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Examining Technological and Productivity Change in the Islamic Banking Industry

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ABSTRACT

Islamic banking dominates the largest market share of global Islamic finance assets. Thus, the performance of Islamic banks is crucial in shaping the future development of Islamic finance. This study aims to examine the performance of Islamic banks in the perspective of technological and productivity change based on the country level assessment. By adopting the Malmquist Index analysis, this study selected 44 Islamic banks from the top ten countries that had the largest Islamic banking asset for the period from 2015 to 2018. The findings reveal that the average productivity of Islamic banks has increased during the study period. Productivity improvements were supported by technological innovation, which significantly increased the level of productivity. Nevertheless, the high-tech expansion was not followed by an improvement in the efficiency level. This finding explains that the development of banking technology is not able to fully support the development of products and services.

Keywords: Islamic banking, Malmquist Index, productivity, technological

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INTRODUCTION

Islamic finance provides a different perspective on financial practice, prohibiting interest, *gharar* (undue hazard), and *maysir* (gambling) and other prohibited activities in its operation. These principles create a difference in the operation of Islamic financial institutions compared to others. Islamic finance has seen rapid growth in the last two decades: assets reached USD 1,760 bn in 2012, and grew to USD 2,524 bn in 2018, with accumulated growth of 43.4% during the period. This growth was mainly due to the growth in the Islamic banking sector, which constituted 70% of Islamic finance assets. Globally, there are 520 Islamic banks (IBs) operating across 72 countries (Thomson Reuters, 2018).

Figure 1 shows the top ten countries with the biggest Islamic banking assets (in billions of dollars, USD). Iran hosts the biggest Islamic banking sector among the Islamic countries, with USD 390 bn in total assets with 24 IBs. The high number of Islamic banks' total assets in Iran is due to the entire financial industry of the country operates only Islamic banking and finance unlike the dual banking system practiced in other countries (The Diplomat, 2015). Iran then is followed by Saudi Arabia and Malaysia, which had USD 214 bn and USD 194 bn with 16 and 38 IBs, respectively. Indonesia had USD 28 bn in total assets, with 34 IBs.

The future development of Islamic banking requires the adoption of high-tech solutions that enable greater competitiveness and profitability (Akhtar, 2010). In addition, Akhtar (2010) had argued that the adoption of cutting-edge technology in IBs would increase their productivity. Hence the role of innovation becomes pivotal for IBs: adopting new and better technology would increase business efficiency. Yildirim (2017)

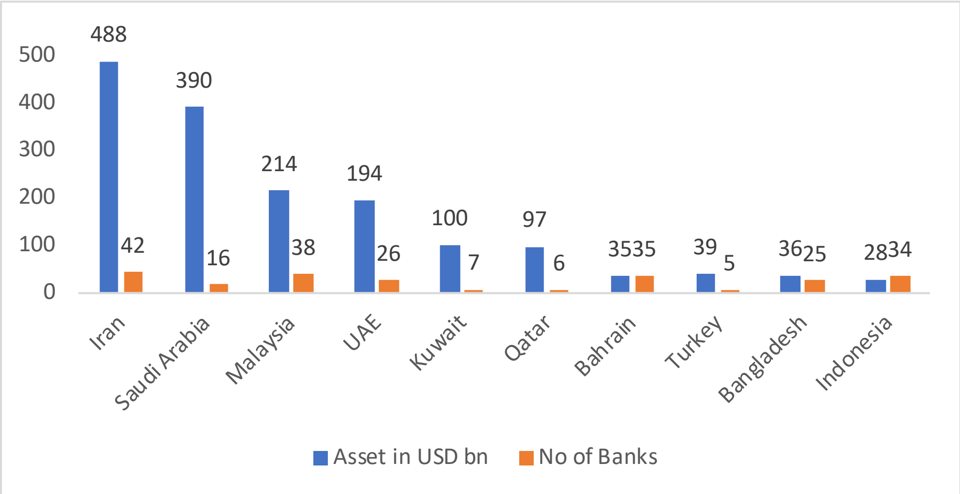


Figure 1. Asset size of Islamic banks in the top ten countries for Islamic Banking (Thomson Reuters, 2018)

stated that efficiency would make IBs able to optimize inputs from funding and financing activities, thus generating more income from these activities. Therefore, by achieving a certain level of efficiency, IBs will be more productive in conducting their business operations.

Measures of banking efficiency had been developed by Abdul-Wahab and Haron (2017), Akhtar (2010), Fakhrunnas et al. (2018), Harahap and Nashihin (2014), Nartey et al. (2019), Sufian (2007), and Sufian and Haron (2008). According to these studies, the measurement of efficiency can be used to measure the technological development in the banking industry as well as the improvement of its productivity. In other words, it also means that the more efficient banks have better technology, and so this is an appropriate indicator for measuring banks' productivity.

Akhtar (2010), in his studies using the Data Envelopment Analysis (DEA), found that Saudi Arabian banks' increased productivity was due to improvement in their technology, and this had increased the banks' efficiency score The finding implies that banks in Saudi Arabia, as intermediary institutions, were able to innovate new banking products that improved productivity. In contrast, Abdul-Wahab and Haron (2017) stated that IBs in Qatar were not able to perform as expected due to low efficiency, especially technical and pure efficiency.

