12-2004

Cost efficiency, Economies of Scale, Technological Progress and Productivity in Indonesian Banks

Heru Margono
Southern Illinois University Carbondale

Subhash C. Sharma
Southern Illinois University Carbondale

Cost efficiency, Economies of Scale, Technological progress and Productivity in Indonesian Banks

Heru Margono
Central Bureau of Statistics, Jakarta,
Department of Economics,
Southern Illinois University Carbondale
Carbondale, IL 62901-4515.

and

Subhash C. Sharma*
Department of Economics,
Southern Illinois University Carbondale,
Carbondale, IL 62901-4515.
Phone: 618-453-5070.
Fax: 618-453-2717.
E-mail: sharma@siu.edu

December 2004

---

*Corresponding Author

Cost efficiency, Economies of Scale, Technological progress and Productivity in Indonesian Banks

Abstract

This study estimates cost efficiency, scale economies, technological progress and productivity growth for Indonesian banks over the period 1993-2000. Overall the cost efficiency of all banks during this period was 69.82%. However, on average the efficiency of banks prior to the Asian crisis and after the Asian crisis were 79.67% and 53.40% respectively. Moreover, the results also indicate that private-owned banks and joint venture/foreign banks were more efficient than public-owned banks. Furthermore, as expected large banks tend to be more efficient as compared to smaller banks. Total factor productivity growth for Indonesian banks over the period 1993-2000 was -3.14%. However, before the Asian crisis, Indonesian banks productivity decreased by 1.48%, while after the crisis it decreased by 6.45%.

JEL Classification: G21.
Keywords: Cost Efficiency, Technological Progress, Total Factor Productivity, Banking.

Cost efficiency, Economies of Scale, Technological progress and Productivity in Indonesian Banks

1. Introduction

For the last two decades the efficiency of the financial sector has received an increased attention of researchers and policy makers around the world. A number of studies have measured/estimated bank efficiencies using different approaches. The stochastic frontier analysis (SFA) usually assumes that inefficiencies follow truncated distribution while random errors follow a symmetric normal distribution. The data envelopment analysis (DEA) assumes that there is no random fluctuation, hence all deviations are attributed to inefficiency. In spite of the increasing attention of researchers to efficiency analysis of financial institutions, the majority of the studies are confined to the banking sector in the U.S. However, for the last five years, many studies have also been conducted on efficiency of European and Asian banks. The empirical studies using stochastic frontier analysis approach for U.S. banks include Elyasiani and Mehdian (1990), Bauer, Berger and Humphrey (1993), Kaparkis, Miller and Noulas (1994), Mester (1996), Berger and Mester (1997), Berger and DeYoung (2001) and Akhigbe and McNulty (2003) among others. These studies have estimated technical efficiency. Elyasiani and Mehdian (1990) used data from 144 US banks in 1985 and observed that the average technical efficiencies were 88%, 90% and 87% for all banks, banks with assets less than US $ 300 million, and banks with assets more than US $ 300 millions respectively. Instead of just using one method, Bauer et al., (1993) compared technical efficiency estimates using two methods, stochastic frontier and thick frontier approaches. The results are comparable and show that the average technical efficiency for 687 banks from 1977 to 1988 was more than 80%. Furthermore, Kaparkis et al., (1994) used 5,548 US banks in 1986 with assets more than US $ 50 million and concluded that the average cost efficiency was 91.2%. They also observed that the cost efficiency was negatively correlated with bank size. Mester (1996) developed two efficiency models for national and district U.S. banks. The district model consists of twelve models according to Federal Reserve Districts. The results indicate that for the national model the technical efficiency is around 84% while for some district models, namely third and forth districts the technical efficiencies are different from the national level, that are 92.1% and 90.7%, respectively. More comprehensive results can be found in Berger and Mester (1997). They used a sample of 5,949 US banks over the period 1990–1995 to estimate cost and profit efficiencies. Their estimates of the mean cost and profit efficiencies are 86% and 50%, respectively. The profit efficiencies of the U.S. banks could be found in Akhavein, Berger and Humphrey (1997), Akhavein, Swamy, Taubman and Singamsetti (1997) and Humphrey and Pulley (1997). For small rural commercial banks, DeYoung and Hassan (1998) found that average profit efficiency for established banks was also approximately 50%. Recently, Berger and DeYoung (2001) studied the effects of geographical expansion on the U.S. bank efficiencies and noted that small banks would be less efficient when they operated nationally. For the U.S. banks, Akhigbe and McNulty (2003) concluded that during 1990 to 1996 small banks in terms of assets were more profitable than larger banks.

Lately, efficiencies of European banks have also been investigated. Lozano (1997) examined 54 Spanish Savings banks during 1986-1991 and noted that the profit efficiency increased from 68% in 1986 to 81% in 1991. Later, Lozano (1998) estimated the cost efficiency rather than the profit efficiency of Commercial and Savings banks by using the data for the same period and using the same approach as in Lozano (1997). Her results suggest that the average cost efficiency of Commercial and Savings banks were 86.5% and 88.6% respectively. Resti (1997) examined panel of 270 Italian banks (1988-1992) to estimate technical efficiency by using both DEA and SFA approaches and observed that the average technical efficiency were close to 69% and 74% respectively. Further, by using the DEA approach, Resti (1998) studied bank mergers on 67 Italian banks and concluded that merged banks increased their technical efficiencies. Technical efficiencies of Portuguese banks show a different picture. Mendes and Rebelo (1999) used stochastic frontier approach and observed that the average efficiency of the Portuguese banks is very high, that is 94.3%. In addition, the author also noted that there is no relationship between the cost efficiency and the size of the bank. Using fourier-flexible stochastic cost frontier, Carbo, Gardener and Williams (2002) estimated cost efficiencies for European banks from 1989 to 1996 and found that the cost efficiency was around 88%. Kasman (2002) used the same function to estimate cost efficiency of 47 Turkish banks. He concluded that average cost efficiency from 1988 to 1998 was 74.6%. More recently, Girardone, Molyneux and Williams (2004) tried to estimate the efficiency of Italian banks. Using the same function as Carbo et al., (2002) they concluded that that Italian savings banks were between 85% and 87% efficient. Maudos et al. (2002) made an effort to compare cost and profit efficiencies of banks from ten countries in Europe for the period 1993-1996. The countries include Austria, Belgium, Finland, France, Germany, Italy, Luxembourg, Portugal, Spain and the UK. They used SFA and DEA approaches. It turns out that cost efficiency is higher than profit efficiency. However, variation in terms of profit efficiency is greater than in terms of cost efficiency.

Studies of Asian bank's efficiencies are relatively few compared to the U.S. and the European banks. Bhattacharyya, Lovell and Sahay (1997) used DEA approach to study the efficiency of 70 Indian banks during 1986 to 1991. They noted, on average the Indian banks were 80.35% efficient. Moreover, using SFA approach, they also found that publicly-owned banks tend to be more efficient than privately-owned banks. Altunbas, Liu, Molyneux and Seth (2000) in their study on Japanese banks (139 banks in 1933 to 1995 and 136 banks in 1996) noted that the average cost efficiencies were between 93.20% and 95.00%. Further, Hao, Hunter and Yung (2001) considered a sample of 19 private Korean banks over the period 1985 to 1995 and estimated technical efficiencies. Their mean technical efficiency was 88.97%, with the lowest and highest efficiencies being 85.95% (in 1987) and 92.37% (in 1990), respectively. They also noted that the efficiencies were correlated with the foreign equity ownership in banks. Hardy and Patti (2001) examined the cost and profit efficiency of 33 Pakistani banks over the period 1981-1988 and concluded that the average profit and cost efficiencies for public banks were always less than those of private banks. For Singaporean commercial banks, Rezvanian and Mehdian (2002) studied efficiency of 70 commercial banks during 1991-1996 using non-parametric method and noted that average efficiency was 57%. Drake and Hall (2003) considered 149 Japanese banks and used the DEA method to conclude that average technical efficiency was 72.36% in 1997. They also classified the sample into 6 groups according the size of their total lending and found that large banks seemed to be more efficient. Ketkar, Noulas and Agarwal (2003) investigated 39 Indian banks using DEA method over the 1990-1995 period and found that overall average efficiency was 64%. Shanmugam and Das (2004) used SFA to estimate efficiency in Indian banks over the 1992 to 1999 period and found that efficiency ranged from 30.06% to 75.64%. They also noted that private domestic banks were less efficient than state banks. More recently, Ataullah, Cokcerill and Le (2004) compared the effect of liberalization on the technical efficiency of banks in India and Pakistan using DEA approach and concluded that after the period of liberalization, bank efficiencies improved significantly for both countries.

