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MALMQUIST INDEX TO MEASURE THE EFFICIENCY AND PRODUCTIVITY OF INDONESIA ISLAMIC BANKS

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MALMQUIST INDEX TO MEASURE THE EFFICIENCY AND PRODUCTIVITY OF INDONESIA ISLAMIC BANKS

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Abstract

The development of Islamic banking industry today is one of the main indicators of economic development of Islamic finance in general in Indonesia. In the banking world, including Islamic banking, the issue of efficiency and productivity measurement are two important things. This study attempts to analyze the BCC model as a base model for DEA to see the efficiency level of Islamic commercial banks (Bank Umum Syariah/BUS) in Indonesia for 2012-2017 period. Furthermore, Malmquist index is used to see the productivity level of Islamic bank, both in terms of changes of its efficiency and also its technological change which is then displayed in the form of four quadrant groups.

The results obtained from the Malmquist index score (TFP Change) show that 9 Islamic banks out of 11 BUS have increased productivity, or about 82% of all Islamic commercial banks. For groups of bank analysis with efficiency change criterion (EFFCH) and technological change (TECH), there is 1 islamic bank in quadrant 1 (technical change and high-efficiency change), there are 4 Islamic bank in quadrant 2 (technical change high but low efficiency change), and 6 Islamic banks that enter into quadrant 3 (technical change is low but high-efficiency change). Meanwhile, none of the Islamic banks are in the quadrant group 4.

Keywords: Efficiency, Productivity, DEA, Malmquist Index, Indonesia Islamic Bank

A. INTRODUCTION

Islamic economics has spread and developed in the world. The latest data published in Islamic Global Finance Report 2017, nowadays Islamic banking industry has been present in at least 45 countries in the world, including in the United States, United Kingdom and China (Islamic Banker Association, 2017). In Indonesia, the economic development of Islamic finance began in about 1992 that was pioneered with the establishment of the first Islamic bank, Bank Muamalat Indonesia.

Currently, according to data from the Financial Services Authority (OJK, 2018) per April 2018, based on islamic banking statistics, the number of islamic banks has reached 13 Islamic Commercial Banks (BUSs), 21 Islamic Business Units and 168 Islamic Lending Banks with a total office network of 2,460 offices in throughout Indonesia.

The existence and development of islamic banking industry today is one of the main indicators of economic development of Islamic finance in general in Indonesia. Therefore, it is necessary to measure the performance of islamic banking to find out how efficient the performance of an islamic bank among other banks. Determination of the limiting factor into a benchmark whether a company has worked efficiently and productively, are separate problems. Not necessarily the factor chosen as a variable to measure the level of efficiency it represents the whole aspect of the company, in this case the bank. For that we need a measurement formulation of efficiency and productivity level that can involve multi-variable.

In the world of efficiency measurement, currently widely known as Data Envelopment Analysis (DEA) approach. DEA is a tool that can be used to measure and compare the performance of a number of service units or business units such as banks, financial industries, hospitals and even educational institutions. DEA may also indicate the inefficiency specifications of the service unit.

Since the DEA method was first introduced by Charnes, Cooper and Rhodes in 1978, researchers in some areas recognize that DEA is an excellent method and relatively easy to use in the operational modeling process for performance evaluation. In this study, DEA is used as a tool to measure and compare the performance of Islamic banking in this case all islamic commercial banks in Indonesia for 2012-2016 period.

Furthermore, to measure the productivity of Islamic banks observed, this study used Malmquist Productivity Index (MPI) analysis. Malmquist index is part of the DEA method that specifically looks at productivity level of each business unit, so that it will see a change in the efficiency and technology levels used based on predetermined inputs and outputs. The Malmquist index is also used to analyze intertemporal performance changes.

B. THEORETICAL BASIS

Efficiency and productivity is a concept that shows the ratio of the result of comparison between input and output. Both ratios show that efficiency and productivity can be controlled by manipulating input and output management, or even both simultaneously. Efficiency and productivity can be used to measure the performance of a unit of economic activity.