From the wider perspective, Sufian et al. (2008) found that IBs in the Middle East and North Africa (MENA) region became the most efficient IBs in the world during 2001-2006. The same study also found that this high efficiency indicated that IBs in MENA had the utmost developed technology compared to banks in other regions. Sufian and Haron (2008) found that Malaysian-owned IBs were more efficient and productive compared to the foreign-owned IBs in Malaysia due to the locally-owned banks' improvements in technology.

Despite the many past studies on the efficiency of IBs, only a few have addressed the efficiency issue from the perspective of technological development and productivity. This study, therefore, attempts to contribute in two aspects. The first is to reconfirm the findings of previous studies; the second is to examine efficiency from the technological perspective at the country level so as to understand the Islamic banking development from the macro perspective (rather than at the level of individual IBs).

This introduction is to be followed with a literature review and then a statement of research methods. Next is the results and discussion; the final section offers conclusions and recommendations.

LITERATURE REVIEW

Efficiency and productivity are two indicators that can explain banks' performance (Abdul-Wahab & Haron, 2017). According to Abdul-Wahab and Haron (2017), *productivity* refers to units of inputs used to create outputs, while *efficiency* refers to additional outputs created while adding more inputs. In relation to this, Sufian (2007) described efficiency as a progressive transformation from input to output performed by the bank. A higher level of efficiency will present when the impact of adding one input creates a higher additional output progressively. In contrast, a lower level of efficiency will exist when there is no progressive additional output following new input (Abdul-Wahab & Haron, 2017).

To examine the banks' efficiency, the frontier efficiency approach is viewed as the most advanced method (Abdul-Wahab & Haron, 2017). This approach compares the business performance of two banks, expressing the comparison in terms of an efficiency ratio. The most efficient bank is taken to be at the frontier, and it will be the benchmark for other banks (Berger & Humphrey, 1997). Frontier efficiency can be established using a parametric or non-parametric approach. According to Abdul-Wahab and Haron (2017), the parametric approach employs econometrics as a foundation for determining an efficiency model; this is called Stochastic Frontier Analysis (SFA). SFA will have an error term in the model and a researcher must have good reason to use this method. In the non-parametric approach, Data Envelopment Analysis (DEA) is utilized to measure bank efficiency. DEA performs a linear programming procedure that accommodates many inputs and outputs while not requiring price information. Furthermore, DEA tends to be used for small sample sizes while SFA requires a bigger sample.

Sealey and Lindley (1977) asserted that efficiency measurement in the banking sector had two approaches: the production and intermediation efficiency approaches. According to the *production efficiency approach*, the bank manages input such as customer deposits (funding activities) and progressively transforms it into output (financing activities). In contrast, the *intermediation efficiency approach* is grounded in the bank's function as an intermediary institution that channels funds from surplus sectors to deficit sectors.

Studies in banking productivity and efficiency have been carried out by many researchers, showing its importance with regards to the discussion of Islamic banking and finance. Staub et al. (2010) studied the efficiency of conventional banking around the world. The study found that banks in Brazil recorded lower economic costs compared to banks in Europe and the United States. DEA was employed and the study found that state-owned banks were significantly more cost-efficient than national private banks, banks with foreign ownership, and private banks.

Meanwhile, Adjei-Frimpong et al. (2015) explained that the banking industry in New Zealand had achieved an optimal level of efficiency. However, this is the case only with respect to scale efficiency, not pure efficiency. This finding could be contributed by the New Zealand banking industry, which only experienced a slight increase during the 2007-2011 period. The increase was due to improvement in banking technology as the use of inputs was made more efficient and the level of output productivity was increasing.

In line with Adjei-Frimpong et al. (2015), the effect of technology on efficiency level was also found by Nartey et al. (2019)

on banking efficiency in Africa. They found that the decline in the productivity of African banks was mainly due to insufficient technological progress, with state banks reported to be more productive than foreign and private banks. Furthermore, their findings showed that non-executive directors, leverage, management quality, credit risk, competition, and exchange rates have a significant influence on bank productivity, however, neither ownership nor quality of CEO has any significant influence.

Abdul-Wahab and Haron (2017) conducted a study on the banking efficiency in Qatar for 2007-2011. They discovered that the banking industry in Qatar was not optimal due to low efficiency. In general, conventional banking in Qatar recorded higher efficiency than Islamic banking in terms of both technical and pure efficiency. Nevertheless, Islamic banking in the country is better in terms of scale efficiency. Malmquist Productivity Index (MPI) is performed in their study and they found that the global economic crisis affected the efficiency of the local banking industry, with efficiency tending to decrease throughout the crisis. Maredza and Ikhide (2013) added that the global financial crisis was one of the key determinants of efficiency in the banking industry. Efficiency was affected by the banking crisis, as was productivity.

Further, Ahmad and Rahman (2012) performed a study on the efficiency of IBs in Malaysia and compared the performance of IBs with that of conventional banks. They used the intermediary approach, categorizing total employee salaries as capital and total third-party funds as input. Meanwhile, lending and financing activities, as well as total income, were measured as output. The study established that conventional banks were more efficient than the IBs because the conventional had better management and were larger in size. This makes them better able to utilize input to raise productivity than IBs.