To the best of our knowledge, there is no efficiency study on Indonesian banks. Thus, in this study, we plan to estimate the cost efficiency of Indonesian banks by using the stochastic frontier approach. In addition to that, economies of scale, technological progress as well as productivity will also be estimated. The panel data of 134 Indonesian banks is used in this study. As it is well known, the Asian crisis in the middle of 1997 effected economies of Asian countries including Indonesia. In this context, we analyze several hypotheses, e.g., whether the Asian crisis effected the Indonesian banks. Have banks become more efficient after recovering from the Asian crisis? How bank technological progress is related to the size of the bank and the ownership. As part of these hypotheses, economies of scale and technological progress before and after the crisis for each type of ownership will also be examined.

The rest of the study is organized as follows. Section 2 briefly discusses banking system in Indonesia. Section 3 presents methodology followed by Section 4 which discusses the data and empirical results. The conclusion is summarized in Section 5.

2. Indonesian Banking System

Like many developing countries, the Indonesian financial sector is dominated by commercial banks rather than by bond and equity markets. The history of Indonesian banking industry started when several Dutch banks were nationalized after Indonesia proclaimed its independence in 1950s. During that period government also allowed entities to establish private commercial banks and limited number of foreign banks. From 1950s to 1970s, banks, especially state banks, were benefited from economic policies introduced by government to boost Indonesian economy. One aspect of these policies was that the state-owned enterprises were required to deposit all their funds in state banks. The government also subsidized state bank deposit rates. However, the enjoyment of having remarkable economic growth resulting from the oil boom was disrupted when the oil prices fell in 1980s. As a result, government introduced again several economic reform policies for the financial sector to strengthen the economy. The financial system was deregulated in 1983. Credit ceilings were removed and state banks were allowed to offer market-determined interest rates on deposits. The major deregulation of Indonesian banking was introduced in October 1988. With this new regulation, it was possible to open joint venture banks which were prohibited in 1969, with a minimum capital requirement of US $ 28 million and maximum foreign ownership of 85%. Reserve requirement to open private banks was reduced. It was possible to open private banks with reserve requirement only 2% of all liabilities as compared to 15% of demand deposits and 10% of saving and time deposits in the previous years. State owned enterprises were allowed to put their funds in private banks (Pangestu and Habir, 2002). Since then, Indonesian banking industry consists of state commercial banks, local government-owned banks, private national banks, joint venture banks and branches of foreign banks. Besides these, there are thousands of small rural credit banks which serve local people in villages. However, the contribution of these banks to the entire banking industry is very low. Moreover, the ease of opening new banks has created problems. A large number of conglomerates established their own banks. As discussed before, the number of banks increased very dramatically and intensified competition among banks which led to an increase in interest rates. The number of commercial banks jumped from 112 in 1989 to nearly 240 in 1994. In 2000, assets of state owned commercial banks together with private national banks accounted for 74% of the total assets. Although bank regulations has improved substantially, the lack of government monitoring with regard to supervising bank activities had created problems. Most banks increased credit especially to risky sectors such as real estate. Loans to real estate sector grew at an annual rate of 37% during 1992-1995, compared with 22% for total bank credit (Montgomery, 1997). In 1996, the asset growth of the construction sector was 180 times higher than that of the previous year. However, in terms of sales, property sector was not successful. Pangestu and Habir (2002) noted that the property sector experienced overinvestment and excess capacity. Huge amounts of property loan could not be repaid and were subject to default. As a result, real estate sector left banks with somewhat between 8 trillion and 16 trillion rupiah worth of nonperforming loans.

High levels of economic growth before 1997 masked a number of structural weaknesses in Indonesia's economy which made it vulnerable to internal or external shocks. The Asian crisis started when Thailand devaluated baht, the local currency, in July 1997. At first, the economic crisis was limited to Thailand's financial sector, but quickly spread out to the neighboring countries including Indonesia. To strengthen the economy, Indonesian government widened the exchange rate band from 8% which led to devaluate the currency by 7%. However, the Indonesian fundamental economy was not strong. A contagious process developed by a currency shock spread to become banking crisis, and soon after, economic crisis. At the end of 1997, combined with high interest rates and a loss of currency value by more than 80%, banking sector was in deep trouble. As a consequence, some banks became insolvent and 16 banks were closed in that year. This triggered panic and the public confidence in banking sector went down. People rushed to banks to withdraw their deposits. In order to restructure banking sector in Indonesia, the government set up Indonesian Bank Restructuring Agency (IBRA) in January 1998. The main task of this agency was to monitor and supervise banks. In the beginning of 1998, 54 banks (accounting more than one-third of the total number of banks) were placed under IBRA supervision. These banks had borrowed more than 200% of their capital from the central bank. By the end of 1999, 66 out of 239 banks were closed (Suta and Musa, 2003).

3. Methodology

Duality theory for production and cost structures allows one to specify technology of production in terms of equivalent cost function. The concept of cost minimization is implemented by minimum cost incurred in producing output with exogenous input prices and output quantities. Under this assumption inputs are determined endogenously but it is not the case for outputs. In other words, in an attempt to minimize cost of producing outputs managements have to decide the level of various inputs under a given level of outputs.

Unlike other industries, in terms of output, the role of banks can be viewed from two different approaches, i.e., as a producer and as an intermediary. The former treats bank as a firm that produces services to consumers such as account holders, while the latter says that bank can be thought of as an agent who provides intermediation between savers and investors. The difference between the two approaches is in the definition of inputs and outputs. Producers approach considers inputs to be only labor and physical capital like other industry since only physical inputs are needed to conduct transactions. In the intermediary approach, beside labor and physical capital, deposits and other borrowed funds are also treated as inputs to produce earning assets. In this paper, intermediation approach will be followed. Moreover, Elyasiani and Mehdian (1990) give some advantages of the intermediation approach over the producer approach. They argue that it is more inclusive of the total banking cost as it does not exclude interest expenses on deposits and other liabilities, and also it appropriately categorizes deposits as inputs.

The choice of functional form in estimating bank efficiency becomes crucial when one uses very heterogeneous data. Many studies in bank efficiency use translog function to represent technology of production. However, Mithell and Onvural (1996), Berger, Leusner, and Mingo (1997) and Altunbas, Evans, and Molyneux (2001), Vennet (2002), Carbo, Gardener and Williams (2002) noted that augmented translog function, or fourier flexible (FF) form offers better approximation of the bank's unknown functional form. In summary, they concluded that adding trigonometrical terms to translog function to form flexible function is very effective to tackle down the problem of unknown multivariate function without misspecification.

Thus, here we use a flexible fourier form to represent cost function for cost efficiencies and economies of scale. Moreover, a cost function is estimated over a profit function because in Indonesia, in the period following the Asian crisis 24 banks recorded loss, or negative profits. Thus, due to the nature of the profit's data, we could not estimate a profit function (since natural logarithm of both the dependent and independent variables are needed).

