

Malmquist Index Productivity of Indonesian Bank: Based on Commercial Bank Business Group

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Abstract—This study aims to measure the level of productivity of conventional banks in Indonesia during the period of 2012 - 2016 using the method of Malmquist Productivity Index (MPI). Of the 50 bank samples, there are only five banks which have the composition of EFFCH, TECHCH, PECH, SECK and TFPCH ≥ 1 , namely Anglomas Bank, Bank Fama, Lampung BPD, Bank of China Limited, JP Morgan Bank, and Bank of Tokyo Mitsubishi. It is because the changes in efficiency and technology are seen to less optimally contribute to enhance the productivity. Design: Malmquist Productivity Index (MPI) method using DEAP 2.1 software. Findings: It shows that banks in the category of BUKU 4 are not yet productive. Moreover, of the total, there are only five banks which indicate the composition of EFFCH, TECHCH, PECH, SECK and TFPCH ≥ 1 , namely Anglomas Bank, Bank Fama, Lampung BPD, Bank of China Limited, JP Morgan Bank, and Bank of Tokyo Mitsubishi, all of which are classified into BUKU 1, 2 and 3. Originality and value: This research was conducted to analyze the extent to which the banking sector are productive when viewed based on the Commercial Bank Business Group (BUKU) classification which had not previously been carried out.

Keywords—Banking Industry, Total Factor of Productivity, Malmquist Productivity Index.

I. INTRODUCTION

As intermediary institutions for the economy of a country, banks are required to be able to perform sound financial management, given that the challenges of globalization and competition are increasingly intense. The increased competition affects not only the state banks but also foreign banks. In addition, good public fund management can improve the bank's performance which then affects the country's economy. The Indonesian Banking Architecture (API) launched by the government in January 2004 is one of Indonesia's banking revitalization programs, aiming at reshaping the banking industry.

The banking sector in Indonesia has experienced rapid growth and even it continues to date. The improvement can be specifically observed through the increased number of offices, which was recorded until 2016 was 32,730 offices with 116 banks. Since 1998 when the economic crisis struck, the number had increased from 7,570 offices and decreased 222 banks. Currently, the number of banks is considered in excess.

Given the current number of banks in Indonesia, the question arises whether the bank is efficient in running its

business. If the aim is to improve the economy and encourage the advancement of the banking industry, then the great assets possession is considered more necessary than having a great number of banks yet still having fewer assets. The API policy requires banks to achieve a sound, strong and efficient banking system; thus, the stability of the financial system to help drive economic growth can be achieved (Table 1).

Tabel 1: Growth of Total Commercial Banks and Bank Offices

Kelompok Bank	1998	2012	2013	2014	2015	2016
State Owned Banks						
Total Banks	7	4	4	4	4	4
Total Bank Offices	1,772	5,363	16,637	17,430	17,809	18,106
Foreign Exchange Commercial Banks						
Total Banks	77	36	36	38	39	42
Total Bank Offices	4,158	7,647	9,230	9,154	8,825	9,658
Non-Foreign Exchange Commercial Banks						
Total Banks	67	30	30	29	27	21
Total Bank Offices	729	1,447	2,221	2,234	2,087	468
Regional Development Banks						
Total Banks	27	26	26	26	26	27
Total Bank Offices	812	1,636	3,254	3,524	3,781	4052
Joint Venture Banks						
Total Banks	34	14	14	12	12	12
Total Bank Offices	58	263	390	285	359	355
Foreign Owned Bank						
Total Banks	10	10	10	10	10	10
Total Bank Offices	41	193	115	112	102	91
Total						
Total Banks	222	120	120	119	118	116
Total Bank Offices	7,570	16,625	31,847	32,739	32,963	32,730

Based on Bank Indonesia Regulation No. 14/26/ PBI/ 2012 dated December 27, 2012 concerning Business Activities and Office Networks Based on the Bank's Core Capital, based on core capital ownership, the banks are classified into 4 business groups (figure 1).