In measuring the degree of efficiency and productivity, Data Envelopment Analysis (DEA) is preferable. DEA is widely used to measure the level of technical efficiency, scale of economic and industrial banks and financial institutions. This is suitable according to research of Kamarudin, et.al (2008); Ozdemir (2013); Shahreki (2012); Tsolas and Dimitris (2012).

An activity can be called efficient if the effort has been done to provide maximum output, both quantity and quality. An activity can also be said to be efficient if the minimum effort can achieve a certain output. Oscar (2008) divides efficiency into several parts, namely: technical efficiency, scale efficiency, cost efficiency and allocation efficiency. Technical efficiency is the process of converting inputs into outputs. This concept applies only to internal technical relationships between inputs and outputs. A company is considered to be economically efficient if it can minimize the production costs to produce certain output within common technology level and market price level (Farrell, 1957, Ramanthan, 2003).

Scale efficiency is associated with achieving the economies of scale of the unit in carrying out its operations. Inefficient on a scale can only be overcome by adopting new technologies or production processes. On the other hand, technical efficiency is a managerial problem, where more output is required for a given number of resources.

However, we must understand that technological differences can create economies of scale in the production process. Economies of scale are terms used to explain the decrease in cost per unit due to the addition of units produced. In a microeconomics, economies of scale are cost savings that companies earn when expanding. Measurement of efficiency can also be assessed using price information or input and / or output costs. This notion is commonly known as the concept of cost efficiency. Meanwhile, the allocation efficiency is related to how to combine various inputs to be able to produce maximum output. If there is more than one input or output, management will be interested in using the proper input mix to maximize the results so that the organization can be efficient.

The discussion is whether the use of various inputs in the calculation of efficiency is appropriate. Is it necessary to weight the use of inputs based on their contribution to output. This weighting is not available, but at least DEA can estimate this weighting in comparative evaluation. In its development, the frontier efficiency measurement model has increased, both in theory and practice concepts. In general, the efficiency and productivity level measurement model is divided into two parts: parametric and nonparametric. The following is a general overview of the development of a successful frontier efficiency measurement model that the author identifies.

Table 1. Development of Frontier Efficiency Measurement Model Analysis

NO	MODEL	YEAR	AUTHOR	TYPE
1	**Stochastic Frontier Approach als77**	1977	Aigner, Lovell, Schmidt	Parametric
2	**SFA Model mvb77**	1977	Meeusen & van den Broeck	Parametric
3	**Data Envelopment Analysis CCR**	1978	Charnes, Cooper, Rhodes	Non parametric
4	**SFA Model stev80**	1980	Stevenson	Parametric
5	**SFA Model mlti**	1981	Pitt & Lee	Parametric
6	**Malmquist Productivity Index**	1982	Caves, Christensen, Diewert	Non parametric
7	**DEA Model BCC**	1984	Banker, Charnes, Cooper	Non parametric