Flexible fourier form of cost function for two output quantities and two input prices used in this study can be written as follows (Gallant, 1981):

$$
\begin{aligned}
\ln TC = {} & a_0 + \sum_{j=1}^{2} a_{y_j} \ln y_j + \sum_{k=1}^{3} a_{p_k} \ln p_k + a_t t \\
& + \frac{1}{2}\left\{ \sum_{j=1}^{2}\sum_{l=1}^{2} a_{y_{jl}} \ln y_j \ln y_l + \sum_{k=1}^{3}\sum_{m=1}^{3} a_{p_{km}} \ln p_k \ln p_m + a_{tt} t^2 \right\} \\
& + \sum_{j=1}^{2}\sum_{k=1}^{3} a_{y_j p_k} \ln y_j \ln p_k + \sum_{j=1}^{2} a_{t y_j} t \ln y_j + \sum_{k=1}^{3} a_{t p_k} t \ln p_k \\
& + \sum_{j=1}^{2} \left\{ b_j \cos z_j + d_j \sin z_j \right\} \qquad (1) \\
& + \sum_{j=1}^{2}\sum_{l=1}^{2} \left\{ b_{jl} \cos(z_j + z_l) + d_{jl} \sin(z_j + z_l) \right\} \\
& + \sum_{j=1}^{2}\sum_{l \geq j}^{2}\sum_{\substack{m \geq l \\ m \neq j}}^{2} \left\{ b_{jlm} \cos(z_j + z_l + z_m) + d_{jlm} \sin(z_j + z_l + z_m) \right\} + e
\end{aligned}
$$

where ln TC is the natural logarithm of total cost, ln y_j is the natural logarithm of jth output, $j = l = 1,2$, ln p_k is the natural logarithm of kth input prices, $k = m = 1,2,3$, and $t = 1,2,3, \ldots T$. z_j are adjusted value output y_j such that their interval are between 0 and $2p$. However, to avoid end points estimation problems around those two limits, Gallant

(1981) suggested to restrict the span of z_j in the interval of $[0.1\times 2p, 0.9\times 2p]$. z_j are calculated by $z_j = 0.2 - q_j a + q_j \ln y_j$ where $q_j \equiv 0.9\times 2p - 0.1\times 2p\ /(a_j - b_j)$, a_j and b_j are the maximum and minimum values of ln y_j respectively. Linear restrictions on equation (1) are imposed to satisfy linear homogeneity in input prices:

$$\sum_{k=1}^{3} a_{p_k} = 1, \quad \sum_{k=1}^{3} a_{p_{km}} = 0 \text{ for all } m \text{ and } \quad \sum_{j=1}^{3} a_{y_j p_k} = 0 \text{ for all } k.$$

These restrictions are carried out by normalizing total cost, and two input prices by the other arbitrary one input price. In addition to the restrictions above, standard symmetry of the function is also imposed, i.e., $a_{y_{jl}} = a_{y_{lj}}$ for all j, l and $a_{p_{km}} = a_{p_{mk}}$ for all k, m.

The error term, e_{it}, in (1) is decomposed into two parts, v_{it} and u_{it}, i.e., $e_{it} = u_{it} + v_{it}$. Following Aigner, Lovell, and Schmidt (1977), it is assumed that v_{it} and u_{it} are independently distributed, v_{it} is distributed as two-sided normal distribution with zero mean and variance, s_v^2, while u_{it} is usually assumed to follow one-sided distribution. It can be either, truncated normal, or exponential or any other distributions. In order to be comparable with other studies, in this paper, u_{it} is assumed to be distributed as truncated-normal with mode = m and variance = s_u^2. Maximum likelihood method is used to obtain estimates of the parameters in equation (1).

Battese and Coelli (1992) extended time invariant efficiency estimate to time variant to allow efficiency changes over time. The basic idea of using time varying cost efficiency is the same as in technical efficiency in production function. However, one should note that in production function the error terms are decomposed as $e_{it} = v_{it} - u_{it}$ while in cost function they are decomposed as $e_{it} = v_{it} + u_{it}$. One of the formulations of time varying of u_{it} proposed by Battese and Coelli (1992) is $u_{it} = h_t u_i$ where $h_t = \exp\{-d(t-T)\}$ [1]. The behavior of cost efficiency over time can be summarized from the parameter estimate d. If $d > 0$, cost efficiency rises at a decreasing rate, if $d < 0$ cost efficiency declines at an increasing rate, and if $d = 0$ cost efficiency remains the same. Cost efficiency estimates under the time varying assumption can be obtained by the minimum mean-square-error predictor (Kumbhakar and Lovell, 2000:p.170):

$$
\begin{aligned}
CE_{it} &= E[\exp(-u_{it}) \mid e_i] \\
&= \left[\frac{1-\Phi(h_t s_* - (m_{*i}/s_*))}{1-\Phi(-(m_{*i}/s_*))}\right]\exp\{-h_t m_{*i} + 0.5 h_t^2 s_*^2\}
\end{aligned}
\qquad (3)
$$

where $m_{*i} = -\dfrac{m s_v^2 - h' e_i s_u^2}{s_v^2 + h'h\, s_u^2}$, $\quad s_*^2 = \dfrac{s_u^2 s_v^2}{s_v^2 + h'h\, s_u^2}$, $\quad h' = (h_1\ h_2\ h_3\ h_4 \cdots h_T)$, and

$\Phi(\bullet)$ is standard normal cumulative distribution function.

The economies of scale in a bank can be used to gain information how banks manage their average costs related to proportional change in their outputs. Overall scale economy (SE) can be estimated by summing up the partial derivation of total cost with respect to each output quantities, i.e,

---

[1] Some studies use different specifications of time varying model. Cornwell, Schmidt and Sickles (1990) propose $h_{it} = g_1 + g_2 t + g_3 t^2$ and Kumbhakar(1990) defines $h_{it} = [1+\exp(g_1 t + g_2 t^2)]$.

$$
\begin{aligned}
SE &= \sum_{j=1}^{2} \frac{\partial \ln TC}{\partial \ln y_j} \\
&= \sum_{j=1}^{2} a_{y_j} + \sum_{j=1}^{2}\sum_{l=1}^{2} a_{y_{jl}} \ln y_j + \sum_{j=1}^{2}\sum_{k=1}^{3} a_{y_j p_k} \ln p_k + \sum_{j=1}^{2} a_{t\, y_j} t \\
&\quad + \sum_{j=1}^{2} q_j \left\{ -b_j \sin z_j + d_j \cos z_j \right\} \\
&\quad + \sum_{j=1}^{2}\sum_{l=1}^{2} q_j \left\{ -b_{jl} \sin(z_j + z_l) + d_{jl} \cos(z_j + z_l) \right\} \\
&\quad + \sum_{j=1}^{2}\sum_{l \geq j}^{2}\sum_{\substack{m \geq l \\ m \neq j}}^{2} q_j \left\{ -b_{jlm} \sin(z_j + z_l + z_m) + d_{jlm} \cos(z_j + z_l + z_m) \right\}
\end{aligned}
\tag{4}
$$

Note that if *SE* is less than 1, a bank exhibits increasing returns to scale, implying economy of scale, if *SE* equal to 1, a bank exhibits constant returns to scale, whereas if *SE* greater than 1, a bank exhibits decreasing returns to scale, implying diseconomies of scale. Thus, economies of scale exist if an equal proportionate increase in all outputs leads to a less than equal proportionate increase in average cost.

From the cost function in (1), one can also estimate technological progress. The rate of technical progress is provided by

$$
\begin{aligned}
TP &= \frac{\partial \ln TC}{\partial t} \\
&= a_t + t a_{tt} + \sum_{j=1}^{2} a_{t\, y_j} \ln y_j + \sum_{k=1}^{3} a_{t\, p_k} \ln p_k
\end{aligned}
\tag{5}
$$

Following Baltagi and Griffin (1988), the technological progress (*TP*) exist when *TP* is negative and a positive *TP* implies a technological recess. Further, the technological progress is contributed by three major components, i.e., pure technological progress,

$a_t + ta_{tt}$, scale-augmenting technological change which represents the change due to modification on scale of production, $\sum_{j=1}^{2} a_{ty_j} \ln y_j$, and non neutral technological change, $\sum_{k=1}^{3} a_{tp_k} \ln p_k$.