Fig 1: Commercial Bank Business Group (BUKU)

Banks that fall into group of BUKU 1 are those which can only carry out collection and distribution of funds activities as their basic products performed in Rupiah, trade financing

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activities, activities with limited coverage for agency and cooperation, payment and electronic banking system activities with limited coverage, temporary capital investment in the context of saving credit, and other services, restricted in Rupiah. Banks of BUKU 1 can only conduct foreign exchange activities as a foreign exchange trader. Meanwhile, banks in BUKU 2 can carry out limited treasury activities including plain vanilla spot and derivatives and make 15% investments in domestic financial institutions. On the other hand, banks that are classified into BUKU 3 can conduct business activities in Rupiah and foreign currencies and invest 25% in limited domestic and foreign financial institutions in the Asian region. At last, banks in BUKU 4 can conduct all business activities in Rupiah and foreign currency and make investments of 35% in financial institutions at home and abroad countries with wider area coverage than that of BUKU 3.

A bank's performance can be observed through the level of efficiency and how productive the bank is in managing funds. Furthermore, it can be seen based on the ratio of inputs and outputs. A greater input ratio will result in higher the bank's performance and vice versa. Furthermore, high productivity will lead to achieve the same level of productivity at a lower cost. In other words, productivity and costs have an inverse relationship, i.e. the higher the productivity, the lower the production costs will be. In the long-run, companies will more easily increase productivity; thus, production costs can be controlled.

A measurement of productivity refers to the Total Factor Productivity (TFP) of all factors which are used; in this case, the most commonly used approach is the Malmquist Productivity Index (MPI). The technique was firstly introduced by Caves, Christensen and Diewert (1982) as a function of distance to describe technology by defining input and output indices. Given the importance of efficiency aspect to the bank, in addition to showing the soundness of the bank, the efficiency can also encourage the investors or the public to invest their funds in the bank. Moreover, the aspect is also required in terms of interbank competition. A bank which has high efficiency will generate high profit; thus, an efficient bank will outperform those which are less efficient. As an intermediary institution, the banking business must act rationally and put in high regard the aspect of efficiency as one of the key words. [1] stated that the current problem of banking efficiency is crucial nowadays and in the future, due to some factors: (1) competition which is increasingly intense; (2) problems arising as a result of reduced resources; and (3) increasing customer satisfaction standards. Therefore, it is an urgent matter to perform banking efficiency analysis in Indonesia to determine the causes of changes in efficiency levels and to take corrective action in order to carry out the efficiency improvements as necessary.

According to [2] the intermediation approach views a financial institution as an intermediary: changing and transferring financial assets from surplus units to deficit ones. As such, institutional inputs which are measured from labor and capital costs and interest payments on deposits, are compared with the outputs measured in form of loans and financial investments. Finally, the asset approach oversees the primary function of a financial institution as the

creator of loans. The last approach is based on an asset that visualizes the primary function of a financial institution as the creator of loans; very close to the intermediation approach, where output is really defined in form of assets.

II. METHOD

In this study, to measure banking productivity in Indonesia, the Malmquist Productivity Index (MPI) was used. It is part of the Data Envelopment Analysis (DEA) method to observe the level of bank productivity specifically based on changes in efficiency and technology used, using the DEAP 2.1 software developed by [3].

To limit the scope of the research, bank data was taken according to banks classification based on BUKU for the period of 5 years from 2012 to 2016. This research is a quantitative research using output and input variables.

1. Input variables: *Personnel expenses*: Total personnel expenses occurred and experienced by each of commercial bank for the certain period i.e. over one year (in the income statement). *Fixed assets*: Total net fixed assets that each commercial bank at the end of year (in the balance sheet). *Total deposits*: total deposits the end of year, that each commercial bank obtains from depositors (in the balance sheet).

Output variables: *Total loans*: Total loans (finance) on all sectors of each commercial bank at the end of year position. *Securities and investments*: Total investment in securities and all placements of each commercial bank at the end of year position. *Other income*: Other income generated by each commercial bank at the end of year position.

