The Evolution of Bank Productivity Growth in Indonesia: An Empirical Analysis during 1993-2011

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Abstract

This study investigates the source of productivity growth in the Indonesian banking sector during 19 years from 1993 to 2011. The industry had been through several periods of reforms, starting from the radical deregulation in the late 1980s, the restructuring period following the 1997 Asian financial crisis, to the consolidation period in the mid-2000s. Using panel data of 101 commercial banks, we explore productivity growth using *Malmquist* indices complemented with bootstrapping technique of Simar and Wilson (1999) to provide measures of the statistical precision of the results. The *Malmquist* index provides measures of total factor productivity, efficiency change and technological change. Results show the productivity is progressing moderately and appears to be less volatile towards the end of the period. Furthermore, technological change tends to be the main sources of productivity improvement rather than efficiency change.

JEL Classification: G21, C14, C61

Keywords: Productivity; Banking; Data envelopment analysis; Bootstrap; Malmquist indices

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1. Introduction

As in many other countries, the Indonesian financial sector has experienced several major changes in the last two decades. Starting from a closed or repression era and moving to the liberalism era, the banking sector of Indonesia has evolved following several changes in regulations. Radical reform in the late 1980s has contributed to the massive increase in the number of banks until the 1997 Asian financial crisis struck the country severely and forced the regulator to close unsound banks. The initial sequence of the financial reform resulted in eliminating the government intervention, increasing competition among banks by easing entry requirements in the industry, improving the intermediary role of the banking sector. Nonetheless, the lack of proper supervision systems, inadequate deposit guarantee schemes, and poor economic fundamentals have contributed to the weakness of the banking sector during the reform process and thereafter. Recently, consistent policies toward a stronger banking structure have been supported by the establishment of mandatory regulatory institutions, such as the Indonesian Deposit Insurance Corporation (IDIC) and the Financial Service Authority (FSA). The latter institution serves as the integrated supervision agency which supervises all the financial institutions.

Given that the banking sector functions as the main engine in the Indonesian financial system, those changes should have affected the bank productivity. Berger and Humphrey (1997) note that that deregulation is typically aimed to improve market competition by reducing barriers to competition, reducing subsidies to protected sectors and improving the regulatory and contracting environment. Therefore, deposits and credits should be intermediated more effectively, reducing inefficiency in the system, boosting productivity and enhancing economic growth.

Empirical studies around the world produce various results with regard to the effect of financial reforms on bank efficiency and productivity. Some show an improvement, other studies reveal opposite results or that there are no significant changes compare to prior reform. With regard to this perspective, no empirical study has investigated the impact of changes in regulation, especially after the Asian crisis, on productivity growth of the Indonesian banks. Thus, this study fills a void in the empirical work to address the question

of whether productivity in Indonesian bank has improved and what is the source of the improvement.

Previous studies on Indonesian bank productivity focus the analysis using a short period of data and/or only investigate the performance of a particular group of banks (Omar, Majid and Rulindo 2007; Hadad et al. 2008; Hadad et al. 2011). In this study, we investigate the productivity of Indonesian banks as a whole during the period from before the Asian crisis (1993) until recently (2011) using the bootstrapped Malmquist productivity index (MPI) proposed by Simar and Wilson (1999). This method allows for the assessment of the "null hypothesis" of no efficiency change, no technological change and no productivity gains or losses (Tortosa-Ausina et al. 2008). Thus, with the longer period of data and provision of statistical tests on the result, this study presents an important extension to the literature especially in the Indonesian context.

The remainder of this paper is organised as follows: the next section briefs the Indonesian banking sector followed by a discussion on related studies in Section 3. Section 4 presents data and variables employed in this study. The empirical analysis, which includes empirical model and estimation results, are discussed in Section 5. Section 6 concludes the paper.

2. The Indonesian Banking Industry

The Indonesian banking system is made up of commercial banks and rural banks. Business line and operational coverage differentiate these two classes of banks. Based on the current Indonesian Banking Act, each of the classifications is further classified into the conventional bank and Islamic (sharia) banks. Table 1 shows the distribution of total assets, number of banks and number of branches for each classification. Despite the large and increasing number of rural and Islamic banks, the conventional commercial banks still dominate the industry by, on average, above 70% of the total assets.

After the 1997/1998 financial crisis, a series of policies and regulations were introduced to restructure and promote the banking sector toward a stronger and resilient industry. A number of bank closures, mergers and acquisitions occurred following the policy.The reforms resulted in a decreasing trend in the number commercial banks, while the assets and number of branches are moving in an upward direction (see Table 1).

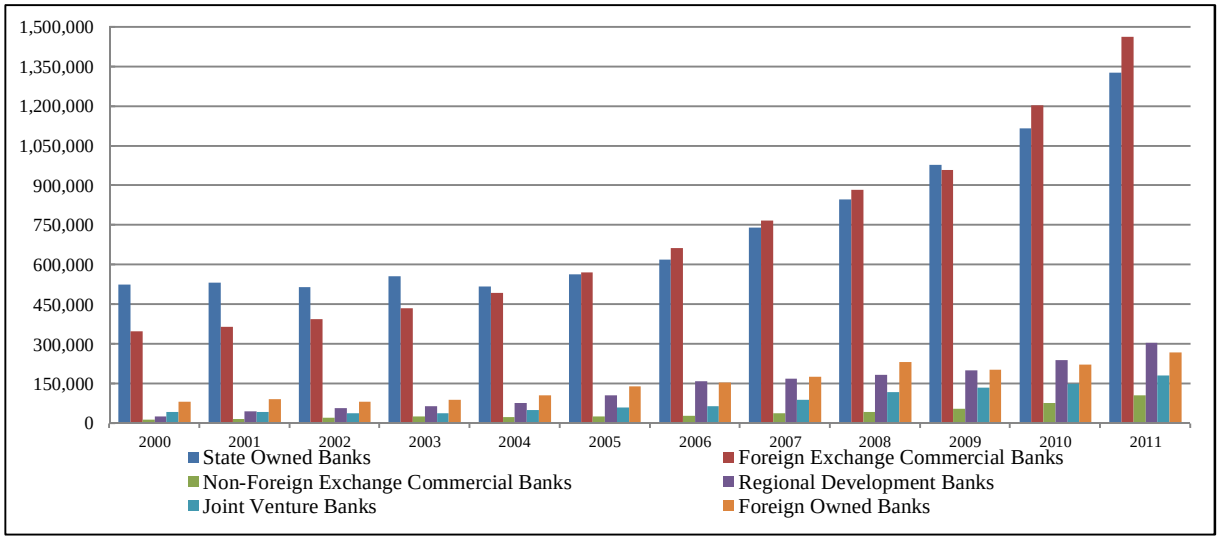
Table 1 Distribution of Total Assets, Total Banks and Total Banks Branches