Bank productivity can be assessed through total factor productivity growth, $\dot{TFP}$. Here, we follow Esho and Sharpe (1995) who extended the idea of Fecher and Pestieau (1993) to formulate the decomposition of total factor productivity growth ($\dot{TFP}$) from the cost side:

$$\dot{TFP} = -TP + (1 - SE)\dot{y} - \dot{CE} \tag{6}$$

where *TP* is technological progress defined in (5), $\dot{y}$ is weighted output growth defined as

$$\dot{y}_{it} = \sum_{j=1}^{2} \left(\frac{SE_j}{\sum_{j=1}^{2} SE_j} (\ln y_{ijt} - \ln y_{ijt-1)} \right) \tag{7}$$

SE_j is scale economy evaluated at mean values and $\dot{CE}$ is cost efficiency changes derived from equation (3). The decomposition of the TFP growth as shown in equation (6) suggests that TFP growth is contributed by the movement along cost function, the growth rate of production and the cost efficiency changes. Thus, by decomposing the TFP growth this way one can assess the sources of productivity.

4. Data and Empirical Results.

4.1. Data

Due to unavailability of all the data for every bank, the data for 134 banks is collected from 1993-2000. The data is obtained from Bank Indonesia. Besides total cost (*TC*), two outputs are considered, i.e., y_1 the value of total aggregate loans and y_2 the value of total aggregate securities. Three input prices are employed, i.e., p_1 the price of labor which is defined as total labor expense divided by total employee, p_2 the price of funds which is total interest expenses divided by total funds, and p_3 the price of capital is equal to the total depreciation and other capital expenses divided by total fixed assets. The composition of 134 banks is as follows: 28 state and local government banks, 28 joint venture/foreign banks and 78 private national banks.

4.2. Empirical Results

As discussed earlier, the performance of Indonesian banks was affected by the Asian crisis. The year 1997 was relatively poor one for Indonesian bank's performance. The high depreciation of Indonesian currency combined with a closer of several banks in 1997 triggered a loss of confidence in banking industry. Since the structural break is quite substantial in the financial sector in Indonesia in 1997, so it is more appropriate to fit separate frontiers before (1993-1997) and after (1998-2000) the Asian crisis[2]. Modified translog cost frontier in equation (1) is estimated using FRONTIER 4.1 software (Coelli,

[2] In addition, from the methodological point of view, using the entire time period, i.e., from 1993 too 2000 will not be able to capture the downturn of bank in 1997. As described earlier estimating time varying cost efficiency deals with parameter h_t as a function of time (*t*). Thus, the time varying cost efficiency either increases with *t* or decreases with *t*.

1996)[3]. Parameter estimates together with their standard errors of the cost frontiers for both periods are presented in Table 1.

Table 1 is here

To save space, analysis of Indonesian banks presented here is based on average cost efficiencies, scale economies, technological progress and TFP growth[4]. The yearly average cost efficiencies, scale economies, technical progress and TFP growth for both time periods are reported in Table 2. The results suggest that average cost efficiency for the period prior to the Asian crisis, i.e., 1993-1997 was 79.68%, However, after the Asian

Table 2 is here

crisis, i.e., 1998-2000, the average cost efficiency for Indonesian banks declined to 53.40%. In other words, Indonesian banks could have annually saved about 20.32% before the Asian crisis and 46.60% after the Asian crisis if they were able to be on the frontier. The average cost efficiency over the period 1993-1997 is somewhat similar to the average cost efficiency in Turkish banks obtained by Kasman (2002). For the same period, he concluded that the average cost efficiency in Turkish banks was 75.68%. It is worth mentioning that cost efficiency increased by 8.78% from 1993 to 1994, but only increased by 4.01% from 1996 to 1997. After the Asian crisis, although average cost efficiency was lower as compared to before Asian crisis, the yearly cost efficiencies still increased. However, the rate of increase after the Asian crisis was smaller as compared to

[3] The authors would like to thank to Tim Coelli for providing Frontier 4.1
[4] The detailed results for each firm are available from the authors

the period prior to the Asian crisis. Note that from 1998 to 2000, cost efficiency only increased by 1.26% per annum as compared to 6.33% from 1993 to 1997. It interesting to note that every year from 1993 to 1997, the level of cost efficiency was much higher than after 1997. Thus, it may be inferred that competitive environment due to several deregulations introduced by the government in the beginning on 1990s led to a better performance in terms of cost efficiency.

As for the scale economies, we note that in general from 1993 to 2000 banks in Indonesia showed evidence of economies of scale as indicated by the economies of scale factor, SE, less than one. Scale economy can be interpreted as the percentage change in bank's average cost associated with a percentage change in bank's output. The results suggest that scale economies of Indonesian banks varied from 0.69517 to 0.86883 before the Asian crisis and from 0.87676 to 0.92517 after the Asian crisis. The average scale economy factor before the Asian crisis was 0.83535 and after the Asian crisis it was 0.90574. Thus, it can be inferred that prior to the Asian crisis a 1.0% increase in output would raise predicted average cost by 0.84% while after the crisis the predicted cost increased by 0.91%. The magnitudes of the scale economy factor for Indonesian banks are higher than the scale economy factor for the Turkish banks, which was around 0.743 for the period 1988-1998 (Kasman, 2002). However, Indonesian banks' scale economies seem to be lower than those of European saving banks over the period 1989-1996 which were between 0.90 and 0.93 (Carbo et al., 2002).

The technological progress (*TP*), a movement towards the frontier can be thought as the bank's technological contribution to the average banking cost. The results regarding technological progress show that before the Asian crisis, on average the

Indonesian banks recorded positive technological progress whereas after the Asian crisis they recorded negative technological progress. Thus, it can be concluded that prior to the crisis banks reduced the average cost due to the technology they used. In this period, on average, the technological progress lowered the average cost by 2.98%. However, after the Asian crisis, Indonesian banks experienced technological recess, i.e., during this period Indonesian banks could not benefit from the technological progress. The results indicate that after 1997, the average cost increased by 6.40% due to the technological recess. The yearly *TP* estimates suggest that the contribution of the technological progress in reducing average cost reached its maximum in 1997, i.e., 12.54%. On the contrary, in 2000 the technological progress increased the average cost by 7.96%; maximum during this period.

In general, the estimates of the technological progress are somewhat different with Portuguese banks which recorded technological progress 6.00% over the period 1990-1995 (Mendes and Rebelo, 1999). However, the results are similar to Turkey's banks. Kasman (2002) reported that technological progress of Turkish banks during 1993-1998 varied between 1.6% and 5.6%. The fact that Indonesian banks' technological progress reduced the average cost before the Asian crisis and increased the average cost after the Asian crisis perhaps is due to the adoption to new technology such as computerization and adding more Automatic teller Machine (ATM). Before the Asian crisis such investment to compete with other banks could reduced the average cost. However, after 1997 the more advanced technology investment combined with the financial difficulties due to the Asian crisis could not lower the average cost, but increased the average cost.

As far as the total factor productivity (*TFP*) growth is concerned, the results show that the TFP growth in Indonesian banks before the Asian crisis, on average, was -1.48%. However, it seems that the total factor productivity growth after the Asian crisis worsened and reached -6.45% annually. It is interesting to note that during the first two years of the period prior to the Asian crisis banks experienced negative TFP growth, but recorded positive technological progresses. As discussed earlier, positive technological progress implies that banks increased the average cost due to adopting technology. Thus, it can be inferred that the declines in the TFP growths in 1994 and 1995 could be due to technological recess in those years. On the other hand, for the period 1996 and 1997, Indonesian banks experienced technological progress. Hence, the banks enjoyed the cost reduction due to the technology which leaded to the positive productivity performance. After the Asian crisis, however, Indonesian banks suffered technological recess. As a result, total factor productivity growth of the Indonesian banks decreased.