In line with Ahmad and Rahman (2012), Fakhrunnas et al. (2018) concluded that IBs in Indonesia was not so efficient as their conventional counterparts. Their studies used total deposits, operational costs, and total financing as input variables while measuring bank income as the output variable. They concluded that although Islamic banking was less efficient, during the 2008 crisis IBs was less vulnerable compared to conventional banks. This is evidenced by the decline in the efficiency of conventional banks, which was higher compared to IBs during the crisis period.

Rusydiana (2018) explained that IBs in Indonesia had performed differently in terms of efficiency and found that eight out of eleven IBs in Indonesia had increased their productivity. The increase in productivity is an indicator of the development of banking technology that enables the management of inputs to become more efficient. The other three IBs, however, did not record an increase in productivity due to the decline or stagnation of technology.

In addition, Sufian et al. (2008) studied 37 IBs spread across 37 countries and used DEA for their analysis. They recorded that Islamic banking in MENA had higher average efficiency compared to other regions in the Asian continent. This is based on the higher technical efficiency value, which is strongly influenced by the pure efficiency value. The findings of their studies confirm the function of IBs as intermediaries where total deposits and assets are utilized as input for producing output in the form of total financing, income, and investment.

Akhtar (2010) recorded that the banking industry in Saudi Arabia experienced an increase in average bank productivity. This is primarily caused by technological changes, which in turn drive changes in efficiency. This is mainly caused by changes in technology relative to changes in efficiency. Banks in Saudi Arabia have managed to catch up by implementing the best banking practices, despite the technical efficiency (TE), on average was still below the optimal level. Using DEA, the results also confirmed that the role of banks as intermediary institutions in Saudi Arabia caused their ability to innovate effectively and thereby increase the level of productivity and efficiency. Innovations in banking products and the technology used can certainly reduce banking operational costs (Raphael, 2013).

METHODS

This study used balanced panel data of 44 IBs from 2014 to 2018. The banks were selected from the 10 countries that had the largest Islamic banking sectors, namely Iran, Saudi Arabia, Malaysia, United Arab Emirates (UAE), Qatar, Kuwait, Bahrain, Indonesia, Turkey, and Bangladesh. The selected countries above-mentioned represent the advanced development of the Islamic banking industry in the world (Thomson Reuters, 2018) and control about 85% of global Islamic banking assets (Islamic Financial Service Board [IFSB], 2019). The top 5 Islamic commercial banks (in terms of assets) were then chosen from each country to represent the Islamic banking development for each of the sample countries.

Table 1 lists the banks selected for the study. Only 1 bank was selected for Iran and 4 each for Turkey and Bangladesh due to the unavailability of data for other banks.

Table 1

Research sample

Country	Number of samples	Bank names
Indonesia	5	Bank Muamalat Indonesia, BRI Syariah, BNI Syariah, Mega Syariah, Syariah Mandiri
Iran	1	Bank Tajerat
Saudi Arabia	5	Al Rajhi, Banque Saudi Fransi, National Commercial Bank, Riyadh Bank, Samba Bank

Table 1 *(Continued)*

Country	Number of samples	Bank names
Malaysia	5	Bank Kerjasama Rakyat, CIMB Islamic Berhad, Maybank Islamic Berhad, Ublic Islamic Berhad, RHB
UAE	5	Abu Dhabi Islamic Bank, Dubai Islamic Bank, Emirates Islamic Bank, Noor Bank, Sharjah Bank
Qatar	5	Commercial Bank, Doha Bank, Qatar International Islamic Bank, Qatar Islamic Bank, Qatar National Bank
Kuwait	5	Ahli United Bank, Boubyan Bank, Kuwait Finance House, Kuwait International Bank, Warba Bank
Bahrain	5	ABC Islamic Bank, Al Salam Bank, Albaraka Islamic Bank, Bahrain Islamic Bank, Khaleeji Commercial Bank
Turkey	4	Albaraka Bank, Halk Bank, Kuwait Turkish Participation, Turkiye Finans
Bangladesh	4	Islami Bank Bangladesh, First Security, Al Arafah Bank, Exim Bank, Social Islami Bank

This study applied an intermediation approach that considered IBs as intermediaries between surplus and deficit units. The intermediation approach uses deposits as input which will later produce output in the form of financing to those who need funds. This approach is considered appropriate for the performance evaluation of financial institutions in general due to the characteristics of IBs as financial intermediaries. In addition, the intermediation approach has also been broadly used in the banking efficiency research performed in many countries. The input and output variables selected are depicted in Table 2.

There are several stages in analyzing the banking performance using the Malmquist Index (MI) with the application of the DEA, together termed Dual Method Programming, as explained in previous studies (Abdul-Wahab & Haron, 2017; Akhtar, 2010; Nartey et al., 2019). In the first stage of this study, efficiency scores were estimated using DEA and then the measurement of bank productivity was performed. In determining the level of productivity, if $MI > 1$, there was an increase in the level of productivity. If $MI = 1$ then there is no increase in productivity or productivity is stagnant, and if $MI < 1$ there is a decrease in the level of productivity.