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Assets (Millions IDR):												
Conventional Commercial Banks	1,038,134	1,097,199	1,108,633	1,206,939	1,259,554	1,452,716	1,672,699	1,959,215	2,276,521	2,486,092	2,929,667	3,535,902
Sharia Comercial Banks	1,721	2,500	3,571	6,579	12,527	17,111	21,151	27,286	34,036	48,014	79,186	116,930
Rural Banks	4,731	6,474	9,080	12,635	16,707	20,393	23,045	27,741	32,533	37,554	45,742	55,799
Sharia Rural Banks	-	-	-	-	-	585	896	1,215	1,693	2,123	2,739	3,520
Total	1,044,586	1,106,173	1,121,284	1,226,153	1,288,788	1,490,805	1,717,791	2,015,457	2,344,783	2,573,783	3,057,334	3,712,151
Total Banks :												
Conventional Commercial Banks	149	143	139	136	130	128	127	127	119	115	111	109
Sharia Comercial Banks	2	2	2	2	3	3	3	3	5	6	11	11
Rural Banks	4,731	2,355	2,141	2,141	2,158	2,009	1,880	1,817	1,772	1,733	1,706	1,669
Sharia Rural Banks	-	-	-	-	-	92	105	114	131	139	150	155
Total	4,882	2,500	2,282	2,279	2,291	2,232	2,115	2,061	2,027	1,993	1,978	1,944
Total Banks Offices :												
Conventional Commercial Banks	6,492	6,681	6,888	7,541	7,676	7,935	8,764	9,282	10,157	12,017	12,622	13,407
Sharia Comercial Banks	55	84	113	189	263	301	346	398	711	820	1,215	1,390
Rural Banks	1,482	2,432	2,747	3,299	3,472	3,110	3,173	3,250	3,367	3,644	3,910	4,172
Sharia Rural Banks	-	-	-	-	-	92	105	185	202	225	286	364
Total	8,029	9,197	9,748	11,029	11,411	11,438	12,388	13,115	14,437	16,706	18,033	19,333

Source: Indonesian Banking Statistics, Bank Indonesia, various editions.

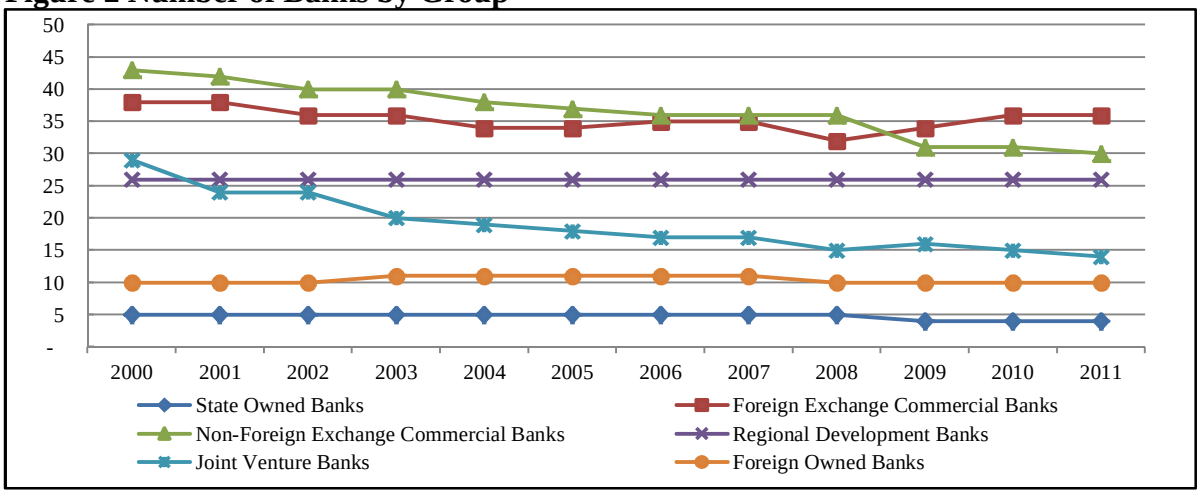
Officially, the commercial banks are classified into six bank groups based on the ownership and or type of authorisation, namely, state owned banks, foreign exchange commercial banks, non-foreign exchange commercial banks, regional development banks, joint venture banks and foreign owned banks (see Figure 1 and Figure 2). Figure 1 presents the total assets and Figure 2 the number of banks per bank group. The shift of leadership in assets from state owned banks to foreign exchange commercial banks, from 2005 onward, is worth to observe. Prior to that period, the state owned banks dominated the total assets of the industry, although the number of banks is the smallest among the groups. The decreasing number of banks is mainly contributed by non-foreign exchange commercial and joint venture banks.

Figure 1 Total Assets (Billion IDR)



Source: Indonesia Banking Statistics, Bank Indonesia, various editions.

Figure 2 Number of Banks by Group



Source: Indonesia Banking Statistics, Bank Indonesia, various editions.

The financial reforms changed the structure of bank ownership in the industry. Before the crisis (1996), the share of domestic private banks to the banking industry was more than half, followed by the share of state owned at 39%, and with the foreign share less than 10%. Afterwards, however, foreign ownership increased steadily and reached almost half of the industry assets share-based in 2008, before it slowed down in 2009. The foreign presence is not merely in the form of full ownership, but also in the form various joint venture businesses. The share of domestic private banks has dropped gradually moving to less than 10% share in the industry. Government ownership enlarged its share sharply during the recovery period before declining from 2005 to 2008.

3. Related Studies

Over the last decade, research interest on bank efficiency and productivity has expanded from developed countries to developing and emerging economies, including Asian countries. Some cross country studies that include Indonesian banks in their analysis are Laeven (1999); (2001); Williams and Nguyen (2005); Ariff and Can (2009) (Gardener, Molyneux and Nguyen-Linh 2011) and Thoraneenitiyan and Avkiran (2009). Their results show the Indonesian banks tend to be fall behind in terms of efficiency or productivity compared to other countries. Their research mainly concentrates on bank performance related to the 1997 Asian financial crisis.

The literature shows there are two basic approaches used to estimate the productivity change: the parametric approach, which is the econometric estimation of a production function; and the non-parametric approach, which is done through the construction of index numbers. This

study adopts the latter because it does not require specifying a functional form for the structure of production technology.

The non-parametric Malmquist productivity index approach, proposed by Caves, Christensen, and Diewert (1982), is 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) for Norwegian banks, Gilbert and Wilson (1998) for Korean banks, Sathye (2002) for Australian banks, Isik and Hassan (2003) for Turkish and Matthews and Zhang (2010) for Chinese banks.