The cost efficiency estimates and scale economies by ownership are reported in Table 3. For each year the average efficiencies of joint venture/foreign banks are greater

Table 3 is here

than those of public and private banks. Moreover, the average efficiencies of public banks are smaller than those of private and joint venture/foreign banks. Thus, we notice that the public banks are inefficient as compared to the private and joint venture/foreign banks. This result is consistent with the study of Altunbas et al. (2001) for German banks. Moreover, on average, public banks were 76.5% efficient and private banks were 79.1% efficient, while joint venture/foreign banks were 84.2% efficient in terms of cost before the Asian crisis hit Indonesia. However, after the Asian crisis hit Indonesia, public and private banks were only 48.8% and 50.6% efficient, while joint venture/foreign banks were 65.3% efficient. It is worth noting that the cost efficiencies dropped across all ownerships after the Asian crisis. The cost efficiency gaps between public and private banks narrowed from 2.6% before the crisis to 1.8% after the Asian crisis. However, cost efficiency gaps between private and joint venture/foreign banks widened, i.e., from 5.1% to 14.7%.

In the case of scale economy, the results reveal that there is an existence of economy of scale in private and public banks, whereas for joint venture/foreign banks, the economy of scale only existed in 1993 and 1994. It is also noticeable that overall scale economies for public and private banks before the Asian crisis were 0.78516 and 0.77186 respectively, while for joint venture/foreign bank the scale economy did not exist. Thus, it can be inferred that a 1.0% increase in output would increase the average cost by 0.79% and 0.77% for public and private banks, respectively. After the Asian crisis, however, the scale economies for the public and private banks were 0.91490 and 0.84577 respectively. Hence, during this period, a 1.0% increase in outputs would raise predicted average cost by 0.91% for public banks and by 0.85% for private banks. Furthermore, for both periods, i.e., before and after the Asian crisis, joint venture/foreign banks, on average, exhibit diseconomies of scale. Perhaps this is due to the fact that joint venture/foreign banks tend to be more prudent in operating business as compared to domestic banks which lead to higher cost. For example, in lending funds to borrowers foreign banks check security document and for the other legal compliance issues are done by lawyers, whereas for local banks often do it is done by their own employees.

Technological progress and TFP growth by ownership are reported in the lower panel of Table 3. The estimates of technological progress among the three types of ownership suggest that prior to the Asian crisis, regardless of the type of the ownership the banks benefited from the technology to reduce the average cost, since banks in this period recorded negative technological progress. The impact of the technological progress in reducing average bank cost for three types of ownership are almost the same, i.e., 3.0% for public banks, 3.1% for private banks and 2.7% for joint venture/foreign banks. However after the Asian crisis, banks could not take advantage of the technological progress. Due to the technological recess, during this period, public, private, and joint venture/foreign banks on average increased the average cost by 5.7%, 5.5% and 9.3% respectively.

The results of the total factor productivity growth indicate that over the period 1994-1997, on average, public banks and joint venture/foreign banks recorded negative TFP growth, i.e., -0.4% and -10.7% respectively, while private banks recorded positive growth, i.e., 1.6%. Furthermore, after the Asian crisis public, private and joint venture/foreign banks decreased the total factor productivity namely by more than 4%. It is interesting to note that the TFP growths for joint venture/foreign banks in both periods (before and after the crisis) are always less than those of their two counterparts. Knowing that technological progress existed in public, private and joint venture/foreign banks prior to the Asian crisis, it is surprising that public banks and joint venture banks still could not improve their total factor productivity. For public banks, this could be due the act that these banks were least efficient as compared to private and joint venture/foreign banks, whereas for joint venture/foreign banks this could be due to the fact that these banks were operating under diseconomies of scale.

The cost efficiencies, economies of scale, technological progress and total factor productivity growths by size are reported in Table 4. In this case the banks are divided into 5 categories based on yearly total assets. The general finding is that small banks (with assets less than 250 billion rupiah) had the lowest efficiency throughout the years of

Table 4 is here

investigation. Perhaps this is due to the fact that small banks usually are local-government-owned (provincial) banks. However, it appears that the largest banks are not necessarily the most efficient banks. On average, before the Asian crisis hit Indonesia, the most efficient banks were with assets between 500 and 749.9 billion rupiah (85.1%) and followed by those who had assets between 750 and 999.9 billion rupiah (82.3%). After the Asian crisis, on average, banks with assets between 500 and 749.9 billion rupiah were the most efficient ones (59.0%) followed by banks with assets more than 999.9 billion rupiah (57.26%). Thus, the results suggest that there is no relationship between cost efficiency and the bank size. This finding is similar to Turkish banks (Kasman, 2000), German public savings and mutual cooperative banks (Altunbas et al., 2001), European savings banks (Carbo et al., 2002) and Italian banks (Giradone et al., 2004). It is also noticeable that banks with assets between 250 and 499.9 billion rupiahs suffered the most from the Asian crisis.

It is worth noting that the magnitude of the scale economy factor increased systematically with size for all years. In other word as the banks increased in their size, they followed diseconomies of scale, i.e., the small banks with assets less than 500 billion rupiah exhibited economies of scale and larger banks with assets more than 500 billion were operating under diseconomies of scale. Thus, for small banks, indeed the cost of producing one unit of output decreased as the output increased. In general, the findings that the Indonesian large banks exhibit diseconomies of scale are consistent with the earlier studies on the U.S. banks (Bauer, 1997) and Portuguese banks (Mendes and Rebelo, 1999). Diseconomies of scale in large banks in Indonesia could suggest that it might be more costly to manage large banks. On average, prior to the Asian crisis, scale economy factor for banks with less than 250 billion was 0.55607 and for banks with assets between 250 and 499.9 billion rupiah this factor was 0.87124. Thus for these two classes, a 1.0% increase in output increase their average cost by 0.56% and 0.87%, respectively. Furthermore, after the Asian crisis, the average economies of scale factors for banks in those two classes were 0.58979 and 0.85582, respectively. In other words, a 1.0% increase in output increase their average cost by 0.59% and 0.86%, respectively.

The technological progress (*TP*) according to asset size reveal that prior to the Asian crisis, TP existed for all size banks. The magnitudes of the average technological progresses are similar among five classes. They varied between -0.02211 to -0.03447. It also seems that the degree of the technological progress is related to the size of the banks. Banks in smallest class, i.e., with assets less than 250 billion rupiah reduced the average cost as a result of technological progress by 2.21%, whereas the largest banks (with assets more than 999.9 billion rupiah) reduced the average cost by 3.45%. On the contrary, the results provide evidence that the Indonesian banks in all classes suffered technological recess after the Asian crisis. Interestingly, like in the period before the Asian crisis, the technological recess is also associated with the size of the banks. In the aftermath of the Asian crisis, the smaller banks exhibited less technological recess in terms of magnitude as compared to the larger banks. This implies that banks with assets less than 250 billion rupiah increased the average cost by 3.12% while banks with assets in excess of 999.9 billion rupiah increased the average cost by 9.46%.

The results of the TFP growth reveal that most Indonesian banks in all sizes recorded negative TFP growths for both periods, i.e., before and after the Asian crisis. However, the average TFP growth for the smallest banks, with assets less than 250 billion rupiah increased the TFP growth by 5.02% before the Asian crisis. However, the TFP growth for four larger groups decreased. Indonesian banks in the largest group, with assets over 999.9 billion rupiah recorded the worst decrease in TFP growth, i.e., 12.22%. For the period after the Asian crisis, the average TFP growths for five classes exhibit the same trend. The TFP growth for banks in the smallest class, i.e., with assets less than 250 billion rupiah slightly (0.086%) whereas the TFP growth for banks in the largest class recorded the worst decline (-10.49%). Nevertheless, compared to the other four classes, it is also noticeable that Indonesian banks with assets in excess of 999.9 billion rupiah are the only ones whose TFP growth improved after the crisis. On average the TFP growth for banks in this class improved by 1.7% (from -12.2% before the Asian crisis to -10.5% after the Asian crisis). The results of the average TFP growth of Indonesian banks also reveal that banks with assets over 500 billion rupiah declined more than that of banks with assets less than 500 billion rupiah, especially for the period after the Asian crisis. Perhaps this is due to the fact that Indonesian banks with assets more than 500 billion rupiah after the Asian crisis experienced big technological recess. In addition to that the banks in this class, as described earlier, were also operating under diseconomies of scale. Technological recess implies that adopting technology raised the bank average cost, while diseconomies of scale mean less output is produced using more cost. The combination of these two facts is reflected in the decline of the total factor productivity growth.