The second stage was a quadrant plot of Islamic bank groups sorted into two categories: firstly, changes in efficiency and secondly, changes in technological factors,

Table 2

Input-output model of DEA

Variable	Definition	Reference(s)
Input		Ahmad and Rahman (2012), Firdaus and Hosen (2013), Widiarti et al. (2015)
Third party funds	The total amount of funds deposited by Islamic banking customers	
Total assets	The total amount of assets in Islamic banks	
Output		Ahmad and Rahman (2012), Firdaus and Hosen (2013), Widiarti et al. (2015)
Financing	The total amount of financing given to the deficit unit of Islamic banks	
Operational income	The net income for operational activity performed by Islamic banks	

with certain criteria. Quadrant 1 shows high technology and high efficiency: this is the category of IBs that is high in technical change and efficiency change. Quadrant 2 shows high technology and low efficiency: these are IBs that have high technical change but on the other hand, have low-efficiency change. Quadrant 3 exhibits low technology and high efficiency: IBs that have low technical change but high-efficiency change. Quadrant 4 shows low technology and low efficiency: IBs that have low technical change and low-efficiency change.

The Malmquist Productivity Index (MPI) was employed to measure banks' productivity. MPI was first introduced by Caves, Christensen, and Diewert (1982) by adopting the distance function methodology to describe technology and define input, output, and productivity indices. Measurement of changes in company productivity between two periods involves two production technology sets, namely S^s and S^t, respectively, for periods *s* and *t*. Each technology set involves the output vectors q_s and q_t, as well as the input vectors x_s and x_t.

For output produced in periods s and t, there is a technology that produces maximum output using x_s and x_t. For instance, if a bank in the period s produces 90% of its maximum capacity with the input vector x_s, and in period t can produce output 40% above its maximum capacity using the input vector x_t, then the change in productivity from period s to t is 1.40 / 0.90 = 1.26

MPI calculations with technological references in the period s are proposed by Caves, Christensen, and Diewert (1982) as follows:

$$m_0^t(q_s, q_t, x_s, x_t) = \frac{d_0^t(q_t, x_t)}{d_0^t(q_s, x_s)}$$

If it is assumed that the bank achieved technical efficiency (hereinafter referred to as *efficiency*) in the second period, then $d_0^s(q_s, x_s) = 1$ so that the above equation becomes:

$$m_0^s(q_s, q_t, x_s, x_t) = d_0^s(q_t, x_t)$$

Furthermore, for MPI with the technology reference in period t, the equation is as follows:

$$m_0^t(q_s, q_t, x_s, x_t) = \frac{d_0^t(q_t, x_t)}{d_0^t(q_s, x_s)}$$

Malmquist TFP Index calculation (MTFPI) is based on MPI measurements in period s and t so that the MTFPI calculation is the geometric average of the two indices in that period:

$$m_0(q_s, q_t, x_s, x_t) = [m_0^s(q_s, q_t, x_s, x_t) \times m_0^t(q_s, q_t, x_s, x_t)]^{0.5}$$

$$MTFPI = \left[\frac{d_0^s(q_t, x_t)}{d_0^s(q_s, x_s)} \times \frac{d_0^t(q_t, x_t)}{d_0^t(q_s, x_s)}\right]^{0.5}$$

The MTFPI equation can be separated into two components: efficiency changes and technological changes, as below:

$$m_0(q_s, q_t, x_s, x_t) = \frac{d_0^t(q_t, x_t)}{d_0^s(q_s, x_s)}\left[\frac{d_0^s(x_t, q_t)}{d_0^t(x_t, q_t)} \times \frac{d_0^s(x_s, q_s)}{d_0^t(x_s, q_s)}\right]^{0.5}$$

$$Efficiency\ Change = \frac{d_0^t(q_t, x_t)}{d_0^s(q_s, x_s)}$$

$$\text{Technical Change} = \left[\frac{d_0^s(x_t, q_t)}{d_0^t(x_t, q_t)} \times \frac{d_0^s(x_s, q_s)}{d_0^t(x_s, q_s)}\right]^{0.5}$$

The equation above is obtained because, in the real world, banks often operate at efficiency levels that are not optimal; in other words, banks operate in inefficient conditions, so: $d_0^s(q_s, x_s) \leq 1$ and $d_0^t(q_t, x_t) \leq 1$.

RESULTS AND DISCUSSION

Description of Results on Efficiency

Table 3 shows the average efficiency of IBs, which is not at the optimal level. Generally, IBs have not been able to optimize all of their resources such that they operate with maximum efficiency. The evidence can be seen in the efficiency values measured below 1. The table also shows that during the study period, Bangladesh had the lowest technical efficiency value (12.4% efficiency). The inefficiency of IBs in Bangladesh occurred due to the scale inefficiency instead of pure technical inefficiency. According to the result, the scale inefficiency value is 86.7%, while the pure technical inefficiency value is only 8.2%. This finding implies that IBs have not been able to achieve their optimal scale (they are either too large or too small). This result is in line with the study conducted by Adjei-Frimpong et al. (2015), who found that bank technical inefficiencies were caused by scale inefficiency instead of pure technical inefficiency.