III. DISCUSSION

Malmquist index is used to compare input and output in the production concept. Initially, the Malmquist Productivity Index (MPI) was created by Sten Malmquist in 1953 to measure productivity; yet, in its development, the index was introduced by [4] who was later developed by [5]. There were two aspects taken into account in measuring the Malmquist index, namely the catch-up effect and the frontier shift effect. The former measures the relative level of change in efficiency from period one to period two.

[5] mentioned that the technical changes which impose to productivity occur because of the changes in technology which can distinguish the diffusion between technology and innovation. Furthermore, according to [3] productivity is a ratio of output produced to the input used. On the other hand, Total Factor Productivity (TFP) is a measure of productivity that incorporates all factors of production measured by changes in the total output of all inputs used. The Malmquist Index has several beneficial characteristics. Firstly, this index is a non-parametric method so it does not require a specification in the form of production function. Fourthly, the Malmquist productivity index can be broken down into two components, namely changes in efficiency and changes in technology. According to [6] this characteristic is very useful because analysis can be performed more specifically based on the components.



In the first generation model developed by [4], there were two models of Malmquist productivity index[7]. The former was Malmquist input quantity index while the latter was Malmquist output quantity index. Malmquist input quantity index is for a production unit, at observation time of t and $t + 1$, for reference technology in period of k , $k = t$, and $t + 1$ is expressed by the following formula (equation 1). The index only measures changes in the input quantity observed between time t and $t + 1$, where:

$$MI_k(y_t, x_t, x_{t+1}) = \frac{E_k^I(y_t, x_t)}{E_k^I(y_t, x_{t+1})}, k = t, t + 1 \quad (1)$$

Meanwhile, the Malmquist output quantity index used for a production unit, at observation time of t and $t + 1$, for reference technology in period of k , $k = t$ and $t + 1$ is expressed by the formula as follows (equation 2). This Malmquist output quantity index only measures changes in the quantity of output observed between time t and $t + 1$, where:

$$MO_k(y_t, y_{t+1}, x_k) = \frac{E_k^O(y_{t+1}, x_k)}{E_k^O(y_t, x_k)}, k = t, t + 1 \quad (2)$$

[7] introduced a new definition of the Malmquist productivity index for units of production between t and $t + 1$ based on the level of technology at times k , $k = t$ and $k = t + 1$, following the tradition of most productivity indices. Adjusting to the Tornqvist productivity index, the index is built using a ratio between an output index and an input index:

$$MTFP_k = \frac{MO_k(y_t, y_{t+1}, x_k)}{MI_k(y_t, x_t, x_{t+1})} = \frac{E_k^O(y_{t+1}, x_k)/E_k^O(y_t, x_k)}{E_k^I(y_t, x_t)/E_k^I(y_t, x_{t+1})}, k = t, t + 1 \quad (3)$$

The above equation illustrates the ratio between the output index and the Malmquist input index. If the productivity index value is greater than 1, it indicates that there is an increase in productivity. On the other hand, when the index value is less than 1, it means that the level of productivity decreases. Meanwhile, when it is equal to 1, there is no change in the level of productivity. According to [8], the Malmquist Index is a measurement of changes in productivity over time and multi-factor can be decomposed into changes in the level of efficiency and technological change.

In this study, estimation of TFP growth and its components refers to the Malmquist Index and the application of the DEA-dual programming method. The TFP Malmquist change index is formed from the value of change in efficiency and technology. Through the value of efficiency change, it will reveal whether there is a change in the level of efficiency from year to year. Meanwhile, the aspect of technological change indicates whether there is a change in the technical efficiency limit from year to year. Productivity index is expressed by the TFP index from Malmquist during a certain period of time. It is like what proposed by [4]. where the index is defined using the distance function which allows the use of multi-input and multi-output without the need to involve price information explicitly.