5. Summary and Conclusion

The main goal of this study is to estimate the cost efficiency, economies of scale, technological progress and total factor productivity growth in Indonesian banks. Average cost efficiencies for all banks in each year increased over time from 1993 to 1997. Over all, the average of cost efficiency over the period 1993-1997 is 79.7% with a minimum of 65.4% and a maximum of 90.7%. However, after the Asian crisis hit Indonesia, the average cost efficiency of Indonesian banks decreased to 53.4%. The average efficiencies for Indonesian banks before the Asian crisis are in the same ballpark as for other countries, e.g., the efficiency of the Korean banks (between 1985 and 1995) was 89.0% (Hao et al., 2001), for European banks it was between 66.9% and 88.9% (Vennet, 2001), for Turkish banks (between 1988 and 1998) it was 74.3% (Kasman, 2002), and for the European savings banks (between 1989 and 1996) it was in the range of 81.1% and 87.0% (Carbo et al., 2004). Cost efficiencies by ownerships indicate that the private banks are always more cost efficient as compared to the public banks before and after the Asian crisis. However, the joint venture/foreign banks seem to have the best cost efficiency among the three kinds of ownerships. This is in line with German banks (Altunbas et al., 2001). We also noted that the Indonesian bank efficiencies are independent of the bank size. This is consistent with other studies, i.e., Turkish banks (Kasman, 2000), German public savings and mutual cooperative banks (Altunbas et al, 2001), European saving banks (Carbo et al., 2002) and Italian banks (Giradone et al., 2004).

The economies of scale are also examined and the findings indicate that before the Asian crisis, the economy of scale, on average, was 0.83535 and after the Asian crisis the economy of scale was 0.90574. These results are lower than those of Turkish banks (between 1988 and 1998) where the economy of scale was 0.743 (Kasman, 2002). Other interesting finding is that there is an existence of scale economies in public and private banks, but joint venture/foreign banks experienced diseconomy of scale. In Indonesia, it appears that there are existence of economies of scale for small banks with asset less than 500 billion rupiah for the period 1993-1997 and 1998-2000. This result is similar to the U.S. banks (Berger, 1997) and Portuguese banks (Mendes and Rebelo, 1999) where large bank experienced diseconomies of scale.

As far as technological progress is concerned, we conclude that, on average, Indonesian banks before the Asian crisis benefited from technological progress, i.e., *TP* reduced the average cost by 2.98%. However, after the Asian crisis the technological progress increased the average cost by 6.40%. The estimates of the technological progress by ownerships show that irrespective of the periods, *TP* seems to have a similar impact on the public, private and joint venture/foreign banks. Prior to the Asian crisis, technological progress reduced the average bank cost by around 3% for all three types of ownerships. However, after the Asian crisis the technological progress increased the average cost by almost 6% for both public and private banks and by around 9% for joint venture/foreign banks. Moreover, the technological progress by bank asset sizes indicate that for all banks regardless of the assets there was existence of technological progress before the Asian crisis meaning that technological progress reduced the average cost. On the contrary, after the Asian crisis, the results show Indonesian banks experienced technological recess which means that technological progress increased the average bank cost.

The average TFP growths suggest that before the Asian crisis, total factor productivity in Indonesian banks decreased by 1.5% and worsened after the Asian crisis, i.e., decreased by 6.4%. On average, only private banks recorded positive growth before the Asian crisis. Moreover, the TFP growth worsened after the Asian crisis, especially for joint venture/foreign banks. The reason, perhaps, foreign banks as branch banks are managed from the headquarters. Because they have less information on the quality of borrowers, foreign-owned banks may be faced with more adverse selection problems than domestic-owned banks. As for the TFP growths, the estimates suggest that smaller banks have better performance in terms of the productivity. The effect of the Asian crisis is reflected by the fact that the TFP growth after the Asian crisis is worse than before the Asian crisis, with exception for banks with assets more than 999.9 billion rupiah.

References

Akhavein, J. D., A.N. Berger and D. B. Humphrey, 1997, The effects of megamergers on efficiency and prices: Evidence from a bank profit function, *Review of Industrial Organization,* 12, pp. 95-130.

Akhavein, J. D., P. A. V. B. Swamy, S. B. Taubman and R. N. Singamsetti, 1997, A general method of deriving the inefficiencies of banks from a profit function, *The Journal of Productivity Analysis* , 8(1), pp 71-93.

Akhigbe, A. and J.E. McNulty, 2003, The profit efficiency of small US commercial banks, *Journal of Banking and Finance*, 27(2), pp.307–325.

Altunbas, Y., M.H. Liu, P. Molyneux, and R. Seth, 2000, Efficiency and risk in Japanese Banking", *Journal of Banking and Finance*, 24(10), pp. 1605-1628.

Altunbas, Y., L. Evans, and Molyneux, 2001, Bank ownership and efficiency, *Journal of Money, Credit and Banking,* 33(4), pp. 926-954.

Attaulah, A.; T. Cockerill, H. Lee, 2004, Financial liberalization and bank efficiency: A comparative analysis of India and Pakistan, *Applied Economics*, 36, pp. 1915-1924.

Battese, G. E. and T. J. Coelli, 1988, Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data. *Journal of Econometrics*, 38, pp. 387-399.

Battese, G. E. and T. J. Coelli, 1992, Frontier production functions, technical efficiency and panel data: With application to paddy farmers in India, *Journal of Productivity Analysis*, 3, pp. 153-169.

Bauer, P., A.N. Berger, and D.B. Humphrey, 1993, Efficiency and productivity growth in US Banking, in: H.O. Fried, C.A.K. Lovell, S.S. Schmidt, (Eds.), *The Measurement of Productive Efficiency: Techniques and Applications*, Oxford University Press, pp. 386--413.

Berger, A. N., J. H. Leusner, and J. J. Mingo. 1997, The efficiency of bank branches, *Journal of Monetary Economics*, 40, pp. 141-162.

Berger, A.N. and D. B. Humphrey, 1997, Efficiency of financial institutions: International survey and direction for future research, *European Journal of Operational Research*, 98, pp. 175-212.

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, pp. 895-947.

Berger, A.N. and R. DeYoung, 2001, The effect of geographical expansion on efficiency, *Journal of Financial Research Services*, 19, pp. 163-184.

Carbo, S.; E.P.M. Gardener, and J. Williams, 2002, Efficiency in banking: Empirical evidence from the savings banks Sector. *The Manchester School*, 70(2), pp.204–228.

Baltagi, B.H and J.M. Griffin, 1988, A general index of technical change, *Journal of Political Economy*, 96(1), pp.20–41.

Bhattacharyya A., Lovell C.A.K. and P. Sahay, 1997, The impact of liberalization on the productive efficiency of Indian commercial banks, *European Journal of Operational Research*, 98(2), pp. 332-345.

Coelli, T, 1996, A guide to frontier version 4.1: a computer program for stochastic frontier production and cost function estimation, CEPA *Working Paper* 96/07, Center for Efficiency and Productivity Analysis, University of New England, Armidale.

Cornwell, C., P. Schmidt, and R.C. Sickles 1990, Production frontiers with cross-sectional and time series-variation in efficiency levels, *Journal of Econometrics*, 46, pp.185-200.

DeYoung, R. and I. Hasan, 1998, The Performance of de novo commercial banks: A profit efficiency approach, *Journal of Banking and Finance*, 22, pp. 565-587.

Drake, L. and M.J.B. Hall, 2003, Efficiency in Japanese banking: An empirical analysis, *Journal of Banking and Finance*, 27, pp. 891-917.

Elyasiani, E. and S. Mehdian, 1990, Efficiency in the commercial banking industry, a production frontier Approach, *Applied Economics*, 22, pp. 539-551.

Esho, N. and I.G. Sharpe, 1995, Long Run Estimates of Technological Change and Scale Economies in a Dynamic Framework: Australian Parliament Building Societies: 1974-1990, *Journal of Banking and Finance*, 19, pp.539-551.

