Bank Efficiency and Productivity Growth in Indonesia during Restructuring Period

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Abstract

More than a decade after the severe economic crisis in 1997, Indonesia has undergone major changes in the banking industry. The restructuring program is continuing up to the present to strengthen and improve the performance of the banking system. This paper examines and analyses the efficiency and productivity change in the Indonesian banking industry during the restructuring period, encompassing the 12 years from 2000 to 2011. Employing non-parametric data envelopment analysis (DEA) and a *Malmquist* productivity index (MPI), this study provides measures of technical efficiency, efficiency change and technological change using panel data from 108 commercial banks. The finding suggests that in general the structural reforms have improved the average level of bank efficiency and productivity in which efficiency change is the main source of productivity improvements rather than technological change. It also reveals that the efficiency score under variable returns to scale is higher than under constant return to scale. Furthermore, the improvement of scale efficiency change indicates the positive effect of the structural reforms through mergers and acquisitions.

JEL classification: G21, G28, G34

Keyword: Efficiency; productivity; data envelopment analysis; *Malmquist* indices; banking.

1. Introduction

After the Asian financial crisis (AFC) in 1997, the Indonesian banking sector underwent tremendous upheaval following changes in government regulations. Currency, banking and debt crises were the additional features of the crisis faced by the Indonesian economy. Most of the actions taken by regulators following this financial crisis have been aimed at bank restructuring. The restructuring aims to rebuild the industry toward a stronger and more resilient system. In the case of Indonesia, the restructuring program was not only because it was urgently needed, but because also it was required by the terms of the IMF assistance

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received (Sato 2005). The restructuring has taken the form of bank closures, mergers, acquisitions and businesses converting from conventional commercial banks to Islamic banks. Officially, the IMF assistance ended in 2004; however, the restructuring action seems to have continued up to the present day. As can be seen in Table 1, mergers have occurred every one of the 12 years, and also there has been an increasing trend for foreign ownership.

Even though the Indonesian banking sector is apparently in better shape than in the year after the crisis, its performance is still worthy of assessment. This paper examines the growth of productivity and efficiency using non-parametric data envelopment analysis (DEA)–*Malmquist* index to measure productivity growth. The advantage of this approach is its ability to decompose productivity growth into efficiency change and technical change.

The remainder of this paper is structured as follows. Section 2 provides a brief history and background of the Indonesian banking sector. Section 3 includes a review of related studies, followed by Section 4 which presents the methodology, variables and data. Section 5 discusses the empirical results and Section 6 concludes the paper.

2. The Indonesian Banking Industry

The financial sector in Indonesia, like most emerging economies, is dominated by the banking industry. However, the share of the financial sector assets as a proportion of the GDP is relatively small (below 60%) compared to China, Korea, Malaysia and Thailand (International Monetary Fund 2010) . Commercial banks are the engine room of the industry, as historically their lead is far ahead of the rural banks. The share of commercial banks to the total assets in the industry is above 90%, on average, during the last decade[2]. The commercial banks are divided into six groups, namely (including their assets share in 2011): state owned banks (36%); foreign exchange commercial banks (40.1%); non-foreign exchange commercial banks (2.9%); regional development banks (8.3%); joint venture banks (5%); and foreign owned banks (7.3%).

Table 1 reveals the structure of Indonesian commercial banks during the last twelve years. It is obvious that the restructuring programs have resulted in a constant decrease in the number of banks from 239 in 1996 to 151 in 2000, then decreasing to 120 banks in 2011. These numbers include two Islamic commercial banks in 2000 and 11 in 2011. The reduction is mainly due to post-crisis liquidations and mergers, which commenced in 1999. Even though

[2] Calculated from Indonesian Banking Statistic, (Bank Indonesia 2000-2011)

the development of Islamic commercial banks is noticeable following the release of Act No 21 of 2008, the conventional commercial banks still dominate the industry with more than 95%[3] of total assets on average during the last decade. Furthermore, the structure of the banking system has also changed due to an increasing foreign presence in the banking industry from 4.5% in 2000 to 45.8% in 2009. The sale of government shares to both domestic and foreign investors during a re-privatisation program from 2000 to 2007 has been a major cause (Zhang and Matthews 2011).