Furthermore, MPI is a bilateral index which is used to compare the production technology of two economic elements based on the concept of a production function which measures the maximum production function with a predetermined input limit. MPI has several beneficial

characteristics. First, the index is a non-parametric method, so it does not require a specification of production function form. Second, MPI does not require the assumption of economic behavior on production unit, such as cost minimization or profit maximization; therefore, it is very useful provided that the objectives of the producers are different or unknown. Third, the calculation of the index does not require price of input and output which is frequently unavailable. Fourth, MTFPI can be decomposed into two components, namely Technical Efficiency Change (EFFCH) and Technological Change (TECHCH). According to [6], this characteristic is very useful since the analysis can be carried out more specifically based on components. A positive EFFCH (positive efficiency change) is evidence that efficiency changes approach the frontier, while a positive TECHCH or positive technological change is defined as innovation. Then EFFCH can be decomposed into two components, namely Pure Technical Efficiency Change (PECH) and Scale Efficiency Change (SECH) [5].

In previous research conducted by [9], they examined the productivity growth, changes in efficiency and technical progress of banking sectors in Turkey using the Malmquist Index, in which they found that the productivity is more profitable because of an improved efficiency. Moreover, [10] in his research assessed the level of efficiency and productivity of growth in deposit institutions by utilizing non-parametric border techniques through the Malmquist Index. The results showed that any growth in productivity did occur because of an increase in efficiency. In their research, [11] affirmed that company size can affect productivity with technical progress and adapt to technological advancement. In addition, [12] showed that domestic banks have higher productivity growth compared to their counterparts of foreign origins. He stated that the productivity improvement results from technological advancement.

Meanwhile, based on the research results conducted by [13], it showed that the average bank productivity is considered stable. They also revealed that what mainly drives the productivity changes in intermediation activities in Indonesia is the factor of technology. Furthermore, [14] discovered that the productivity of commercial banks in Indonesia occurs due to technological changes; rather than changes in technical efficiency, which implies the importance of technological development and innovation in achieving the productivity of the banking sector.

[15] conducted similar research on changes in the productivity of commercial banks in Tanzania. It turned out that the change in efficiency of large domestic banks was higher compared to other groups of banks. In the meantime, the value of small banks' productivity was higher than that of large domestic and foreign banks. The research conducted by [16] in Albania showed that the value of productivity is positively influenced by changes in efficiency instead of changes in technology. The following table presents the estimation of the Malmquist Productivity Index (MPI) of commercial banks which are the object of observation in Indonesia.



Changes in Productivity in each BUKU 1 Bank in Indonesia

Table 2: Malmquist Index Summary of Annual Means Bank of BUKU 1 in Indonesia

YEAR	EFFCH	TECHCH	PECH	SECH	TFPCH
2012 – 2013	1.103	0.913	1.159	0.952	1.007
2013 – 2014	0.928	0.994	0.912	1.017	0.922
2014 – 2015	1.032	0.998	0.998	1.035	1.030
2015 – 2016	0.971	1.115	0.991	0.980	1.083
Mean	1.006	1.002	1.011	0.995	1.009

Based on Table 2, the changes in productivity of 20 Indonesia banks in BUKU 1 have reached a productive stage given the evident from their average achievement. There is a year period (2013 – 2014), which has the score of changes in Total Productivity Factors (TFPCH) which is not optimum (value of 1), i.e. 0.922.

Table 3 Malmquist Index Summary of Means Bank Firm BUKU 1

FIRM	EFFCH	TECHCH	PECH	SECH	TFPCH
1	1.000	0.999	1.000	1.000	0.999
2	1.000	1.161	1.000	1.000	1.161
3	1.000	0.921	1.000	1.000	0.921
4	1.073	0.979	1.125	0.953	1.050
5	0.922	0.956	0.940	0.981	0.881
6	1.329	0.989	1.327	1.002	1.315
7	0.964	0.920	0.972	0.991	0.887
8	1.118	1.139	1.000	1.118	1.273
9	0.917	0.992	0.917	1.000	0.910
10	1.000	1.087	1.000	1.000	1.087
11	1.000	0.970	1.000	1.000	0.970
12	0.896	1.070	0.915	0.979	0.959
13	1.000	1.054	1.000	1.000	1.054
14	0.978	0.899	1.000	0.978	0.879
15	0.964	0.922	1.027	0.939	0.889
16	1.000	1.015	1.000	1.000	1.015
17	1.000	1.003	1.000	1.000	1.003
18	1.080	1.049	1.077	1.002	1.133
19	0.959	1.021	0.984	0.974	0.979
20	1.000	0.950	1.000	1.000	0.950
mean	1.006	1.002	1.011	0.995	1.009

