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ANALYSIS OF TOTAL FACTOR PRODUCTIVITY CHANGES IN ISLAMIC AND CONVENTIONAL BANKS: EMPIRICAL EVIDENCE FROM THREE REGIONS

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ABSTRACT

The objective of this study is to examine total factor productivity changes (TFPCH) in Islamic and conventional banks to determine whether they exhibit progression or regression. As earlier studies have focused mainly on productivity in conventional banks rather than Islamic banks, the current study aims to bridge the gap in the literature by investigating both types of bank in the Middle East, Southeast Asia, and South Asia. A total of 385 Islamic and conventional banks from 18 countries were selected, with data acquired for the period from 2008 to 2017. Panel data analysis was undertaken using DEA-based MPI to investigate the impact of selected determinants of banks' productivity, as indicated by TFPCH. The results from both the *t*-test and nonparametric tests revealed that Islamic banks are more productive than conventional banks, which can be attributed to the increase in efficiency changes. However, no statistically significant difference in productivity exists between the types of bank. The main contribution of this study is that it provides not only corroboration for previous studies but also additional insight into bank productivity in Islamic and conventional banks, which will be important to banks, regulators, investors, and researchers.

Contribution/Originality: This study is one of very few that have investigated the level of productivity in Islamic and conventional banks sector. It specifically focuses on countries in the Middle East, Southeast Asia, and South Asia, which are representative of global Islamic banking and finance.

1. INTRODUCTION

As a result of the global financial crisis (GFC), which occurred between mid-2007 and early 2009, Islamic banking has attracted significant interest and attention as an alternative to conventional banking–especially after investment banks collapsed (Rosman, Wahab, & Zainol, 2014). Likewise, the deterioration in banks' performance during the more recent financial crises has encouraged academia, financial markets, and banks to investigate the factors associated with performance to avoid the adverse effects that threaten and contribute to potential instability in the financial markets.

Nonetheless, the banking sector continues to grow, at least until another form of banking emerges, and both Islamic and contemporary economists are becoming more interested in Islamic banking. Islamic banks are able to not only provide Muslims with institutions that follow the Islamic legal code, *Shariah* (Rosman et al., 2014) but also reduce the risks in financial transactions, which affects economic growth (Hassan & Aliyu, 2018).

In principle, the Islamic financial system prohibits paying or charging interest, speculation, uncertainty (*gharar*), and transactions related to alcohol, tobacco, pornography, and any activity considered detrimental to society (Hassan & Aliyu, 2018). The theoretical differences between Islamic banks offering *Shariah*-compliant finance and conventional banks appear in the levels of complexity, agency costs, and maturity and development (Beck, Demirgüç-Kunt, & Merrouche, 2013); other differences include risk-taking, interest rates, income streams, and size (Habib, 2018). However, both Islamic and conventional banks prioritize profitability by focusing on productivity.

Consequently, several studies have analyzed the efficiency of Islamic banks to assess their performance (Kamarudin, Sufian, Loong, & Anwar, 2017a; Rosman et al., 2014; Said, 2013; Sufian & Kamarudin, 2017; Sufian, Kamarudin, & Md. Nassir, 2017; Wanke, Azad, Kalam, Barros, & Hassan, 2016), but few have examined productivity of neither Islamic nor conventional banks acting as intermediaries (Kamarudin et al., 2017a). Thus, this study aims to contribute a better understanding of banks' productivity to the existing body of literature.

As Siddiqi (2006) asserted that Islamic economic and financial theories were still underdeveloped, this study uses real-life data to validate foundational theories of productivity, which, along with profitability and growth, is a crucial dimension in assessing the broad concept of financial performance (Bottazzi, Secchi, & Tamagni, 2008). Profitability, which is required to maximize the shareholder wealth, reflects overall efficiency; however, to generating increased profits, productivity is essential. Indeed, Bottazzi et al. (2008) revealed that high productivity can lead to high profitability.

On a global scale, Islamic banking occupies a small share of the financial market, but this is rapidly expanding in many regions, particularly Asia and the Middle East (International Monetary Fund, 2015). According to Houben (2003) and Kamarudin et al. (2017a), though, Southeast Asia is neglected by researchers across the world, despite its rising Muslim population. However, as Islamic finance becomes a greater part of the global capital market, it has the distinct potential to contribute to economic growth (Imam & Kpodar, 2016); hence, it is important that Islamic banks remain productive to be competitive. As such, the current study benefits research in this field by comparing the productivity of Islamic and conventional banks, focusing on three regions: South Asia (SA), Southeast Asia (SEA), and Middle East (ME). It will also continue the ongoing debate on which are more productive, Islamic or conventional banks. The research question is thus whether the productivity of Islamic banks differ from that of conventional banks?

This paper begins with a brief review of related studies, followed by a description of the sources of data and methodology, a discussion of the empirical results, and finally the conclusion.

2. LITERATURE REVIEW

The role of the conventional banking sector as a financial intermediary cannot be overlooked considering its influence on stable economic growth and development. Islamic banks plays a similar but slightly different role, and are therefore considered a replacement or an alternative source of banking, albeit *Shariah*-compliant, products and services.

To date, no definite decision has been reached on whether Islamic banks should be more productive, or efficient, than their conventional counterparts (Beck et al., 2013). Islamic banks base their financial decisions on the productivity of the project in which it invests, meaning productivity is extremely important to ensure high profitability. Moreover, the Shariah Advisory Council (SAC) plays a key part in this respect by confirming stakeholders' *Shariah*-compliant behavior and being responsible for minimizing information asymmetry and agency costs within Islamic banks.

As, according to Jensen and Meckling (1976), a conflict of interest between the principals (shareholders) and agents (bank management) can influence organizational performance, information asymmetry and agency conflicts should occur less often in Islamic banks(Hussain, Kamarudin, Thaket and Salem, 2019; Toumi, Louhichi, and Vivian, 2012). In fact, the SAC's external monitoring can prevent agency conflicts and reduce agency costs, thereby increasing the efficiency, and so productivity, as demonstrated by Ang, Cole, and Lin (2000). However, the opposite may occur given that the productivity dimensions—such as complexity, and maturity and development—exert distinctly different effects on Islamic and conventional banks.