There are a few scholarly studies focussing on Indonesian banks that use MPI method. These studies are Omar et al. (2007), Hadad et al. (2010) and Hadad et al. (2011). Omar et al. assess private national banks and find that total factor productivity (TFP) improves during the period of 2002-2004, with the year 2003-2004 noted as having the highest growth. The technical change is found to be the main contributor to the TFP growth. Hadad et al. (2010) research listed bank productivity using monthly data from 2003 to 2007 and report that Indonesia's listed banks' productivity fluctuate and that the productivity mainly is driven by the frontier shift. Using quarterly data of 2003 through 2007, Hadad et al. (2011) find that the main sources of the productivity change in the financial intermediary activities of Indonesian banks is the improvement in their intermediation technology.

Despite their important findings, these studies investigate the industry partially with no further update data beyond 2007. This leaves a void in the literature, especially in Indonesian banks context to further research on the evolution of Indonesian bank productivity. Also, a key criticism is that the standard Malmquist index does not provide statistical properties. However, there are now a small number of studies using bootstrap MPI. Some important research using this method include Tortosa-Ausina et al. (2008), Arjomandi, Valadkhani, and Harvie (2011) and Wheelock and Wilson (1999). We add to the literature by extending that data sample to 2011 and by adopting the bootstrap MPI method.

4. Data and Variables

We obtain our dataset from individual bank financial statements published by the Indonesian Central Bank (*Bank Indonesia*) over the period 1993 to 2011 (19 years). The data set is

comprised of annual observations of 101 commercial banks, which is comprised of state banks (4 banks), private banks (53 banks), regional development banks (25 banks), joint venture banks (11 banks) and foreign banks (8 banks). Retaining a balanced panel data for almost two decades length is challenging, especially when the banking industry has been through extensive restructuring. Therefore, some adjustment has to be made. The banks that are included in the data set are all those that existed continuously from 1993 until 2011. Excluded are banks that liquidated or closed during the period of study, have extensive missing data, or were just established within the covered period. Yet, the included banks represent 96% of total commercial bank assets over the period of analysis.

There are two main methods that appear frequently in the literature for modelling the bank production process, the intermediation and production approaches. The first approach, developed by Sealey and Lindley (1977), focuses on the function of banks in intermediating funds from depositors to borrowers, with deposits used to produce loans and other assets. The second approach views banks as production centres, where banks utilise physical inputs (labour and capital) to produce deposits and other outputs (Denizer 2000). Berger and Humphrey (1997) emphasise that the intermediation approach is suited to measuring efficiency for the whole financial institution, while the production approach is properly used for the bank branch level.

We utilise both approaches and specify inputs and outputs under two models, Model A and Model B Under Model A, total deposits and fixed assets are set as inputs, while total loans and other earning assets are set as outputs. In Model B, the inputs include interest expenses and non-interest expenses, whereas the outputs comprise of interest income and non-interest income. Details of the inputs and outputs are presented in Table 2.

Table 2 Input and Output Variables

Model	Outputs	Inputs
Model A	Total Loans (y_1)	Total Deposits (x_1)
	Other Earning Assets (y_2)	Fixed Assets (x_2)
Model B	Interest Income (y_1)	Interest Expenses (x_1)
	Non-Interest Income (y_2)	Non-Interest Expenses (x_2)

5. Empirical Results

5.1 Methodology

Following Färe et al. (1994) the output-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:

$$m_0\ (y_s, x_s, y_t, x_t\ ) = \left[\frac{d_0^s\ (x_t, y_t)}{d_0^s\ (x_{s,}\ y_s)} \times \frac{d_0^t\ (x_t, y_t)}{d_0^t\ (x_{s,}\ y_s)}\right]^{1/2} \quad (1)$$

where $d_0^s\ (x_{s,}\ y_s)$ and $d_0^t\ (x_{s,}\ y_s)$ are measures of technical efficiency in period *s* and period *t* respectively. $d_0^s\ (x_t, y_t)$ is the distance function from the period *t* observation to the period *s* technology $d_0^t\ (x_s, y_s)$ is the distance function from the period *s* observation to the period *t* technology and $m_0\ (y_s, x_s, y_t, x_t\ )$ is the MPI. If the value of m_0 is greater than one then there is positive growth of TFP from period *s* to period *t*, whereas a value less than one implies a declining TFP between the two periods.

Färe and Lovell (1978) show that the MPI can be decomposed into two elements to find the catching-up effect and frontier-shift effect by rewriting the productivity index as follows:

$$m_0\ (y_s, x_s, y_t, x_t\ ) = \frac{d_0^t\ (x_t, y_t)}{d_0^s\ (x_{s,}\ y_s)}\left[\frac{d_0^s\ (x_t, y_t)}{d_0^t\ (x_t, y_t)} \times \frac{d_0^s\ (x_{s,}\ y_s)}{d_0^t\ (x_{s,}\ y_s)}\right]^{1/2} \quad (2)$$

The term outside the square brackets in Equation 2 represents the change in the output-oriented measure of Farrell technical efficiency between periods *s* and *t*. The term in the square brackets stands for the technical change (or the technological change) between period *s* and *t*.

Equation (2) does not inform about the statistical reliability of the change in productivity, efficiency or technology. Thus, a consistent bootstrapping procedure is employed in obtaining confidence intervals for the Malmquist index and its components, efficiency change and technological change. In adapting the bootstrapping procedure for Malmquist indices Simar and Wilson (1999) use a bootstrap algorithm for efficiency scores with a bivariate smoothing procedures to avoid any temporal correlation.

This process can be summarised as follows:

1. Calculate the MPI $\widehat{M}_i(t_1, t_2)$ for each bank $(i = 1, \dots, N)$ at time $(t_1 \text{ and } t_2)$ by solving the linear programming models (see e.g. Coelli et al. (2005, 297))

2. Construct a pseudo-dataset $\{(x_{it}^*, y_{it}^*); i = 1, \dots, N; t = 1,2\}$ to form the reference bootstrap technology using the bivariate kernel density estimation and the reflection method proposed by Simar and Wilson (1999)
3. Calculate the bootstrap estimate of the Malmquist index $\widehat{M}_i(t_1, t_2)$ for each bank using the original estimators for the pseudo-sample obtained in step 2.
4. Repeat steps 2 and 3 *B* times (in this study, *B* = 2,000 times), to facilitate a set of estimates for each bank.
5. Construct the confidence intervals for the Malmquist indices accordingly.

Once the bootstrap estimates of the MPI are obtained, a multivariate regression model is employed to estimate the determinants of productivityusing a regression equation of the form:

$$Y_{it} = z_i \beta_i + \varepsilon_i \quad (3)$$

where *Y* is a measure of the productivity index of bank *i* in period *t*. z_i is the vector of observed variables explaining bank productivity, which includes macroeconomic conditions, market concentration, bank-specific factors, bank restructuring, regulatory change, bank status and ownership structure. β is the vector of parameters to be estimated and ε denotes an error term.

