business, and were largely left to engage in more risky activities. Commercial banks had more freedom to choose their business mix and faced similar restrictions across countries. For the above reasons, we exclude finance companies and merchant banks from our analysis and focus only on commercial banks.

The local commercial banks in all five East Asian countries were originally set up by the State, a handful of families who controlled large enterprises (such as rice farms in the case of Thailand), or by trading houses. Despite attempts by the government to diversify the ownership of the local commercial banks, Indonesian and Thai commercial banks are still dominated by a handful of families. All the banks have powerful connections with the local and international business community and with the government. In Korea, the largest banks are typically connected to a large conglomerate, the so-called *chaebol*, by acting as the main bank. The State is involved in the commercial banks through ownership of large savings banks that are important for channelling private savings to investment projects.

All five East Asian financial sectors had financial liberalisation, a weak regulatory and supervisory framework, poor risk management and excessive lending in common. But there were differences in magnitudes and origins.[2] In 1983, Indonesia started to liberalise its financial system, after declining oil prices in 1982 had led to a devaluation of the rupiah. The main financial sector reform was the dismantling of the credit ceiling system, that was imposed in the 1970s in order to control credit growth and money supply. The reform was directed to private banks only. For state banks, credit restrictions remained in place. In fact, Indonesian state banks had limits on their asset growth up to the crisis year 1997.

Montes et al. (1998) argues that the flexibility to extend credit led private banks to take on more risky projects, while state banks, hampered by cumbersome procedures in granting loans, were more successful in attracting deposits, as they owned large branch networks and were considered less risky by the public, who assumed an implied government guarantee. To foster competition, Indonesia introduced another financial reform package in 1988, which included the reduction of bank reserve requirements from 15 to 2 percent of assets, and permitting public sector entities to place up to 50 percent of their deposits outside state banks.

Montes et al. (1998) reports that the introduction of these measures led to an explosive growth of new banks from 124 in 1988 to 244 in 1994. The increased competition, subsequently, led most of Indonesia's large conglomerates to set up or acquire at least one bank. As in the other countries, financial liberalisation sparked a lending boom in Indonesia, with large exposures to the property development sector. Since the private banks showed the largest growth of loans during the 1990s and had significant cross-ownership links with other financial institutions and

[2] See Claessens and Glaessner (1997) for an overview of the financial sector weaknesses in East Asia.

conglomerates, Montes et al. (1998) argues that they did not necessarily fare better in terms of their loan performance than did state-owned banks.

In Korea, the government provided priority strategic sectors and industries with subsidised credit through a government-directed banking system and protected them from foreign competition. This nurtured the large *chaebols* in the 1960s and 70s. After privatisation of the banks, the *chaebols* were allowed to take minority stakes in the banks of up to 5% only. Because of this restriction the large Korean banks became publicly and widely owned. According to Ha-Joon (1998), the *chaebols* have become more independent of the government, as they started gaining direct access to international capital markets and acquired controlling stakes in certain minor regional banks. However, instead of focusing on long-term value-adding investments only Korea's conglomerates also bought up a substantial amount of real estate and speculated heavily on the stock market, mostly financed with short-term debt. Bullard et al. (1998) reports that by 1996, total bank exposure to real estate reached 25 percent, higher than either Thailand or Indonesia, and according to Ha-Joon (1998) the share of Korea's short-term debt in total debt rose to over 58 percent in 1996. The result of this investment boom was that the financial state of Korea's conglomerates deteriorated. Bullard et al. (1998) reports that by 1996, the top 20 listed Korean companies were earning a mere 3 percent on assets, while the average cost to borrowing had risen to 8.2 percent, and the average debt to equity ratio had risen to 220 percent.

In Thailand, financial liberalisation in 1992 enabled commercial banks to borrow more freely in foreign currencies from abroad, which subsequently led to substantial borrowing from abroad and a high level of investments. Lauridsen (1998) reports that during the 1990-96 period, the investment ratio was over 40 percent and that by August 1997 the foreign debt was about US$ 90 billion, of which US$ 20 billion was due by the end of 1997. The massive inflow of money caused a misallocation of investment resources and a boom-bust cycle involving property and stock markets. Lauridsen (1998) reports that loans from financial institutions to property developers tripled during the period 1992-1996 causing inflated assets in the real estate sector. Not only the Thai commercial banks contributed to the lending boom, but the 91 Thai finance companies as well.

In Malaysia, major companies borrowed heavily from abroad as well, at least until 1994 when restrictions on foreign borrowing were put into place. However, compared to Thailand and Indonesia, a lower share of foreign borrowing was of a short-term nature and a higher proportion was hedged. But as in the other countries, Malaysia also seems to have misallocated investments.

According to Jomo (1998), in the period 1992-96 more than 70 percent of bank lending in Malaysia has not been for investments in manufacturing, agriculture or mining, but for other purposes, most notably real property and share purchases.

The story of the Philippines slightly differs, since the Philippines entered the 1990s with an economic recession, while the other four countries seemed to fare well under export-led growth. The Philippine financial system has been small compared to the other four East Asian countries, because high inflation has discouraged household savings. In 1992, the Philippines agreed to a debt restructuring program based on the Brady plan which converted loans into long-term bonds, and started to liberalise its financial system by easing the entry of banks. Financial liberalisation also allowed unhedged foreign borrowings, which, as Lim (1998) notes, was attractive because the central bank's policy of a stable currency made sure that domestic interest rates were above foreign rates. Financial liberalisation without sufficient prudential regulation and enforcement by the central bank led also in the Philippines to an overexposure to risky loans, especially real estate loans, foreign borrowings and consumer loans to high risk groups.

4. Data

The data used in this study are taken from BankScope, which is a rich source for balance sheet and profit & loss account data for individual banks across the world. In order to estimate the bank efficiencies we have gathered the following variables: interest expenses on deposits and borrowings, personnel expenses, operating expenses (on equipment, building, machinery, etc.), net loans (equal to gross loans or credit plus accrued interest minus loan losses), and investments in securities (including securities purchased with a resale agreement). In addition, we have collected data on total assets, deposits, equity capital, loan loss provisions, short-term borrowings (domestic and foreign) and ownership structures. The data is on 54 commercial banks in Indonesia, 25 in Korea, 34 in Malaysia, 29 in the Philippines, and 29 in Thailand for the years 1992-96[3] (see Appendix, Tables 1-4, for summary statistics of the data).

