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Efficiency in Indonesian Banking: Recent Evidence

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ABSTRACT:

In one of the first stand-alone studies covering the whole of the Indonesian banking industry, and utilising a unique dataset provided by the Indonesian central bank, this paper analyses the levels of intermediation-based efficiency obtaining during 2007. Using Tone's (2001) input-oriented, non-parametric, slacks-based DEA model, and modifying it where necessary to deal with negative inputs and outputs (Sharp et al. 2006), we firstly estimate the relative average efficiencies of Indonesian banks, both overall, and by group, as determined by their total asset size and status. In the second part of the analysis, we adopt Simar and Wilson's (2007) bootstrapping methodology to eliminate the 'bias' in the efficiency estimates and to formally test for the impact of size and status on Indonesian bank efficiency.

The results from the initial analysis show that: (i) average bank efficiency within the industry during 2007 lay between 62% – 67%; (ii) the most efficient group of banks was the 'state-owned' group with an average efficiency score of over 90%, with the least efficient group being the 'regional government-owned' banks with average efficiency scores between 45% and 58%; (iii) 'listed banks' performed better, on average, than 'non-listed banks'; and (iv) 'Islamic banks', despite their different operational structure when compared with conventional banks, enjoyed average efficiency scores between 54% and 74%. In the second stage of the analysis, the bias-corrected efficiency scores demonstrate that 'regional government-owned', 'foreign exchange', 'non-foreign exchange', 'joint-venture' and 'foreign' groupings were significantly less efficient than 'state-owned' banks, with the first-mentioned being the most inefficient and the other groupings ranked in ascending order of efficiency,

∗ The opinions expressed in this paper do not necessarily reflect those of Bank Indonesia or its staff.

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as listed. Moreover, large banks were shown to be more efficient than their smaller counterparts, providing support for Bank Indonesia's consolidation policies.

JEL Classification: C23; C52; G21
Keywords: Indonesian Finance and Banking; Efficiency.

1. INTRODUCTION

Empirical studies of bank efficiencies have mushroomed in recent years as interest has spread beyond banking markets in North America and Western Europe and modelling methodologies have evolved to tackle the increasingly-complex nature of banking operations and their diverse operating environments. On the modelling front, there is a schism between the proponents of parametric and non-parametric approaches to assessing bank efficiencies, whilst elsewhere debates rage about the appropriate form of the input/output specifications – the traditional 'intermediation-based' versus the 'production' or 'profit/revenue' approaches (see Drake et al., 2006) – to be adopted and the merits of allowing for slacks in non-parametric modelling

This paper represents one of the first attempts, as far as the authors are aware, to analyse Indonesian banks on a stand-alone basis. Moreover, the study is unique in that it uses, as a dataset, supervisory data provided by Bank Indonesia, the Indonesian central bank. The analysis of banking markets in Indonesia is long overdue given the country's growing importance within the resurgent region of South East Asia and its significance as a major ASEAN nation. Moreover, it is one of only a few studies to analyse bank efficiency in this region since the end of the Asian financial crisis (1997/98). Accordingly, it represents a timely and warranted addition to the extant empirical literature on banking efficiency, especially for the South East Asian region.

As for our preferred methodology, for the reasons outlined below, we choose to adopt a non-parametric approach to efficiency estimation (input-oriented Data Envelopment Analysis (DEA)), based upon the intermediation activities of banks and accounting for output and input slacks. This methodology is used to address the issue of how efficient Indonesian banks were during 2007 and which type of banks (by ownership and status, that is, listed/non-listed, Islamic/conventional) were the most efficient. Furthermore, the differences in efficiencies, both between ownership

groups and different asset sized groups, were then formally tested using the bootstrapping procedures of Simar and Wilson (2007).

The paper is structured as follows. In Section 2, we briefly set out the structure of the Indonesian banking system, highlighting the respective asset shares of the different groups. In Section 3 we present the modelling methodology, duly explaining the reasons for our choice of approach, the nature of the dataset used, and the input/output variables deployed in the intermediation-based efficiency analysis. In Section 4 we set out our results, and explain their policy implications, and, in Section 5, we conclude the analysis.

2. THE INDONESIAN BANKING INDUSTRY: A BRIEF STRUCTURAL REVIEW

As shown in Table 1, at the end of 2007 there were 130 banks operating in Indonesia with a combined balance sheet of over IDR 1,986 trillion (US$ 213 billion). This comprised 5 state-owned banks, 35 foreign exchange private banks, 36 non-foreign exchange private banks, 26 regional government-owned banks, 17 joint-venture banks and 11 foreign banks. This number compares with a total of 222 banks which were in existence at the end of December 1997 and reflects a post-Asian financial crisis policy of consolidation through liquidation and suspension, as agreed with the IMF following the country's bailout (see Jao, 2001, Chapter 2), and more recently, though officially-encouraged mergers.

INSERT TABLE 1

That is, since the Asian financial crisis (AFC) in 1997/98, Indonesia has seen a complete transformation of its financial services industry compared with that which operated under the General Soeharto regime. The AFC saw Indonesia sign a 'Letter of Intent' on 13th October 1997 with the International Monetary Fund (IMF) to reform the banking system and its operations and supervision. The country pledged that "insolvent banks have been closed and weak, but viable, institutions have been required to formulate and implement rehabilitation plans. At the same time, steps are being taken to minimize future systemic risks. In particular, the legal and regulatory

environment will be strengthened by establishing strong enforcement mechanisms and introducing a stringent exit policy," ('Letter of Intent' paragraph 24, Indonesia, http://www.imf.org/external/country/idn/). However, given the problems surrounding the financial crisis, where Indonesia was the worst affected (see Jao, 2001, Chapter 2), there was no quick solution to overcoming the country's inherent internal problems (Sato, 2005).

Whilst the IMF was supervising the transformation of the Indonesian financial system up to 2003, the Indonesian government introduced the Central Bank Act (Act No. 23) of 1999, which gave independence to Bank Indonesia. This was then superseded by the 2004 amendment to the Central Bank Act of 1999 which enhanced the representation of and supervision by government officials, and reintroduced Bank Indonesia's status as 'lender of last resort'. Since then, the evolution of supervision and regulation has continued, embracing, *inter alia*, the introduction of deposit guarantees and the establishment of a Financial Stability Net (involving Bank Indonesia, the Ministry of Finance and the Deposit Guarantee Agency (LPS)) in March 2007.