5.2 Productivity of the Indonesian Banking Sector

Table 3 reports the annual average change in productivity, efficiency and technology for each year from 1993 to 2011. The results of each model show that the industry has exhibited progress in TFP based on the mean over the considered period. Model B appears to have a slightly higher mean TFP growth (0.9%) than Model A (0.39%). The growth in Model A is largely driven by gains in technological change with an annual average change of 4.06%, whereas efficiency change contributes negatively to TFP growth by -3.52%. In Model B, both components contribute positively to the TFP index, with the technological component shown to be slightly higher (0.46%) than the efficiency change (0.43%).

These results suggest that productivity growth under each model largely results from the frontier shift rather than from catching up. This outcome is even more evident in the intermediation function (Model A) of the banking industry. These results confirm the findings of Omar, et al. (2007) of a positive contribution of technological change to

improvement in TFP. By contrast, Hadad et al. (2008), employing the DEA-Malmquist index, discover that technological change drives TFP downward.

Table 3 Annual Mean of TFP, Efficiency and Technological Change

Year	TFP		Efficiency Change (EC)		Technological Change (TC)		Pure Efficiency (PE)		Scale Efficiency (SE)		Pure Technology(PT)		Scale of Technology (ST)	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
1993-94	1.005	1.003	0.838	0.998	1.200	1.005	0.901	0.987	0.930	1.011	1.187	1.023	1.014	0.982
	(0.047)	(0.016)	(0.045)	(0.016)	(0.022)	(0.003)	(0.042)	(0.012)	(0.025)	(0.016)	(0.029)	(0.028)	(0.027)	(0.021)
1994-95	1.136	0.953	0.653	0.969	1.740	0.983	0.830	1.037	0.786	0.935	1.490	0.932	1.169	1.054
	(0.062)	(0.041)	(0.029)	(0.050)	(0.059)	(0.010)	(0.028)	(0.027)	(0.020)	(0.015)	(0.047)	(0.008)	(0.046)	(0.008)
1995-96	1.010	0.955	1.567	0.949	0.644	1.007	1.153	0.959	1.360	0.989	0.915	1.007	0.703	1.000
	(0.036)	(0.016)	(0.073)	(0.014)	(0.030)	(0.006)	(0.047)	(0.012)	(0.075)	(0.008)	(0.037)	(0.008)	(0.022)	(0.007)
1996-97	0.920	1.035	0.850	1.076	1.083	0.962	1.055	1.059	0.806	1.017	0.840	0.966	1.309	0.995
	(0.032)	(0.025)	(0.042)	(0.025)	(0.045)	(0.017)	(0.067)	(0.020)	(0.028)	(0.013)	(0.034)	(0.016)	(0.066)	(0.007)
1997-98	0.835	1.314	0.543	1.527	1.537	0.861	0.644	1.271	0.844	1.201	1.278	0.942	1.199	0.906
	(0.058)	(0.280)	(0.036)	(0.229)	(0.048)	(0.030)	(0.030)	(0.119)	(0.026)	(0.192)	(0.059)	(0.036)	(0.035)	(0.017)
1998-99	0.959	0.906	1.728	1.194	0.555	0.759	1.147	1.290	1.506	0.925	0.817	0.726	0.673	1.058
	(0.059)	(0.081)	(0.103)	(0.113)	(0.022)	(0.018)	(0.052)	(0.139)	(0.093)	(0.053)	(0.047)	(0.022)	(0.022)	(0.028)
1999-00	1.127	0.850	0.878	0.669	1.283	1.270	1.098	0.690	0.800	0.970	1.014	1.284	1.275	0.989
	(0.047)	(0.060)	(0.043)	(0.032)	(0.040)	(0.024)	(0.043)	(0.033)	(0.033)	(0.020)	(0.037)	(0.052)	(0.046)	(0.019)
2000-01	1.041	0.915	1.047	0.945	0.994	0.968	1.056	0.985	0.992	0.960	0.964	0.933	1.032	1.038
	(0.035)	(0.024)	(0.046)	(0.024)	(0.015)	(0.012)	(0.040)	(0.022)	(0.030)	(0.010)	(0.017)	(0.015)	(0.019)	(0.015)
2001-02	1.050	0.967	0.912	1.009	1.152	0.959	0.898	1.052	1.016	0.959	1.125	0.916	1.024	1.045
	(0.035)	(0.026)	(0.029)	(0.034)	(0.011)	(0.019)	(0.028)	(0.034)	(0.041)	(0.012)	(0.027)	(0.020)	(0.018)	(0.016)
2002-03	1.110	1.070	1.157	2.694	0.960	0.397	0.993	1.873	1.164	1.438	1.062	0.551	0.903	0.716
	(0.059)	(0.027)	(0.063)	(0.139)	(0.005)	(0.035)	(0.026)	(0.113)	(0.056)	(0.079)	(0.015)	(0.041)	(0.012)	(0.020)
2003-04	0.993	1.103	0.770	1.517	1.290	0.727	0.892	1.269	0.863	1.196	1.107	0.825	1.166	0.879
	(0.020)	(0.064)	(0.041)	(0.076)	(0.061)	(0.008)	(0.025)	(0.105)	(0.036)	(0.039)	(0.034)	(0.023)	(0.061)	(0.041)
2004-05	0.991	1.157	0.729	0.282	1.359	4.108	0.956	0.430	0.762	0.655	1.025	2.719	1.328	1.532
	(0.033)	(0.587)	(0.023)	(0.046)	(0.051)	(0.224)	(0.021)	(0.039)	(0.018)	(0.031)	(0.033)	(0.330)	(0.038)	(0.115)
2005-06	0.976	0.927	1.038	0.909	0.940	1.020	0.990	0.927	1.049	0.980	0.951	0.983	0.989	1.039
	(0.012)	(0.017)	(0.020)	(0.017)	(0.012)	(0.008)	(0.019)	(0.016)	(0.014)	(0.011)	(0.012)	(0.010)	(0.014)	(0.010)
2006-07	0.986	1.034	1.058	0.974	0.932	1.062	0.991	0.992	1.068	0.981	1.003	1.054	0.928	1.006
	(0.020)	(0.011)	(0.022)	(0.010)	(0.017)	(0.005)	(0.015)	(0.009)	(0.018)	(0.008)	(0.016)	(0.017)	(0.015)	(0.009)
2007-08	1.021	1.005	1.421	0.964	0.719	1.042	1.283	1.006	1.108	0.959	0.811	1.016	0.885	1.025
	(0.018)	(0.021)	(0.025)	(0.020)	(0.007)	(0.010)	(0.032)	(0.020)	(0.024)	(0.013)	(0.017)	(0.015)	(0.013)	(0.013)
2008-09	1.025	0.981	1.113	1.225	0.921	0.801	1.127	1.052	0.987	1.165	0.888	0.926	1.040	0.865
	(0.022)	(0.015)	(0.026)	(0.019)	(0.011)	(0.012)	(0.036)	(0.017)	(0.018)	(0.017)	(0.015)	(0.020)	(0.016)	(0.013)
2009-10	0.944	1.059	0.908	1.048	1.040	1.011	0.872	0.989	1.040	1.060	1.066	1.063	0.976	0.953
	(0.016)	(0.018)	(0.014)	(0.019)	(0.008)	(0.021)	(0.016)	(0.017)	(0.022)	(0.013)	(0.017)	(0.021)	(0.016)	(0.030)
2010-11	0.987	1.016	0.894	0.747	1.104	1.361	0.971	0.855	0.921	0.873	1.005	1.216	1.098	1.121
	(0.033)	(0.018)	(0.024)	(0.018)	(0.029)	(0.018)	(0.024)	(0.019)	(0.018)	(0.016)	(0.031)	(0.068)	(0.017)	(0.022)
Mean	**1.004**	**1.009**	**0.965**	**1.004**	**1.041**	**1.005**	**0.981**	**1.001**	**0.983**	**1.003**	**1.018**	**1.005**	**1.023**	**1.001**