Table 1 Summary of Indonesian Banking Industry Profile

Descriptions	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Mergers*	7 (1)	9 (4)	5 (1)	2 (1)	3 (1)	2 (1)	2 (1)	4 (2)	7 (3)	2 (1)	2 (1)	2 (1)
Number of Banks	151	145	141	138	133	131	130	130	124	121	122	120
Total Assets (IDR tn)	1,039.9	1,099.7	1,112.2	1,213.5	1,272.1	1,469.8	1,693.9	1,986.5	2,310.6	2,534.1	3,008.9	3,652.8
Foreign ownership**	4.5 %	NA	NA	31.0%	NA	39.7%	41.9%	42.1%	48.0%	45.8%	NA	NA

Note: * Number outside the parentheses is total banks closed through merger; number in parentheses is the number of merged banks
** Including foreign bank branches, joint-venture and foreign acquisition banks. The rest of the percentage is domestic ownership which consist of state and privately owned banks
Source: Indonesia Bank Directory, (Bank Indonesia 1995-2010b)
Indonesia Bank Statistic, (Bank Indonesia 2000-2011)
IMF Country Report (International Monetary Fund 2004) and Bank Supervision report(Bank Indonesia 1995-2010a)

The better shape of the industry is evident in the increase in total assets, which is reversing the trend of the number of banks. However, the increase is not a constant growth as the global economic turbulence in 2009 lowered the growth rate to only 9.7% in 2009 while in 2008 the growth was 16.3%.

Following the crises, the Indonesian banking industry underwent substantial regulatory changes due to: the amendment of Central Bank Act (No 23 of 1999) in 2004; the enactment the of Islamic Bank Act in 2008; the establishment of The Indonesian Deposit Insurance Corporation (IDIC) in 2004; and lately, the establishment of the Financial Service Authority (FSA) in 2011. The essence of these events is to convey the industry toward international practice standards such as: the independence of the central bank; a proper deposit guarantee scheme; and an integrated supervision system.

3. Related Studies

Efficiency and productivity studies in the literature have grown rapidly during the last decade, including applications in banking sector. After being predominantly conducted in

[3] Calculated from Indonesian Banking Statistic, (Bank Indonesia 2000-2011)

developed economies, recently, the studies have been expanded to consider emerging economies including Asian countries (Kourouche 2008). Some of the studies in emerging economies include Taiwan (Chiu, Chen, and Bai 2011), Hong Kong (Drake, Hall, and Simper 2006)India (Kumar, Malathy, and Ganesh 2010), Singapore (Lee, Worthington, and Leong 2010), the Philippines (Manlagñit 2011), Malaysia (Sufian 2009) and Brazil (Tecles and Tabak 2010). However, in the case of Indonesian banks only a few studies appear in the literature. These include studies by Harada and Ito (2005), Hadad et al. (2008), Hadad et al. (2010a), Sufian (2010), and Zhang and Matthews (2011) who use non-parametric data envelopment analysis (DEA) to examine Indonesian bank efficiency. While (Margono, Sharma, and Melvin 2010) employing parametric stochastic frontier analysis (SFA) find that cost efficiency of Indonesian banks increased from 65% to 91% in the pre-crisis period then later decreased to 53%.

There are two basic approaches that are used to estimate the productivity change: the parametric approach which is the econometric estimation of production; and non-parametric which is the done through the construction of an index number. This study adopts the latter because it does not require setting a functional form in the structure of production technology. The non-parametric *Malmquist* productivity index approach has been widely employed in measuring total factor productivity growth in the banking industry. A survey by Fethi and Pasiouras (2010) shows that most of the bank performance measurement studies employ a DEA-like *Malmquist* index to estimate the total factor productivity growth in banking. Among others, studies that employ the *Malmquist* method in the banking industry are: Berg, Førsund, and Jansen (1992) who assess the productivity of Norwegian banks; Gilbert and Wilson (1998) and Lee, Worthington, and Leong (2010) who both examine Korean banks in different periods, Drake (2001) analyses UK banks; Sathye (2002) and Salim, Hoquea, and Suyanto (2010) Australian banks, Isik and Kabir Hassan (2003) Turkish banks; Rezitis (2008) Greek banks; Matthews and Zhang (2010) examine Chinese banks from 1997 to 2007; and Arjomandi, Valadkhani, and Harvie (2010) examine Iranian banks.