In contrast, Qatar had the highest value of technical efficiency, at 71.7%. This means

Table 3
Description of efficiency result

Country/Efficiency	Mean	Minimum	Maximum	SD
Indonesia				
Technical Efficiency	0.689	0.483	0.802	0.254
Pure Technical Efficiency	0.773	0.512	0.942	0.192
Scale Efficiency	0.788	0.625	0.992	0.074
Iran				
Technical Efficiency	0.408	0.258	0.579	0.064
Pure Technical Efficiency	0.821	0.372	1.000	0.316
Scale Efficiency	0.497	0.338	0.694	0.071
Saudi Arabia				
Technical Efficiency	0.544	0.231	0.763	0.198
Pure Technical Efficiency	0.774	0.586	0.865	0.051
Scale Efficiency	0.704	0.277	0.914	0.303
Malaysia				
Technical Efficiency	0.661	0.276	0.949	0.350
Pure Technical Efficiency	0.840	0.572	0.952	0.102
Scale Efficiency	0.788	0.313	0.999	0.369
UAE				
Technical Efficiency	0.593	0.265	0.847	0.236
Pure Technical Efficiency	0.743	0.535	0.860	0.066
Scale Efficiency	0.806	0.370	0.997	0.298
Qatar				
Technical Efficiency	0.717	0.338	0.904	0.225
Pure Technical Efficiency	0.873	0.832	0.921	0.006
Scale Efficiency	0.819	0.395	0.999	0.276
Kuwait				
Technical Efficiency	0.633	0.365	0.851	0.165
Pure Technical Efficiency	0.714	0.540	0.871	0.101
Scale Efficiency	0.892	0.679	0.979	0.062
Bahrain				
Technical Efficiency	0.630	0.438	0.729	0.056
Pure Technical Efficiency	0.868	0.793	0.910	0.010
Scale Efficiency	0.733	0.560	0.818	0.044

Table 3 *(Continued)*

Country/Efficiency	Mean	Minimum	Maximum	SD
Turkey				
Technical Efficiency	0.334	0.149	0.457	0.058
Pure Technical Efficiency	0.379	0.152	0.527	0.089
Scale Efficiency	0.859	0.796	0.936	0.011
Bangladesh				
Technical Efficiency	0.124	0.045	0.229	0.018
Pure Technical Efficiency	0.918	0.880	1.000	0.009
Scale Efficiency	0.133	0.045	0.253	0.023

that IBs in Qatar can produce similar levels of output by reducing their inputs by 28.3%. In other words, IBs are able to produce identical levels of output using only 71.7% of the total input held. The measurement results indicate that scale inefficiency is higher than pure technical inefficiency, with small differences of 18.1% and 12.7%. This suggests that IBs in Qatar had not achieved their optimal scale and 12.7% of the total technical inefficiencies could be contributed by inefficient management of IBs (i.e. management that is less competent at using input resources). In addition, IBs also possibly do not practice proper management in their operational activities. This finding differs from Abdul-Wahab and Haron (2017), which revealed that the pure technical inefficiency of IBs in Qatar was higher than their scale inefficiency. The findings of the current study are also consistent with the efficiency of IBs in several other countries, such as Indonesia, UAE, Kuwait, and Turkey. The results show that the technical inefficiency of IBs in each country is mostly caused by the less competent management of IBs—management that is less efficient at using banks' input resources.

Figure 2 describes the technical efficiency of IBs in the 10 countries that have the largest Islamic banking asset. It shows a declining trend during the period from 2014 to 2017 then an increase in 2018. The significant decline occurred in 2017, with technical efficiency on average at 0.364 or 36.4%, then increased in 2018 to 60.8%. Based on Figure 2, it appears that the scale efficiency is lower than pure technical efficiency, except in 2017 when it was the opposite. This finding is in accordance with studies conducted by Hassan (2006), which found that the inefficiency of IBs was caused by output (scale inefficiency) rather than input use (pure technical inefficiency). This implies that IBs have not been able to reach the optimal scale. Total assets or bank size is one of the reasons why IBs have not been able to achieve the economics of scale. Larger bank sizes are often associated with higher scale efficiency as revealed by Hassan (2006). Meanwhile, Hassan and Sanchez (2007) revealed that one of the factors that could help banks reach their optimal scale was an improvement in technology.