The latter developments are consistent with the aim of Bank Indonesia to see a more stable banking environment by reducing the number of banks in the country. This was implemented in three different ways. The first was that banks must have a minimum Tier I capitalisation of Rp 80 billion (US$ 8.81 billion) by 2007, increasing to Rp 100 billion (US$10.2 billion) by 2010; hence, many small private banks would be priced out of the market and would have to merge.[1] Secondly, in June 2006, Bank Indonesia introduced the 'single presence policy' that prohibits investors from holding more than 25% of the shares of more than one bank. This creates problems, not only for multiple holdings by foreign investors but also for the government itself, which owns stakes in five of the country's largest banks, including Bank Mandiri, Bank Rakyat Indonesia and Bank Negara Indonesia. It is hoped that the 'single presence policy' will lead to further consolidation within the industry in the coming years. Finally, the Financial Stability Net, introduced in 2007, saw a reduction in the depositor guarantee level from Rp 2 billion to Rp 100 million (US$11,000), which covers 98% of all depositors and 38% of deposits. Given the increased risk of holding

[1] The rise in the Tier I minimum capital requirement is due to the central bank's feeling that, presently, 50 out of the 130 banks operating in Indonesia are too small and hence mergers are the only viable option to ensure the future stability of the financial system.

cash in banks in excess of the deposit guarantee level it is hoped that investors will be more selective in their choice of bank, leading to a natural consolidation in the financial services industry in Indonesia.

In summary, the changes outlined above and set in train by Bank Indonesia allowed the banks to put many of their previous problems behind them and contributed towards increased financial stability in Indonesia. Hence, 2007 is an ideal year in which to analyse Indonesian bank efficiency. We next discuss the data and methodology used to estimate the efficiencies across the different sectors of the Indonesian banking system.

3. DATA AND MODELLING METHODOLOGY

3.1. Estimation of Efficiency

Estimation of a bank's level of efficiency involves a comparison of its actual and best possible performances, given the inputs and outputs specified. In this study, we focus on input-reduction strategies and evaluate input-oriented efficiency measures estimating by how much banks could reduce the usage of their resources (inputs) given the outputs they produce. Formally, the optimum level of inputs is given by the relevant frontier which represents the common technology T banks use to transform inputs X ($m \times n$) into outputs Y ($s \times n$), given by equation (1):

$$\mathrm{T} = \{(\mathrm{X}, \mathrm{Y}) \mid \ \mathrm{X} \ \ \text{can} \ \ \text{produce} \ \ \mathrm{Y}\} \qquad (1)$$

However, given that the true frontier is not observable, it can be approximated by a 'best-practice' frontier, in which the literature has posited two estimation approaches, the non-parametric and parametric methodologies. The former approach is based on mathematical programming and the latter makes use of econometric estimation techniques. The advantages of the non-parametric technique is that it does not assume any functional form in the construction of the frontier unlike its parametric counterparts (for further discussion, see Coelli et al. 2005). In this paper, we utilise the non-parametric linear programming technique, DEA, which originated

from Farrell's (1957) seminal work and was later extended by Charnes et al., (1978), Banker et al. (1984) and Färe et al. (1985), to estimate the frontier. In addition, the individual input-oriented efficiency for each bank is computed relative to the estimated frontier by solving the Slacks-Based Model (SBM) DEA linear programming problem, as suggested by Tone (2001). The SBM efficiency estimator takes into account the input slacks arising in a bank's production. In the analysis of public sector DMUs, for which DEA was originally proposed by Farrell (1957), the idea of slacks was not a problem unlike when DEA is employed to measure cost efficiencies in a 'competitive market' setting. Hence, in a 'competitive market' setting, output and input slacks are essentially associated with the violation of 'neo-classical' assumptions. For example, in an input-oriented approach, the input slacks would be associated with the assumption of strong or free disposability of inputs which permits zero marginal productivity of inputs and hence extensions of the relevant isoquants to form horizontal or vertical facets. In such cases, units which are deemed to be radial or 'Farrell efficient' (in the sense that no further proportional reduction in inputs is possible without sacrificing output), may nevertheless be able to implement further reductions in some inputs. Such additional potential input reductions are typically referred to as non-radial input slacks, in contrast to the radial slacks associated with DEA or Farrell inefficiency, that is, radial deviations from the efficient frontier. To overcome these potential violations of the neo-classical assumptions in production modelling, Tone's (2001) SBM efficiency estimator is estimated and is given by the following formula:

$$
\begin{aligned}
\text{min} \quad & \hat{\rho}(x, y|T(x)) = 1 - \frac{1}{m}\sum_{k=1}^{m} s_k^- / x_{ko} \\
\text{subject to} \quad & x_o = X\lambda + s^-, \\
& y_o = Y\lambda - s^+, \\
& \sum \lambda = 1, \\
\text{and} \quad & \lambda \geq 0, \;\; s^- \geq 0, \;\; s^+ \geq 0,
\end{aligned}
\tag{2}
$$

where an optimal solution of the SBM program (2) is given by $(\hat{\rho}, \hat{\lambda}, \hat{s}^-, \hat{s}^+)$. In particular, $\hat{\rho}$ is the estimated input-oriented efficiency score of the bank, $\hat{\lambda}$ is the

estimated intensity variable and represents the peers of the considered bank, and $\hat{s}^-$ and $\hat{s}^+$ are the estimated output shortfalls and input excesses respectively.

Furthermore, it is interesting to note that program (2) requires positive inputs when estimating efficiency scores but allows outputs to have negative values. For example, if output variables are found to be negative, then program (2) allows for these negative outputs to be translated, that is, an arbitrary number can be added to the output vector resulting in the non-negativity of all elements of that output vector. However, in the case of banking, especially as bank balance sheets change to incorporate new trading positions, the case of only having to translate one side of the input or output variable vector is becoming rarer. That is, in our sample of Indonesian banks, off-balance-sheet outputs can be positive or negative dependent on the trading position in that quarter, and total provisions, which are used as an input (commonly now utilised in the bank modelling literature and explained in more detail below), could also be positive or negative according to whether the bank increased or decreased those said provisions in the quarter under study. Hence, to overcome the limitations inherent in the standard SBM program when one or more inputs and outputs have negative values, the Modified Slack-Based Model (MSBM) can be utilised (see, Sharp et al., 2006) in accordance with program (3):

$$
\begin{aligned}
\text{min} \quad & \hat{\rho}(x, y|T(x)) = 1 - \frac{1}{m}\sum_{k=1}^{m} s_k^- / P_{ko}^- \\
\text{subject to} \quad & x_o = X\lambda + s^-, \\
& y_o = Y\lambda - s^+, \\
& \sum \lambda = 1, \\
\text{and} \quad & \lambda \geq 0, \;\; s^- \geq 0, \;\; s^+ \geq 0,
\end{aligned}
\tag{3}
$$

where P_{ko}^- is a range of possible improvements for inputs of bank o and is given by $P_{ko}^- = x_{ko} - \min_i(x_{ki})$.