Kopleman (1986) defined productivity as the relationship between the amount of physical output(s) produced by a certain amount of physical input(s): total production (output) is influenced by the amount of capital invested and labor involved. Fare, Grosskopf, Norris, and Zhang (1994) asserted that productivity could be further decomposed into changes in efficiency, or the catching-up effect, and changes in technology, or innovation, assuming that the outputs are equivalent to the inputs. The total factor productivity (TFP) growth index measures the changes, or innovation, in technology, which can be considered as a change in performance that can be adjusted by altering a chosen input. Basically, higher productivity means higher profitability (Alaeddin et al., 2018; Kamarudin, Hue, Sufian, & Anwar, 2017b; Kamarudin et al., 2017a; Sufian, 2012; Sufian & Kamarudin, 2014; Sufian & Kamarudin, 2015): when banks increase their productivity, they generate additional output from a given amount of input. The Cobb–Douglas production function is thus used in this study to compare productivity levels between Islamic and conventional banks in SA, SEA, and the ME.

There have been previous comparative studies with varying findings: some show that Islamic banks are significantly more productive than conventional banks, others show the opposite, while a few show no difference. More recently, Alexakis, Izzeldin, Johnes, and Pappas (2018) reported that both Islamic and conventional banks experienced a decline in productivity, though to a greater extent in the latter, during 2008/09. Maredza and Ikhide (2013) stated that this was probably due to GFC in the Gulf Cooperation Council (GCC) banking sector. The results also indicated that there were differences in technological changes and efficiency between GCC Islamic banks, possibly because a number of mature banks do exist in a developing banking sector, although it may be owing to the various financial products, bank status, client base, and innovation.

On the other hand, Rodoni, Salim, Amalia, and Rakhmadi (2017) conducted a comparative study of productivity and efficiency in 31 Islamic banks across Pakistan, Indonesia, and Malaysia between 2009 and 2013. Using the Malmquist productivity index (MPI) and data envelopment analysis (DEA) to measure productivity and efficiency, respectively, they found that the Malaysian banking sector was far more efficient than in Indonesia, while Pakistan was close to 100% efficient. Kamarudin et al. (2017a) undertook a similar study of productivity in 29 Islamic banks in Malaysia, Indonesia, and Brunei between 2006 and 2014. Using a nonparametric DEA-based MPI to estimate TFP, they found that no statistical difference in productivity and efficiency between locally and internationally managed banks with similar technology and client base.

In another study, Doumpos, Hasan, and Pasiouras (2017) investigated the financial robustness of 347 conventional banks, 101 Islamic banks, and 52 Islamic windows within conventional banks across 57 member countries of the Organisation of Islamic Cooperation (OIC) between 2000 and 2011. They found that the individual financial ratios of differed between banks, but no statistically significant difference in overall financial strength was evident. Furthermore, Mobarek and Kalonov (2014) compared the performance of 101 Islamic and 307 conventional banks in 18 member countries during the pre-GFC period (2004–2006) and actual GFC (2007–2009). DEA and stochastic frontier analysis (SFA) of cross-sectional data indicated that the efficiency of conventional banks between 2006 and 2009 was higher than Islamic banks; however, this was an unfair comparison because the mean value of the efficiency score was larger for conventional banks.

Finally, Kamarudin, Nordin, Muhammad, and Hamid (2014) examined the efficiency—in terms of the profit, revenue, and costs—of 47 conventional and 27 Islamic banks between 2007 and 2011 in the GCC region. Taking an intermediation approach, DEA revealed that conventional banks exhibited higher levels of efficiency in all three areas. Moreover, the results suggested that the primary determinant for the level of profit efficiency was the level of revenue efficiency.

Thus, most of the earlier studies have reported disparate findings on the level of efficiency in Islamic and conventional banks worldwide, while studies on productivity levels in those banks are less common, particular in Asian regions where Islamic banks are prevalent (Kamarudin et al., 2017a). Hence, this study intends to offer empirical evidence for the productivity levels of Islamic and conventional banks.

3. METHODS

3.1 Data Sources

The data source for this study was the Fitch Connect online database, which comprises financial reports, accounting ratios, and credit ratings of over 30,000 Islamic and conventional banks worldwide. Data were extracted for Islamic and conventional banks in SA, SEA, and the ME between 2008 and 2017 (Khan & Bhatti, 2008). To facilitate the comparison, all currencies were expressed in US dollars, while to prevent bias, a dummy variable representing the 2008–2009 GFC was applied.

A total of 385 banks (66 Islamic and 319 conventional) were selected from 18 countries (3 in SA, 4 in SEA, and 11 in the ME) with dual banking systems were selected, as represented in Table 1. All investment banks, and insurance and finance companies were excluded to maintain homogeneity.

Table-1. Bank data.

No.	Country	Income Group*	Region	No. of Islamic Banks	No. of Conventional Banks
1	Bahrain	High	Middle East	8	12
2	Egypt	Lower Middle	Middle East	1	23
3	Iran	Upper Middle	Middle East	1	8
4	Iraq	Upper Middle	Middle East	1	3
5	Jordan	Upper Middle	Middle East	2	11
6	Kuwait	High	Middle East	1	4
7	Lebanon	Upper Middle	Middle East	2	31
8	Oman	High	Middle East	2	7
9	Qatar	High	Middle East	3	5
10	Saudi Arabia	High	Middle East	3	8
11	UAE	High	Middle East	7	14
12	Brunei	High	South East Asia	1	1
13	Indonesia	Lower Middle	South East Asia	8	92
14	Malaysia	Upper Middle	South East Asia	13	31
15	Singapore	High	South East Asia	1	8
16	Bangladesh	Lower Middle	South Asia	4	37
17	Maldives	Upper Middle	South Asia	1	1
18	Pakistan	Lower Middle	South Asia	7	23
	Total			66	319

Note: Income levels extracted from World Bank Open Data.
Source: Fitch connect.

3.2. Data Envelopment Analysis-Based Malmquist Productivity Index

DEA was developed by Charnes, Cooper, and Rhodes (1978), who posited that the greater the output generated by the inputs, the greater the efficiency of the production process. The method has since become a recognized performance measurement tool across all fields of management science, as revealed by.