Sources: Results based on MPI calculation. Note: TFP denotes total factor productivity. The standard errors are in the parentheses.

A further decomposition of efficiency change and technological change reveals that in Model A, pure efficiency and scale efficiency deteriorate by an average of -1.88% and -1.67%, respectively, which fully decomposes the decline in efficiency change. For technological change in Model A, pure technology and the scale of technology improve by 1.83% and 2.28%, respectively.

In Model B, all subcomponents contribute positively to the improvement of efficiency and technological change, particularly, scale efficiency and pure technology are major drivers, respectively.

Table 4 Summary of Bootstrap Results for TFP, Efficiency and Technological Change

Year		TFP Change						Efficiency Change (EC)						Technological Change (TC)					
		Modal A			Modal B			Modal A			Modal B			Modal A			Modal B		
		#	5%	1%	#	5%	1%	#	5%	1%	#	5%	1%	#	5%	1%	#	5%	1%
1993-94	Growth	43	37	3	52	52	-	24	24	-	47	47	-	80	80	-	45	45	-
	Stagnation	-	-	-	-	-	-	1	-	-	4	-	-	-	-	-	-	-	-
	Decline	58	44	8	49	48	-	76	76	-	50	50	-	21	21	-	56	56	-
1994-95	Growth	67	52	11	31	31	-	7	7	-	28	28	-	101	101	-	49	49	-
	Stagnation	-	-	-	-	-	-	1	-	-	4	-	-	-	-	-	-	-	-
	Decline	34	23	10	70	68	2	93	93	-	69	69	-	-	-	-	52	52	-
1995-96	Growth	55	55	-	43	37	3	84	84	-	42	42	-	16	16	-	54	54	-
	Stagnation	-	-	-	-	-	-	1	-	-	5	-	-	-	-	-	-	-	-
	Decline	46	46	-	58	52	4	16	16	-	54	54	-	85	85	-	47	47	-
1996-97	Growth	49	48	-	68	64	3	39	39	-	60	60	-	56	56	-	61	61	-
	Stagnation	-	-	-	-	-	-	1	-	-	2	-	-	-	-	-	-	-	-
	Decline	52	51	-	33	30	2	61	61	-	39	39	-	45	45	-	40	40	-
1997-98	Growth	27	27	-	60	58	1	14	13	-	81	67	-	94	94	-	25	23	-
	Stagnation	-	-	-	-	-	-	2	-	-	1	1	-	-	-	-	-	-	-
	Decline	74	74	-	41	41	-	85	47	18	19	19	-	7	7	-	76	36	18
1998-99	Growth	37	32	2	43	40	-	87	86	-	59	59	-	8	8	-	16	16	-
	Stagnation	-	-	-	-	-	-	3	-	-	2	-	-	-	-	-	-	-	-
	Decline	64	50	6	58	57	-	11	11	-	40	40	-	93	51	19	85	85	-
1999-00	Growth	66	63	0	44	40	2	34	34	-	13	11	-	80	80	-	93	93	-
	Stagnation	-	-	-	-	-	-	5	-	-	2	-	-	-	-	-	-	-	-
	Decline	35	32	2	57	55	1	62	62	-	86	79	2	21	21	-	8	8	-
2000-01	Growth	57	52	3	29	28	1	43	43	-	35	35	-	67	67	-	49	49	-
	Stagnation	-	-	-	-	-	-	3	-	-	3	-	-	-	-	-	-	-	-
	Decline	44	33	8	72	67	1	55	54	-	63	63	-	34	34	-	52	52	-
2001-02	Growth	62	47	3	53	45	5	30	30	-	32	32	-	101	101	-	84	84	-
	Stagnation	-	-	-	-	-	-	3	-	-	3	-	-	-	-	-	-	-	-
	Decline	39	25	8	48	45	-	68	68	-	66	66	-	-	-	-	17	17	-
2002-03	Growth	68	54	4	75	74	-	78	78	-	90	67	-	19	19	-	7	7	-
	Stagnation	-	-	-	-	-	-	2	-	-	2	-	-	-	-	-	-	-	-
	Decline	33	20	10	26	24	1	21	21	-	9	9	-	82	82	-	94	13	54
2003-04	Growth	62	58	1	75	74	-	38	38	-	91	91	-	67	67	-	-	-	-
	Stagnation	-	-	-	-	-	-	2	-	-	2	-	-	-	-	-	-	-	-
	Decline	39	39	-	26	24	1	61	61	-	8	8	-	34	34	-	101	101	-
2004-05	Growth	47	47	-	69	62	3	10	10	-	3	1	1	88	88	-	101	98	-
	Stagnation	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
	Decline	54	51	-	32	28	-	88	62	6	98	52	30	13	13	-	-	-	-
2005-06	Growth	45	42	-	32	29	-	57	56	-	23	22	-	39	39	-	62	62	-
	Stagnation	-	-	-	-	-	-	4	-	-	4	-	-	-	-	-	-	-	-
	Decline	56	53	1	69	67	1	40	40	-	74	74	-	62	62	-	39	39	-
2006-07	Growth	47	47	-	69	68	-	59	59	-	40	40	-	39	39	-	98	98	-
	Stagnation	-	-	-	-	-	-	6	6	-	6	-	-	-	-	-	-	-	-
	Decline	54	53	-	32	32	-	36	36	-	55	55	-	62	59	-	3	3	-
2007-08	Growth	58	51	3	52	50	1	94	93	1	31	31	-	-	-	-	88	88	-
	Stagnation	-	-	-	-	-	-	3	-	-	4	-	-	-	-	-	-	-	-
	Decline	43	35	3	49	45	1	4	4	-	66	66	-	101	100	-	13	13	-
2008-09	Growth	51	47	-	40	36	1	71	71	-	86	86	-	27	27	-	8	8	-
	Stagnation	-	-	-	-	-	-	4	-	-	5	-	-	-	-	-	-	-	-
	Decline	50	42	5	61	54	4	26	26	-	10	10	-	74	74	-	93	93	-
2009-10	Growth	36	34	0	68	66	-	22	22	-	63	63	-	80	80	-	41	41	-
	Stagnation	-	-	-	-	-	-	5	-	-	5	-	-	-	-	-	-	-	-
	Decline	65	60	2	33	32	1	74	74	-	33	33	-	21	21	-	60	60	-
2010-11	Growth	39	38	1	48	48	-	28	28	-	7	7	-	70	70	-	101	100	-
	Stagnation	-	-	-	-	-	-	4	-	-	5	-	-	-	-	-	-	-	-
	Decline	62	60	-	53	53	-	69	68	-	89	87	-	31	31	-	-	-	-