Finally, to test which bank-specific factors have an impact on banking efficiency, in the second stage of this analysis the efficiency measures $\hat{\rho}_j$, estimated using programs (2) or (3), are regressed on z_j, a set of explanatory variables such as

ownership, type and size dummy variables. The specification of the truncated regression used in this study is as follows:

$$0 \leq \rho_j = \alpha + z_j\beta + \varepsilon_j \leq 1 \tag{4}$$

where β is a vector of parameters associated with each factor to be estimated. The distribution of the error term ε_j is assumed to be truncated normal with zero mean and unknown variance. The left and right truncation points of the ε_j's distribution are $(-z_j\beta)$ and $(1-z_j\beta)$ respectively.

We correct the efficiency scores $\hat{\rho}_j$ for the biased term using an adapted Algorithm 2 of Simar and Wilson (2007) for left and right truncation points, as suggested by Kenjegalieva et al. (2008).[2] The bias arises due to the piecewise linear frontier used as a benchmark (the *true* frontier is smooth) and the differences in the environment in which banks operate. In addition, it can potentially capture leads and/or lags in the variables used in the panel data analysis as well as some reporting errors of the data. Mathematically, it is expressed as equation (5),

$$\text{BIAS}(\hat{\rho}_i(x, y|T)) \equiv E(\hat{\rho}_i(x, y|T)) - \rho_i(x, y|T) \tag{5}$$

and decreases asymptotically with an increase in the number of observations in the sample and in the number of bootstrapped iterations, and with a reduction in the number of input/output variables considered.

In the first bootstrap procedure, we correct efficiency scores for the estimated bias by running 100 iterations. The second bootstrapping technique ensures that the problem of serial correlation of the efficiency measures is avoided. This involved performing 5000 bootstrap replications. Once the set of bootstrap parameter estimates for β and σ_ε have been obtained, the percentile bootstrap confidence intervals are

[2] Alternative approaches to the technique of Simar and Wilson (2007) are those of Daraio and Simar (2005) and Balaguer-Coll et al. (2007). The former use a probabilistic formulation of the frontier whereas the latter use a combination of non-parametric kernel regression and bivariate density estimation in the second stage. Although the utilised Simar and Wilson (2007) technique makes several assumptions, including the truncated normal distribution of (in)efficiency, it corrects the efficiency measures for the bias arising from the environment that the banks operate in.

constructed (for further details on the bootstrapping techniques utilised see Kenjegalieva et al., 2008).

3.2. Data and Input/Output Variables

This paper utilises quarterly supervisory data from Bank Indonesia and covers the four quarters of 2007 in which all 130 Indonesian banks feature in the sample. In modelling the intermediation approach, we specify three outputs and four inputs, in line with Sealey and Lindley (1977). The first output is 'total loans' (total customer loans), the second output is 'other earning assets' (placements in Bank of Indonesia + interbank assets + securities held + other claims + equity participation + cash), and the third output is 'net total off-balance-sheet income' (net income from dividends/fees/commissions/provisions + net income from forex/derivative transactions + (securities appreciation - securities depreciation) – insurance expenses – capital market transactions). The third output variable set is included in the analysis to reflect the fact that banks around the world have been diversifying, at the margin, away from traditional financial intermediation (margin) business and into "off-balance-sheet" and fee income business. Hence, it would be inappropriate to focus exclusively on earning assets as this would fail to capture all the business operations of modern banks. The inclusion of 'net total off-balance-sheet income' is therefore intended to proxy the non-traditional business activities of Indonesian banks.

The inputs estimated in the intermediation approach are: 'total consumer deposits and commercial borrowing' (demand deposits + saving deposits + time deposits + liabilities to Bank of Indonesia + inter-bank liabilities + securities issued + borrowings + other payables + guarantee deposits + inter office liabilities); 'total employee expenses' (total salaries and wages + total educational spending); 'total non-employee expenses' (R & D + rent + promotion + repair and maintenance + goods and services + other costs); and 'total provisions' (allowances for loan losses). With respect to the last-mentioned input variable, it has long been argued in the literature that the incorporation of risk/loan quality is vitally important in studies of banking efficiency. Akhigbe and McNulty (2003), for example, utilising a profit function approach, include equity capital "to control, in a very rough fashion, for the potential increased cost of funds due to financial risk" (page. 312). Altunbas et al. (2000) and Drake and Hall (2003) also find that failure to adequately account for risk

can have a significant impact on relative efficiency scores. In contrast to Akhigbe and McNulty (2003), however, Laevan and Majnoni (2003) argue that risk should be incorporated into efficiency studies via the inclusion of loan loss provisions. That is, "following the general consensus among risk agent analysts and practitioners, economic capital should be tailored to cope with unexpected losses, and loan loss reserves should instead buffer the expected component of the loss distribution. Consistent with this interpretation, loan loss provisions required to build up loan loss reserves should be considered and treated as a cost; a cost that will be faced with certainty over time but that is uncertain as to when it will materialise" (page 181). We agree with this view and hence also incorporate 'total provisions' as an input in the relative efficiency analysis of Indonesian banks.

INSERT TABLE 2

Based on these input and output variables – summary statistics are provided in Table 2 - we specify two models: a model with quarterly income and expenses and a model based on the original balance sheet and profit/loss accounts, that is, with cumulative income and expenses. The former model captures the quarterly activities of the banks, that is, expenses incurred and income earned during the given quarter, and banking risk is measured by the change in total provisions. The latter model, on the other hand, covers the activities of the banks from the beginning of the year to the given quarter. In other words, quarter 3 in this model, for example, covers banking activities for 9 months. It is also interesting to note, that to the authors' knowledge, the data set provided by Bank Indonesia allows for one of the first studies comparing efficiency scores between inter-year-quarters and those obtaining at the end of a year.

4. RESULTS

The non-parametric frontier constructed in this study represents the '*best* approximated' frontier as it is based on the practices of *all* 130 Indonesian banks operating in 2007. The average efficiency scores across the different types of banks estimated for both the cumulative model using SBM and for the quarterly model using

MSBM are given in Table 3 and bank rankings by average efficiency score are presented in Appendix.

INSERT TABLE 3

As can be seen from the table, although the efficiency estimates reported by the MSBM quarterly model are somewhat higher than those of the SBM cumulative model, the results are relatively stable and are not particularly sensitive to either the modelling specification or the non-parametric technique utilised. The exceptions are the results for Islamic and regional government-owned banks where the difference in efficiency scores for quarters 2, 3 and 4 is over 18% and 13% respectively[3]. In addition, the average MSBM results for Islamic banks are higher (at 74%) than the industry average (67%), whereas the average SBM results for this group (54%) are lower than the industry average (62%).[4] This result seems to be driven by the differences in operating structure of Islamic and conventional banks. That is, due to the profit-sharing nature of Islamic banking and its prohibition on interest-bearing investments, these banks perform less efficiently when the modelling is based on cumulating off-balance-sheet income. Indeed, as Table 3 shows, the average efficiency of Islamic banks according to the SBM cumulative model decreases continuously through the year. On the other hand, if the analysis is based on a shorter time scale (i.e. 3 months), the off-balance sheet income of conventional banks is not substantial enough to allow them to be considered as outperforming the Islamic banks. Moreover, according to Tables 4 and 5, the efficiency of the Islamic banks is not significantly different from the industry average. This implies that, although the operational structure of Islamic banks is different, in this study they can be considered alongside conventional banks in the analysis of Indonesian bank efficiency.