The coverage of the data is quite good. In terms of bank loans, the coverage of the total commercial banking system by our sample of commercial banks is about 70% in Indonesia, 90% in the Philippines, 98% in both Korea and Malaysia, and 100% in Thailand. In terms of number of

[3] However, data are not available for all banks for all five years. For Malaysia, no data was available for 1993, and for 1994 only for a few of the large banks.

commercial banks, the coverage by our sample is 23% in Indonesia, 96% in Korea, 97% in Malaysia, 57% in the Philippines and 100% in Thailand (see Appendix, Tables 1 and 2).

We consider five different ownership forms: state-owned, family-owned, company-owned, foreign-owned, and widely-owned (dispersed ownership). The ownership category state-owned means that the state is a majority shareholder. Family-owned means that a handful of families own the majority of the voting rights. Majority ownership is defined as having over 33% of the voting rights, which in general is identical to owning more than 33% of the shares, although in some cases there is a large difference between ownership of control rights and ownership of cash flow rights. Similarly, company-owned means that a handful of companies own the majority of the voting rights and foreign-owned means that the financial institution is owned mainly by foreigners. Widely-owned means that there are no majority owners, but that the shares are widely-held, possibly amongst some minority owners, who each own between 5% and 33% of shares.

Ownership is thought to be related to a financial institution's performance, because the incentives for managers to efficiently allocate resources might differ under different ownership arrangements. If owners do not have the incentive or capability to monitor the activity of management, then agency problems and subsequent costs are thought to increase. In particular it is expected that foreign-owned banks will be relatively efficient, because their corporate governance is of international standards. In addition, it is expected that company-owned, family-owned and state-owned banks are relatively inefficient. Company-owned and family-owned banks are likely to suffer from poor governance and connected lending. In particular, the company or family might be tempted to use the bank to finance their own businesses. In terms of efficiency, state-ownership is in general thought to be inferior to private ownership.

The ownership structure of banks differs substantially among the five East Asian countries (see Appendix, Tables 1 and 3). Indonesian commercial banks are predominantly owned by the state, families and companies, Korean banks are predominantly widely-held, Malaysian and Philippine banks are predominantly owned by companies, and Thai domestic banks are predominantly owned by families. However, in terms of total controlled commercial banks assets, the dominant ownership forms are state-ownership and family-ownership in Indonesia (both control 37%), dispersed ownership in Korea (56%), company-ownership in Malaysia (56%), company-ownership in the Philippines (57%), and family-ownership and dispersed ownership in Thailand (both control 36%). In East Asia, family-ownership is not unique to the banking sector.

Claessens et al. (1999a) show that in most East Asian countries, ownership of corporations (including banks) is concentrated in the hands of a few families, and that there are extensive links between corporations and the governments. For all countries each of the collected variables (if averaged across banks) has increased substantially during the period 1992-96 (see Appendix, Table 4)[4]. Some variables even show growth rates up to 287% for this period, such as the amount of short term borrowing by Indonesian banks. These growth rates are a sign of excessive growth and risk taking of the East Asian banks during the period 1992-96.

5. Methodology

We will analyse the efficiency of banks in one framework, i.e. within a country we will relate all types of commercial banks for all years to the same 'grand frontier'. We estimate such a 'grand frontier' for each country to allow for differences across countries. The problems of using one frontier are that not all banks in a given country operate in the same environment, and that the environment in which banks operate might change over time. The inefficiencies of state-owned banks, for example, might have been caused by quite different factors than those of the privately-owned banks as within all five countries they operated in a different regulatory and supervisory framework, had different funding costs and had small overlap in client groups with the commercial banks. These differences are, however, relatively small. Also, bank efficiency is not constant over time. However, our sample period is relatively short (1992-96) and, with liberalisation measures mostly imposed by 1992, covers a period with relatively minor changes in banking laws. The advantage of using one frontier is that within a given country we are able to compare the efficiencies of all types of banks with each other across time. Therefore, we decide to calculate for each country the combined frontier of all the banks for all years, realising that we are making the strong assumption that all banks in a given country operate in the same environment during our sample period.

Given the high credit growths it is most likely that the goal of the East Asian banks has been output maximisation instead of input minimisation. We will therefore use the output orientation to calculate technical inefficiency. This means that we assume that East Asian banks

[4] These figures include the annual inflation rates which were on average 9% in Indonesia, 5% in South Korea, 4% in Malaysia, 8% in the Philippines and 5% in Thailand during 1992-96 (Source: IFS, IMF).

seek to maximise their service provision, given the resources at their disposal. We will specify the following variables for the model (1)-(5). The input variables (x) include interest expense (x_1), labour expense (x_2), other operating expense (x_3). The output variables (y) include loans (y_1), and securities (y_2). Our variable specification follows the intermediation approach to modelling bank production. Nonperforming loans are not included as an environmental variable. The reason for this is that nonperforming loans are likely to be endogenous, meaning that they are caused by bad management or monitoring of the loan portfolio. Nonperforming loans would be exogenous if caused by negative economic shocks. These shocks are likely to affect all banks in the same way and are therefore expected to have similar impacts on each banks profit.

Since we relate the efficiency of individual banks in each of the five East Asian countries to a 'country grand frontier' and since the initial conditions of these five countries were different, we cannot compare the estimated bank efficiencies across countries. However, changes in efficiency are comparable across countries, since it is likely that there were only minor or similar changes in the bank environment of the five countries during the period 1992-96. We can thus pool the data on efficiency across countries and time. This increases the number of observations and therefore the power of our tests.

To explain the variation in changes in output efficiencies through time we specify a second-step regression model. For each country, the second-step regression model is specified as a two-factor fixed effects model with ownership dummies

$$\Delta\tilde{E}_y(x^{ftg}, y^{ftg}) = a_0 + a_g + a_t + \sum_{j=1}^{J} b_j \Delta B_j^{ftg} + \sum_{k=1}^{K} d_k D_k^{ftg} + e^{ftg}, \qquad (8)$$

where $\tilde{E}_y(x^{ft}, y^{ft})$ is the vector of efficiencies calculated in the first step using DEA, a, b and d are vectors to be estimated, B^{ft} is a matrix of J explanatory variables for bank f in period t, Δ denotes that a variable is in first differences, for example, $\Delta B_j^{ft} = B_j^{ft} - B_j^{f(t-1)}$, g denotes one of the five countries, D_k^{ftg} are ownership dummies corresponding to K different ownership forms and e^{ftg} is normally distributed with mean zero and variance s_e^2. Equation (8) has an overall constant (a_0) as well as a country effect for each of the five countries (a_g) and a time effect for each period (a_t). As explanatory variables we include the capital adequacy ratio[5], the ratio of loan loss provisioning to loans, the amount of loans, and the amount of short term borrowings. The

capital adequacy ratio and the ratio of loan loss provisioning to loans are to a large extent imposed upon the banks by the regulators. They are included as explanatory variables, because it is likely that, while imposing their rules upon the banks, regulators discriminated across banks and that regulators became more lax regarding enforcement of their rules during the period 1992-96, as it became clear to them that some banks were facing financial difficulties. An increase in the amount of loans, and especially an increase in the amount of short term borrowings is a good indicator for the degree of bank risk-taking. They are included as explanatory variables because risk-taking is likely to be related to changes in bank efficiency. All explanatory variables are in first differences. To avoid multicollinearity in estimating (8), we will suppress one of the ownership dummies.