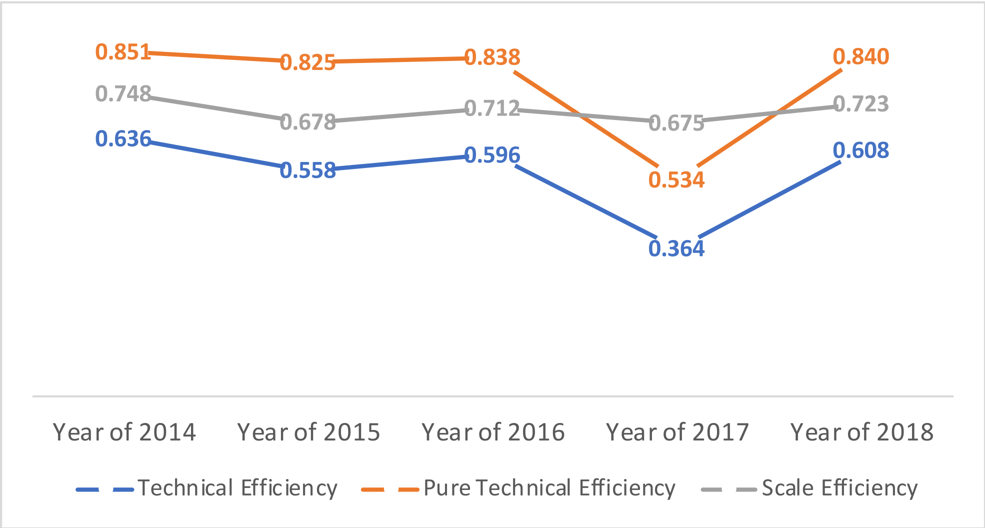


Figure 2. Islamic bank efficiency development, 2014-2018

Productivity Measurement Based on Malmquist Total Factor Productivity (TFP) Index

Based on the results, generally, IBs had increased their productivity, indicated by the average TFPCH value of 1.055. The increase in productivity by 5.5% (1.055) was supported by improvements in banking technology, which grew more advanced by 6.8% (1.068). These results are similar to past studies, such as those by Akhtar (2010) and Abd-Kadir et al. (2010), who revealed that the increase in banks' productivity-driven more by changes in technology, which in turn drove changes in efficiency. This suggests that the technology of IBs is improving and can stimulate incremental improvements in banking productivity. However, the technical efficiency change indicates a slight decrease, or tend to stagnate, with a value close to 1 (0.988). This implies that the efficiency of IBs tends to remain unchanged during the period of study.

Table 4 shows that during the period of 2014-2018, there were five countries that recorded increases in IBs productivity: Iran, Saudi Arabia, Kuwait, Bahrain, and

Turkey. The increase in productivity of IBs in these five countries was driven by technological improvements and banking efficiency improvements, except for Bahrain and Turkey, which were more supported by technological changes. Meanwhile, the productivity of IBs in Indonesia, Malaysia, UAE, Qatar, and Bangladesh tend to stagnate or slightly decline. The declining level of efficiency of IBs in these countries caused the banks to experience a decrease in productivity.

Table 4
Islamic banks' productivity

Country	Effch[1]	Techch[2]	Pech[3]	Sech[4]	Tfpch[5]
Indonesia	0.952	1.021	0.984	0.967	0.972
Iran	1.061	1.464	1.000	1.061	1.552
Saudi Arabia	1.046	1.039	1.027	1.018	1.087
Malaysia	0.995	0.998	0.999	0.995	0.993
UAE	0.979	1.021	0.985	0.994	0.999
Qatar	0.986	1.005	0.989	0.996	0.991
Kuwait	1.015	1.031	1.007	1.008	1.046
Bahrain	0.991	1.041	1.003	0.988	1.031
Turkey	0.944	1.097	0.985	0.958	1.036
Bangladesh	0.919	1.030	0.987	0.931	0.947
Mean	0.988	1.068	0.997	0.991	1.055

Notes: [1]effch: efficiency change, [2]techc: technological change, [3]pech: pure efficiency change, [4]sech: scale efficiency change, [5]tfpch: total factor productivity change.

Figure 3 describes the productivity development of IBs which shows a fluctuating trend. During the period from 2015 to 2017, there was an increase in productivity, with values increasing by 6.8%, 13.2%, and 2.7%, respectively. But in 2018 the productivity of Islamic banks decreased by 12.3%. This was due to the technological change, which was the driving factor in increasing the productivity of IBs in the previous period (2015 to 2017). However, the massive technological changes were also followed by a 51% decline in banking efficiency. The phenomenon that occurred in 2016 showed that product innovation or technology development was able to drive improvements in the productivity of IBs by 13.2%, despite a substantial decrease