Note: #, 5%, and 1% denote number of estimates, number significant at 5% and at 1 %, respectively.

In Table 4, we present the bootstrap results by number of banks that have productivity growth (above unity), no change or stagnation (unity) and decline (below unity) in each year at 95% and 99% confidence intervals. The table shows most of the results are significant at 5%, which suggests that the changes in each components are relatively reliable. As emphasised by Simar and Wilson (1999, 471) 'as with any estimator, it is not enough to know whether the Malmquist index estimator indicates increases or decreases in productivity, but whether the indicated changes are significant in a statistical sense'. On average, 94% and 96% of % of the individual bank results for TFP change are significant, ranging from 82.2% to 100% and from 91% to 99%, for Model A and Model B, respectively.

Next, we analyse productivity growth for Indonesian bank by groups and size category as presented in Table 5 and Table 6, respectively. The investigation on groups of bank is done by averaging the TFP score for each of the five bank groups mentioned earlier and for three size categories. Also for simplicity, the annual results are averaged into four main periods; the period before the crisis (1993/94 - 1995/96), the crisis period (1996/97 – 1999/00), the recovery period (2000/01 – 2004/05) and the consolidation period (2005/06 – 2010/11).

Table 5 TFP, Efficiency and Technological Change by Bank Group

Year	Model A					Model B				
	SOB	**PNB**	**RDB**	**JVB**	**FB**	**SOB**	**PNB**	**RDB**	**JVB**	**FB**
TFP Change										
1993/94 - 1995/96	1.0525	1.0436	1.0261	1.1951	1.0470	0.9762	0.9723	0.9631	0.9803	0.9741
1996/97 - 1999/00	1.3088	0.9524	0.9514	0.9892	0.9234	1.8164	1.0003	0.9923	1.1004	1.0207
2000/01 - 2004/05	0.9267	1.0592	1.0089	1.0816	1.0210	1.0590	1.0522	1.0088	1.0305	1.1569
2005/06 - 2010/11	0.9369	0.9806	1.0375	1.0008	0.9404	0.9923	1.0052	1.0082	1.0401	0.9637
Overall mean	**1.0138**	**1.0011**	**1.0043**	**1.0395**	**0.9643**	**1.0198**	**1.0093**	**0.9937**	**1.0112**	**1.0000**
Efficiency Change (EC)										
1993/94 - 1995/96	1.0219	1.0785	1.0129	0.9810	0.9097	0.9880	0.9773	0.9482	1.0044	0.9724
1996/97 - 1999/00	1.4416	0.9916	1.0165	0.9807	0.9548	1.7485	1.0952	1.0936	1.0709	1.0748
2000/01 - 2004/05	0.7928	0.9264	0.9195	1.0152	0.9619	1.1728	1.3505	1.5021	1.1410	1.0412
2005/06 - 2010/11	1.0518	1.0809	1.0963	1.0793	0.9731	0.9685	0.9744	0.9868	1.0131	0.9652
Overall mean	**0.9888**	**0.9596**	**0.9575**	**1.0000**	**0.9446**	**1.0001**	**1.0025**	**0.9994**	**1.0031**	**0.9957**
Technological change (TC)										
1993/94 - 1995/96	1.1298	1.1610	1.2911	1.2646	1.2076	0.9888	0.9947	1.0164	0.9783	1.0022
1996/97 - 1999/00	1.0195	1.1779	1.1456	1.0281	1.0251	1.0136	0.9694	0.9308	1.0212	1.0282
2000/01 - 2004/05	1.2253	1.1866	1.1165	1.1426	1.0627	1.2747	1.4392	1.7257	1.1871	1.2797
2005/06 - 2010/11	0.9130	0.9303	0.9674	0.9397	0.9782	1.0535	1.0651	1.0361	1.0489	1.0117
Overall mean	**1.0253**	**1.0433**	**1.0489**	**1.0396**	**1.0208**	**1.0197**	**1.0068**	**0.9943**	**1.0081**	**1.0044**

Sources: Author's calculations. Note: SOB refers to a state-owned bank, PNB refers to a private national bank, RDB refers to a regional development bank, JVB refers to a joint venture bank and FB refers to a foreign bank.

All groups of banks are shown to have a positive productivity change over the period of study, except foreign banks (-3.57%) in Model A and regional development banks (-0.63%) in Model B. The decline in foreign banks derives mainly from the negative efficiency change, whilst in regional banks both components drag down the TFP. Comparison of the overall means in Model A indicates that the joint venture banks show the highest growth (3.95%), followed by state owned banks (1.38%), regional development banks (0.43%) and private national banks (0.11%). In Model B, state banks rank on the top (1.98%) of the list, followed by joint-venture banks (1.12%), private national banks (0.93%) and foreign banks (no change). These findings are consistent with those of Sufian (2011) and Fujii, Managi, and Matousek (2014) with regard to domestic banks outperforming foreign banks.

Technological change contributes most to the growth in the overall mean TFP index across the groups in both models. In Model A, remarkable technology improvement is recorded for regional banks and private national banks (4.89% and 4.33%, respectively). These results may be observed because most of the banks in these groups are in the stage of developing the technology that is commonly utilised in the banking business, such as ATMs, mobile banking and internet banking.