We will use the DEA calculated efficiency measures to calculate our measure of risk-taking. The measure of risk-taking is comparable across countries, since it is likely that there were only minor or similar differences in risk-taking behaviour across the five countries during the period 1992-96. We can thus pool the data across countries. This increases the number of observations and therefore the power of our tests. We specify the following one-factor fixed effects model with ownership dummies to explain differences in risk-taking behaviour among banks and across countries

$$R_y^{fg} = a_g + \sum_{j=1}^{J} b_j B_j^{fg} + \sum_{k=1}^{K} d_k D_k^{fg} + e^{fg}, \qquad (9)$$

where g denotes one of the five countries, R_y^{fg} is our risk-taking estimate for bank f in country g, D_k^{fg} are ownership dummies, and e^{fg} is normally distributed with mean zero and variance s_e^2. Instead of an overall constant, model (9) has a country effect for each of the five countries (a_g). As explanatory variables we include the market share of bank assets in 1992[6], the growth in the ratio of loan loss provisioning to loans during the period 1992-96 and the growth in short-term borrowing during the period 1992-96. The market share of banks assets in 1992 is included as an initial condition to control for a possible size effect. It is expected that small banks are likely to take more risk than large banks in their efforts to become big as well. The growth in the ratio of loan loss provisioning to loans is included to correct for a possible discrimination by the regulator of banks in imposing provisioning rules. The growth in short-term borrowing is included because high

[5] We have calculated capital adequacy ratios as the ratio of equity capital to the sum of loans and securities.

short-term debt was a key factor behind the financial difficulties of many banks, and is therefore expected to be positively linked to bank risk-taking. To avoid multicollinearity we will suppress one of the ownership dummies.

6. Empirical Findings

The DEA efficiency results are obtained from applying model (1)-(5) to estimate a 'grand frontier'. As noted before, the 'grand frontier' approach implicitly assumes that there are no changes in technology, regulation, and market environment during the period 1992-96 that affect bank efficiency. Since the sample of banks is large enough not to put too many banks on the efficiency frontier, we decide to use the VRS results.

For the period 1992-96, our DEA efficiency estimates (see Appendix, Table 5) show that for all five East Asian countries bank efficiency did not decrease significantly. For Indonesia, the Philippines and Thailand we see a substantial increase in efficiency, and Korea and Malaysia stay roughly constant at their initial levels. This is a surprising result, since one would expect that bank efficiency in these countries would be lower in 1996, one year before the crisis year 1997, than in 1992, that is, if in this case bank efficiency is indeed a good indicator for bank performance. However, this may not be the case, since during the same period all five countries experienced extremely high loan growths (up to 151% for the Philippines - see Appendix, Table 4)[7]. Ex-post we know that a substantial part of those loans were actually non-performing, and therefore risky. The strong correlation between efficiency growth and loan growth makes it evident that in the case of East Asia, where non-performing loans have been underestimated or not fully reported, technical bank efficiency estimates are not a good indicator for the performance of banks, but are merely an indicator for how well banks were in transforming their inputs into loans, both bad and good loans. The technical efficiency measure, therefore, does not take into account that excessive loan growth can indicate excessive risk taking instead of increased bank performance.

To explain the variation in DEA-estimated bank efficiency both across ownership groups and through time we have estimated the two-factor fixed effects regression model specified in equation (8). Detailed results can be found in the Appendix (Regression 1). After correcting for

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[6] The asset market share of bank *f* in country *j* is defined as the amount of assets of bank *f* in 1992 divided by the total amount of assets of all banks in country *j* in 1992.

[7] These figures are inclusive of the inflation rate. The real growth of bank loans were extremely high as well (for example, 111% in the Philippines).

bank-specific effects, we find that family-owned and foreign-owned banks showed an increase in efficiency relative to other banks and that widely-owned banks showed a decrease in efficiency relative to other banks across the region during the period 1992-96. A second result is that on average Philippine banks showed an relative increase in efficiency and Malaysian banks a decrease in efficiency relative to banks in the other three countries. We also find a positive time effect for the change in efficiency of the region's banking sector during 1992-93, and a negative time effect during 1994-95. Most importantly, we find that high loan growth is significantly correlated with an increase in efficiency among all countries[8]. We find a correlation of 36%, which confirms our view that bank efficiency measures cannot perfectly distinguish bank performance from excessive credit growth. We thus need to correct for bank risk taking.

For each bank across all five countries we have calculated our risk-taking measure in equation (7). Our findings across different ownership groups are summarised in Box I (see Appendix, Table 6 for further details), where we have defined 'high risk' as having a relatively high measure of risk-taking during the period 1992-96. Box I also reports the share of bank assets as of end 1996 (between brackets) to find out how well distributed our findings are across the different risk-taking groups.

Box I **Relative risk-taking across ownership groups**

Country	*High Risk*	*Medium Risk*	*Low Risk*
Indonesia	Family (37.2%)	Company (15.7%)	State, Widely, Foreign (47.1%)
Korea	State (30.5%)	Widely, Foreign Company (62.9%)	(6.6%)
Malaysia	Widely**, Company (64.7%)	State, Family (13.0%)	Foreign (22.2%)
Philippines	Company, Foreign (66.8%)	Family (10.1%)	State, Widely (23.0%)
Thailand	Foreign (8.6%)	State, Widely (55.6%)	Family** (35.8%)

** Significantly different from average at a 5% level; * Significantly different from average at a 10% level

We find a reasonably good distribution across risk-taking groups for all countries. An explanation for Indonesian state-owned banks having a low risk is that for the period 1992-96 they were

[8] This result also holds if we do not pool the efficiency data across countries.

limited by the regulator in their asset growth. In fact, they were operating under an implicit ceiling on their loan growth. Their market share in loans dropped significantly as a consequence.

To explain the variation in risk-taking across ownership groups we have estimated the one-factor fixed effects regression model specified in equation (9). Our findings are summarised in Box II (see Appendix, Regression 2.a-b for further details), where we define 'high risk' as having a relatively high measure of risk-taking during the period 1992-96 after correcting for bank-specific effects.