When analyzed based on the Total Productivity Factor (TFPCH), the banks which are considered to have positive productivity are Bank Andara, Bank Agris, International Business Bank, Bank Fama, Bank Ina Perdana, Mitraniaga Bank, BPD Jambi, BPD Lampung, and BPD Bengkulu. Based on the value of efficiency changes (EFFCH), it is also found that those banks have the optimum value based output and input factors. When viewed based on Technology Change (TECHCH), the banks are considered efficient in improving technology both from the financial system factor and ATM coverage to the ease of IT-based transactions. Yet, it occurs in some banks where the TECHCH condition has

not yet been reach optimum, such as Bank Agris and the International Business Bank.

Changes in productivity in each bank of BUKU 2 category in Indonesia

Based on Table 4, the changes in productivity of 16 banks in BUKU 2 category in Indonesia have not reached a productive level. It can be observed that in one year period (2013 – 2014), their average achievement has an optimum score of Total Productivity Factors (TFPCH), i.e. 1.175. However, the optimum value of TFPCH is not in line with that of EFFCH which is only 0.911. As such, it is assumed that the banks of BUKU 2 are not efficient in managing their input and output, given the value of PECH and SECH which are only 0.977 and 0.933, respectively. If analyzed on the average during the period of observation, the productivity value is not optimum, i.e. 0.986, which is almost 1. Based on the aspect of the improvement in bank's technology, the banks in BUKU 2 have reached the optimum level on an average of 1.098.

Table 4: Malmquist Index Summary of Annual Means Bank of BUKU 2 in Indonesia

YEAR	EFFCH	TECHCH	PECH	SECH	TFPCH
2012 – 2013	0.945	1.021	1.030	0.918	0.965
2013 – 2014	0.911	1.289	0.977	0.933	1.175
2014 – 2015	0.836	1.012	0.832	1.006	0.846
2015 - 2016	0.903	1.093	1.008	0.896	0.987
mean	0.898	1.098	0.958	0.937	0.986

The condition of each bank is presented in Table 6.

Table 5: Malmquist Index Summary of Means Bank Firm BUKU 2

FIRM	EFFCH	TECHCH	PECH	SECH	TFPCH
1	1.000	1.033	1.000	1.000	1.033
2	0.748	1.169	0.890	0.840	0.874
3	1.000	1.260	1.000	1.000	1.260
4	1.038	1.140	1.000	1.038	1.184
5	1.060	0.942	1.072	0.989	0.999
6	0.876	1.023	0.944	0.927	0.896
7	0.782	1.230	0.854	0.915	0.962
8	1.068	1.064	1.000	1.068	1.136
9	0.970	0.967	1.000	0.970	0.937
10	0.750	1.073	0.897	0.836	0.805
11	1.147	1.137	1.124	1.020	1.304
12	0.821	1.170	1.003	0.818	0.961
13	0.833	1.144	1.000	0.833	0.953
14	0.683	1.033	0.911	0.749	0.705
15	0.874	1.098	0.835	1.047	0.960
16	0.876	1.142	0.854	1.026	1.001
mean	0.898	1.098	0.958	0.937	0.986

Furthermore, the banks which have reached the optimum level in terms of productivity followed by optimum values of change in efficiency, pure technical efficiency, and scale efficiency are Bank China Limited, JP Morgan Bank, BNP Paribas Bank, Sinarmas Bank, BPD South Sulawesi and West Sulawesi. However, Bank BPD North Sumatra, despite its productivity value of 1.001, has not yet reached optimum level since the value of changes in efficiency and pure technical efficiency is less than 1, which is 0.876 and 0.854, respectively.