Table 6 TFP Index and Its Decomposition by Bank Size Category

Year	Model A			Model B		
	Large	**Medium**	**Small**	**Large**	**Medium**	**Small**
TFP change						
1993/94 - 1995/96	1.0346	1.0145	1.0524	0.9756	0.9495	0.9718
1996/97 - 1999/00	1.1696	0.9763	0.9464	1.5572	1.1399	1.0101
2000/01 - 2004/05	0.9425	1.0560	1.0436	1.0522	1.0827	1.0247
2005/06 - 2010/11	0.9594	1.0172	0.9839	0.9996	1.0004	1.0082
Overall mean	**1.0019**	**1.013**	**1.0005**	**1.0057**	**1.0231**	**1.0053**
Efficiency Change (EC)						
1993/94 - 1995/96	0.9758	0.9415	1.0279	0.9908	0.9591	0.9725
1996/97 - 1999/00	1.2717	1.0220	0.9799	1.5969	1.1792	1.1054
2000/01 - 2004/05	0.8152	0.9527	0.9269	1.1266	1.1507	1.3689
2005/06 - 2010/11	1.0550	1.0808	1.0683	0.9771	0.9755	0.9814
Overall mean	**0.9752**	**0.9822**	**0.9573**	**0.9903**	**1.0082**	**1.0023**
Technological change (TC)						
1993/94 - 1995/96	1.1942	1.1784	1.1967	0.9853	0.9902	0.9993
1996/97 - 1999/00	0.9853	1.0215	1.1429	1.0086	1.0029	0.9529
2000/01 - 2004/05	1.2083	1.1292	1.1594	1.2310	1.3443	1.5494
2005/06 - 2010/11	0.9255	0.9583	0.9468	1.0467	1.0468	1.0509
Overall mean	**1.0274**	**1.0313**	**1.0452**	**1.0155**	**1.0148**	**1.003**

Sources: Author's calculations. Note: TFP denotes total factor productivity.

The results, based on bank size (Table 6), reveal that all size categories have a positive productivity growth. However, unlike Rebelo and Mendes (2000), who find large and small banks have higher productivity, this study, under both models, finds medium-sized banks on average have achieved higher productivity growth than the two other categories.

We observe that for all sizes the growth in TFP index is slightly higher under Model B than Model A during the study period, which indicates that banks are more productive in term of generating revenue than intermediating funds. However, if the analysis is directed to sub-periods, the results are varied. For instance, in the pre-crisis period all categories have more productivity growth in a Model A than Model B. The industry was in its rapid expansion period, where banks were aggressively performed their lending activities and collecting deposits. However, revenue growth was reduced due to the small margin of interest between deposit and loan interest. The productivity of large banks isshown to have deteriorated consistently after the crisis, while medium banks took the lead in generating industry productivity growth.

On the decomposition side, TFP progress throughout the entire study period results from technological change by large, medium and small banks (2.74%, 3.13% and 4.52%, respectively). These increases are offset by the decreases in efficiency of -2.48%, -1.78% and -4.27% for large, medium and small banks, respectively. The decline in TFP in the three periods, which is during the Asian financial crisis of 1997, privatisation and the global financial crisis, is largely attributed to the decline in the efficiency index, which is larger than the increase in the technological index.

5.3 The Determinants of Indonesian Banks' Productivity Growth

Variation in the TFP scores among banks suggests that banks show varying responses to changes in regulations, policies and other external factors. This section examines potential drivers of bank productivity growth, including bank characteristics, macroeconomic conditions, mergers, regulatory changes, ownership structures and market concentration. The ability of banks to cope with these factors determines their relative performance and the performance of the industry as a whole.

To estimate the effect of the explanatory variables on bank productivity, Equation (3) is specified as a linear function of explanatory variables as follows:

$$TFP_{it} = \alpha + \beta_1 size_{it} + \beta_2 CAR_{it} + \beta_3 NPL_{it} + \beta_4 ROA_{it} + \beta_5 HHI_t + \beta_6 GDP_t + \beta_7 inlf_t + \beta_8 BMoney_t + \beta_9 Dforex_{it} + \beta_{10} Dlisting_{it} + \beta_{11} Dmerger_{it} + \beta_{12} DregCh_t + \beta_{13} D\_state_i + \beta_{14} D\_PureFB_i + \beta_{15} D\_private_i + \beta_{16} D\_JVB_i + \beta_{17} D\_RDB_i + \varepsilon_{it} \quad (4)$$

where TFP_{it} is the TFP index of bank i in year t as calculated using the bootstrapping MPI estimation. $size_{it}$ is the size of bank measured by the natural log of total assets bank i in year t. CAR_{it} NPL_{it} and ROA_{it} are the capital adequacy, non-performing loan and return on assets ratio of bank i in year t, respectively. These variables are included as bank characteristics. HHI_t is the Herfindahl index of market concentration in year t, measured as the sum of squared share for each bank of its loans to total loans. GDP_t, $inlf_t$, and $BMoney_t$ capture the macro economics conditions, which are annual gross national product growth, inflation measured by the annual percentage of consumer price and broad money measured by the sum of the currency outside the bank as a percentage of GDP, respectively. Bank status is represented by $Dforex_{it} = 1$ if bank i in year t is a foreign exchange bank, otherwise zero, and $Dlisting_{it} = 1$ if bank i in year t is listed in Indonesian stock exchange, otherwise zero. To capture the restructuring and regulatory change, respectively, $Dmerger_{it} = 1$ if bank i in year t is a merged bank, otherwise zero and $DregCh_t = 1$ for all observations after 2004, otherwise zero. Ownership structure consists of D_state_i, D_PureFB_i, $D\_private_i$, D_JVB_i, and D_RDB_i,, with each represented by a dummy = 1 if, respectively, bank i is a state bank, pure foreign bank, private national bank, joint venture bank or regional development bank, otherwise zero. ε_{it} is a random error term, $i = 1,\ldots, 101$, and $t = 1,\ldots, 19$.

We estimate two separate regressions due to unavailability of data for some bank-specific variables from before 2000. The first regression includes the period 1999 – 2011 without *CAR*, *NPL* and *ROA*, whereas the second regression only covers the period 2000 – 2011 but has all variables are included. The estimation results are presented in Table 7 for Model A and B.

All models have good explanatory power for both sample periods, and the Wald chi^2 tests are all statistically significant at 1%. All of the groups of banks (five groups) are included, but no estimated coefficient is shown for the regional development banks as this is the base case. Among bank characteristic variables, only the ROA consistently shows negative and strongly significant coefficients at 1% in both models, suggesting that banks with higher profitability have lower productivity growth. This finding confims other studies of

Indonesian banks by Hadad et al. (2011) and Malaysian banks by Sufian (2011), where banks with higher profits have less productivity growth. The negative effect of profitability on productivity suggests highly profitable banks are less engaged in cutting costs through increasing productivity.