8	**Free Disposal Hull [FDH]**	1984	Deprins, Simar, Tulkens	Non parametric
9	**SFA Model fe**	1984	Schmidt & Sickles	Parametric
10	**SFA Model regls**	1984	Schmidt & Sickles	Parametric
11	**DEA Additive Model**	1985	Charnes,Cooper,Golany,Seiford,Stutz	Non parametric
12	**DEA Window Analysis**	1985	Charnes, Clarke, Cooper, Golany	Non parametric
13	**DEA Assurance Region [DEA-AR]**	1986	Thompson, Singleton, Thrall, Smith	Non parametric
14	**DEA Cross Efficiency**	1986	Sexton, Silkman, Hogan	Non parametric
15	**DEA Facet Model**	1988	Bessent, Bessent, Elam, Clark	Non parametric
16	**SFA Model mlti**	1988	Battese & Coelli	Parametric
17	**SFA Model fecss**	1990	Cornwell, Schmidt, Sickles	Parametric
18	**SFA Model kumb90**	1990	Kumbhakar	Parametric
19	**DEA Cone Ratio**	1990	Charnes, Cooper, Huang, Sun	Non parametric
20	**TFA [Thick Frontier Approach]**	1991	Berger & Humphrey	Parametric
21	**SFA Model bc92**	1992	Battese & Coelli	Parametric
22	**Fuzzy DEA**	1992	Sengupta	Non parametric
23	**DFA [Distribution Free Approach]**	1993	Berger	Parametric
24	**SFA Model fels**	1993	Lee & Schmidt	Parametric
25	**DEA Super Efficiency**	1993	Andersen & Peterson	Non parametric
26	**SFA Model bc95**	1995	Battese & Coelli	Parametric
27	**Network DEA**	1996	Fare & Grosskopf	Non parametric
28	**Hierarchical/Nested Model DEA**	1998	Cook, Chai, Doyle, Green	Non parametric
29	**Bootstrapped DEA**	1998	Simar & Wilson	Parametric
30	**DEA Russell Measure [ERM]**	1999	Pastor, Ruiz, Sirvent	Non parametric
31	**Imprecise Data [IDEA]**	1999	Cooper, Park, Yu	Non parametric
32	**Parallel Model DEA**	2000	Cook, Hababou, Tuenter	Non parametric
33	**Dynamic DEA**	2000	Fare & Grosskopf	Non parametric
34	**DEA Slack Based Measure [SBM]**	2001	Tone	Non parametric
35	**Meta Frontier**	2003	Rao, O'Donnel, Battese	Non parametric
36	**Context-Dependent DEA**	2003	Seiford & Zhu	Non parametric
37	**SFA Model gre03**	2003	Greene	Parametric
38	**SFA Model tfe**	2005	Greene	Parametric
39	**SFA Model tre**	2005	Greene	Parametric
40	**Game Cross Efficiency**	2008	Liang, Wu, Cook, Zhu	Non parametric

(Source: Rusydiana, 2018)

The concept of productivity is basically a relationship between output and input in a production process. Productivity can be measured partially or totally. Partial productivity is the relationship between output with one input. Examples of commonly used partial productivity are labor productivity which shows the average output per worker, as well as the capital productivity that describes the average output per capital.

Total productivity or so-called Total Factor Productivity (TFP) measures the relationship between outputs with multiple inputs simultaneously. The relationship is expressed in the ratio of the output index to the aggregate input index. If the increased ratio means more output can be produced using a certain number of inputs, or some output can be produced using fewer inputs.

In productivity measurement, the most widely used is the total factor productivity (TFP) method. This method is used to overcome the weakness of efficiency calculation more than one input and one output. TFP is measured using index numbers that can measure changes in price and quantity over time. In addition, TFP also measures comparisons and differences between entities.

The TFP ab index measures the change in the output value of the selected N number from period "a" to "b" where p represents the output price. Commonly used indices for measuring TFP are Malmquist Index, Laspeyres Index, Pasche Index, Fisher Index and Tornqvist Index. In this study, which will be used to calculate the productivity level (TFP) is the Malmquist Index.

The Malmquist index was first created by Sten Malmquist in 1953 to measure productivity. But in its development, Malmquist Index was introduced by Caves et.al (1982). There are two things that are calculated in Malmquist index measurement that is catch-up effect and frontier shift effect. The catch-up effect measures the rate of change in relative efficiency from period 1 to period 2. Meanwhile the frontier shift effect measures the rate of technological change that is a combination of input and output from period 1 to period 2. The frontier shift effect is often called an innovation effect.

The Malmquist index is a bilateral index used to compare production technologies of two economic elements. The Malmquist index is based on the concept of a production function that measures the maximum production function with defined input limits. In the calculation, this index consists of several results: efficiency change, technological change, pure efficiency change, economic scale change and TFP change.

The Malmquist index has some favorable characteristics. First, this index is a non-parametric method so it does not require specification of production function form. Secondly, the Malmquist index does not require the assumption of the economic behavior of production units such as cost minimization or profit maximization, so it is useful if the goals of the producers are different or unknown. Third, the calculation of this index does not require data prices that are often not available. Fourth, the Malmquist productivity index can be broken down into two components: efficiency change and technological change. According to Avenzora (2008) this is very useful because the analysis can be done more specifically by component.