Changes in productivity of each bank in BUKU 3 category in Indonesia

Table 6 presents the condition of 10 banks classified in BUKU 3. Based on the observation period, during the years of 2013 – 2014 and 2015 – 2016 are the period when the values of total productivity are greater than 1, which are 1.029 and 1.108, respectively. Despite the improvements of technology in line with increasingly sophisticated and more practical banking services, the overall performance and the use of technology of the bank have not yet reached optimum level since the values are less than 1, i.e. only 0.971 and 0.941, respectively.

Table 6: Malmquist Index Summary of Annual Means Bank of BUKU 3 in Indonesia

YEAR	EFFCH	TECHCH	PECH	SECH	TFPCH
2012–2013	1.102	0.897	1.016	1.084	0.989
2013–2014	0.958	1.073	0.991	0.967	1.029
2014–2015	1.061	0.742	1.010	1.051	0.787
2015–2016	1.010	1.097	0.989	1.022	1.108
mean	1.031	0.941	1.001	1.030	0.971

In category of BUKU 3, there are only three banks which have optimum changes in Total Factor Productivity (TFPCH), namely Bank Mega, Standard Chartered Bank and Bank of Tokyo Mitsubishi, indicated by the value greater than 1, i.e. 1.053; 1.136 and 1.165, respectively. This is certainly not surprising given that of those entities, there are two banks which are able to grow rapidly from year to year which can be seen from the optimum value of the bank's efficiency (Table 7).

Table 7: Malmquist Index Summary of Means Bank Firm BUKU 3

FIRM	EFFCH	TECHCH	PECH	SECH	TFPCH
1	0.957	1.018	0.957	1.000	0.974
2	1.271	0.777	1.047	1.214	0.987
3	1.000	1.053	1.000	1.000	1.053
4	0.993	0.964	1.000	0.993	0.957
5	1.085	0.750	1.000	1.085	0.813
6	1.000	0.794	1.000	1.000	0.794
7	1.000	1.136	1.000	1.000	1.136
8	1.000	0.925	1.000	1.000	0.925
9	1.041	0.930	1.013	1.028	0.968
10	1.000	1.165	1.000	1.000	1.165
mean	1.031	0.941	1.001	1.030	0.971

Changes in productivity of each bank in BUKU 4 category in Indonesia

Table 8: Malmquist Index Summary of Annual Means Bank of BUKU 4 in Indonesia

YEAR	EFFCH	TECHCH	PECH	SECH	TFPCH
2012–2013	0.915	0.913	0.982	0.931	0.836
2013–2014	1.093	0.906	1.018	1.074	0.990
2014–2015	0.979	1.005	1.000	0.979	0.984
2015–2016	1.021	0.783	1.000	1.021	0.800
mean	1.000	0.898	1.000	1.000	0.898

In general, the banks grouped in BUKU 4 are considered less productive (Table 8). This is indicated by the lack of optimum use of technology during the period of study which only reaches the value of 0.898. Neither is it optimum in

terms of technology utilization which is only worth 0.898 in value. Based on the core capital ownership, the banks in BUKU 4 have more than 30 trillion rupiah; yet, they still lack the use of several aspects. In contrast, based on efficiency management which is optimum at 1.000, when observing each bank, only four banks in BUKU 4 are efficient in managing their inputs and outputs in terms of both scale efficiency and pure technical efficiency. But in terms of total factor productivity of the four banks, all banks, namely BCA, BNI, BRI and Bank Mandiri have not yet been optimum (Table 9).