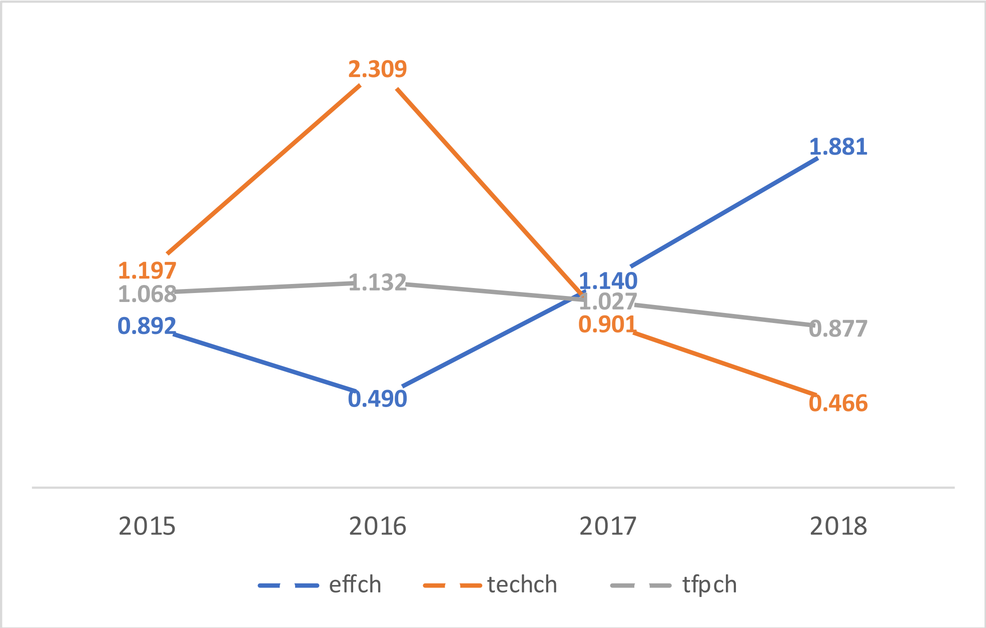


Figure 3. Development of Islamic bank productivity, 2015-2018

in efficiency scores in the same year. This result is consistent with the findings of Abd-Kadir et al. (2010) which revealed that technological advances allowed IBs to produce certain levels of output with fewer inputs. Despite this, technological advances can result in a decrease in average banking efficiency even with the increase in banking productivity. A possible explanation for this is, technology demands that banking personnel to learn new skills, adapt to new systems, and change their behavior. While a new iteration of technology may offer more capacity, productivity, or performance, those advantages are at least partly offset by the time banking personnel have to spend learning to use it, hence affecting the overall efficiency (World Economic Forum, 2018).

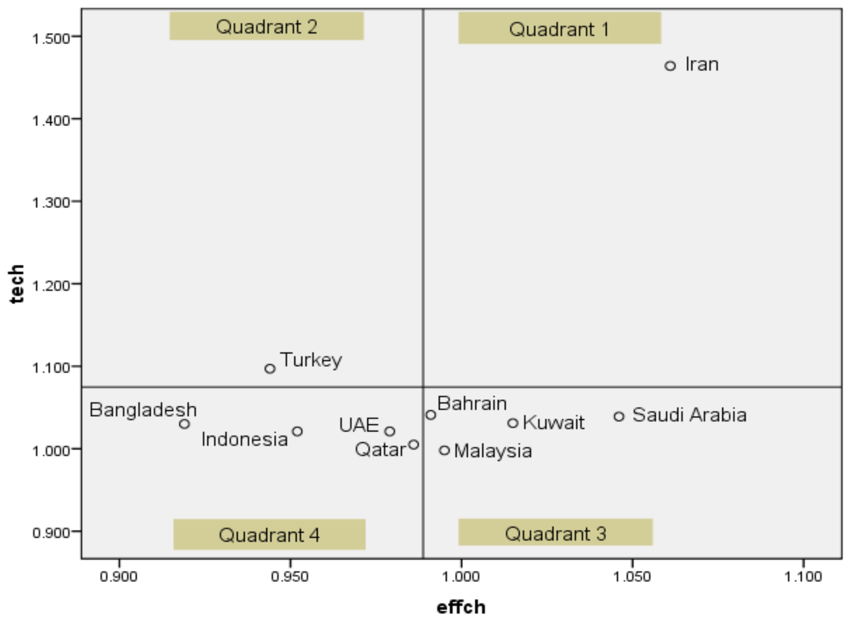
Interestingly, the reduction in inefficiency is primarily caused by a decrease in scale inefficiency. Thus it can be determined that the high-tech expansion that occurred in 2016 has not been able to spur the banking industry to reach optimal scale and that IBs are operating at the wrong scale (size, either too large or too small). One of the possible reasons is that not all banking customers have switched to digital banking services. As noted by Abdul-Wahab and Haron (2017), although most IBs provide online banking services, some customers do not utilize this service due to security reasons. Another factor is that existing information technology has not been able to support the products (services) development, hence causing the efficiency of IBs to be suboptimal. Abd-Kadir et al. (2010) suggested that large banks tended to successfully implement and operate technology in the banking industry. This is because to implement the technology, a large amount of funds is needed to buy machines and meet the recurring cost of recruiting trained staff. This possible reason is reinforced by the findings for 2018, which showed a decline in technological innovation of 53.4%, but a rise in banking efficiency of 88.1%. Even though IBs have increased their efficiency, they have not been able to increase bank productivity. This can happen because in general, the efficiency of IBs has not reached the optimal point (100%) despite the improvement in bank efficiency of 88.1% during the year.

Islamic Bank Quadrant Grouping Based on Malmquist Total Factor Productivity (TFP) Index

To find out the level of productivity of IBs in each country, a quadrant plot of a bank group was conducted, consisting of two categories. The first category is the change in efficiency, represented by the X-axis, while the second category is the change in technology, shown on the Y-axis. IBs in each country were grouped into one of the four quadrants based on their placement in the Technical Efficiency Change (EFFCH) and Technological Change (TECH) categories.