INSERT TABLES 4 AND 5

[3] Given that the expenses in Quarter 1 are the same for both the quarterly expenses and the cumulative expenses models, the efficiency results for the given quarter are expected to be fairly similar. The slight discrepancy in the efficiency estimates for the quarter is due to the difference in the accounting for banking risk captured by provisions.

[4] To put the average efficiency scores into perspective, the industry average of 62% under the SBM model compares with an industry average of 71% for Japanese banks in 2002 under another study of South East Asian bank efficiency using the SBM/intermediation approach (see Drake et al., 2009, Table 2).

Looking at Table 3 again, it can be seen that the average efficiency of listed banks, the other group differentiated by "bank status", consistently exceeds average industry efficiency by at least 6%, ranging from 66% to 78%. However, the regression results –see Tables 3 and 4- imply that it is not statistically different from the industry's performance.

The impact of *ownership* on banking efficiency reveals that the state-owned banks are the most efficient group of banks in Indonesia. Their average efficiency levels vary between 88% and 100% in the SBM modelling and between 81% and 100% in the MSBM case, exceeding the industry average by at least 17% on all occasions (see Figure 1).

INSERT FIGURE 1

The next best performing groups of banks are the foreign and joint-venture banks. The average efficiency of the former group is in the range 72% to 90%. The latter group has average efficiency of between 74% and 86%. Although the average performances of both groups are better than the industry average, they significantly lag behind the state-owned banks (Tables 4 and 5). For example, although the foreign banks are the second best according to the cumulative results, their average score of 84% lies well below the corresponding 94% score of the state-owned banks. Similarly, although quarterly financial intermediation performances of the joint-venture banks are, on average, virtually identical to those of foreign banks – at 80% - they are considerably worse than the 91% average score of the state-owned banks.

As for the rest, the efficiencies of non-foreign exchange and foreign exchange bank groups are broadly similar, although the latter slightly outperform the former. Meanwhile, the least efficient group of banks is clearly that relating to those banks owned by regional governments. Their efficiency scores are well below the industry average and range between 39% and 58% in the cumulative model and between 54% and 63% in the quarterly model. In other words, the financial intermediation performance of an average bank owned by regional governments could be improved by over 33% if they were brought up to the state banks' level.

As far as *size* is concerned, the results suggest that the larger banks are significantly more efficient than medium and smaller-sized banks (Tables 4 and 5).

As can be seen from Figure 2, while the medium-sized and small banks perform slightly below the industry average, the average efficiency level of large banks is much higher. Interestingly, the majority of the large banks are foreign exchange private banks (10 out of 17 banks), although the average efficiency of this group is lower than the industry average. The rest of the large bank group comprises 4 state banks, 2 foreign banks and a bank owned by a regional government.

INSERT FIGURES 2 AND 3

The implications of these results are as follows. Firstly, in cases where both Islamic and conventional banks are considered, analysis based on shorter time periods (quarterly analysis) allows us to include off-balance-sheet activities into the study without over-estimating the performance of conventional banks and under-estimating the efficiency of Islamic banks. Secondly, the activities of banks owned by regional governments need closer scrutiny. As this group of banks holds the third largest share (at 9%) of Indonesian customer deposits, the relative intermediation inefficiency of this type of banks is somewhat worrying. Thirdly, the relatively-high efficiency rankings of the larger banks and the state-owned banks – see the Appendix - suggest that an in-depth study of their operations could be used by regulators to inform the debates on how to raise overall levels of performance in the banking industry and on bank mergers, which are still being sought to help stabilise the banking and financial sectors in Indonesia.

5. SUMMARY AND CONCLUSIONS

Using a unique dataset provided by Bank Indonesia and adopting input-oriented SBM (Tone, 2001) and MSBM (Sharp et al., 2006) intermediation-based approaches, we have estimated the average efficiencies of Indonesian banks during 2007, both overall and by group, as determined by size and status. The results demonstrate the following: (i) average bank efficiency within the industry during 2007 lay between 62% and 67%; (ii) the most efficient group of banks was the 'state-owned' group, recording an average efficiency score of over 90%; (iii) the 'foreign' banks and 'joint-venture' banks were the next best performing groups, both recording

average efficiency scores of around 80%; (iv) next in order of the ranking came the 'foreign exchange private' banks and the 'non-foreign exchange private' banks recording average levels of efficiency of around 60%, just below the industry average; (v) the 'regional government-owned' banks were shown to be the least efficient – worryingly given that they have the 3rd largest share (9% at 1.1.08) of customer deposits – recording average efficiency levels of between 45% and 58%; (vi) listed banks, with average efficiency levels of around 70%, were shown to be more efficient than the average non-listed bank; and (vii) despite their very different operational structure when compared with conventional banks, Islamic banks were shown to have enjoyed average levels of efficiency of between 54% and 74%.

In the second stage of the analysis we employed the bootstrapping methodology of Simar and Wilson (2007) to remove the bias in the efficiency estimates and to formally test for the impact of size and status on bank efficiency. The results demonstrate that the intermediation-based efficiency of regional government-owned, foreign exchange, non-foreign exchange, joint-venture and foreign groupings are significantly lower than that recorded by the state-owned group, with the first-mentioned being the most inefficient and the other groupings ranked in ascending order of efficiency, as shown. Moreover, large banks were shown to be significantly more efficient than their smaller counterparts.

Finally, it is worth repeating the main policy implications of our study. Firstly, given that they have the third greatest share of customer deposits yet are the most inefficient group , supervisory resources should be devoted to trying to understand why the regional government-owned banks' intermediation-based activities are so inefficient with a view to raising their performance to at least the industry average. Secondly, closer analysis of the operations of the state-owned and larger banks might be undertaken with a view to eliciting "best industry practice" and disseminating such findings to the rest of the industry. And, finally, close inspection of the relative efficiency rankings might also be used to inform the continuing debate on bank mergers by identifying those tie-ups which are likely to prove most beneficial, whether they arise as a result of private sector initiatives or from officially-sanctioned 'assisted mergers', a common feature of banking markets around the world as regulators seek to stabilise their financial systems in the wake of the sub-prime crisis and the global economic downturn. The empirical findings that large banks are significantly more efficient than their smaller counterparts offers some support to

Bank Indonesia's efforts to force further consolidation in the Indonesian banking sector.