Efficiency and productivity are interrelated in the current study: changes in the former are affected by alterations in the latter. The input–output ratio can be used to determine productivity, but it is important to remember that efficiency fails to take account of the time taken by the production process. Therefore, MPI, sometimes referred to as TFP, has been widely adopted for DEA in a range of countries and sectors due to its ability to assess any change in efficiency or technology in terms of progress or regress over time. Output-based MPI is used to not only measure and understand the change in productivity of banks but also to determine the change in TFP (TFPCH), which can be decomposed into technical change (TCH) and efficiency change (EFCH). In addition, EFCH can be further decomposed into changes in scale efficiency (SECH) and pure technical efficiency (PTECH). Figure 1 illustrates these interactive relationships.

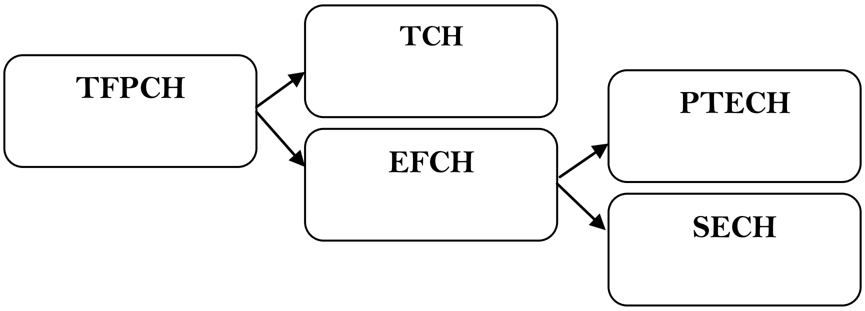

Figure-1. Interactive relationship between MPI efficiency indices.

Source: Fare et al. (1994).

Equations 3.1 and 3.2 express the MPI measurement of change in productivity related to technology over the reference period from t to $t + 1$. Thus, the MPI associated with technology in period t is:

$$M_0^t = \frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \tag{3.1}$$

and the corresponding output-based MPI associated with technology in period $t + 1$ is:

$$M_0^{t+1} = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^t, y^t)} \tag{3.2}$$

To overcome the need of choosing between t and $t + 1$ as a benchmark period, the output-based MPI is defined as the geometric mean of Equations 3.1 and 3.2 (Fare et al., 1994), as expressed in Equation 3.3:

$$M_0^{t,t+1}(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\left(\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)}\right) \times \left(\frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^t, y^t)}\right)\right]^{1/2} \tag{3.3}$$

An alternative way of expressing output-based MPI, proposed by Fare et al. (1994), involves its decomposition into efficiency change $(EFCH^{t,t+1})$ as well as technical change $(TCH^{t,t+1})$, which is expressed in Equation 3.4:

$$M_0^{t,t+1}(x^{t+1}, y^{t+1}, x^t, y^t)$$

$$= \underbrace{\frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)}}_{EFCH^{t,t+1}} \times \underbrace{\left[\left(\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})}\right) \times \left(\frac{D_0^t(x^t, y^t)}{D_0^{t+1}(x^t, y^t)}\right)\right]^{1/2}}_{TCH^{t,t+1}} \tag{3.4}$$

In Equations 3.3 and 3.4, M represents the level of productivity change due to an alteration in technology at years t and $t + 1$, in which most of the recent time point (x^{t+1}, y^{t+1}) corresponds to the previous time point (x^t, y^t). When $M > 1$, productivity in period $t + 1$ is higher than in period t: productivity progress; when $M < 1$, productivity in period $t + 1$ is lower than in period t: productivity regress; and when $M = 1$, no variation in productivity occurs between the two periods: no TFPCH). Finally, D in Equations 3.3 and 3.4 represent the output distance functions.

The interrelation between the MPI and its two subindices is shown in Equation 3.5:

$$M_0^{t,t+1} = \text{Efficiency Change} \times \text{Technical Change} \tag{3.5}$$

Where,

$$\text{Efficiency Change (EFCH)} = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \tag{3.6}$$

$$\text{Technical Change (TCH)} = \left[\left(\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})}\right) \times \left(\frac{D_0^t(x^t, y^t)}{D_0^{t+1}(x^t, y^t)}\right)\right]^{1/2} \tag{3.7}$$

By decomposing the EFCH index further (Fare et al., 1994), detailed measurements are possible: PTECH ($\Delta PureEff^{t,t+1}$) relative to the variable returns to scale (VRS) technology; and SECH ($\Delta Scale^{t,t+1}$), which calculates the variation between constant returns to scale (CRS) and VRS technologies. These are expressed in Equations 3.8 to 3.10:

$$\text{Efficiency Change} = \Delta PureEff^{t,t+1} \times \Delta Scale^{t,t+1} \tag{3.8}$$

Where,

$$\Delta PureEff^{t,t+1} = \frac{D_{VRS}^{t+1}(x_j^{t+1}, y_j^{t+1})}{D_{VRS}^t(x_j^t, y_j^t)} \tag{3.9}$$

$$\Delta Scale^{t,t+1} = \frac{D_{CRS}^{t+1}(x_j^{t+1}, y_j^{t+1})/D_{VRS}^{t+1}(x_j^{t+1}, y_j^{t+1})}{D_{CRS}^t(x_j^t, y_j^t)/D_{VRS}^t(x_j^t, y_j^t)} \tag{3.10}$$

Moreover, by comparing the values of TCH and EFCH, it is possible to determine the cause of productivity regress or progress: when EFCH > TCH, productivity progress primarily stems from improvement in efficiency; when EFCH < TCH, productivity progress is mainly due to technological improvements.

To summarize, the analysis is conducted in stages of increasing decomposition of the MPI. First, the TFPCH of banks is determined using output-based MPI. Second, TFPCH ($M_0^{t,t+1}$) is measured relative to both EFCH and TCH under VRS technology (Equation 3.5). Third, PTECH is calculated relative to VRS technology, and SECH to identify the variation between CRS and VRS technologies (Equation 3.8).

In the analysis, 2007 was set as the benchmark year, with the MPI and all its components starting with a value of 1; the efficiency scores were constrained within the lower bound of 0 and upper bound of 1. Hence, banks with an efficiency score lower/higher than 1 after 2007 perform below/above the efficiency frontier (i.e., when the decision-making unit (DMU) operates at the optimal efficiency). Furthermore, efficiency scores represent the radial distance between the efficiency frontier and DMU under consideration.