Fecher F and P. Pestieau, 1993, Efficiency and Competition in O.E.C.D. Financial Services”, in: H.O. Fried, C.A.K. Lovell, S.S. Schmidt, (Eds.), *The Measurement of Productive Efficiency: Techniques and Applications*, Oxford University Press, pp. 386-413.

Gallant, R., 1981, On the bias of flexible functional forms and an essentially unbiased Ffrm, *Journal of Econometrics*, 15, pp. 211--245.

Girardone, C.; P. Molyneux and E.P.M. Gardener, 2004, Analyzing the determinants of bank efficiency: The case of Italian banks, *Applied Economics*, 36(3), pp.215–227.

Hao, J., W. C. Hunter and W. K. Yung, 2001, Deregulation and efficiency: The case of private Korean banks, *Journal of Economics and Business*, 53, pp. 237-254.

Hardy, D.C. and E.B. di Patti, 2001, Bank reform and bank efficiency in Pakistan, *Working Paper*, WP 01/138, International Monetary Fund.

Humphrey, D.B. and L.B. Pulley, 1997, Banks' responses to deregulation: Profits, technology and efficiency, *Journal of Money, Credit and Banking*, 29(1), pp. 73-93.

Kaparkis, E. M., S. M. Miller, and A.G. Noulas, 1994, Short-run cost inefficiency of commercial banks: A flexible stochastic frontier approach, *Journal of Money, Credit, and Banking*, 26(4), pp. 875-893.

Kasman, A, 2002, Cost efficiency, scale economies, and technological progress in Turkish banking. *Central Bank Review*, 1, pp. 1–20.

Ketkar, K.W.; A.G. Noulas and M.M. Agarwal, 2003, An analysis of efficiency and productivity growth of the Indian banking sector *Finance India*, 17(2), pp. 511-521.

Kumbhakar, S. C., 1990, Production frontier, panel data, and time-varying technical efficiency, *Journal of Econometrics*, 46, pp.201-212.

Lozano A.V., 1997, Profit efficiency for Spanish saving banks, *European Journal of Operational Research*", 98, pp.381-394.

Lozano, A.V., 1998, Efficiency and technical change for Spanish banks, *Applied Financial Economics*, 8, pp.289-300.

Maudos, J; J.M. Pastor, F. Perez and J. Quesada, 2002, Cost and profit efficiency in European banks, *Journal of International Financial Markets, Institutions and Money*, 12(1), pp.33-58.

Mendes, V. and J. Rebelo, 1999, Productive Efficiency, Technological Change and Productivity in Portuguese Banking, *Applied Financial Economics*, 9, pp. 513-521.

Mester, L. J., 1996. Measuring efficiency at U.S. banks: Accounting for heterogeneity is important, *Working Paper*, No. 96-11/R, Federal Reserve Bank of Philadelphia.

Mitchell, K. and N.M. Onvural, 1996, Economies of scale and scope at large Commercial banks: Evidence from the fourier flexible functional form, *Journal of Money, Credit and Banking*, 28(2), pp.178–199.

Montgomery, J., 1997, The Indonesian financial systems: Its contribution to economic performance and key policy issues, *Working Paper*, WP/97/45, International Monetary Fund.

Pangestu, M. and M. Habir, 2002, The boom, bust, restructuring of Indonesian banks", *Working Paper*, WP/02/66, International Monetary Fund.

Resti, A., 1997, Evaluating the Cost-efficiency of the Italian Banking System: What Can be Learned from The Joint Application of Parametric and Non-parametric techniques, *Journal of Banking And Finance*, 21(2), pp. 221-250.

Resti, A., 1998, Regulation can foster mergers, can mergers foster efficiency? The Italian case, *Journal of Economics and Business*, 50(2), pp. 157-169.

Rezvanian, R and S. Mehdian, 2002, An examination of cost structure and production performance of commercial banks in Singapore, *Journal of Banking and Finance*, 26, pp. 78-98.

Shanmugam, K.R. and A. Das, 2004, Efficiency of Indian commercial banks during the reform period, *Applied Financial Economics*, 14, pp. 681-686.

Suta, I.G.P.A and S. Musa, 2003, *Membedah krisis perbankan*, Jakarta, Yayasan Sad Satria Bhakti.

Vennet, R.V, 2002, Cost and profit efficiency of financial conglomerates and Universal banks in Europe, *Journal of Money, Credit and Banking*, 34(1), pp.254–282.

Table 1
Parameter estimates of flexible fourier cost function

Variable	Parameter	Estimates	Std. Error	Variable	Parameter	Estimates	Std. Error
1993-1997							
Intercept	a_0	-37.3551**	6.9206	t ln y_1	$a_{t y_1}$	-0.0165**	0.0076
ln y_1	a_{y_1}	-5.7785**	1.1560	t ln y_2	$a_{t y_2}$	0.0200**	0.0073
ln y_2	a_{y_2}	-0.2741	1.0207	t ln p_1	$a_{t p_1}$	-0.0002	0.0108
ln p_1	a_{p_1}	0.0787	0.2120	t ln p_2	$a_{t p_2}$	-0.0506**	0.0107
ln p_2	a_{p_2}	0.1905	0.1924	Cos (z_1)	b_1	-3.2809**	0.7588
t	a_t	0.1518	0.1093	Sin (z_1)	d_1	1.0410**	0.3467
0.5ln y_1 ln y_1	$a_{y_{11}}$	0.5750	0.0660	Cos (z_2)	b_2	-0.9483	1.0615
0.5ln y_2 ln y_2	$a_{y_{22}}$	0.0976	0.1024	Sin (z_2)	d_2	0.5510	0.3594
ln y_1 ln y_2	$a_{y_{12}}$	-0.0451*	0.0189	Cos (z_1+ z_1)	b_{11}	-0.7047**	0.1239
0.5ln p_1 ln p_1	$a_{p_{11}}$	-0.0758**	0.0227	Sin (z_1+ z_1)	d_{11}	0.3489**	0.1052
0.5ln p_2 ln p_2	$a_{p_{22}}$	-0.0203	0.0304	Cos (z_2+ z_2)	b_{22}	0.0635	0.1371
ln p_1 ln p_2	$a_{p_{12}}$	0.0607**	0.0224	Sin (z_2+ z_2)	d_{22}	0.0764	0.1030
$0.5t^2$	a_{tt}	-0.0646**	0.0133	Cos (z_1+ z_2)	b_{12}	-0.3380**	0.0908
ln y_1 ln p_1	$a_{y_1 p_1}$	-0.0233	0.0145	Sin (z_1+ z_2)	d_{12}	0.0096	0.0615
ln y_1 ln p_2	$a_{y_1 p_2}$	0.0910	0.0142	Cos (z_1+ z_1+ z_2)	b_{112}	-0.3096**	0.0697
ln y_2 ln p_1	$a_{y_2 p_1}$	0.0269	0.0140	Sin (z_1+ z_1+ z_2)	d_{112}	0.0121	0.0689
ln y_2 ln p_2	$a_{y_2 p_2}$	-0.0557**	0.0132				
1998-2000							
Intercept	a_0	-7.4125**	1.3617	t ln y_1	$a_{t y_1}$	0.0046	0.0065
ln y_1	a_{y_1}	1.8367**	0.4822	t ln y_2	$a_{t y_2}$	0.0056	0.0053
ln y_2	a_{y_2}	0.5083	0.5964	t ln p_1	$a_{t p_1}$	0.0241*	0.0104
ln p_1	a_{p_1}	0.3434	0.1961	t ln p_2	$a_{t p_2}$	0.0085	0.0082
ln p_2	a_{p_2}	-0.4554**	0.1260	Cos (z_1)	b_1	1.8403**	0.3287
t	a_t	-0.0690	0.1058	Sin (z_1)	d_1	0.1842	0.2348
0.5ln y_1 ln y_1	$a_{y_{11}}$	-0.0750	0.0422	Cos (z_2)	b_2	0.2771	0.6343
0.5ln y_2 ln y_2	$a_{y_{22}}$	0.0010	0.0597	Sin (z_2)	d_2	-0.0186	0.1929
ln y_1 ln y_2	$a_{y_{12}}$	-0.0351**	0.0079	Cos (z_1+ z_1)	b_{11}	0.2412**	0.0744
0.5ln p_1 ln p_1	$a_{p_{11}}$	0.1244**	0.0277	Sin (z_1+ z_1)	d_{11}	0.0675	0.0688
0.5ln p_2 ln p_2	$a_{p_{22}}$	0.0692**	0.0091	Cos (z_2+ z_2)	b_{22}	0.0569	0.0879