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Table 1
The Structure of the Indonesian Banking Industry at end-December 2007

Type of Bank*	Number of Banks	Total Assets (IDR tn.)	Total Assets Share (%)
State-owned banks	5	742.0	36%
Foreign exchange private national banks	35	768.7	39%
Non-foreign exchange private national banks	36	39.0	2%
Regional government-owned banks	26	170.0	9%
Joint venture banks	17	90.5	5%
Foreign banks (branching)	11	176.3	9%
Total	130	1986.5	100%

Note. * There are also 24 listed banks, comprising 17 foreign exchange private banks, 2 non-foreign exchange private banks, a regional government-owned bank, a joint venture bank, and 3 state-owned banks. As well as this there are 3 Islamic banks, which comprise two foreign exchange private banks and a non- foreign exchange private bank.

Table 2.
Summary statistics for Indonesian banks' Inputs and Outputs in IDR tn.
(4 quarters 2007)

Variable	Mean	Minimum	Maximum	Std.Dev.
Quarterly expenses model				
Inputs				
Total non-employee expenses incurred during the given quarter	27181	59	435745	65311
Total consumer deposits and commercial borrowing	7679449	5139	147460957	19944439
Total employee expenses incurred during the given quarter	33480	177	848528	97023
Δ total provisions made during the given quarter	-5285	-1598168	439183	94421
Outputs				
Total loans	4256254	2813	71525267	10359452
Other earning assets	5962014	6669	164157634	19431607
Net total off-balance sheet income earned during the given quarter	16746	-582073	482845	66086
Cumulative expenses model				
Inputs				
Total non-employee expenses	62559	59	1419024	167148
Total consumer deposits and commercial borrowing	7679449	5139	147460957	19944439
Total employee expenses	80321	194	2989067	257059
Total provisions	244271	96	10983686	1040628
Outputs				
Total loans	4256254	2813	71525267	10359452
Other earning assets	5962014	6669	164157634	19431607
Net total off-balance sheet income	45538	-164318	1458077	147743

Table 3.

Average efficiency results for Indonesian banks

	No. of banks	Quarter 1 2007		Quarter 2 2007		Quarter 3 2007		Quarter 4 2007		Average 2007	
		SBM (Cumul.)	MSBM (Quarter)	SBM (Cumul.)	MSBM (Quarter)	SBM (Cumul.)	MSBM (Quarter)	SBM (Cumul.)	MSBM (Quarter)	SBM (Cumul.)	MSBM (Quarter)
Bank Status											
Listed banks	24	0.765	0.782	0.679	0.751	0.656	0.704	0.657	0.710	0.689	0.737
Islamic banks	3	0.720	0.732	0.521	0.817	0.483	0.764	0.449	0.634	0.543	0.737
Ownership Status Groups											
State- Owned	5	1.000	1.000	0.934	0.932	0.879	0.900	0.926	0.814	0.935	0.912
Foreign Exchange Private Banks	35	0.699	0.763	0.576	0.699	0.565	0.587	0.569	0.564	0.602	0.653
Non-Foreign Exchange Private Banks	36	0.682	0.666	0.554	0.615	0.518	0.612	0.514	0.603	0.567	0.624
Regional Government-Owned banks	26	0.583	0.628	0.435	0.578	0.407	0.565	0.387	0.538	0.453	0.577
Joint Venture Banks	17	0.820	0.816	0.786	0.860	0.743	0.742	0.821	0.768	0.792	0.797
Foreign Banks	11	0.818	0.852	0.843	0.877	0.818	0.751	0.895	0.717	0.843	0.799
Size Groups											
Small	40	0.694	0.672	0.596	0.645	0.552	0.650	0.554	0.619	0.600	0.646
Medium	73	0.681	0.698	0.566	0.653	0.537	0.628	0.553	0.614	0.584	0.648
Large	17	0.860	0.876	0.794	0.854	0.804	0.783	0.895	0.717	0.822	0.823
Overall Banking System	**130**	**0.709**	**0.713**	**0.605**	**0.676**	**0.576**	**0.616**	**0.592**	**0.639**	**0.620**	**0.671**

Note: The average for the year 2007 is the average of the efficiency scores for 4 quarters. The numbers of banks in the ownership status and size groups add up to the total number of banks in the banking system. A bank is classified as "small" if its total customer deposits are less than IDR 500,000 tn., "medium" if total deposits range between IDR 500,000 tn. and 10,000,000 tn., and "large" if total deposits exceed IDR 10,000,000 tn..

Table 4.

Results of the truncated regression with two truncations: SBM input-oriented efficiency measures (cumulative model)

	Est. Coef.	Bounds of the Bootstrap Est. Confidence Intervals					
		5% low	5% up	1% low	1% up	10% low	10% up
Listed	-0.033	-0.093	0.031	-0.109	0.047	-0.082	0.020
Islamic	-0.006	-0.117	0.109	-0.147	0.151	-0.100	0.091
Foreign Exchange	-0.573*	-0.875	-0.378	-0.993	-0.313	-0.821	-0.406
Non-Foreign Exchange	-0.536*	-0.843	-0.336	-0.960	-0.283	-0.781	-0.367
Regional Government Owned	-0.693*	-0.996	-0.490	-1.114	-0.432	-0.943	-0.522
Joint-Venture	-0.254*	-0.559	-0.053	-0.679	-0.003	-0.497	-0.079
Foreign	-0.200***	-0.508	0.012	-0.628	0.077	-0.452	-0.022
Large	0.310*	0.230	0.391	0.206	0.415	0.242	0.376
Small	-0.037	-0.087	0.015	-0.102	0.029	-0.079	0.006
Constant	1.160***	0.962	1.463	0.910	1.583	0.989	1.408
$\hat{\sigma}_{\varepsilon}$	0.178***	0.162	0.191	0.158	0.195	0.164	0.188

Notes: Statistical significance:* denotes statistically significant at the 1% level; ** denotes statistically significant at the 5% level; and *** denotes statistically significant at the 10% level (according to the bootstrap confidence intervals). The α-% lower and upper bounds of confidence intervals represent a range within which the (100-α) percentile of bootstrapped coefficients lies.

Table 5.

Results of the truncated regression with two truncations: MSBM input-oriented efficiency measures (quarterly model)

	Est. Coef.	Bounds of the Bootstrap Est. Confidence Intervals					
		5% low	5% up	1% low	1% up	10% low	10% up
Listed	-0.004	-0.073	0.070	-0.094	0.095	-0.062	0.058
Islamic	0.064	-0.071	0.210	-0.108	0.260	-0.049	0.187
Foreign Exchange	-1.090*	-1.736	-0.717	-1.988	-0.626	-1.591	-0.767
Non-Foreign Exchange	-1.054*	-1.705	-0.675	-1.941	-0.595	-1.554	-0.731
Regional Government Owned	-1.203*	-1.855	-0.821	-2.112	-0.730	-1.708	-0.872
Joint-Venture	-0.769*	-1.413	-0.394	-1.636	-0.298	-1.266	-0.446
Foreign	-0.839*	-1.480	-0.457	-1.738	-0.357	-1.335	-0.503
Large	0.321*	0.227	0.422	0.199	0.455	0.241	0.405
Small	-0.064**	-0.123	-0.004	-0.141	0.014	-0.112	-0.013
Constant	1.680*	1.297	2.330	1.214	2.585	1.354	2.190
$\hat{\sigma}_{\varepsilon}$	0.205*	0.186	0.222	0.181	0.228	0.188	0.218

Notes: Statistical significance:* denotes statistically significant at the 1% level; ** denotes statistically significant at the 5% level; and *** denotes statistically significant at the 10% level (according to the bootstrap confidence intervals). The α-% lower and upper bounds of confidence intervals represent a range within which the (100-α) percentile of bootstrapped coefficients lies.