3.3. Specification for Input and Output of Banks

To explore the productivity of banks, DEA has been adopted for this study because of its widespread use and sustained relevance and effectiveness over 40 years, appearing in more than 1000 published studies per year (Emrouznejad & Yang, 2018). In addition, an intermediation approach has been taken to classify the input and output of banks, once more owing to its use in many studies (Bhatia, Basu, Mitra, & Dash, 2018; Kamarudin, Sufian, & Nassir, 2016) as the initial stage of DEA, as well as the significant role played by banks as financial intermediaries.

Inputs and outputs were selected for the current study by following the process described in several studies (Alexakis et al., 2018; Colwell & Davis, 1992; Kamarudin et al., 2017a; Sufian & Habibullah, 2014). Table 2 presents all the variables, derived from the MPI model, that were examined through nonparametric DEA in the initial stages of the analysis.

Table-2. Bank input and output variables.

Variable	Symbol	Variable Name	Definition
Outputs	y1	Loans	Net loans
	y2	Investments	Total securities
Inputs	x1	Deposits	Total deposits, money market, and short-term funding
	x2	Labor	Personnel expenses
	x3	Physical capital	Book value of fixed assets

Note: According to Casu and Girardone (2006) and Ariss (2010), loans are identified as financing activities by Islamic banks.

According to Banker and Datar (1989) and Cooper, Seiford, and Tone (2002), the number of inputs and outputs selected must meet a predetermined assumption prior to performing DEA:

$$n \geq max\{m \times s, 3(m + s)\}$$

Where:

n = number of DMUs.

m = number of inputs.

s = number of outputs.

4. RESULTS AND DISCUSSIONS

This study investigates the TFP levels of Islamic and conventional banks in SA, SEA, and the ME with DEA-based MPI. To determine the variation in productivity (*y*-axis) between Islamic and conventional banks, a parametric (*t*-test) and nonparametric (Mann–Whitney [Wilcoxon] and Kruskal–Wallis) tests were performed. Table 3 presents the summary statistics for each variable, in US $m, which were used to construct the efficiency frontiers for banks' productivity.

Table-3. Summary statistics for inputs and output variables in the DEA model (US $m).

Variables	Outputs		Inputs		
	Net loans ($y1$)	Total investments ($y2$)	Deposits ($x1$)	Labor ($x2$)	Capital ($x3$)
Mean					
Conventional banks	7149.850	2699.019	10169.089	103.599	114.275
Islamic banks	3912.597	893.724	5071.302	55.818	76.435
Minimum					
Conventional banks	0.191	0.020	0.800	0.217	0.008
Islamic banks	0.140	0.048	0.338	0.057	0.013
Maximum					
Conventional banks	241732.006	86833.757	314909.471	2113.571	3834.810
Islamic banks	62276.160	11346.560	75069.360	766.320	2095.493
Conventional banks	20306.069	7239.711	26700.945	222.327	269.518
Islamic banks	7342.828	1591.596	9064.359	100.137	182.581

Notes: $y1$ (short-term + long-term loans); $y2$ (total securities); $x1$(total deposits, money market, and short-term funding); $x2$(personnel expenses); $x3$ (fixed assets).

4.1. Productivity Decomposition of Islamic and Conventional Banks

Table 4 shows the geometric mean scores of both TFPCH and its components for all banks (Panel A), conventional banks (Panel B), and Islamic banks (Panel C). The performance of the banks can thus be assessed for each year between 2007 and 2017.

Table-4. MPI decompositions.

Year	Indices				
	TFPCH	TCH	EFCH	PTECH	SECH
Panel A: All banks					
2007	1.000	1.000	1.000	1.000	1.000
2008	1.038	0.808	1.286	1.289	0.997
2009	0.936	1.149	0.814	0.856	0.952
2010	0.949	1.041	0.911	0.991	0.920
2011	1.058	0.898	1.178	1.091	1.080
2012	0.995	0.978	1.018	1.013	1.004
2013	1.080	1.056	1.023	1.074	0.952
2014	0.916	0.999	0.917	0.912	1.005
2015	0.954	0.981	0.973	0.953	1.021
2016	1.052	0.990	1.063	1.062	1.001
2017	0.662	0.599	1.101	1.109	0.993
Geometric mean	0.919	0.908	1.012	1.019	0.994
Panel B: Conventional banks					
2007	1.000	1.000	1.000	1.000	1.000
2008	1.025	0.790	1.297	1.294	1.002
2009	0.928	1.163	0.798	0.842	0.948
2010	0.997	1.054	0.945	1.021	0.925
2011	1.066	0.897	1.189	1.102	1.079
2012	0.949	0.984	0.965	0.973	0.992
2013	1.093	1.045	1.045	1.103	0.948
2014	0.926	0.983	0.941	0.921	1.023
2015	0.991	0.995	0.995	0.992	1.004
2016	0.961	0.983	0.977	0.976	1.001
2017	0.679	0.592	1.148	1.154	0.995
Geometric mean	1.010	0.915	1.016	0.994	0.924
Panel C: Islamic banks					
2007	1.000	1.000	1.000	1.000	1.000
2008	1.140	0.943	1.209	1.255	0.963
2009	0.988	1.059	0.934	0.954	0.978
2010	0.716	0.967	0.739	0.833	0.888
2011	1.017	0.903	1.124	1.037	1.086
2012	1.259	0.947	1.329	1.245	1.068
2013	1.018	1.106	0.921	0.947	0.972
2014	0.869	1.078	0.806	0.872	0.924
2015	0.797	0.917	0.870	0.789	1.104
2016	1.648	1.023	1.611	1.609	1.001
2017	0.581	0.634	0.898	0.913	0.984
Geometric mean	0.959	0.945	1.013	1.016	0.997

Note: The table presents the geometric means for total factor productivity change (TFPCH), and its mutually exhaustive components of technical change (TCH) and efficiency change (EFCH), which is further decomposed into pure technical efficiency change (PTECH) and scale efficiency change (SECH).