Table 1 (cont.)
Parameter estimates of flexible fourier cost function

Variable	Parameter	Estimates	Std. Error	Variable	Parameter	Estimates	Std. Error
$\ln y_1 \ln y_2$	$a_{y_{12}}$	-0.0351**	0.0079	$\text{Cos}(z_1+z_1)$	b_{11}	0.2412**	0.0744
$0.5\ln p_1 \ln p_1$	$a_{p_{11}}$	0.1244**	0.0277	$\text{Sin}(z_1+z_1)$	d_{11}	0.0675	0.0688
$0.5\ln p_2 \ln p_2$	$a_{p_{22}}$	0.0692**	0.0091	$\text{Cos}(z_2+z_2)$	b_{22}	0.0569	0.0879
$\ln p_1 \ln p_2$	$a_{p_{12}}$	0.0302*	0.0147	$\text{Sin}(z_2+z_2)$	d_{22}	-0.1130*	0.0510
$0.5t^2$	a_{tt}	0.0287	0.0258	$\text{Cos}(z_1+z_2)$	b_{12}	-0.0564	0.0446
$\ln y_1 \ln p_1$	$a_{y_1 p_1}$	-0.0178	0.0115	$\text{Sin}(z_1+z_2)$	d_{12}	0.1304**	0.0317
$\ln y_1 \ln p_2$	$a_{y_1 p_2}$	0.0454**	0.0093	$\text{Cos}(z_1+z_1+z_2)$	b_{112}	-0.0060	0.0474
$\ln y_2 \ln p_1$	$a_{y_2 p_1}$	0.0228**	0.0082	$\text{Sin}(z_1+z_1+z_2)$	d_{112}	0.0804*	0.0407
$\ln y_2 \ln p_2$	$a_{y_2 p_2}$	0.0159**	0.0052				

note: */** indicate significance at 5%/1 % level of significance

Table 2
Cost Efficiency, Scale Economy, Technical Progress and TFP Growth

Year	Cost Efficiency	SE	TP	TFP Growth
1993	0.65416	0.69517	-	-
1994	0.74197	0.77936	0.06589	-0.06998
1995	0.81290	0.83960	0.00207	-0.03832
1996	0.86731	0.89377	-0.06174	0.03715
1997	0.90744	0.96883	-0.12542	0.01177
Average	0.79676	0.83535	-0.02980	-0.01485
1998	0.52142	0.92517	-	-
1999	0.53407	0.87676	0.04846	-0.04264
2000	0.54659	0.91530	0.07961	-0.08637
Average	0.53403	0.90574	0.06404	-0.06451

SE: Economies of scale factor
TP: Technological progress

Table 3
Cost Efficiency, Scale Economy, Technological Progress and
TFP Growth by ownership

Year	Cost Efficiency			Scale Economy		
	Public	Private	Joint Venture/ Foreign	Public	Private	Joint Venture/ Foreign
1993	0.60046	0.64726	0.72592	0.67534	0.62098	0.90941
1994	0.70164	0.73553	0.79919	0.72181	0.72263	0.98561
1995	0.78387	0.80735	0.85647	0.77565	0.77604	1.07012
1996	0.84697	0.86285	0.89932	0.84773	0.84291	1.07311
1997	0.89343	0.90405	0.93033	0.90525	0.89675	1.22129
Average	0.76527	0.79141	0.84225	0.78516	0.77186	1.05191
1998	0.47379	0.49357	0.64202	0.89374	0.87351	1.09200
1999	0.48760	0.50651	0.65274	0.90756	0.81303	1.01300
2000	0.50130	0.51936	0.66326	0.94341	0.85078	1.05629
Average	0.48756	0.50648	0.65267	0.91490	0.84577	1.05376
	Technological Progress			TFP Growth		
1994	0.06582	0.06486	0.06865	-0.05712	-0.03488	-0.17482
1995	0.00180	0.00102	0.00507	-0.05725	-0.00854	-0.09744
1996	-0.06191	-0.06258	-0.05939	0.06402	0.05772	-0.04361
1997	-0.12594	-0.12666	-0.12166	0.03448	0.05085	-0.11335
Average	-0.03006	-0.03084	-0.02683	-0.00397	0.01629	-0.10731
1999	0.04285	0.03904	0.07875	-0.00582	-0.03873	-0.08971
2000	0.07281	0.07125	0.10834	-0.07988	-0.07154	-0.13171
Average	0.05783	0.05515	0.09355	-0.04285	-0.05514	-0.11071

Table 4
Cost Efficiency and Scale Economy, Technological Progress and TFP Growth by size

Year	Asset (Billion of Rupiah)				
	< 250	250 – 499.9	500 – 749.9	750 – 999.9	> 999.9
			Cost Efficiency		
1993	0.62274	0.74700	0.73258	0.64601	0.68972
1994	0.69964	0.82343	0.82124	0.73272	0.75501
1995	0.77201	0.84652	0.89064	0.86750	0.82006
1996	0.83718	0.87228	0.90886	0.92353	0.87449
1997	0.88492	0.91084	0.90210	0.94642	0.92602
Average	0.76330	0.84001	0.85108	0.82324	0.81306
1998	0.46359	0.50884	0.54068	0.54107	0.56592
1999	0.49837	0.50020	0.61441	0.46366	0.56881
2000	0.51106	0.50965	0.61625	0.46888	0.58006
Average	0.49101	0.50623	0.59045	0.49120	0.57160
			Scale Economy		
1993	0.48712	0.83444	0.99097	1.05058	1.22691
1994	0.54225	0.88188	1.03421	1.14455	1.24457
1995	0.54926	0.91488	1.03242	1.13957	1.25178
1996	0.59542	0.86382	1.02132	1.10673	1.25132
1997	0.60632	0.86118	1.13404	1.16450	1.32508
Average	0.55607	0.87124	1.04259	1.12119	1.25993
1998	0.64357	0.87751	0.98138	1.09739	1.13006
1999	0.53751	0.82832	0.93389	0.98225	1.09220
2000	0.58828	0.86163	0.96513	1.01347	1.12233
Average	0.58979	0.85582	0.96013	1.03104	1.11486
			Technological Progress		
1994	0.06217	0.06676	0.06906	0.07033	0.07483
1995	-0.00256	0.00233	0.00436	0.00602	0.01026
1996	-0.06646	-0.06296	-0.06092	-0.05919	-0.05467
1997	-0.13103	-0.12799	-0.12451	-0.12369	-0.11886
Average	-0.03447	-0.03047	-0.02800	-0.02663	-0.02211
1999	0.01474	0.03247	0.04494	0.04728	0.07944
2000	0.04758	0.06111	0.07532	0.07905	0.10980
Average	0.03116	0.04679	0.06013	0.06317	0.09462
			TFP Growth		
1994	0.01009	-0.10768	-0.15115	-0.19696	-0.22464
1995	0.01608	-0.03568	-0.06204	-0.09108	-0.14053
1996	0.12538	0.02360	-0.03135	0.00763	-0.04080
1997	0.04916	0.08446	0.07192	0.04167	-0.08302
Average	0.05018	-0.00883	-0.04316	-0.05969	-0.12225
1999	0.03461	-0.08008	-0.06739	-0.06591	-0.06377
2000	-0.01739	-0.05120	-0.08459	-0.09530	-0.14600
Average	0.00861	-0.06564	-0.07599	-0.08061	-0.10489