Figure 1.
The average efficiency scores of Indonesian banks by ownership status compared with the average efficiency of the banking system

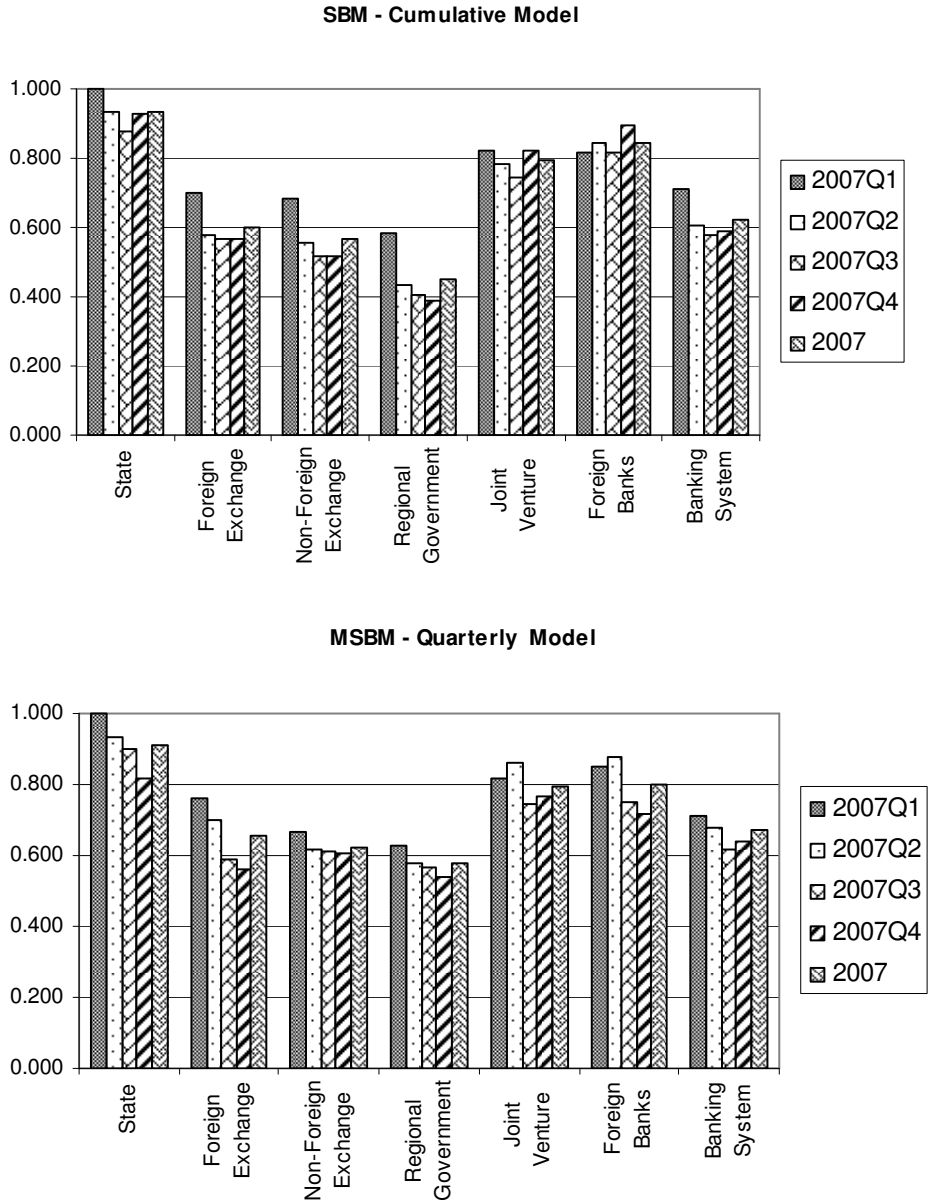
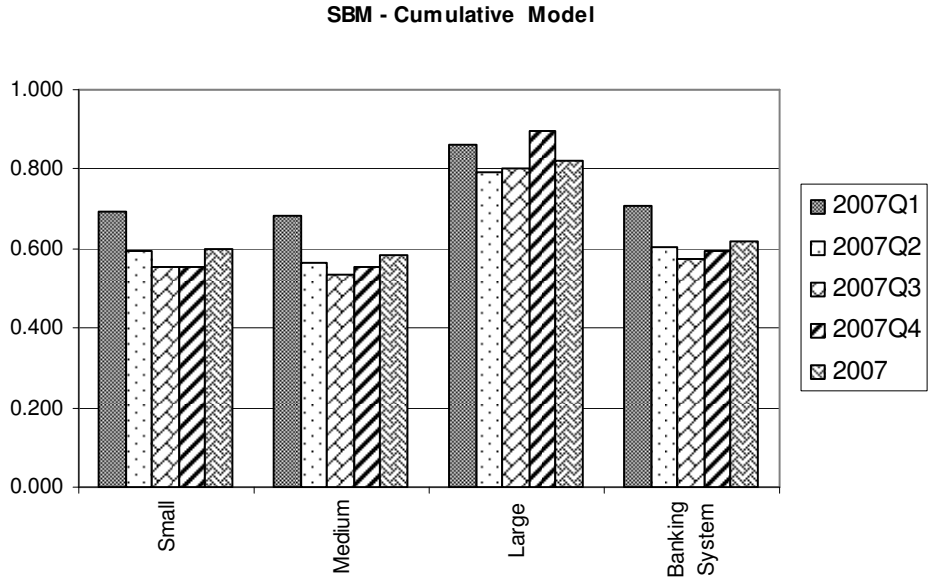


Figure 2.
The average efficiency scores of Indonesian banks by size compared with the average efficiency of the banking system