Figure 4 shows the first quadrant is IBs that have high technical efficiency change and technological change. The banks in quadrant 1 have a high level of productivity. Iran is the only country included in the first quadrant, with an increase in productivity of 55.2%. The increase was driven by technological improvements and increased in bank efficiency, with a value of 46.4% and 6.1%, respectively. These results imply that Islamic banking in Iran is capable of making more than sufficient technological innovations (46.4%), which encourage a significant increase in productivity (55.2%). This is consistent with the findings of Akhtar (2010), which showed that the high levels of technology adoption in IBs could increase banking productivity. Conversely, improvements in the efficiency of IBs in Iran illustrate the improved management of input resources. The more efficient a bank is, the greater its ability to optimize all of its resources, as revealed by Yildirim (2017), which showed that efficiency would result in IBs' optimizing the utilization of inputs. It can be further established that the efficiency of IBs in Iran was driven by an improvement in the scale efficiency of 6.1%, which indicated that during the study period, the banks were able to optimize the economics of scale. This is inseparable from technological innovation, as noted by Hassan and Sanchez (2007). They suggested that banks could reach a more optimal scale when there was technological change. This view is supported by the findings of Abdul-Wahab and Haron (2017), Akhtar (2010), Fakhrunnas et al. (2018), Harahap and Nashihin (2014), Nartey et al. (2019), and Sufian et al. (2008), who revealed that the efficient bank could describe the better development of banking technology.

The second quadrant is a category of countries where IBs have high technical



Notes:
[1]**Quadrant 1** (High TECH, High EFFCH)
[2]**Quadrant 2** (High TECH, Low EFFCH)
[3]**Quadrant 3** (Low TECH, High EFFCH)
[4]**Quadrant 4** (Low TECH, Low EFFCH)

Figure 4. Islamic banks productivity quadrants

change but low-efficiency change. Turkey was included in the second quadrant and had experienced an increase in productivity of 3.1%, supported by technological improvements of 4.1%. This result is similar to Adjei-Frimpong et al. (2015), who found that changes in banking productivity were driven by changes in technology. However, banking efficiency in Turkey had reduced by 5.6%. In this case, the banks' inefficiency of 1.5% is caused by management that is less competent in using input resources or inappropriate utilization of input settings, while 4.2% is caused by banks not yet reaching their optimal scale.

Meanwhile, Bahrain, Malaysia, Kuwait, and Saudi Arabia were grouped in the third quadrant, which had a relatively lower technical change value but had a high rate of efficiency change. The IBs in this quadrant were the banks that were able to achieve optimal levels of efficiency even though the level of technological improvement was relatively low. In this case, the countries had experienced an average technological improvement; however, the value was relatively low compared to other countries. Kuwait and Saudi Arabia were countries that had increased their efficiency by 4.6% and 1.5%, respectively. Increased efficiency is supported by the better management of inputs (pure technical efficiency) and the optimization of banking operations (scale efficiency). Sufian and Haron (2008) and Sufian (2007) revealed that an increase in efficiency could encourage productivity improvements. In contrast, the productivity of IBs in Malaysia tended to be stagnant (i.e. not experience an increase). The likely causal factor is that the efficiency and technology level during the period decreased slightly, by 0.5% and 0.2%.

The fourth quadrant represents IBs with relatively low technical change as well as low-efficiency change. The countries included in the fourth quadrant were Bangladesh, Indonesia, UAE, and Qatar. Indonesia was one of the countries that experienced a decline in productivity of 2.8% during the study period. The decrease in productivity was caused by a 4.8% decrease in the level of bank efficiency. Several studies conducted by Ahmad and Rahman (2012) and Fakhrunnas et al. (2018) found that IBs in Indonesia were less efficient than conventional banks. Similar results were also recorded by Karimah et al. (2016), who found that Islamic commercial banks in Indonesia had not operated efficiently. The low efficiency of banks can affect their level of productivity, as revealed by Abdul-Wahab and Haron (2017).

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of this study, generally, the level of technical efficiency of IBs is not optimal. The inefficiency of IBs is mainly caused by scale inefficiency instead of pure technical inefficiency. From the productivity perspective, the average productivity of IBs in the world has increased during the study period. Productivity improvements were supported by technological improvements, which significantly increased the level of productivity. However, from the perspective of productivity development, it shows quite an interesting result: during the study period, the high-tech expansion did not materialize in an increase in efficiency level. This illustrates that the development of banking technology has not been fully able to support the development of products and services.

This study has implications. There is a need for IBs to improve their efficiency especially in terms of scale efficiency. What banks need to do to achieve scale efficiency is to optimize technology utilization. Technology innovation can be optimized if supported by sufficient capital and competent human resources. In addition, support from regulators is also needed to encourage IBs to expand the scale of their operations. Besides that, literacy about digital banking also needs to be improved so that public access to banking technology increases. Once technological developments are supported by efficiency improvements, the productivity of IBs will be even greater, and they will be more competitive

This study has a limitation. The first is on its small sample size per country. Future research can extend to bigger sample size to make the study more impactful. Researchers may also consider comparing the level of productivity of Islamic banks between Muslim majority countries and non-Muslim majority countries. Second, we suggest that it is important to analyze the determinants of Islamic banking productivity both at the bank-specific and macro-economic level of the countries that operate Islamic banking.

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