Nonetheless, as far as the authors are aware, there have been only two studies on Indonesian banks which use this methodology that have been published scholarly journals. These studies are by Omar, Majid, and Rulindo (2007) and Hadad et al. (2010b). The first study only covers 21 national commercial banks over the period 2002–2004. They report that the TFP has improved by 4.6% and the main contributor to the improvement is technical change. While

the second study reveals similar results in which the average productivity of Indonesian banks, represented by 130 banks, was around 0.964 to 1.074.

4. Methodology

4.1 *Malmquist* Productivity Index

Färe et al. (1992) combine the study of efficiency measurement by (Farrell 1957) with measurement of productivity by Caves, Christensen, and Diewert (1982) to construct the *Malmquist* productivity index and explain the decomposition of total factor productivity into efficiency change and technical change. Later, Färe et al. (1994) provide the decomposition of efficiency change into pure technical efficiency change and scale efficiency change.

The *Malmquist* productivity index can be defined by using the technology set, ***S***. Assume that for every time period $t = 1, 2, \ldots, T$, ***S*** transforms inputs into outputs as:

$$S = \{(x, y) : x \text{ can produce } y\} \quad (1)$$

Given the a production technology defined by ***S*** in Equation 1, it is similarly defined using the output set, ***P(x)***, which represents the set of all output vectors, ***y***, which can be produced using the input vector, ***x***. Hence,

$$P(x) = \{y : x \text{ can produce } y\}^4 \quad (2)$$

The framework of the Färe et al. (1994) basic idea regarding a production frontier is also clearly illustrated using the diagram in Coelli et al. (2005, 71). The MPI measures the total factor productivity (TFP) change between two data points by computing the ratio of the distances of each data point relative to a common technology. Two types of distance function are an input-distance function or an output-distance function. The input-distance function is described as the minimum proportional reduction of the input vector, given a fixed output vector. Likewise, the output-distance function is defined as a maximum proportional increase of the output vector, given a fixed input vector. Therefore, it is possible to estimate the MPI using an output-orientated or input-orientated procedure.

As the Indonesian banking sector seems to have less control over output produced compared to inputs used, this study adopts input-orientated MPI to estimate the efficiency and

[4] The underlying assumption regarding the model is discussed in Coelli et al. (2005)

productivity. Other studies that employ this approach are Gilbert and Wilson (1998), Rebelo and Mendes (2000) and Lee, Worthington, and Leong (2010).

Following Färe et al. (1994), the input-orientated *Malmquist* TFP index is expressed using the distance function with respect to two periods: period *s* (the base period) and period *t*, as follows:

$$m_I\ (y_s, x_s, y_t, x_t\ ) = \left[\frac{d_I^s\ (x_t, y_t)}{d_I^s\ (x_{s,}\ y_s)} \times \frac{d_I^t\ (x_t, y_t)}{d_I^t\ (x_{s,}\ y_s)}\right]^{1/2} \qquad (3)$$

where the subscript *I* denotes an input-orientation, $d_I^s\ (x_{s,}\ y_s)$ and $d_I^t\ (x_{s,}\ y_s)$ are measures of technical efficiency in period *s* and period *t* respectively, $d_I^s\ (x_t, y_t)$ is the distance function from the period *t* observation to the period *s* technology and $m_I\ (y_s, x_s, y_t, x_t\ )$ represents the MPI, which shows the change in productivity of the DMU under review. If the value of m_I is greater than one then it indicates a positive growth of TFP from period *s* to period *t*, whereas, if it is less than one, it implies a declining TFP between the two periods.

The MPI can be decomposed into two elements to find the catching-up effect and frontier-shift by rewriting the productivity index as follows:

$$m_I\ (y_s, x_s, y_t, x_t\ ) = \frac{d_I^t\ (x_t, y_t)}{d_I^s\ (x_{s,}\ y_s)}\left[\frac{d_I^s\ (x_t, y_t)}{d_I^t\ (x_t, y_t)} \times \frac{d_I^s\ (x_{s,}\ y_s)}{d_I^t\ (x_{s,}\ y_s)}\right]^{1/2} \qquad (4)$$

The term outside the square brackets represents the change in the input-oriented measure of Farrell technical efficiency between periods *s* and *t*. Hence, the change in technical efficiency is equivalent to the ratio of Farrell technical efficiency in period *t* to the Farrell technical efficiency in period *s.* The term in the square brackets represent the technical change (or the technological change) between periods *s* and *t*. Using Equation 3, this study separates the technical efficiency change from technological change.