Box II Relative risk-taking (pooled regression results)

Variable	*High Risk*	*Medium Risk*	*Low Risk*
Ownership	Family*, Company**	Widely	State*, Foreign*
Country	Indonesia*, Philippines* Thailand		Korea*, Malaysia*

** Significantly different from average at a 5% level; * Significantly different from average at a 10% level

We find that across countries state-owned and foreign-owned banks took least risk (in terms of our defined measure of risk-taking), and that family-owned and company-owned banks took most risk. A second result is that Indonesian and Philippine banks took relatively more risk than banks from the other three countries. We also find that banks with large increases in short-term borrowings were riskier. Although the results show a negative relationship between bank risk taking and bank size (i.e., small banks took more risk), this size effect is not significant.

Note that these results do not take into account that some banks operated under more restrictions than others. For example, the bank regulator might have been more lax towards state-owned banks in imposing its rules. It is, however, likely that foreign banks were not favoured by any of these rules and restrictions. Given the fact that foreign banks were disadvantaged by a number of restrictions[9], especially in comparison with state banks, we might conclude from the above results that foreign banks were the best performers in terms of taking the least risk. Besides being favoured in terms of having fewer restrictions and more lax regulation, a possible explanation for the result that state-owned banks took relatively risk, might be that the credit growth of state banks in Indonesia, which comprise a large part of our sample of state-owned banks, was restricted during the period 1992-96. An explanation for the second result might be that family-owned and company-owned banks engaged more intensively into insider lending than

state-owned, foreign-owned and widely-held banks, because of their more intimate relationships between shareholders and bank managers.

The risk-measure we have defined in equation (12) is a function of the change in bank efficiency. Therefore, any relationship we would find between the change in efficiency and our measure of risk-taking would be an artefact of our definition. However, this problem does not arise when we relate risk-taking to the initial level of efficiency (in the year 1992) only. The relationship between our measure of risk-taking and the DEA calculated technical efficiency measure in 1992 is negative for all five countries. This means that banks that were efficient in 1992 took less risk during the period that followed (1992-96).

Since all banks experienced loan growths over the period 1992-96, the implicit relationship between our measure of risk-taking and decreases in efficiency is negative. This is the relationship we would expect, because banks that show a large decrease in efficiency during 1992-96 took on less loans (*ceteris paribus*) and therefore less risk. A bank typified as being highly inefficient by traditional technical efficiency measures might thus have withstood the crisis simply because it took on relatively few (risky) loans.

7. Risk-taking and Bank Restructuring

A major cause of the East Asian financial crisis was the weak regulatory and supervisory frameworks set by the East Asian governments and central banks. Although the East Asian governments have been too lax in enforcing their rules in the past, there are signs that they are making efforts to prevent such mismanagement in the future. The East Asian governments have already taken many actions to restructure the banking systems[10]. In Indonesia, so far, bank restructuring has affected 146 of the 237 commercial banks - 50 commercial banks have been shut down, another 26 commercial banks have been taken over by the government restructuring agency IBRA, and another 54 commercial banks have become directly controlled by the government. In addition, four of the seven state banks are to merge and 12 commercial banks have been nationalised. In Korea, four of the 26 commercial banks have been nationalised, five commercial banks have been absorbed into other institutions, and 2 commercial banks have been sold to foreigners. In addition, 16 of the 30 merchant banks and 10 of 25 leasing companies have been shut down. Since the Malaysian government has opted for absorption, there has been no

[9] Foreign banks faced for example restrictions on the number of branches they could have.
[10] Source: Goldman Sachs Investment Research; Claessens et al. (1999b). All figures as of Sept. 1999.

closure of any of 35 commercial banks or 39 finance companies. Thus far, two Malaysian commercial banks have been absorbed by other entities, and 16 Malaysian finance companies have been absorbed by parent banks. There are plans to merge the remaining 58 institutions into 6 groups. In the Philippines no banks have been closed down. The Philippine government and central bank encourage consolidation of banks instead. Two major banks have already merged. In Thailand, one of the 15 commercial banks has been closed down, two commercial banks have been nationalised, and two commercial banks have been absorbed by government entities. In addition, 55 of the 91 finance companies have been closed down, and 16 finance companies have been absorbed by other entities. Finally, Thai banking legislation has been changed so that it is easier for foreigners to buy into Thai financial institutions.

If our risk-taking measure correctly measures excessive risk-taking by banks we would expect that our measure of risk-taking is higher for banks that have been restructured than for banks that have not been restructured. We will classify a bank as being restructured if it was either suspended, re-capitalised, merged, taken over, nationalised or closed down after 1997. The 14 foreign-owned banks in Thailand are all branches of foreign banks, and can therefore be supported by the parent if necessary. As a consequence, none of these banks have been restructured. We therefore exclude them from this ex-post analysis in order to prevent distortion of our results, which leaves us a sample of 156 banks. We indeed find for all five countries that banks that have been restructured since the onset of the financial crisis took more risk during 1992-96 in terms of our risk measure than banks that have not been restructured (see Table 7). To assess the explanatory power of our risk measure in more detail we have estimated a binomial logit regression model with a binary restructuring variable that takes value one if the bank has been restructured and zero if the bank has not been restructured as dependent variable. We include bank assets in 1992 as explanatory variable to control for a possible size effect, and add country dummies and ownership dummies to control for country and ownership effects. We thus pool the data across the five countries. The results from the binomial logit model indicate that our risk measure has explanatory power in terms of predicting which banks were to be restructured after 1997, i.e. the regression coefficient of the risk measure variable is significant at a 1% level. The binomial logit model is quite powerful; it predicts restructuring correctly in 77% of cases. A summary of our findings is presented in Box III (see Appendix, Regression 3 for further details).

Box III Bank restructuring (binomial logit regression results)

	Many restructured banks among	*Few restructured banks among*
Risk-taking	Banks that took a lot of risk**	Banks that took little risk**
Bank size	Large banks**	Small banks**
Ownership	Family-owned and company-owned banks**	Foreign-owned banks**
Country	Korean and Thai banks**	Indonesian, Malaysian, and Philippine banks**

** Significantly different from average at a 5% level; * Significantly different from average at a 10% level

Not only do we find that banks that were restructured had excessive credit growth in terms of our defined measure of risk-taking, but we also find that a relatively high number of restructured banks was family-owned or company-owned, an average number was state-owned or widely-held and a relatively small number was foreign-owned. In addition, we find that a relatively higher number of restructured banks among Korean or Thai banks than among Indonesian, Malaysian or Philippine banks. This result might indicate that the latter three countries have not made a lot of progress with the restructuring of their banking sectors. Finally, we find that large banks (in terms of assets) were more likely to be restructured than small banks.