Table 9: Malmquist Index Summary of Means Bank Firm BUKU 4

FIRM	EFFCH	TECHCH	PECH	SECH	TFPCH
1	1.000	0.909	1.000	1.000	0.909
2	1.000	0.931	1.000	1.000	0.931
3	1.000	0.852	1.000	1.000	0.852
4	1.000	0.902	1.000	1.000	0.902
mean	1.000	0.898	1.000	1.000	0.898

Changes in productivity of banking in Indonesia

Furthermore, Table 10 below shows the Malmquist TFPCH and its components which are based on the value of 1.000 for 2012 as the base year. If the MTFPI score is greater than 1.000, the productivity will experience growth. Meanwhile, if the value is equal to 1.000, it means that the productivity will experience stagnation. At last, if the value of MTFPI is less than 1.000, there will be a decline in productivity.

Table 10: Malmquist Index Summary of Annual Means Bank in Indonesia

YEAR	EFFCH	TECHCH	PECH	SECH	TFPCH
2012–2013	1.081	0.934	1.059	1.021	1.010
2013–2014	0.871	1.152	0.925	0.942	1.003
2014–2015	0.899	1.017	0.968	0.929	0.915
2015–2016	0.985	1.078	0.991	0.993	1.061
mean	0.956	1.042	0.985	0.971	0.996

In Table 10, it appears that during the period of study, commercial banks in Indonesia showed a decline in productivity growth, as indicated by a decrease in the value of TFPCH of 0.996. The decrease in TFPCH indicates poor level of innovation in the banking sector in Indonesia. In fact, this is not in line with the increase in the value of TECHCH, which indicates 1.042. When viewing the efficiency aspect, it can be seen that there is a negative EFFCH or a decrease in the level of efficiency. The decrease in efficiency value of EFFCH is considered insufficient to encourage all TFPCH levels in the banking sector in Indonesia from 2012 to 2016. The EFFCH value of 0.956 is also considered unable to optimize the resources they possess. It can also be seen from pure technical value (PECH) and value of efficiency scale (SECH) as a component of technical efficiency change (EFFCH) which is at a value of 0.985 and 0.971, respectively.



Based on the analysis results, it is interesting to note that the decline in the productivity growth of commercial banks in Indonesia during the period from 2012 to 2016 is generally caused by technological change as indicated by the increase in TECHCH, given the fact that financial services have been more innovative in relation to the development of banking technology, such as infrastructure (telephone banking, mobile banking, and internet banking) [17]. Likewise, financial technology (fintech) in the banking industry in Indonesia has experienced some changes. Based on the total calculation and observation on all banks, the banks which have a total productivity factor of more than 1 are Anglomas Bank, Bank Andara, Bank Agris, Bank BisnisInternasional, Bank Fama, Ina Perdana Bank, Bank KesejahteraanEkonomi, Mitraniaga Banks, Lampung BPD, Bengkulu BPD, Bank of China Limited, JP Morgan Bank, BNP Paribas Bank, Sinarmas Bank, South Sulawesi and West Sulawesi BPD, Standard Chartered Bank, HSBC Bank, Bank of Tokyo Mitsubishi, and BCA Bank. However, not all the banks are efficient in managing inputs and outputs, such as Bank Andara, Bank Ina Perdana, Bank KesejahteraanEkonomi, Standard Chartered Banks and HSBC Bank. In terms of technology utilization or technological change, Bank Agris and Bank Sinarmas have not reached optimum level. Meanwhile, those which have the value of EFFCH, TECHCH, PECH, SECK \geq 1, which means that the banks indicate optimum productivity levels, namely Anglomas Bank, Bank Fama, Lampung BPD, Bank of China Limited, JP Morgan Bank, and Bank of Tokyo Mitsubishi (Table 11).