To obtain the empirical results, four distance functions in equation 4 are calculated for each firm (in this case, bank) and in each pair of adjacent years. Coelli et al. (2005) describe the mathematical programming technique needed to calculate the distances measure. The DEAP Version 2.1 software (Coelli 1996) is utilised to calculate the indices.

4.2 Data

The data are taken from the individual bank's financial statement published by the Indonesian Central Bank (*Bank Indonesia*) over the period 2000 to 2011 . The data set is comprised of annual observations for 108 commercial banks. The representation of banks in each group is: state owned banks (4 banks), foreign exchange commercial banks (31 banks), non-foreign exchange commercial banks (24 banks), regional development banks (26 banks), joint venture banks (14 banks) and foreign owned banks (9 banks). Based on the number of existing banks in 2011, 12 banks have to be excluded because of incomplete data and some others started their business operations after 2000. Yet, the average representation of data in terms of total commercial bank assets is 93% over the period of analysis.

The measure of efficiency and productivity might be meaningless if input and output measures used are not specified carefully. Das and Ghosh (2006) and Sathye (2001) emphasise the input and output specification in banking efficiency and productivity studies has a crucial effect on the outcome. The literature shows intermediation and production approaches are the most popular method in specifying input and output in efficiency and productivity studies (Berger and Humphrey 1997). However, up to the present time there is no consensus which approach work best.

The production approach regards banks as production centres for depositors and borrowers (Denizer 1999) in which deposits are placed as one of the outputs. While the intermediation approach, introduced by Sealey Jr and Lindley (1977), focuses on the function of banks in intermediating funds from depositors to the borrowers, where deposits are treated as inputs together with other input variables.

Following the intermediation approach, this study includes four inputs: total deposits (x_1) including saving deposits, time deposits, demand deposits and other purchased funds; employee expenses (x_2) measured by the total salaries and wages; fixed assets (x_3) representing capital, measured by the book value of premises and fixed assets; and total non-employee expenses (x_4) including non-interest expenses namely repairs and maintenance, promotion, goods and services. Whereas, the four outputs consist of: total loans (y_1); measured by total commercial loans; other earning assets (y_2) including placement in other banks (interbank assets), securities held and placement in Bank Indonesia; interest income (y_3); and non-interest income (y_4) including fee and commission income, gains on sale of financial assets and other income. Table 2 provides a summary of the inputs and outputs used

over the study period. The Table reveals that total deposits is the dominant input while total loans is the biggest part of the output on average.

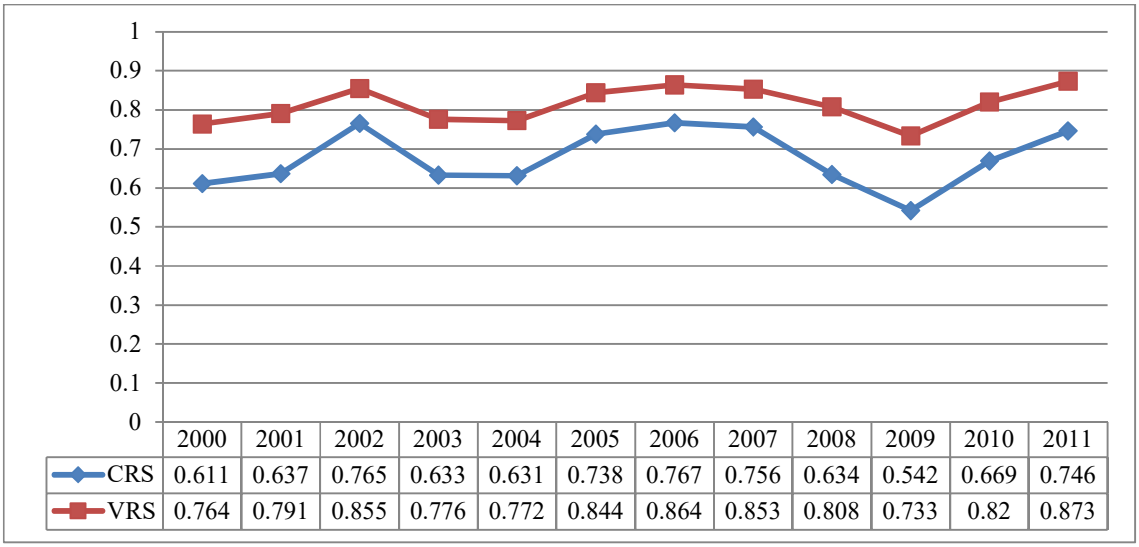
Table 2. Descriptive Statistics (in Million IDR)