The risk measure performs better in predicting bank restructuring than the more straightforward measure of loan growth. Estimation of the previous binomial logit model with the average annual loan growth during the period 1992-96 as explanatory variable instead of our risk measure gives an insignificant coefficient for the loan growth variable (see Appendix, Regression 4 for further details). Although the risk measure is based upon loan growth during 1992-96, it follows that the risk measure contains additional useful information, namely the change in the efficiency of the bank (see equation (7)). In fact, the correlation between average annual loan growth and the risk measure is only 32%. The above suggests that the risk measure developed in this paper can be a useful tool for assessing the risk of a bank.

8. Conclusions

We have used a linear programming technique called Data Envelopment Analysis (DEA) to estimate the efficiencies of the commercial banks in Indonesia, Korea, Malaysia, the Philippines and Thailand for the years 1992-96. In this particular case, we found that in assessing the overall

performance of a bank it is not enough to look at efficiency measures only, but that risk factors should be taken into account as well. The best bank is not simply the most efficient producer of loans, but is a bank that combines high efficiency with low risk-taking. We therefore introduced a measure of risk-taking based upon the well-established efficiency measure that enabled us to assess the overall performance of banks.

Our findings are that foreign-owned banks took little risk relative to other banks in the East Asian region, and that family-owned banks, were among the most risky banks, together with company-owned banks. Our risk measure does better than credit growth alone in predicting bank restructuring after the crisis of 1997. Not only do we find that banks that were restructured had excessive credit growth, but we also find that the restructured banks were mostly family-owned or company-owned, and almost never foreign-owned.

The results of our risk-taking model indicate that family and company ownership of banks should be discouraged, and that foreigners should be encouraged to become core group of investors of banks. These conclusions should, however, be interpreted with caution given the sensitivity of our technical methods. In particular, our analysis might have overlooked that some banks operated under more restrictions than others. It is, however, likely that foreign banks were not favoured by any of these rules and restrictions. We therefore argue that banking regulation should be such that all banks, including foreign banks, can compete on an arms-length bases and that foreign ownership of East Asian banks should be encouraged.

Since it is impossible to separate efficiency improvements from excessive risk taking, we have assumed that efficiency is constant during 1992-96 in order to construct our measure of risk taking. Of course, bank efficiency is not constant over time, even for a relatively short period of 5 years with no significant changes in bank management and bank regulation. However, the increases in estimated efficiency that we see for most banks in our sample are clearly overstated, since a lot of those banks entered financial distress or even bankruptcy after 1997. It seems evident that on average the increase in calculated efficiency was mainly (in most cases even completely) due to excessive risk-taking instead of a true increase in efficiency/performance. Therefore, although we acknowledge that our risk measure is only a rough estimate of bank risk taking, we argue that on average our risk measure should give a good indication of the extent of risk taking across banks.

Traditional bank efficiency measures do not only disregard the risk profile of a bank's business, but they also suffer from the limitation that they do not account for business mix, the

quality of service, and exogenous shocks. Although we have made an attempt to take the risk profile of a bank's business into account by assessing a bank's risk-taking behaviour, our measure still suffers from not accounting for business mix and the quality of service. Accurate data on a sectoral breakdown of extended loans might be used to account for business mix, but further research is needed to develop methods that will enable us to assess the performance of a bank given its accounting data.

References

Aigner, D.J., C.A. Knox Lovell, and P. Schmidt (1997), "Formulation and Estimation of Stochastic Frontier Production Function Models", *Journal of Econometrics* 6: 21-37.

Banker, R., A. Charnes and W. Cooper (1984), "Some Models for Estimating Technical and Scale Efficiencies in Data Envelopment Analysis", *Management Science* 30(9): 1078-92.

Berger, A.N. and L.J. Mester (1997), "Inside the Black Box: What Explains Differences in the Efficiencies of Financial Institutions?", *Journal of Banking and Finance* 21: 895-947.

Bhattacharyya, A., C.A.K. Lovell and P. Sahay (1997), "The Impact of Liberalization on the Productive Efficiency of Indian Commercial Banks", *European Journal of Operational Research* 98: 332-345.

Bullard, N., W. Bello, and K. Malhotra (1998), "Taming the Tigers: The IMF and the Asian Crisis", pp. 85-136, in: Jomo K.S. (ed.), *Tigers in Trouble: Financial Governance, Liberalisation and Crisis in East Asia*, Zen Books: London, UK.

Button, K.J. and T.G. Weyman-Jones (1992), "Ownership Structure, Institutional Organization and Measured X-Inefficiency", *American Economic Review* 82(2): 439-445.

Charnes, A., W.W. Cooper and E. Rhodes (1978), "Measuring the efficiency of decision-making units", *European Journal of Operations Research* 2(6): 429-44.

Claessens, S. and T. Glaessner (1997), "Are Financial Sector Weaknesses Undermining the East Asian Miracle?", World Bank, Washington, DC, US.

Claessens, S., S. Djankov, and L.H.P. Lang (1999a), "Who Controls East Asian Corporations?", *Policy Research Working Paper No. 2054*, World Bank, Washington, DC, US.

Claessens, S., S. Djankov, and D. Klingebiel (1999b), "Financial Restructuring in East Asia: Halfway There", *Financial Sector Discussion Paper No. 3*, World Bank, Washington, DC, US.

Farrell, M.J. (1957), "The Measurement of Productive Efficiency", *Journal of the Royal Statistical Society* (Series A) 120/3: 253-281.

Ferrier, G. and C.A. Knox Lovell (1990), "Measuring Cost Efficiency in Banking: Econometric and Linear Programming Evidence", *Journal of Econometrics* 46: 229-245.

Gilbert, R.A. and P.W. Wilson (1998), "Effects of Deregulation on the Productivity of Korean Banks", *Journal of Economics and Business* 50: 133-155.

Greene, W. (1993), "The Econometric Approach to Efficiency Analysis", in H.O. Fried, C.A. Knox Lovell and P. Schmidt (eds), *The Measurement of Productive Efficiency: Techniques and Applications*, Oxford University Press: Oxford, UK.

Ha-Joon, C. (1998), "South Korea: The Misunderstood Crisis", pp. 222-231, in: Jomo K.S. (ed.), *Tigers in Trouble: Financial Governance, Liberalisation and Crisis in East Asia*, Zen Books: London, UK.