From Table 4 Panel A, it is evident that, on average, all banks exhibited TFPCH regression of –8.1% (0.919) over the whole study period, with a low in 2017 when regression was –33.8% (0.662) and a high in 2013 when progression was 8.0% (1.080). The –8.1% (0.919) average regression could be mainly due to the –9.1% (0.908) decrease in TCH, as there was a 1.2% (1.012) increase in EFCH, which appears to have been caused more by PTECH than SECH. Therefore, all banks were efficient in managing cost control, though operating at a non-optimal scale. The results for conventional banks are shown in Table 4 Panel B, in which TFPCH was a 1.0% (1.010) progression on average; the highest progression occurred in 2013 with a TFPCH of 9.3% (1.093). The 1.6% (1.016) increase in EFCH led to the progression in conventional banks, as TCH decreased by –8.5% (0.915). Moreover, the reason for the increase in EFCH was mainly managerial (PTECH) rather than scale of operation (SECH). Likewise, Table 4 Panel C shows the results for Islamic banks. On average, the TFPCH reflects a –4.1%

(0.959) regression, indicating a lower level of productivity than conventional banks. The results reveal that the lowest level of productivity occurred in 2017 with a TFPCH regression of 41.9% (0.581), while the highest level was reached in 2016 with a progression of 64.8% (1.648). The cause of the overall TFPCH regression appears to be the decrease of −5.5% (0.945) in TCH, whereas the EFCH seems to have increased by 1.3% (1.013). As in conventional banks, the increase in EFCH of Islamic banks was due to management rather than scale of operation.

Therefore, productivity progress in conventional banks stems primarily from improvement in efficiency (EFCH), while productivity regress in Islamic banks results mainly from technological stagnation (TCH). Overall, it is evident that both conventional and Islamic banks are more productive in cost control, but are operating on the wrong scale.

4.2. Progressive and Regressive Productivity in Islamic and Conventional Banks

To control for possible outliers, Table 5 reports the trend in the number and percentage of all banks that experienced a productivity progress or regress during the study period. It can be seen from Table 5 Panel A that only 121 (35.80%) of all banks experienced productivity progress in 2008, but then increased substantially to a maximum of 206 (56.13%) banks by2013, before declining to 142 (38.38%) banks in 2017. Technical progress also increased from 157 (46.45%) banks in 2008 to 232 (63.22%) in 2013, and then drastically declined to 76 (20.54%) banks in 2017. These figures were validated by the banks that experienced technical regress, which declined from 174 (51.48%) banks in 2008 to 134 (36.51%) 2013, then radically rose to 294 (79.46) in 2017.

The trend for just conventional banks over the study period is shown in Table 5 Panel B. The results follow a similar trend to that in Panel A: productivity progress increased from 99 (33.45%) of banks in 2008 to 175 (55.73%) in 2014, then decreased gradually to 118 (33.44%) in 2017; technical regress decreased from 159 (53.72%) banks year 2008 to 114 (37.50%) in 2013, followed by an increase to 248 (80.78%) in 2017, although there was a sudden, sharp rise between 2010 and 2012, up to 210 (70.47%). As can be seen in Table 5 Panel C, of the trend in Islamic banks over the study period fluctuates. Between 2008 and 2017, there were two periods of productivity progress, albeit unstable: after a decline from 22 (52.38") of banks in 2008, a substantial increase to 31–35 (52.4–55.56%) occurred between 2010 and 2013, followed by another slight decline in 2014 to 27 (41.54%) and gradual rise to a peak of 45 (71.43%) in 2016, ending in a sharp decline to 24 (38.10%) in 2017. Likewise, there were significant increases and declines in technical progress during the first half of the study period, rising from 25 (59.52%) of banks in 2008 to its peak in 2013 of 43 (68.25%), followed by smaller peaks and troughs before drastically declining to 17 (26.98%) by 2017. In contrast, the fluctuations in technical regress consisted of a series of steady increases and decreases over the study period, starting with15 (37.71%) of banks in 2008, experiencing a peak at 47 (79.66%) in 2012, and ending with 46 (73.02%) in 2017. A more comprehensive analysis of productivity, by not only type of bank but also income level of country, was performed. Figure 2 illustrates the trend in productivity levels of Islamic and conventional Banks from 2008 to 2017, revealing that Islamic banks outperformed conventional banks for most of the study period after the 2008–2009 GFC. Nevertheless, on average, both Islamic and conventional banks had productivity indices above 1.00, demonstrating that all banks experienced annual productivity progress. However, this trend was uneven between 2008 and 2017, particularly in Islamic banks where sharp peaks were reached in 2012 and 2016. This trend can be explained by the growing Muslim population, particularly in SEA, leading to the ethical character and financial stability of Islamic finance becoming popular as an alternative to conventional banks (Komijani & Hesary, 2018). Moreover, the global *sukuk* (*Shariah*-compliant bonds) market reached its peak in 2012, due to its growing popularity in the corporate sector and among sovereigns in SEA for raising funds, mainly in Malaysia and Indonesia, which enabled the region to dominate over 70% of the world's *sukuk* issuances. Furthermore, in 2016, *sukuk* issuances played an important role in financing infrastructure development in SA, which was essential for economic growth (Asian Development Bank, 2017; Komijani & Hesary, 2018).

Table-5. Number and percentage of banks experiencing progressive and regressive productivity.