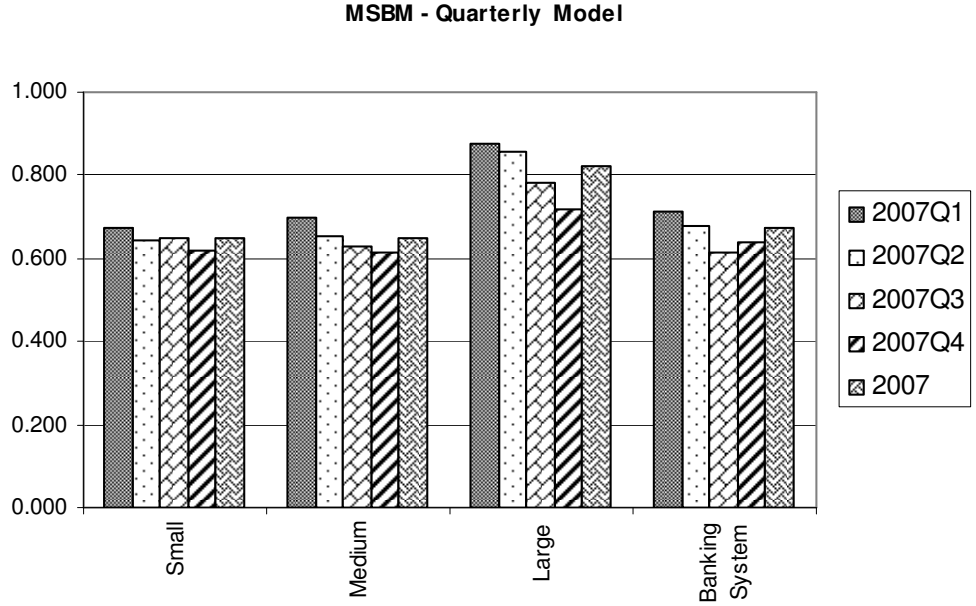
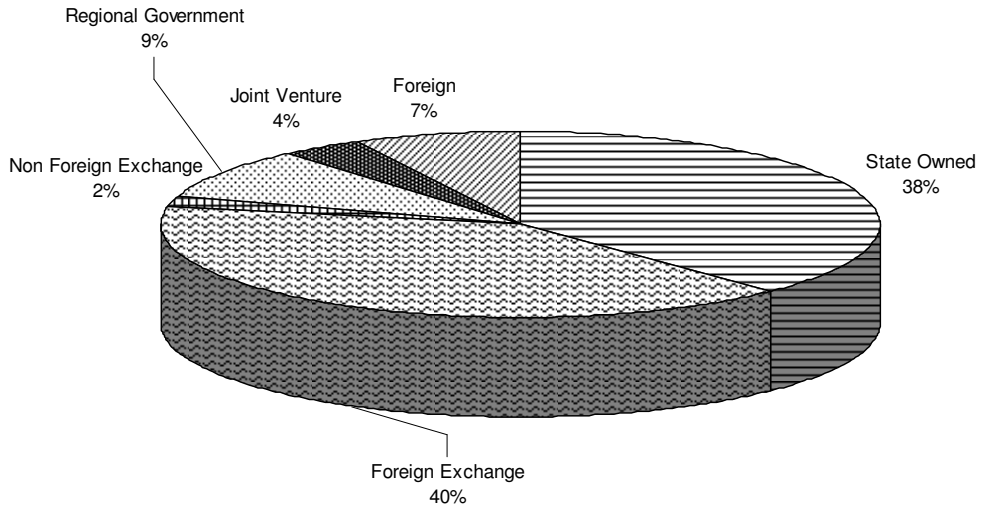


Figure 3.
The share of total customer deposits held by Indonesian banks (by ownership of banks) as at 01.01.2008



Appendix 1. Bank rankings by average efficiency scores.

SBM					MSBM				
Eff. score	Ranking	Bank name [1]	Type of bank [2]	Size grouping [3]	Eff. score	Ranking	Bank name [1]	Type of bank [2]	Size grouping [3]
1.000	1	iiir	A, LS	L	1.000	1	iiir	A, LS	L
1.000	1	iidi	A	S	1.000	1	iidi	A	S
1.000	1	iipi	A, LS	L	1.000	1	iipi	A, LS	L
1.000	1	iihp	B, LS	L	1.000	1	iira	F	M
1.000	1	iibi	B, LS	L	1.000	1	didi	C	S
1.000	1	iibr	F	M	1.000	1	drqr	E	S
1.000	1	iira	F	M	0.990	7	iiar	B, LS	L
1.000	1	iirr	F	M	0.980	8	iiap	B, LS	L
1.000	1	iiqb	E	M	0.967	9	idii	E	M
1.000	1	iddp	E	S	0.959	10	iibr	F	M
1.000	1	idpb	E	M	0.956	11	idai	E	M
1.000	1	didi	C	S	0.955	12	ipsp	D	M
1.000	1	drqr	E	S	0.946	13	iirr	F	M
0.996	14	iiar	B, LS	L	0.942	14	idpb	E	M
0.972	15	iipb	B, LS	L	0.930	15	iihp	B, LS	L
0.965	16	idhr	F	M	0.928	16	idhr	F	M
0.965	17	disa	C	S	0.910	17	iiqr	E	M
0.961	18	irsb	B, LS	L	0.893	18	idpi	E	M
0.960	19	idai	E	M	0.878	19	dqip	E	M
0.952	20	idia	F	M	0.841	20	iipp	A, LS	L
0.945	21	iipp	A, LS	L	0.833	21	idap	F	S
0.929	22	idii	E	M	0.833	22	irda	C	S
0.928	23	dqip	E	M	0.832	23	irsb	B, LS	L
0.888	24	iqpp	C	S	0.825	24	iihi	B, LS	L
0.887	25	idpa	E	M	0.824	25	iipb	B, LS	L
0.880	26	iihb	B, LS	L	0.803	26	iiqb	E	M
0.851	27	idir	F	M	0.803	27	idpp	E	M
0.830	28	idpp	E	M	0.800	28	iirb	F	L
0.821	29	ddii	C	S	0.796	29	iahi	C	M
0.820	30	iiba	F	M	0.792	30	dima	C	S
0.768	31	iiqa	E	M	0.791	31	iqib	B, I	M
0.763	32	idpi	E	M	0.785	32	idia	F	M
0.739	33	iiap	B, LS	L	0.777	33	disb	C	S
0.739	34	dima	C	S	0.771	34	iphb	D	M
0.737	35	irda	C	S	0.764	35	diqr	C	S
0.736	36	iirb	F	L	0.764	36	iibb	F	L
0.732	37	iiqr	E	M	0.758	37	iddr	E	M
0.729	38	iaia	A	L	0.757	38	iqpp	C	S
0.688	39	didb	C, I	M	0.754	39	iddp	E	S
0.683	40	dqia	E	M	0.750	40	ddii	C	S
0.683	41	ipsp	D	M	0.748	41	ipqr	B, I	M
0.667	42	idap	F	S	0.746	42	irrb	B, LS	L