Hao, J., W.C. Hunter, and W.K. Yang (1999), "Deregulation and Efficiency: The Case of Private Korean Banks", Mimeo, Federal Reserve Bank of Chicago.

Jomo, K.S. (1998), "Malaysia: From Miracle to Debacle", pp. 181-198, in: Jomo K.S. (ed.), *Tigers in Trouble: Financial Governance, Liberalisation and Crisis in East Asia*, Zen Books: London, UK.

Lauridsen, L. (1998), "Thailand: Causes, Conduct, Consequences", pp. 137-61, in: Jomo K.S. (ed.), *Tigers in Trouble: Financial Governance, Liberalisation and Crisis in East Asia*, Zen Books: London, UK.

Leibenstein, H. (1966), "Allocative Efficiency vs 'X-Efficiency'", *American Economic Review* 56: 392-415.

Leightner, J.E. (1997), "The Achilles Heel of Thailand's Financial Market", Mimeo, Augusta State University.

Leightner, J.E., and C.A. Knox Lovell (1997), "The Impact of Financial Liberalization on the Performance of Thai Banks", Mimeo, Augusta State University.

Lim, J.Y. (1998), "The Philippines and the East Asian Economic Turmoil", pp. 199-221, in: Jomo K.S. (ed.), *Tigers in Trouble: Financial Governance, Liberalisation and Crisis in East Asia*, Zen Books: London, UK.

Mester, L.J. (1996), "A Study of Bank Efficiency Taking Into Account Risk-Preferences", *Journal of Banking and Finance* 20: 1025-1045.

Montes, M. and M.A. Abdusalamov (1998), "Indonesia: Reaping the Market", pp. 162-180, in:

Jomo K.S. (ed.), *Tigers in Trouble: Financial Governance, Liberalisation and Crisis in East Asia*, Zen Books: London, UK.

Schmidt, P. (1986) "Frontier Production Functions", *Econometric Reviews* 4: 289-328.

Appendix Tables and Figures

Table 1 Overview of commercial banking sector (as of end 1996)

Number	*Indonesia*	*Korea*	*Malaysia*	*Philippines*	*Thailand*
Local	193	25	23	31	14
Foreign	44	1	12	20	15
Total	237	26	35	51	29

Source: Central banks, Goldman Sachs. In addition, Korea has 30 merchant banks, and 25 leasing companies, Malaysia has 39 finance companies, and Thailand has 91 finance companies.

Table 2 Sample number of commercial banks (as of end 1996)

Ownership	*Indonesia*	*Korea*	*Malaysia*	*Philippines*	*Thailand*
State-owned	6	4	2	1	3
Family	16	0	1	6	8
Company	17	5	18	13	0
Widely	2	15	2	3	4
Foreign	13	1	11	6	14
Total	54	25	34	29	29

Source: BankScope, World Bank. Korean figures are excluding merchant banks; Malaysian figures are excluding merchant banks and finance companies; Thai figures are excluding finance companies.

Table 3 Share of commercial bank assets by ownership (includes sample only)

Ownership	*Indonesia*	*Korea*	*Malaysia*	*Philippines*	*Thailand*
State-owned	37.4	30.5	12.8	13.2	20.0
Family	37.2	0	0.2	10.1	35.8
Company	15.7	6.6	56.2	56.5	0
Widely	6.2	55.5	8.5	9.8	35.6
Foreign	3.5	7.4	22.2	10.3	8.6

Source: BankScope; World Bank; Bank of Thailand.

Table 4 **Summary statistics for Asian banks 1992-96 (standard deviation between brackets)**

	Country	*1992*	*1993*	*1994*	*1995*	*1996*	*Growth (in %)*	
Loans	Indonesia	1759	2048	2441	3022	3787	115%	
		(4102)	(4307)	(4454)	(5265)	(6407)		
	Korea	5650	5613	6741	7875	9381	66%	
		(4666)	(5163)	(5899)	(6692)	(7937)		
	Malaysia	-	*	5985	6973	8927	49%	
		-	*	(7840)	(9375)	(11060)		
	Philippines	13.80	15.36	18.49	24.94	34.60	151%	
		(13.04)	(16.58)	(20.31)	(27.95)	(36.36)		
	Thailand		79.06	94.51	115.28	139.78	160.65	103%
		(128.34)	(148.71)	(174.00)	(203.13)	(226.53)		
Securities	Indonesia	45	215	198	209	249	453%	
		(110)	(772)	(614)	(629)	(711)		
	Korea	711	785	1065	1288	1547	118%	
		(650)	(702)	(896)	(1032)	(1276)		
	Malaysia	-	*	1204	1385	1751	45%	
		-	*	(1886)	(2175)	(2544)		
	Philippines	4.10	3.52	4.04	4.51	4.75	16%	
		(5.41)	(5.13)	(5.89)	(8.23)	(7.52)		
	Thailand		4.75	5.13	5.74	6.96	7.27	53%
		(7.09)	(7.20)	(8.38)	(9.70)	(9.92)		
Interest Expense	Indonesia	257	237	243	379	496	93%	
		(538)	(472)	(434)	(619)	(829)		
	Korea	473	417	521	687	798	69%	
		(358)	(369)	(436)	(552)	(623)		
	Malaysia	-	*	385	441	645	68%	
		-	*	(606)	(625)	(846)		
	Philippines	1.60	1.12	1.41	1.87	2.68	68%	
		(1.64)	(1.30)	(1.88)	(2.41)	(2.99)		
	Thailand		6.38	6.69	7.12	11.12	12.97	103%
		(9.93)	(10.18)	(10.48)	(15.87)	(18.17)		
Personnel Expense	Indonesia	27	33	40	47	56	107%	
		(53)	(62)	(76)	(89)	(103)		
	Korea	110	112	133	160	181	65%	
		(358)	(369)	(436)	(552)	(623)		
	Malaysia	-	*	90	92	110	22%	
		-	*	(122)	(130)	(151)		
	Philippines	0.40	0.40	0.45	0.52	0.72	80%	
		(0.60)	(0.65)	(0.70)	(0.83)	(1.01)		
	Thailand		0.84	0.96	1.16	1.37	1.50	79%
		(1.35)	(1.56)	(1.89)	(2.22)	(2.34)		
Operating Expense	Indonesia	10	12	20	23	21	110%	
		(26)	(30)	(51)	(59)	(40)		
	Korea	41	44	63	74	83	102%	
		(47)	(45)	(62)	(65)	(70)		
	Malaysia	-	*	49	52	68	39%	
		-	*	(68)	(68)	(93)		
	Philippines	0.65	0.68	0.74	0.80	1.13	74%	
		(0.67)	(0.75)	(0.86)	(1.01)	(1.36)		
	Thailand		0.99	1.13	1.37	1.69	2.06	108%
		(1.49)	(1.67)	(1.99)	(2.43)	(2.84)		

Source: BankScope. For 1992, Malaysian data was unavailable (-) and for 1993 only a relatively small number of Malaysian banks was available (*). All figures for Indonesia in billions of Rupiah; for Korea in billions of Won; for Malaysia in millions of Ringit; for the Philippines in billions of Pesos; and for Thailand in billions of Baht.