	Total factor productivity change (TFPCH)			Technical change (TCH)			Efficiency change (EFCH)			Pure technical efficiency change (PTECH)			Scale efficiency change (SECH)		
	Progress	Regress	No Δ	Progress	Regress	No Δ	Progress	Regress	No Δ	Progress	Regress	No Δ	Progress	Regress	No Δ
Period	No.(%)	No.(%)	No.(%)	No.(%)	No.(%)	No.(%)	No.(%)	No.(%)	No.(%)	No.(%)	No.(%)	No.(%)	No.(%)	No.(%)	No.(%)
Panel A: All banks															
2007-2008	121(*35.80*)	89(*26.33*)	128(*37.87*)	157(*46.45*)	174(*51.48*)	7(*2.07*)	201(*59.47*)	127(*37.57*)	10(*2.96*)	225(*66.57*)	91(*26.92*)	22(*6.51*)	142(*42.01*)	151(*44.67*)	45(*13.31*)
2008-2009		140(*41.18*)	64(*18.82*)	162(*47.65*)	175(*51.47*)	3(*0.88*)	133(*39.12*)	201(*59.12*)	6(*1.76*)	131(*38.53*)	194(*57.06*)	15(*4.41*)	145(*42.65*)	149(*43.82*)	46(*13.53*)
2009-2010	142(*40.69*)	155(*44.41*)	52(*14.90*)	212(*60.74*)	134(*38.40*)	3(*0.86*)	153(*43.84*)	188(*53.87*)	8(*2.29*)	193(*55.30*)	139(*39.83*)	17(*4.87*)	95(*27.22*)	212(*60.74*)	42(*12.03*)
2010-2011	166(*47.16*)	146(*41.48*)	40(*11.36*)	140(*39.77*)	211(*59.94*)	1(*0.28*)	202(*57.39*)	136(*38.64*)	14(*3.98*)	202(*57.39*)	126(*35.80*)	24(*6.82*)	169(*48.01*)	130(*36.93*)	53(*15.06*)
2011-2012	178(*49.86*)	145(*40.62*)	34(*9.52*)	99(*27.73*)	257(*71.99*)	1(*0.28*)	213(*59.66*)	132(*36.97*)	12(*3.36*)	198(*55.46*)	136(*38.10*)	23(*6.44*)	151(*42.30*)	156(*43.70*)	50(*14.01*)
2012-2013	206(*56.13*)	152(*41.42*)	9(*2.45*)	232(*63.22*)	134(*36.51*)	1(*0.27*)	172(*46.87*)	183(*49.86*)	12(*3.27*)	186(*50.68*)	163(*44.41*)	18(*4.90*)	127(*34.60*)	192(*52.32*)	48(*13.08*)
2013-2014	202(*53.30*)	173(*45.65*)	4(*1.06*)	161(*42.48*)	218(*57.52*)	0(*0.00*)	182(*48.02*)	185(*48.81*)	12(*3.17*)	203(*53.56*)	155(*40.90*)	21(*5.54*)	133(*35.09*)	197(*51.98*)	49(*12.93*)
2014-2015	183(*48.54*)	189(*50.13*)	5(*1.33*)	210(*55.70*)	167(*44.30*)	0(*0.00*)	212(*56.23*)	155(*41.11*)	10(*2.65*)	194(*51.46*)	163(*43.24*)	20(*5.31*)	165(*43.77*)	164(*43.50*)	48(*12.73*)
2015-2016	189(*50.40*)	179(*47.73*)	7(*1.87*)	156(*41.60*)	217(*57.87*)	2(*0.53*)	191(*50.93*)	170(*45.33*)	14(*3.73*)	186(*49.60*)	167(*44.53*)	22(*5.87*)	141(*37.60*)	185(*49.33*)	49(*13.07*)
2016-2017	142(*38.38*)	226(*61.08*)	2(*0.54*)	76(*20.54*)	294(*79.46*)	0(*0.00*)	177(*47.84*)	190(*51.35*)	3(*0.81*)	156(*42.16*)	204(*55.14*)	10(*2.70*)	173(*46.76*)	191(*51.62*)	6(*1.62*)
Panel B: Conventional banks															
2007-2008	99(*33.45*)	77(*26.01*)	120(*40.54*)	132(*44.59*)	159(*53.72*)	5(*1.69*)	177(*59.80*)	113(*38.18*)	6(*2.03*)	200(*67.57*)	78(*26.35*)	18(*6.08*)	124(*41.89*)	135(*45.61*)	37(*12.50*)
2008-2009	116(*39.19*)	121(*40.88*)	59(*19.93*)	146(*49.32*)	149(*50.34*)	1(*0.34*)	113(*38.18*)	181(*61.15*)	2(*0.68*)	113(*38.18*)	174(*58.78*)	9(*3.04*)	128(*43.24*)	134(*45.27*)	34(*11.49*)
2009-2010	123(*41.41*)	123(*41.41*)	51(*17.17*)	182(*61.28*)	112(*37.71*)	3(*1.01*)	136(*45.79*)	157(*52.86*)	4(*1.35*)	169(*56.90*)	118(*39.73*)	10(*3.37*)	85(*28.62*)	179(*60.27*)	33(*11.11*)
2010-2011	133(*44.93*)	125(*42.23*)	38(*12.84*)	120(*40.54*)	175(*59.12*)	1(*0.34*)	168(*56.76*)	119(*40.20*)	9(*3.04*)	170(*57.43*)	111(*37.50*)	15(*5.07*)	141(*47.64*)	111(*37.50*)	44(*14.86*)
2011-2012	147(*49.33*)	119(*39.93*)	32(*10.74*)	88(*29.53*)	210(*70.47*)	0(*0.00*)	180(*60.40*)	109(*36.58*)	9(*3.02*)	166(*55.70*)	115(*38.59*)	17(*5.70*)	126(*42.28*)	129(*43.29*)	43(*14.43*)
2012-2013	171(*56.25*)	125(*41.12*)	8(*2.63*)	189(*62.17*)	114(*37.50*)	1(*0.33*)	144(*47.37*)	151(*49.67*)	9(*2.96*)	156(*51.32*)	135(*44.41*)	13(*4.28*)	103(*33.88*)	160(*52.63*)	41(*13.49*)
2013-2014	175(*55.73*)	135(*42.99*)	4(*1.27*)	129(*41.08*)	185(*58.92*)	0(*0.00*)	160(*50.96*)	144(*45.86*)	10(*3.18*)	173(*55.10*)	127(*40.45*)	14(*4.46*)	119(*37.90*)	156(*49.68*)	39(*12.42*)
2014-2015	152(*48.72*)	155(*49.68*)	5(*1.60*)	175(*56.09*)	137(*43.91*)	0(*0.00*)	178(*57.05*)	127(*40.71*)	7(*2.24*)	166(*53.21*)	132(*42.31*)	14(*4.49*)	134(*42.95*)	140(*44.87*)	38(*12.18*)
2015-2016	144(*46.15*)	161(*51.60*)	7(*2.24*)	125(*40.06*)	185(*59.29*)	2(*0.64*)	151(*48.40*)	149(*47.76*)	12(*3.85*)	144(*46.15*)	151(*48.40*)	17(*5.45*)	117(*37.50*)	157(*50.32*)	38(*12.18*)
2016-2017	118(*38.44*)	187(*60.91*)	2(*0.65*)	59(*19.22*)	248(*80.78*)	0(*0.00*)	149(*48.53*)	157(*51.14*)	1(*0.33*)	132(*43.00*)	170(*55.37*)	5(*1.63*)	144(*46.91*)	159(*51.79*)	4(*1.30*)
Panel C: Islamic banks															
2007-2008	22(*52.38*)	12(*28.57*)	8(*19.05*)	25(*59.52*)	15(*35.71*)	2(*4.76*)	24(*57.14*)	14(*33.33*)	4(*9.52*)	25(*59.52*)	13(*30.95*)	4(*9.52*)	18(*42.86*)	16(*38.10*)	8(*19.05*)
2008-2009	20(*45.45*)	19(*43.18*)	5(*11.36*)	16(*36.36*)	26(*59.09*)	2(*4.55*)	20(*45.45*)	20(*45.45*)	4(*9.09*)	18(*40.91*)	20(*45.45*)	6(*13.64*)	17(*38.64*)	15(*34.09*)	12(*27.27*)
2009-2010	19(*36.54*)	32(*61.54*)	1(*1.92*)	30(*57.69*)	22(*42.31*)	0(*0.00*)	17(*32.69*)	31(*59.62*)	4(*7.69*)	24(*46.15*)	21(*40.38*)	7(*13.46*)	10(*19.23*)	33(*63.46*)	9(*17.31*)
2010-2011	33(*58.93*)	21(*37.50*)	2(*3.57*)	20(*35.71*)	36(*64.29*)	0(*0.00*)	34(*60.71*)	17(*30.36*)	5(*8.93*)	32(*57.14*)	15(*26.79*)	9(*16.07*)	28(*50.00*)	19(*33.93*)	9(*16.07*)
2011-2012	31(*52.54*)	26(*44.07*)	2(*3.39*)	11(*18.64*)	47(*79.66*)	1(*1.69*)	33(*55.93*)	23(*38.98*)	3(*5.08*)	32(*54.24*)	21(*35.59*)	6(*10.17*)	25(*42.37*)	27(*45.76*)	7(*11.86*)
2012-2013	35(*55.56*)	27(*42.86*)	1(*1.59*)	43(*68.25*)	20(*31.75*)	0(*0.00*)	28(*44.44*)	32(*50.79*)	3(*4.76*)	30(*47.62*)	28(*44.44*)	5(*7.94*)	24(*38.10*)	32(*50.79*)	7(*11.11*)
2013-2014	27(*41.54*)	38(*58.46*)	0(*0.00*)	32(*49.23*)	33(*50.77*)	0(*0.00*)	22(*33.85*)	41(*63.08*)	2(*3.08*)	30(*46.15*)	28(*43.08*)	7(*10.77*)	14(*21.54*)	41(*63.08*)	10(*15.38*)
2014-2015	31(*47.69*)	34(*52.31*)	0(*0.00*)	35(*53.85*)	30(*46.15*)	0(*0.00*)	34(*52.31*)	28(*43.08*)	3(*4.62*)	28(*43.08*)	31(*47.69*)	6(*9.23*)	31(*47.69*)	24(*36.92*)	10(*15.38*)
2015-2016	45(*71.43*)	18(*28.57*)	0(*0.00*)	31(*49.21*)	32(*50.79*)	0(*0.00*)	40(*63.49*)	21(*33.33*)	2(*3.17*)	42(*66.67*)	16(*25.40*)	5(*7.94*)	24(*38.10*)	28(*44.44*)	11(*17.46*)
2016-2017	24(*38.10*)	39(*61.90*)	0(*0.00*)	17(*26.98*)	46(*73.02*)	0(*0.00*)	28(*44.44*)	33(*52.38*)	2(*3.17*)	24(*38.10*)	34(*53.97*)	5(*7.94*)	29(*46.03*)	32(*50.79*)	2(*3.17*)