In the first generation model developed by Caves et.al (1982), there are 2 (two) Malmquist productivity index models (Bjurek, 1996). The first is 'Malmquist input quantity index' and the second is 'Malmquist output quantity index'.
Malmquist input quantity index for a production unit, at observation time t and t + 1, for tech reference in period k, k = t and t + 1. The Malmquist input quantity index measures only the change in the quantity of inputs observed between time t and t + 1, where:

$$MI_k\,(y_k, x_t, x_{t+1}) = \frac{E_k^I\,(y_k, x_t)}{E_k^I\,(y_k, x_{t+1})}\;,\; k = t,\; t+1 \qquad (1)$$

Next, for the Malmquist quantity output index for a production unit, at observation time t and t + 1, for tech reference in period k, k = t and t + 1. This Malmquist quantity output index measures only the change in the observed quantity of output between time t and t + 1, where:

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

Bjurek (1996) introduces a new definition of the Malmquist productivity index for the production unit between t and t + 1 based on the technological level at k, k = t and k = t + 1, following the tradition of most productivity indices. Adjusting the Tornqvist productivity index, the index constructed is the ratio between an output index and an input index:

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

The equation above illustrates the ratio between the output index and the Malmquist input index. If the value of the productivity index is greater than the number 1, then there has been an increase in productivity. If the index value is less than 1, the productivity level decreases, whereas if it equals 1, the productivity level does not change.

Some research that applies banking productivity measurement with TFP change value for example done by Yaumidin (2007). Raphael (2013) and Yildirim (2015). Yaumidin (2007) tried to compare the efficiency of Islamic banks in the Middle East and Southeast Asia. This is based on the failure of the bank which then affects the occurrence of financial crisis, both domestic and international. Overall, the results show that Islamic banks in Southeast Asia are slightly more efficient than Islamic banks in the Middle East. One of the causes was tragedy 9/11 in 2001 and the Iraq war of 2002. Likewise the value of TFP change.

Meanwhile Raphael (2013) tried to measure changes in productivity of commercial banks in Tanzania for 7 years. The result, in general, the majority of commercial banks there have increased EFFCH productivity by 67 percent, TECH by 83 percent, PECH by 67 percent and SECH by 50 percent. One of the most important recommendations is that small banks need to invest in IT to improve their efficiency and productivity.

Other than that, Yildirim (2015) conducted research on 4 Islamic banks operating in Turkey and 13 Islamic banks operating in Malaysia. Half of the total bank, able to use the assets and equity efficiently. The results also found that changes in technical efficiency (EFFCH) of Islamic banks in both countries of observation, never reached above 1 value for any period. That is, Islamic banks still have not reached its maximum production limit.

The other researchs in efficiency and productivity on banking industry in Indonesia also conducted by Hadad et al (2003a), Hadad et al (2003b), also Shawtari et al (2014) in Yaman. Meanwhile, the application of efficiency and productivity on Islamic banking industry done by Ascarya and Yumanita (2007), Rani etal (2017), Sufian (2006), Hassan (2003), and Yudistira (2003).

C. RESEARCH METHODOLOGY

In this study, the estimated growth of TFP and its components refers to Malmquist Index and application of DEA-Dual Programming method. The Malmquist TFP change index is formed from the value of efficiency change and technology change. Through the value of efficiency change will be known whether there is a change in the efficiency level from year to year. While technological change indicates whether there is a change of technical limit of efficiency from year to year. The malmquist TFP change is part of DEA method developed by Charnes Cooper Rhodes and Banker Charnes Cooper (Coelli et al, 1998, Coelli et al, 2005, Cooper et al, 2010). DEA is a mathematical programming technique that measure the efficiency and productivity of decision making unit or DMU to other similar DMU (Cooper et al, 2002). Early DEA and Malmquist TFP change are widely applied to the banking industry (Sherman & Gold, 1985).