Variables	Mean	Median	Max.	Min.	Stdr Dev
Inputs					
Total deposits (x_1)	13,046,648	1,799,763	392,682,681	173	38,700,364
Employee expenses (x_2)	248,008	37,939	8,104,779	862	729,953
Fixed assets (x_3)	377,784	54,429	9,258,876	1,559	1,112,789
Total non-employee expenses (x_4)	359,736	44,842	15,476,439	659	1,076,050
Outputs					
Total loans (y_1)	8,213,922	1,223,047	283,586,497	1,229	24,274,878
Other earning assets (y_2)	4,978,003	882,970	188,450,470	7,579	15,400,674
Interest income (y_3)	1,577,999	247,136	50,312,251	1,168	4,489,227
non-Interest income (y_4)	231,319	16,330	6,321,040	36	647,957

5. Empirical results

The average efficiency scores across 108 banks over twelve years (2000–2011) using input-oriented non-parametric DEA-like MPI, under both CRS and VRS, are illustrated in Figure 1. The values show the percentage of the realized amount of input compared to the minimum potential input level at any given output produced on average. A value of unity indicates that the bank is on the frontier or relatively efficient and a value below unity indicates that the bank is below the frontier or relatively less efficient. Both results, either under CRS or VRS, exhibit the same pattern. Even though the industry is inefficient over the years, in general it shows an improvement. The technical efficiency was increasing in the initial period until 2002, then the efficiency score declines in 2004 which is in line with the Omar, Majid, and Rulindo (2007) result, however, this is not the only decline because in 2009 the efficiency hit the lowest levels, 0.542 (CRS) and 0.733 (VRS). The global economic crisis in 2008–2009 affected the performance of the Indonesian banking industry. Afterwards, the efficiency level increased remarkable during 2010–2011. It is obvious from Figure 1 that under VRS, the annual mean of technical efficiency of the Indonesian banks is higher than under CRS.

Figure 1. Efficiency under CRS and VRS (annual mean)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
CRS	0.611	0.637	0.765	0.633	0.631	0.738	0.767	0.756	0.634	0.542	0.669	0.746
VRS	0.764	0.791	0.855	0.776	0.772	0.844	0.864	0.853	0.808	0.733	0.82	0.873

Table 3 shows a summary of the number efficient banks in each group both under CRS and VRS along with the number of observed banks in each group[5]. Under CRS, state owned banks represent the least in terms of the percentage number of efficient banks over the period with zero percentage. The smallest number of efficient banks under VRS is for regional development banks from year 2000 to 2007, then replaced by foreign exchange commercial banks from 2008 onward. To the contrary, under VRS the state owned banks provide the highest number of efficient banks where all of the banks in this group are on the frontier. Whereas, joint venture banks have the most banks that are on the frontier under CRS from 2000 to 2007, but then foreign banks take over the lead. This finding is relatively similar to Hadad et al. (2008) in relation to the state owned banks and regional development banks being the most and the least efficient respectively in their analysis.

[5] The results for all banks in each year of analysis are available from authors upon request.

Table 3. Number of Efficient Banks in Each Group.