Table 11: Malmquist Index Summary of Annual Means Bank Firm in Indonesia

No	EFFCH	TECHCH	PECH	SECH	TFPCH
1	1.000	1.134	1.000	1.000	1.134
2	0.932	1.275	1.158	0.805	1.188
3	0.968	0.963	1.000	0.968	0.932
4	1.063	0.957	0.998	1.065	1.017
5	0.936	0.969	0.950	0.985	0.907
6	1.088	1.055	1.375	0.791	1.148
7	0.887	0.997	0.797	1.113	0.885
8	1.334	1.022	1.000	1.334	1.364
9	0.970	0.991	0.957	1.014	0.962
10	0.981	1.048	1.000	0.981	1.028
11	0.959	1.013	1.000	0.959	0.971
12	0.876	1.195	0.847	1.035	1.047
13	1.120	1.012	1.224	0.915	1.133
14	0.868	1.083	1.000	0.868	0.940
15	0.997	0.946	0.977	1.020	0.943
16	0.812	1.075	0.782	1.039	0.873
17	1.028	1.139	1.010	1.018	1.171
18	1.184	1.152	1.234	0.959	1.363
19	0.818	1.183	0.814	1.005	0.968
20	0.880	0.980	0.884	0.996	0.862
21	1.000	1.033	1.000	1.000	1.033
22	0.748	1.164	0.818	0.914	0.871
23	1.000	1.231	1.000	1.000	1.231
24	1.027	1.134	0.977	1.052	1.164
25	1.063	0.938	1.019	1.044	0.998
26	0.912	0.961	0.912	1.000	0.877

No	EFFCH	TECHCH	PECH	SECH	TFPCH
27	0.889	1.110	0.933	0.952	0.986
28	1.178	0.984	1.178	1.000	1.159
29	1.014	0.902	1.023	0.991	0.914
30	0.750	1.070	0.794	0.945	0.802
31	1.217	1.027	1.205	1.009	1.250
32	0.821	1.161	0.914	0.898	0.953
33	0.913	1.042	1.006	0.908	0.951
34	0.711	1.070	0.802	0.887	0.761
35	0.922	1.054	0.911	1.012	0.972
36	0.962	1.035	1.015	0.947	0.995
37	0.846	1.143	0.945	0.896	0.967
38	1.020	0.962	1.149	0.887	0.981
39	1.000	0.979	1.000	1.000	0.979
40	0.878	0.992	1.000	0.878	0.871
41	0.960	0.887	0.963	0.997	0.851
42	0.921	0.931	0.969	0.950	0.857
43	0.984	1.100	1.000	0.984	1.082
44	1.000	0.939	1.000	1.000	0.939
45	0.919	1.104	1.017	0.904	1.015
46	1.000	1.131	1.000	1.000	1.131
47	0.939	1.074	1.000	0.939	1.009
48	0.983	0.967	1.000	0.983	0.951
49	0.878	0.981	1.000	0.878	0.861
50	0.967	0.990	1.000	0.967	0.958
mean	0.956	1.042	0.985	0.971	0.996

IV. CONCLUSION

The level of banking productivity measurement in Indonesia indicates an average value of 0.996. Based on the result, it shows that the banks in Indonesia have not optimized their productivity levels during the period of observation. It is because changes in efficiency and technology are regarded as contributing factors still not optimally utilized to improve the level of productivity in spite of the TECHCH value of 1.042. The improvement in banking technology, such as ATM networks and coverage which need to be broadened and other banking technology systems but still needs to be in line with improvement of human resources, so as to reduce the cost of training which will then impact on the cost efficiency.

On the other hand, based on the composition of EFFCH, TECHCH, PECH, SECK and TFPCH, the values of which are greater than 1, the banks are Bank Anglomas, Bank Fama, BPD Lampung, Bank of China Limited, JP Morgan Bank, and Bank of Tokyo Mitsubishi. Furthermore, based on each BUKU classification, the banks which belong to BUKU 1 are Bank Andara, Bank Fama, Bank Ina Perdana, Mitraniaga Bank, BPD Jambi, BPD Lampung, and BPD Bengkulu; those of BUKU 2 are Bank China Limited, JP Morgan Bank, BNP Paribas Bank, Sinarmas Bank, BPD South Sulawesi and West Sulawesi; those of BUKU 3 are Bank Mega, Standard Chartered Bank and Bank of Tokyo Mitsubishi. Yet, none of the banks in BUKU 4 are optimum at overall performance.



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