Table 4 Continued **Summary statistics for Asian banks 1992-96**

	Country	*1992*	*1993*	*1994*	*1995*	*1996*	*Growth (in %)*	
Assets	Indonesia	2543	3016	3445	4223	5365	111%	
		(5598)	(6121)	(6257)	(7303)	(9011)		
	Korea	9193	8899	10689	12537	14939	63%	
		(7041)	(7562)	(8712)	(10023)	(11733)		
	Malaysia	-	*	10589	11558	14587	38%	
		-	*	(14705)	(16036)	(18824)		
	Philippines	28.30	28.32	33.63	41.94	54.79	94%	
		(26.78)	(31.84)	(37.80)	(49.15)	(60.61)		
	Thailand		92	112	137	166	189	105%
		(149)	(175)	(206)	(239)	(267)		
Equity	Indonesia	148	204	249	296	376	154%	
		(218)	(318)	(367)	(423)	(520)		
	Korea	658	605	736	812	880	38%	
		(442)	(466)	(557)	(601)	(633)		
	Malaysia	-	*	702	809	1067	52%	
		-	*	(844)	(988)	(1218)		
	Philippines	3.30	3.29	4.31	5.37	6.98	112%	
		(3.08)	(3.46)	4.60)	(5.84)	(7.55)		
	Thailand		7	9	12	17	21	200%
		(10)	(14)	(16)	(19)	(23)		
Deposits	Indonesia		1609	1967	2315	2824	3650	127%
			(3276)	(3776)	(3977)	(4754)	(6190)	
	Korea		7247	6774	8030	9250	10832	49%
			(6019)	(6234)	(7117)	(8055)	(9257)	
	Malaysia	-	*	8601	9241	11633	35%	
		-	*	(12140)	(12932)	(14893)		
	Philippines	20.60	20.88	24.56	29.51	37.47	82%	
		(20.54)	(25.06)	(29.09)	(35.46)	(42.17)		
	Thailand		79	93	108	129	145	84%
		(134)	(154)	(175)	(202)	(224)		
Loan loss provisions	Indonesia	13	7	21	28	27	108%	
		(38)	(11)	(76)	(85)	(52)		
	Korea	37	39	89	67	66	78%	
		(43)	(52)	(114)	(74)	(74)		
	Malaysia	-	*	41	42	62	151%	
		-	*	(990)	(67)	(93)		
	Philippines	0.10	0.10	0.10	0.16	0.23	130%	
		(0.00)	(0.00)	(0.02)	(0.24)	(0.43)		
	Thailand		0.53	0.49	0.60	0.56	1.40	164%
		(1.07)	(1.10)	(1.06)	(0.97)	(4.14)		
Short-term borrowings	Indonesia	207	264	377	635	802	287%	
		(305)	(417)	(679)	(1076)	(1582)		
	Korea	3717	3307	4101	4806	5600	51%	
		(3879)	(3832)	(4288)	(4781)	(5232)		
	Malaysia	-	*	2212	2441	3257	47%	
		-	*	(3545)	(3760)	(4953)		
	Philippines	0.82	0.93	0.84	1.00	1.02	24%	
		(1.29)	(1.53)	(1.94)	(1,82)	(1.21)		
	Thailand		12	12	16	19	19	58%
		(26)	(25)	(25)	(28)	(33)		

Source: BankScope. For 1992, Malaysian data was unavailable (-) and for 1993 only a relatively small number of Malaysian banks was available (*). All figures for Indonesia in billions of Rupiah; for Korea in billions of Won; for Malaysia in millions of Ringit; for the Philippines in billions of Pesos; and for Thailand in billions of Baht.

Table 5 **Average technical efficiency scores in % (standard deviations between brackets)**

	1992	*1993*	*1994*	*1995*	*1996*	*1992-96*
Indonesia	48 (24)	59 (22)	70 (19)	63 (18)	66 (21)	61 (22)
Korea	89 (11)	94 (7)	92 (9)	84 (10)	87 (12)	89 (10)
Malaysia	-	73 (28)	73 (25)	68 (21)	70 (21)	70 (22)
Philippines	56 (20)	61 (24)	65 (25)	77 (26)	79 (23)	68 (25)
Thailand	68 (21)	77 (18)	83 (19)	78 (18)	83 (17)	78 (19)

Table 6 **Average risk-taking by ownership form in % for the period 1992-96 (standard errors between brackets)**

Ownership	*Indonesia*	*Korea*	*Malaysia*	*Philippines*	*Thailand*
State-owned	6 (109)	7 (15)	11 (37)	25 (0)	24 (16)
Family	235 (250)	-	-9 (0)	134 (84)	14 (20)
Company	169 (203)	-20 (76)	24 (48)	145 (150)	-
Widely	-17 (103)	-13 (40)	47 (16)**	15 (278)	29 (32)
Foreign	82 (123)	-4 (0)	-41 (65)	201 (140)	80 (76)
All banks	143 (204)	-11 (45)	3 (59)	134 (151)	49 (62)

** Significantly different from average at 5% level

Table 7 **Average risk-taking across not-restructured and restructured banks during 1992-96 (standard errors between brackets)**

	Not-Restructured Banks		*Restructured Banks*	
	Risk-taking	*Number of banks*	*Risk-taking*	*Number of banks*
Indonesia	0.79 (1.12)	22	1.97 (2.43)	32
Korea	-0.43 (0.53)	6	-0.01 (0.38)	19
Malaysia	-0.04 (0.72)	22	0.15 (0.21)	12
Philippines	1.18 (1.57)	21	1.78 (1.20)	8
Thailand	0.00 (0.00)	1	0.22 (0.23)	14

Regression 1 **Two-factor fixed effects model for the region of changes in efficiency**

Dependent variable:	$\Delta\tilde{E}_y(x^{ftg}, y^{ftg})$
Model size:	565 Observations (panel data)
Adjusted R-squared:	0.28801
Model test:	F[16, 548] = 15.26; Prob value = 0.00000**