The productivity index is expressed by the TFP index of Malmquist over a given period. As the suggestion of Caves et.al (1982), this index is defined using a distance function that permits multi-input and multi-output use without the need to involve explicit price information. The function of this distance can be classified into a distance function oriented to the input and output. The input distance function seeks a minimal proportional expansion of input vectors for a constant output vector. In contrast, the output distance function seeks a minimum proportional expansion of the output vector for a constant input vector. Malmquist The TFP index measures TFP changes between two data points by computing the distance ratio for each data point, relative to the technological constraints.

The data used in this study are 11 islamic commercial banks from 2012 to 2017. The input and output variables are obtained from the balance sheet and profit and loss statements of each bank. Three inputs and two outputs are used to measure the efficiency and productivity level of islamic banks. As input variables are Third Party Funds (X1), Personnel Costs (X2) and Administrative and General Cost (X3). Meanwhile, the output variables are Total Financing (Y1) and Operating Income (X2). Table 2 describes the descriptive statistics of each of the input and output variables used in this study.

Table 2. Descriptive Statistics of Input and Output Variables

Indicator	**Output (Million IDR)**	**Input (Million IDR)**

	Financing	Operating Income	Third Party Fund	Personnel Cost	General Administration Fee
Mean	12.277.702	1.586.876	13.469.289	309.414	176.928
Max	50.460.000	6.851.461	59.283.492	1.359.776	760.186
Min	244.443	83.490	154.936	10.727	1.633
Std.Dev	16.398.491	2.000.912	18.358.616	366.298	226.934

The analysis tools used in this research are Banxia Frontier Analyst 3 to measure the efficiency level of all Islamic bank DMUs during 2012-2017. To measure Malmquist's productivity index, the DEAP 2.1 software is used. Furthermore, to make the plot of islamic bank group quadrant with 2 categories (change of efficiency and technological change) on x and y axis, SPSS 16 software is used as a tool. This classification based on Rusydiana & Sanrego (2018) also Rusydiana & Firmansyah (2017).

D. RESULT AND DISCUSSION

BUS Quadrant Based on the Malmquist Productivity Index

Islamic Banks are grouped into 4 (four) quadrants based on technical change level (TECH) categories and efficiency change (EFFCH) level categories, ie high and low. Quadrant 1 includes islamic bank which has technical change and high-efficiency change, so it can be considered as a high-productivity islamic bank.