Notes: Productivity growth: TFPCH > 1; Productivity Loss: TFPCH < 1; Productivity Stagnation: TFPCH = 1.

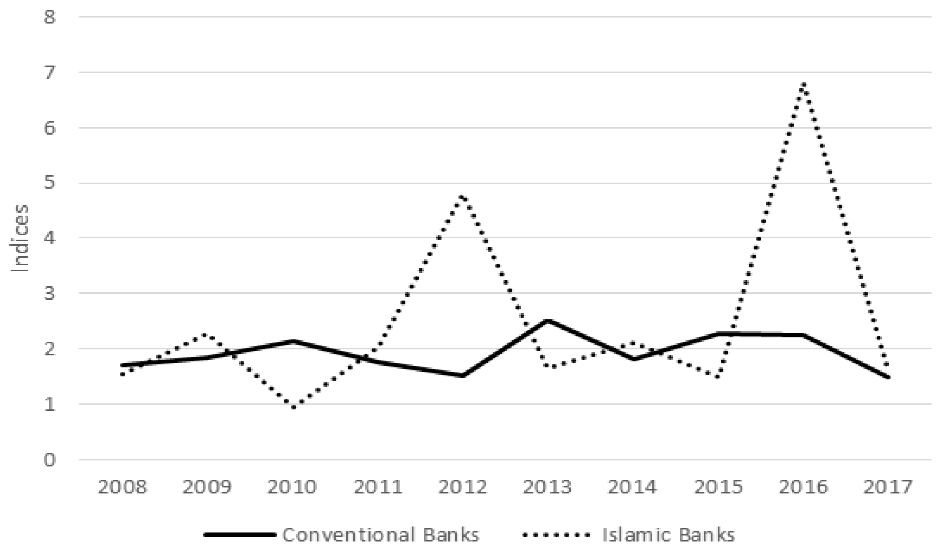

Figure-2. Trend in productivity levels for conventional and Islamic banks from 2008 to 2017.
Source: Banks' annual reports.