Variable	*Coefficient*	*Standard Error*	*T=b/s.e.*	*P[|T| ³ $t_{0.05}$]*
Constant	-0.04298	0.03047	-1.411	0.15835
ΔLOANS	0.35662	0.03069	11.620	0.00000**
ΔCAR	-0.02459	0.02215	-1.110	0.26696
ΔPROVRT	-0.69814E-06	0.22817E-05	-0.306	0.75963
ΔSHORT	-0.79680E-04	0.56249E-04	-1.417	0.15661
STATE	0.01390	0.04397	0.316	0.75186
FAMILY	0.03707	0.03979	0.932	0.35152
COMPANY	0.02053	0.03672	0.559	0.57614
FOREIGN	0.03884	0.03785	1.026	0.30487

Country	*Coefficient*	*Standard Error*	*T=b/s.e.*	*No. of Obs.*
Indonesia	0.02100	0.01633	1.29	186
Korea	-0.04516	0.02963	-1.54	94
Malaysia	-0.08828	0.02998	-2.94	69**
Philippines	0.06228	0.02377	2.62	100**
Thailand	0.00174	0.02326	0.07	116

Year	*Coefficient*	*Standard Error*	*T=b/s.e.*	*No. of Obs.*
1992-93	0.13292	0.02088	6.37	119**
1993-94	0.00282	0.01785	0.16	153
1994-95	-0.09089	0.01705	-5.33	161**
1995-96	-0.01224	0.01959	0.62	132

** Significant at 5% level; * Significant at 10% level

Regression 2.a **OLS regression model for region of risk-taking measure**

Dependent variable:	R_y^{fg}
Model size:	141 Observations (panel data)
Adjusted R-squared:	0.23366
Model test:	F[7, 133] = 7.10; Prob value = 0.00000**

Variable	*Coefficient*	*Standard Error*	*T=b/s.e.*	*P[|T| ³ $t_{0.05}$]*
Constant	0.36924	0.30163	1.224	0.22305
$ASSETS_{92}$	-3.1769	2.0454	-1.553	0.12276
$\Delta_{92\text{-}96}$PROV	0.0040678	0.004827	0.843	0.40090
$\Delta_{92\text{-}96}$SHORT	0.0017194	0.000339	5.070	0.00000**
STATE	-0.032229	0.45315	-0.071	0.94341
FAMILY	1.1661	0.36975	3.154	0.00199**
COMPANY	0.56149	0.34280	1.638	0.10379*
FOREIGN	0.053983	0.36196	0.149	0.88167

** Significant at 5% level; * Significant at 10* level

Regression 2.b **One-factor fixed effects model for region of risk-taking measure**

Dependent variable:	R_y^{fg}			
Model size:	141 Observations (panel data)			
Adjusted R-squared:	0.31345			
Model test:	F[11, 129] = 6.81; Prob value = 0.00000**			
Variable	*Coefficient*	*Standard Error*	*T=b/s.e.*	*P[|T| ³ $t_{0.05}$]*
$ASSETS_{92}$	-2.3755	2.0182	-1.177	0.24128
$\Delta_{92\text{-}96}$PROV	0.005117	0.004615	1.109	0.26950
$\Delta_{92\text{-}96}$SHORT	0.001589	0.000325	4.887	0.00000**
STATE	-0.20144	0.43816	-0.460	0.64645
FAMILY	0.63515	0.41041	1.548	0.12408
COMPANY	0.23818	0.38163	0.624	0.53361
FOREIGN	-0.20694	0.40414	-0.512	0.60945
Country	*Coefficient*	*Standard Error*	*T=b/s.e.*	*No. of Obs.*
Indonesia	1.01568	0.38831	2.62	45**
Korea	0.02488	0.32722	0.08	19
Malaysia	0.07737	0.43251	0.18	29
Philippines	1.35716	0.44377	3.06	19**
Thailand	0.44645	0.40082	1.11	29

** Significant at 5% level; * Significant at 10* level

Regression 3 **Binomial logit model for region of restructuring incl. risk measure**

Dependent variable:	RESTRUCT (=1 if bank has been restructured; =0 if no restructuring)			
Model size:	156 Observations (panel data)			
Model test:	Chi^2 with 10 degrees of freedom = 61.80; Prob value = 0.00000**			
Variable	*Coefficient*	*Standard Error*	*T=b/s.e.*	*P[|T| ³ $t_{0.05}$]*
R_y^{fg}	0.59642	0.22749	2.622	0.00875**
$ASSETS_{92}$	10.523	5.8226	1.807	0.07073*
STATE	1.1917	0.98071	1.215	0.22431
FAMILY	1.7047	0.87935	1.939	0.05255**
COMPANY	1.2494	0.76474	1.634	0.10230*
FOREIGN	-0.21142	0.87311	-0.242	0.80867
Indonesia	-1.4231	0.81501	-1.746	0.08079*
Korea	0.52276	0.55837	0.936	0.34916
Malaysia	-1.8046	0.82411	-2.190	0.02854**
Philippines	-3.5053	0.97421	-3.598	0.00032**
Thailand	0.94273	1.1707	0.805	0.42066

** Significant at 5% level; * Significant at 10* level

Regression 3 **Frequencies of actual & predicted outcomes**

	Predicted		
Actual	No restructuring	Restructuring	*Total*
No restructuring	52	20	*72*
Restructuring	18	66	*84*

Total	*70*	*86*	*156*

Regression 4 **Binomial logit model for region of restructuring incl. loan growth**

Dependent variable:	RESTRUCT (=1 if bank has been restructured; =0 if no restructuring)			
Model size:	156 Observations (panel data)			
Model test:	Chi^2 with 10 degrees of freedom = 52.68; Prob value = 0.00000**			
Variable	*Coefficient*	*Standard Error*	*T=b/s.e.*	*P[|T| ³ $t_{0.05}$]*
Loan growth	-0.24596	0.58535	-0.420	0.67434
$ASSETS_{92}$	8.2611	5.7902	1.427	0.15365
STATE	1.0364	0.93492	1.109	0.26764
FAMILY	2.0139	0.85657	2.351	0.01872**
COMPANY	1.4954	0.76351	1.959	0.05016*
FOREIGN	-0.20815	0.85488	-0.243	0.80763
Indonesia	-0.77037	0.79934	-0.964	0.33517
Korea	0.53513	0.57689	0.928	0.35361
Malaysia	-1.7038	0.85885	-1.984	0.04728**
Philippines	-2.5818	0.94310	-2.738	0.00619**
Thailand	1.2236	1.1716	1.044	0.29632

** Significant at 5% level; * Significant at 10* level