Table 3. Productivity Level of BUS in Indonesia 2013-2017

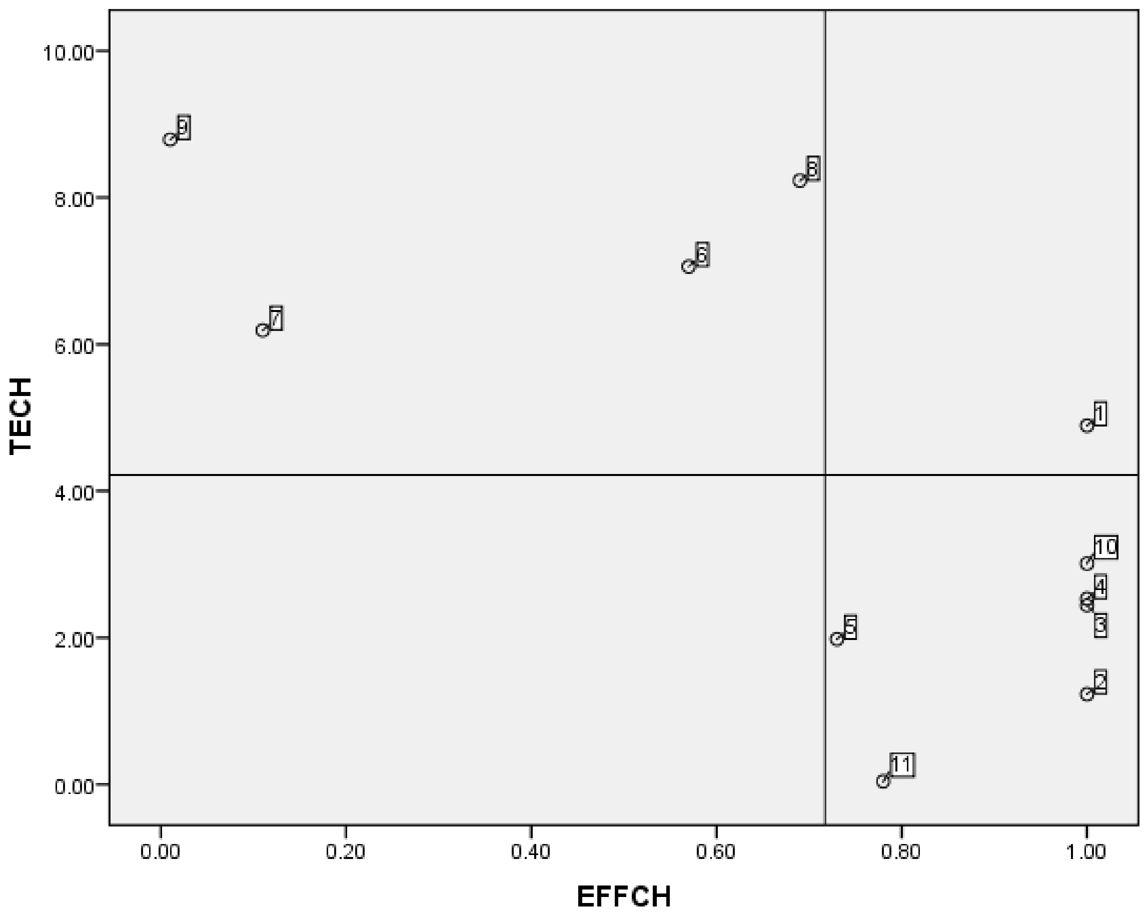
DMU	EFFCH	TECH	PE Change	Ec.Scale Change	TFP Change
BSM	1.000	4.893	1.000	1.000	4.893
BMI	1.000	1.227	1.000	1.000	1.227
BRIS	1.000	2.441	1.000	1.000	2.441
BNIS	1.000	2.530	1.000	1.000	2.530
Mega Sy.	0.735	1.981	0.855	0.853	1.456
Panin Sy.	0.569	7.064	0.861	0.660	4.019
BJBS	0.117	6.186	1.369	0.077	0.724
BSB	0.693	8.231	2.372	0.290	5.704
BCAS	0.115	8.795	0.016	0.404	1.011
Maybank Sy.	1.000	3.005	1.000	1.000	3.005
Victoria Sy.	0.787	0.035	1.000	0.781	0.028

On the other hand, Quadrant 4 is a group of islamic bank with low technical change and efficiency change. A collection of islamic banks in this group can be regarded as a islamic bank whose productivity progress is relatively stagnant due to the small value of TECH and EFFCH.

Quadrant 2 includes BUS that has a high technical change, but on the other hand has a low efficiency change. A collection of islamic banks in this group can be regarded as a islamic bank with low catching up ability. Increasing the number of DMUs of islamic banks in this 2nd quadrant is a sign of ineffectiveness of islamic banks to produce efficiently (technical change and efficiency change rates are classified into high and low categories based on their mean values).

The quadrant 3 includes groups of BUS that have a low technical change, but on the other hand has a relatively high-efficiency change. The collection of islamic banks in quadrant 3 can be regarded as a islamic bank with low production technology improvement, but relatively able to achieve a high level of efficiency improvement.

Below is a division of a group of islamic bank (BUS) based on the calculation of Malmquist Productivity Index (MPI), with two categories namely technical change (TECH) on y axis and efficiency change (EFFCH) on x axis.