SBM					MSBM				
Eff. score	Ranking	Bank name [1]	Type of bank [2]	Size grouping [3]	Eff. score	Ranking	Bank name [1]	Type of bank [2]	Size grouping [3]
0.666	43	irrb	B, LS	L	0.741	43	ddhb	C, LS	M
0.660	44	diqr	C	S	0.734	44	iqhb	C	S
0.660	45	iddr	E	M	0.733	45	iiqa	E	M
0.656	46	iimi	F	S	0.720	46	iibi	B, LS	L
0.646	47	iqar	C	M	0.718	47	iaia	A	L
0.641	48	disb	C	S	0.715	48	ipap	D	M
0.633	49	iibb	F	L	0.708	49	idmr	B	M
0.620	50	ddpr	C	S	0.701	50	iimb	E, LS	S
0.617	51	idqr	B, LS	M	0.700	51	iihb	B, LS	L
0.617	52	idrp	B	M	0.694	52	iisi	B, LS	M
0.614	53	diaa	C	S	0.686	53	ippa	D	L
0.612	54	iphb	D	M	0.677	54	iisb	B	L
0.595	55	ipap	D	M	0.672	55	didb	C, I	M
0.595	56	iiaa	B	M	0.666	56	dqii	E	M
0.591	57	idmr	B	M	0.663	57	idir	F	M
0.587	58	diib	C	S	0.654	58	idqa	B, LS	M
0.585	59	ihpb	B	M	0.651	59	iqar	C	M
0.585	60	iisi	B, LS	M	0.642	60	iqqp	B	M
0.578	61	iapr	C	M	0.636	61	ihib	B	M
0.574	62	ihpp	B	M	0.631	62	idpa	E	M
0.573	63	iisb	B	L	0.626	63	iqma	B	M
0.572	64	dirr	C	S	0.611	64	drqa	E	S
0.567	65	iqrb	C	S	0.610	65	ippb	D	M
0.565	66	dibb	C	S	0.610	66	ipbi	D	M
0.562	67	iqmp	C	S	0.606	67	diib	C	S
0.560	68	ihdr	B	M	0.603	68	iqmp	C	S
0.559	69	idqa	B, LS	M	0.602	69	ddpi	C, LS	M
0.556	70	ippa	D	L	0.596	70	ipar	D	M
0.552	71	ddpp	C	S	0.596	71	iimi	F	S
0.551	72	ihdi	B	M	0.595	72	ddpr	C	S
0.550	73	ddhp	C	S	0.591	73	idqi	B	S
0.549	74	dqii	E	M	0.591	73	ihir	B	S
0.543	75	ihib	B	M	0.589	75	disa	C	S
0.541	76	iihi	B, LS	L	0.589	76	dddi	C	S
0.541	77	iphi	D	M	0.585	77	iphi	D	M
0.539	78	disi	C	S	0.582	78	iimr	B, LS	M
0.538	79	iqma	B	M	0.580	79	ipqa	B, LS	M
0.527	80	ihhr	B, LS	M	0.579	80	ipsa	D	M
0.518	81	ipqr	B, I	M	0.573	81	ipbr	D	M
0.514	82	ipqa	B, LS	M	0.570	82	disi	C	S
0.511	83	ipba	D	M	0.569	83	idqr	B, LS	M
0.507	84	dihi	C	S	0.568	84	ipma	D, LS	M
0.494	85	dimb	C	S	0.564	85	iphp	D	M
0.490	86	ihhb	C	S	0.557	86	ihdi	B	M
0.488	87	ipbp	D	M	0.557	87	ipmp	D	S
0.486	88	iimr	B, LS	M	0.553	88	diaa	C	S

SBM					MSBM				
Eff. score	Ranking	Bank name [1]	Type of bank [2]	Size grouping [3]	Eff. score	Ranking	Bank name [1]	Type of bank [2]	Size grouping [3]
0.478	89	ddhb	C, LS	M	0.549	89	ipsb	D	M
0.477	90	ipar	D	M	0.549	90	dibb	C	S
0.475	91	idri	B	S	0.548	91	ipbp	D	M
0.473	92	iqqp	B	M	0.547	92	ddhr	C	M
0.462	93	iqra	C	M	0.546	93	ihpp	B	M
0.458	94	ipha	D	M	0.545	94	ipha	D	M
0.454	95	iphp	D	M	0.541	95	irar	C	S
0.449	96	ihpr	B	S	0.540	96	ddhp	C	S
0.448	97	idsb	B, LS	M	0.538	97	iapr	C	M
0.447	98	ipsi	D	M	0.538	98	dihi	C	S
0.446	99	ipab	D	M	0.536	99	ihpb	B	M
0.442	100	ddda	C	M	0.536	100	dirr	C	S
0.441	101	ihhp	B	S	0.536	101	dqia	E	M
0.433	102	ipsb	D	M	0.534	102	ipba	D	M
0.429	103	ipbr	D	M	0.533	103	ipaa	D	M
0.427	104	ippb	D	M	0.533	104	dimb	C	S
0.426	105	dddi	C	S	0.529	105	ihhb	C	S
0.424	106	iqib	B, I	M	0.527	106	ipsi	D	M
0.419	107	irar	C	S	0.527	107	ddpp	C	S
0.418	108	ipai	D	M	0.527	108	ihhp	B	S
0.415	109	iphr	D	M	0.525	109	iqra	C	M
0.413	110	ipbi	D	M	0.524	110	ipai	D	M
0.412	111	ipmi	D	M	0.521	111	ihhr	B, LS	M
0.407	112	ihir	B	S	0.520	112	diii	C	S
0.400	113	iahi	C	M	0.519	113	ddda	C	M
0.395	114	diii	C	S	0.519	114	iqrb	C	S
0.394	115	ipsa	D	M	0.519	115	iiba	F	M
0.393	116	drqa	E	S	0.518	116	iiaa	B	M
0.390	117	ipqb	B, LS	M	0.511	117	ihdr	B	M
0.390	118	iimb	E, LS	S	0.511	118	diab	C	S
0.386	119	ipma	D, LS	M	0.510	119	ipab	D	M
0.380	120	ippr	D	M	0.509	120	idrp	B	M
0.378	121	ipaa	D	M	0.509	121	ipqb	B, LS	M
0.371	122	ddhr	C	M	0.507	122	idri	B	S
0.369	123	dihr	C	S	0.504	123	dihr	C	S
0.363	124	ddpi	C, LS	M	0.495	124	idsb	B, LS	M
0.356	125	ipsr	D	M	0.495	125	ipbb	D	M
0.351	126	iqhb	C	S	0.491	126	iphr	D	M
0.338	127	diab	C	S	0.486	127	ihpr	B	S
0.337	128	ipmp	D	S	0.467	128	ipmi	D	M
0.323	129	ipbb	D	M	0.466	129	ipsr	D	M
0.286	130	idqi	B	S	0.461	130	ippr	D	M

Notes: 1. Codes are used to preserve anonymity.
2. A = state-owned, B = foreign exchange, C = non-foreign exchange, D = regional government-owned, E = joint venture, F = foreign, I = Islamic, LS = listed.
3. S = small, M = medium, L = large.