Table 7 Determinants of TFP Growth – Tobit Regression Model

Variable	Model A				Model B			
	1993-2011		2000-2011		1993-2011		2000-2011	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Size	-0.006	0.009	0.004	0.009	0.032	0.036	0.046	0.048
CAR	-		-0.010	0.009	-		0.031	0.046
NPL	-		0.093	0.119	-		-0.267	0.638
ROA	-		-0.489***	0.171	-		-3.888***	0.916
HHI	-0.169	0.128	0.582	0.562	-0.158	0.510	6.817**	3.013
GDP	0.008	0.007	-0.011	0.018	-0.004	0.028	0.100	0.098
Infl	0.000	0.003	-0.006*	0.003	0.013	0.011	0.020	0.018
BMoney	0.001	0.003	0.010**	0.004	0.008	0.013	0.044*	0.023
Dforex	0.000	0.027	-0.008	0.027	-0.080	0.109	-0.048	0.146
Dlisting	0.020	0.033	-0.008	0.032	0.152	0.131	0.011	0.173
Dmerger	-0.056	0.048	-0.048	0.041	-0.177	0.193	-0.172	0.221
DRegCh	-0.104***	0.038	0.059	0.074	0.158	0.153	0.926**	0.399
D_state	0.032	0.056	-0.091*	0.055	0.373*	0.224	-0.185	0.296
D_PureFB	0.026	0.040	-0.026	0.041	0.461***	0.161	0.623***	0.221
D_Private	0.006	0.026	0.028	0.028	0.064	0.104	0.023	0.148
D_JVB	0.076**	0.038	0.045	0.040	0.156	0.151	0.098	0.214
Intercept	1.156***	0.187	0.254	0.553	0.306	0.746	-6.993**	2.962
/sigma_u	0.000	0.014	0.000	0.013	0.000	0.077	0.000	0.140
/sigma_e	0.397***	0.007	0.321***	0.007	1.583***	0.026	1.723***	0.035
Rho	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Log likelihood	-898.34		-343.95		-3414.19		-2378.42	
Wald chi^2	38.34***		64.16***		42.26***		38.73***	
Observation	1818		1212		1818		1212	

Note: ***, **, and * denote significance at the 1% level, the 5% level and the 10% level, respectively. SE is the standard error.

Results in Table 7 show no significant effect on bank size on productivity growth. Size has a positive impact on productivity when there are scale economies, but this may not be realised due to complexity of business, bureaucratic procedure and others (Ataullah and Hang 2006, and ; Delis, Molyneux and Pasiouras 2011). The weak impact of the size variable is consistent with the results in Table 6, where bank productivity is not linearly related to bank size.

The HHI coefficient is only statistically significant in the shorter period of Model B. Here, the positive coefficient suggests that banks tend to experience higher productivity growth in less competitive markets, but in Model A and for the longer sample period the coefficient is not significant and is of mixed sign. Also, there is no significant effect of bank mergers on productivity growth, although the estimated coefficients are consistently negative.

The macroeconomics variables are also varied across periods and models. Growth of *GDP* has mixed and statistically insignificant coefficients, which is similar to the findings of Sufian (2011) for Malaysian banks. Inflation has generally insignificant positive coefficients, but is weakly significant and negative in the shorter period (2000-2011) of Model A, which suggests that a higher inflationary environment is unfavourable to productivity growth. The coefficient of broad money is positive and statistically significant for the shorter sample period, which indicates that a higher amount of currency outside of the banks is associated with higher productivity growth of banks.

Operating as a foreign exchange bank and/or a listing bank has no significant effect on bank productivity. To some extent, this is surprising given that such banks are able to engage in an extended operation, more diversified financial products and has other option to finance their operation.

Estimates of the effect of regulatory change on productivity are mixed. The coefficient is positive and statistically significant under Model B in the shorter period, which suggests the change in regulation has enabled banks to increase productivity in generating revenue. However, the negative and significant effect in the longer period (1993–2011) of Model A suggests that changes in regulation decreases the rate of productivity growth in intermediating funds. Deliset al. (2011) report varying effects of changes in regulation upon productivity growth in Europe transition countries.

Most included ownership types show a positive relationship to the productivity growth over both sample periods, suggesting these bank groups have higher productivity growth than the excluded regional development bank type. Pure foreign banks have positive and highly significant coefficients in both periods with Model B, indicating more productivity growth in generating revenue than the excluded group. This result supports the typical findings in developing country studies, namely that foreign banks outperform their domestic counterparts. Private national and joint venture banks have positive coefficients across both models and periods, although the coefficient is only significant for joint venture banks in Model A for 1993-2011.The latter result again suggests a positive influence of foreign involvement on productivity growth.

With regard to state banks, the coefficient is negative in the shorter period (2000-2011), although this effect is only slightly statistically significant in Model A and not significant in

Model B. For the longer period the coefficient is positive for in both models, so that overall there appears little difference in the productivity growth of state banks compared to the excluded group of regional development banks.

6. Conclusions

The present study investigates the productivity the Indonesian banks during the period of 1993 to 2011. The bootstrap Malmquist productivity index (MPI) approach is used to measure productivity growth. Using panel data for Indonesian commercial banks, the investigation is conducted using both the intermediation and revenue approaches. The empirical findings suggests that, overall, productivity growth of the Indonesian banking industry positive under both approaches and that Model B has slightly higher productivity growth (0.90% per annum) than Model A (0.39% per annum), with growth appearing to be less volatile towards the end of the period. The source of growth under the both approaches is primarily through technological progress. Under the revenue approach, productivity growth is driven by technical efficiency improvement as well, although technological change is still marginally more important.

The estimates of MPI for five groups of banks reveal that positive growth is experienced by most of the groups, except for foreign banks in Model A (intermediation approach) and regional development banks in Model B (revenue approach). Performance of all groups fluctuates widely from the beginning of the period until 2000/2001, with especially unstable economic performance surrounding the 1997 AFC. The size category results show all size categories experience an improvement in productivity over the period of analysis under both models. We find that medium-sized banks consistently achieve the highest growth under both models.

The investigation is continued by employing a multivariate regression model to examine the role of some variables on the level of bank productivity growth. Our empirical results suggest that the profitability ratio negatively affects productivity growth, while, among macro economics factors, broad money is found to be positively related to productivity growth. There is no strong evidence that bank restructuring (merger), foreign exchange activity and listing bank are related to productivity growth. Turning to bank ownership structure, foreign banks show an important positive effect on bank productivity under revenue based model. Finally, there is mixed evidence of an effect of regulatory change on productivity growth,

with negative impact on productivity in intermediation during the full sample period and positive effect on productivity in net revenue generation in the period from 2000 to 2011.

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