Picture. Four BUS Quadrants Based on the Malmquist Productivity Index

Information:

Quadrant 1 (High TECH, High EFFCH): BSM

Quadrant 2 (High TECH, Low EFFCH): BCAS, BSB, Panin, BJBS

Quadrant 3 (Low TECH, High EFFCH): Victoria, BMI, Mega, BRIS, BNIS, Maybank

Quadrant 4 (Low TECH, Low EFFCH): No

In the picture above shows that in the study period 2012-2017, there is 1 islamic commercial bank that is in quadrant 1, there are 4 islamic banks that are in quadrant 2, and 6 islamic banks that enter into quadrant 3. Meanwhile there is no one even islamic banks that enter the quadrant category 4.

Group quadrant 1 is a BUS category that has technical change and high-efficiency change. Islamic banks in this category are Bank Syariah Mandiri (BSM). BSM has a technical change value of 4,893, and an efficiency change of 1,000. Therefore, BSM is included in islamic bank with high productivity value.

Quadrant Group 2 is a BUS category that has a high technical change, but on the other hand has a low efficiency change. There are 4 islamic banks that fall into this category, namely: Bank Central Asia (BCA) Syariah, Bank Syariah Bukopin, Panin Syariah Bank, and BJB Syariah. BCA Syariah has a high technical value of 8,795, but the efficiency change is only 0.115. Bank Syariah Bukopin has a high technical change value of 8,231, and efficiency change of 0.693. Bank Panin Syariah has a high technical value of 7.064, and a change of 0.569. Meanwhile BJB Syariah has a high technical change value of 6,186, but the efficiency change is only 0.117. The collection of islamic banks in this group is considered a islamic bank with low catching up ability.

Group quadrant 3 is a BUS category that has a low technical change, but on the other hand has a relatively high efficiency change. There are 6 islamic banks that fall into this category: Bank Victoria Syariah, Bank Muamalat Indonesia (BMI), Bank Syariah Mega Indonesia, BRI Syariah, BNI Syariah, and Maybank Syariah.

Victoria Syariah has a technical change value of 0.035, and an efficiency change of 0.787. Bank Muamalat Indonesia has a technical change value of 1.227, and an efficiency change of 1,000. Bank Syariah Mega has technical change value of 1,981, and efficiency change of 0.735. BRI Syariah has a technical change value of 2,441, and an efficiency change of 1,000. BNI Syariah has a technical change value of 2,530, and an efficiency change of 1,000. Meanwhile, Maybank Syariah has a technical change value of 3,005, and the efficiency change of 1,000. Thus, these six BUSs in quadrant 3 can be considered as islamic banks with low production technology improvements, but are relatively capable of achieving a high level of efficiency.

The last quadrant is quadrant 4 is a group of islamic bank with technical change and low efficiency change. Based on the results listed in the picture above, no Islamic banks are included in this category. The collection of islamic banks in this group can be considered as a islamic bank whose productivity progress is relatively stagnant.

The distribution of BUS in 4 (four) quadrants above can be influenced by the characteristics of the existing islamic bank in each group. Some variables that can describe the characteristics of each islamic bank such as the intensity of research and development, product innovation, sales orientation, location and network of banks and types of ownership of the company. This figure is still indicative and requires formal testing, but is not covered in this study.

E. CONCLUSION

This research tries to analyze BCC model as base model in DEA to see efficiency level of islamic bank in Indonesia for period 2012-2017. Further Malmquist index is used to see the productivity level of islamic bank, both in terms of changes in efficiency and technological change which is then displayed in the form of quadrant 4 groups.

The results obtained from the Malmquist index score (TFP Change) indicate that 9 islamic banks out of 11 BUSs have increased productivity, or about 82% of all islamic banks. It is marked with a score of more than 1. While the rest show relatively low productivity levels.

For analysis of bank group with efficiency change criterion (EFFCH) and technological change (TECH), there is 1 islamic bank in quadrant 1 (technical change and high-efficiency change), there are 4 islamic bank in quadrant 2 (technical change high but low efficiency change), and 6 islamic banks that enter into quadrant 3 (technical change is low but high-efficiency change). Meanwhile, none of the islamic banks are in the quadrant category 4.

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