Years		State Owned Banks	Foreign Exchange Commercial Banks	Non-Foreign Exchange Commercial Banks	Regional Development Banks	Joint Venture Banks	Foreign Owned Banks	Total
Number of banks		**4**	**31**	**24**	**26**	**14**	**9**	**108**
2000	CRS	0	4	4	0	6	1	15
	VRS	3	10	7	2	7	7	36
2001	CRS	0	2	1	1	6	1	11
	VRS	3	8	5	5	8	5	34
2002	CRS	1	2	4	2	5	3	17
	VRS	3	12	10	6	9	7	47
2003	CRS	0	1	0	1	5	2	9
	VRS	4	7	5	2	8	7	33
2004	CRS	0	1	0	0	7	3	11
	VRS	3	8	3	3	8	7	32
2005	CRS	0	1	3	2	9	4	19
	VRS	4	9	5	4	10	7	39
2006	CRS	0	1	4	2	6	4	17
	VRS	4	9	5	3	7	8	36
2007	CRS	0	0	3	2	5	3	13
	VRS	4	6	5	5	7	8	35
2008	CRS	0	0	1	2	4	6	13
	VRS	4	5	3	7	7	9	35
2009	CRS	0	0	2	0	3	7	12
	VRS	3	5	4	5	5	9	31
2010	CRS	0	0	3	1	5	6	15
	VRS	4	8	4	9	6	7	38
2011	CRS	0	1	8	1	5	7	22
	VRS	4	11	11	9	5	9	49

Measurement of technical efficiency over time only provides a partial view of bank performance. Since the improvement or deterioration in efficiency could be caused by either the change of input-output mix of the banks (efficiency change) or the shift of the boundary of the production frontier over time (technological change).

The empirical result obtained from the *Malmquist* productivity index is divided in three parts: the estimation of total factor productivity (TFP) change; the decomposition of productivity change into technological change or 'frontier-shift effect'; and efficiency change or 'catch-up effect'. The last is the further decomposition of efficiency change into pure efficiency change and scale efficiency change. The summary of all components of efficiency is presented in Table 4, including the number of efficient banks in each component.

Table 4. Summary of Annual Mean of TFP, Technological and Efficiency Change in Indonesian Banks

Year	TFP change		Technological change		Efficiency Change		Efficiency Change			
							PE change		SE change	
	Result	No. of efficient banks	Result	No. of efficient banks	Result	No. of efficient banks	Result	No. of efficient banks	Result	No. of efficient banks
2001	1.071	67	1.008	41	1.062	73	1.057	75	1.005	69
2002	1.009	55	0.835	5	1.209	99	1.105	95	1.093	90
2003	0.902	27	1.127	66	0.800	29	0.893	47	0.896	32
2004	0.964	49	0.946	44	1.019	65	1.012	70	1.006	65
2005	0.971	51	0.817	13	1.188	95	1.098	92	1.08	77
2006	1.082	78	1.035	58	1.045	75	1030	79	1.015	73
2007	0.932	30	0.947	17	0.984	58	0.989	66	0.995	56
2008	1.003	57	1.225	100	0.819	21	0.952	57	0.860	22
2009	0.996	57	1.118	97	0.840	26	0.897	51	0.937	47
2010	0.993	42	0.785	5	1.263	103	1.121	98	1.127	81
2011	0.984	49	0.875	28	1.125	83	1.066	83	1.055	75
Mean	**0.990**		**0.970**		**1.021**		**1.017**		**1.003**	

Note: PE Change is pure efficiency change; SE change is scale efficiency change

The findings suggest that, on average, the TFP change shows a slight decreasing trend over the period of analysis. During two years at the beginning of the period, the productivity change is above unity, and then it decreases in the following year before it gains the highest score at 1.081 in 2006. Afterwards, the annual mean of TFP is decreasing until the end of the period where during the last three years it is always below unity and ends up with a negative 1.6%. Explicitly, Table 4 reveals the deterioration in TFP change was due to decreasing technological change of 3%, while the improvement in efficiency change was only 2.1%.

It is obvious from Table 4 that the main driver of productivity change is the efficiency change. The annual mean score efficiency changes are mostly above unity over the period, except during 2003, 2007, 2008 and 2009 where the score is decreased by 20%, 1.6%, 18.1% and 16% respectively. While during these four years, technological change takes the lead above efficiency change to contribute more to the productivity change in 2003, 2008 and 2009 by gaining 12.7%, 22.5% and 11.8% respectively. Nevertheless, these divergences have resulted in different effects on TFP growth. In 2003 and 2009 TFP growth falls is regressed by 9.8% and 0.4% respectively due to larger declines in efficiency change, but then it improves by 0.3% in 2008 due to a larger improvement in technological change. This fact

implies that the Indonesian banking industry is still vulnerable to the global financial crisis which happened in 2008–2009. Moreover, in terms of the number of banks, of the 108 there were 87 in 2008 and 82 in 2009 that declined in their "best-practice" measures in reaction to that crisis or in other words only 21 and 26 banks perform above the frontier.

It is important to note that banking restructuring is supposed to move the industry towards good management practices, improve the efficiency of resource utilisation and enlarge productive capacity, and hence increase productivity growth. However, this may not seem to hold true if the results of TFP change in Table 4 are observed. The TFP growth exhibits an increase by 7.1%in the initial period but then it falls by 1.6% at the end. In terms of technological change, it does not seem that the rapid development of current banking technology, such as automatic teller machines (ATMs) and e-banking, have greatly increased technological change in the industry. This is noticeable from Table 4 in which technological change decreases by 21.5% and 12.5% in 2010 and 2011, respectively, whereas at the beginning of the period it was above 1.00.

As discussed previously, the efficiency change is the important source of TFP growth; it is evident in Table 4 that the efficiency change is relatively consistent being above 1.00 except in 2003, 2008 and 2009. It starts at a positive 6.2% in 2001, it is ends just over double that at the end of the period at 12.5%. A further examination is conducted to investigate the source of efficiency change through decomposition of this component into pure efficiency change and scale efficiency change. The result is presented in Columns 8 and 10, in Table 4 along with the number of efficient banks in Columns 9 and 11 in the same table. The results show that most of the banks perform efficiently except for the year 2003, and 2007 to 2009 which is identical with the earlier analysis. On average, both pure efficiency and scale efficiency contribute positively towards the efficiency change. Although, it is found that pure efficiency change contributes a larger amount (1.7 %) than scale efficiency (0.3 %). This implies that the size of the bank has an insignificant effect on efficiency change.

Based on the summary of individual bank MPI measures, the number of efficient banks could be classified per group of banks[6]. Table 5 reveals the number of efficient banks that lie above the frontier in each group. Foreign banks are seen to be the most productive in terms of TFP and technological change by having 66.7% and 33.3%, respectively, of its banks lying above

[6] The results for all banks in each year of analysis are available from author upon request

the frontier, while the joint venture banks group is the least (0%). The better performance of foreign banks in technological change indicates that this group is more advanced in their technology while offering their services.

All state owned banks and foreign banks are efficient in the efficiency change measure including pure efficiency change and scale efficiency change. Whereas regional development banks have the least number of banks efficient in terms of technological change.

Table 5 Summary of Bank Means based on the Number of efficient Banks per Group

Group of banks	Number of banks	TFP Ch	Tech Ch	Eff Ch	PE Ch	SE Ch
State Owned Banks	4	2	1	4	4	4
Foreign Exchange Commercial Banks	31	11	4	23	25	13
Non-Foreign Exchange Commercial Banks	24	12	3	20	18	21
Regional Development Banks	26	14	1	24	20	13
Joint Venture Banks	14	0	1	8	9	6
Foreign Owned Banks	9	6	3	9	9	9
Total	108	45	13	88	85	66

In general, Table 5 shows that the number of banks that are efficient in technological change is less than half of the total banks. While the number of efficient bank in others components, efficiency change, pure efficiency change and scale efficiency change, are more than half above the frontier.

6. **Conclusions**

This paper employs *Malmquist* indices, calculated using the DEA approach, to examine efficiency and productivity growth in the Indonesian Banking Industry during the restructuring period. A panel data set of 108 banks is utilised. The overall technical efficiency is improved during the study period even though the mean scores are below the frontier. The efficiency change is found to be the main contributor to the productivity change rather than technological change. Furthermore, pure efficiency change is the main source of efficiency change. The improvement of scale efficiency could be regarded as the result of the restructuring program conducted by the monetary authority. Some of the results are similar to the findings in studies conducted by Omar, Majid, and Rulindo (2007) and Hadad et al. (2008) regarding the efficiency of the Indonesian banking sector. However different data sets and periods of study produce different scores.

The policy implication is that the efficiency and productivity growth of the Indonesian Banking Industry still has the space to improve. This improvement could be gained through a proper adoption of technology given the remarkable technological innovations in the banking industry worldwide.

Eventually, it should be noted that this study is conducted using a non-parametric MPI approach and the reliability of the results are not tested. Hence, the estimation might provide more comprehensive results and findings if statistical testing is conducted.

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