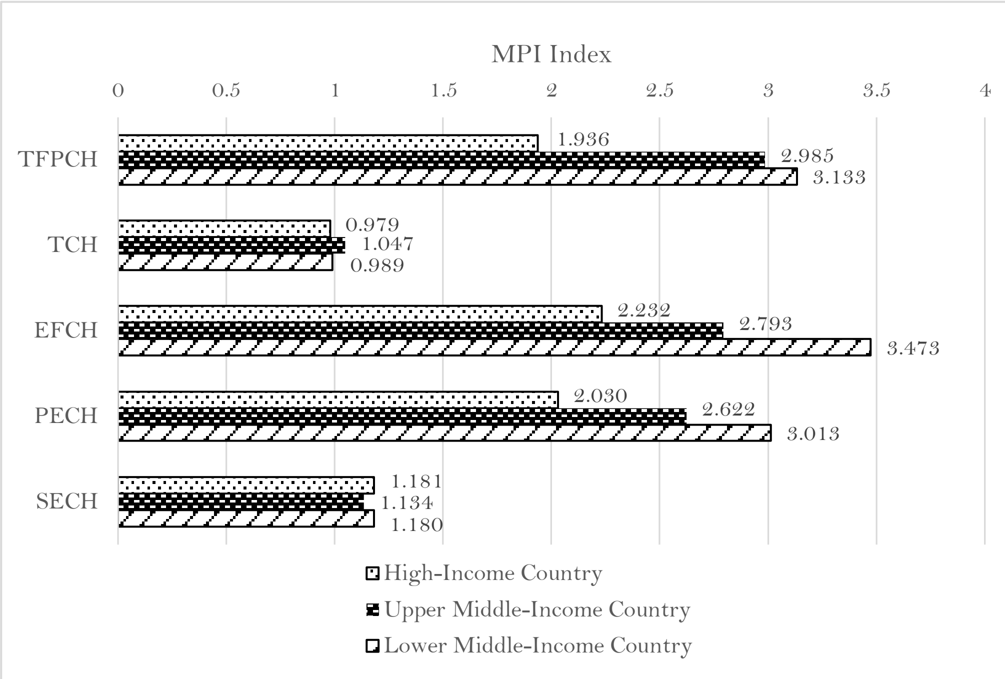

Figure-3. TFPCH for Islamic banks in different income groups from 2008 to 2017.

Source: Banks' annual reports and authors' calculations.

Figure 3 represents the TFPCH of Islamic banks in high-, upper middle-, and lower middle-income countries from 2008 to 2017. Overall, high-income countries have the lowest TFPCH, TCH, EFCH, and PECH, while lower middle-income countries have the highest TFPCH, EFCH, PECH, and SECH, and the upper middle-income countries have slightly higher TCH than the other countries.

This can be explained by the increasing number of Islamic banks in upper middle-and lower middle-income countries, such as Malaysia, Indonesia, Pakistan, and Bangladesh, where there are also large Muslim populations whose income levels positively affect the development of the Islamic banking sector (Boukhatem & Moussa, 2018). In addition, according to Boukhatem and Moussa (2018), those countries that adopted a hybrid legal system based on both common and Islamic (*Shariah*) law have been able to respond flexibly to changing macroeconomic conditions, which has contributed to the development of Islamic banks.

These conditions have created a highly competitive market between Islamic and conventional banks in these countries, which, according to Abedifar, Hasan, and Tarazi (2016), can motivate banks to be more innovative and increase the efficiency of the whole banking system. It is evident from Figure 3, TFPCH in all countries stems from EFCH, revealing managerial changes in the banks.

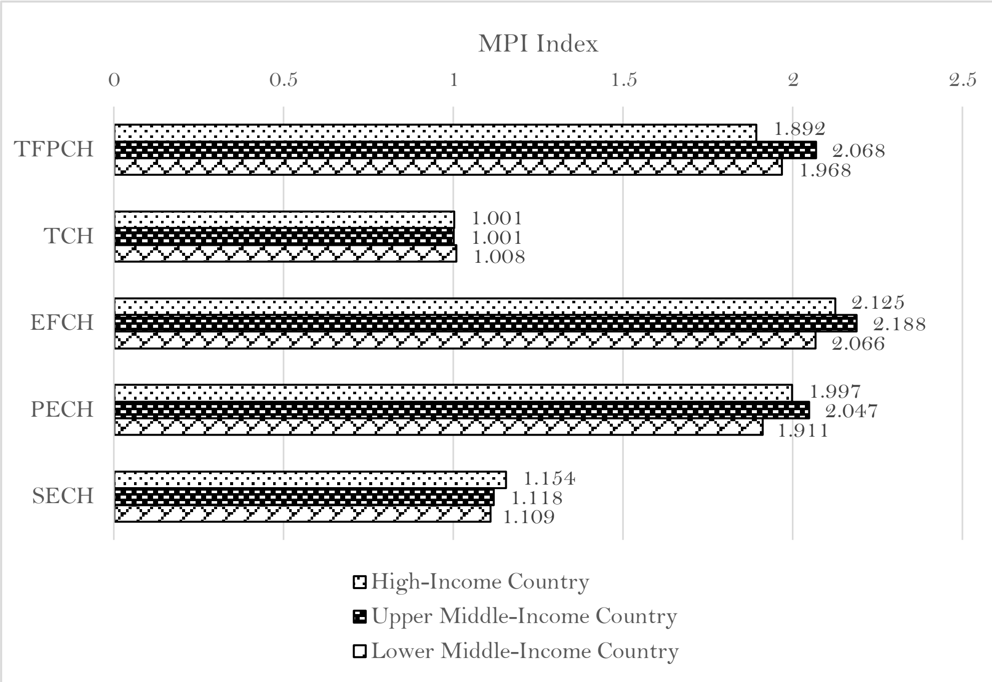

Figure-4. TFPCH for conventional banks in different income group from year 2008 to 2017.

Source: Bank annual report and authors own calculation.

Figure 4 represents the TFPCH of conventional banks for the same income groups over the study period. The upper middle-income countries have a slightly higher TFPCH than the others, much of which is again due to EFCH, or in other words, managerial efficiency. This finding corresponds to that of Aluko and Ajayi (2018), who also discovered that lower- more than high-income countries tend to have more efficient banks. This was explained by Ghosh (2016) as owing to high-income countries having a larger banking sector in which greater competitive pressures result in higher agency and overhead costs, and consequently, lower productivity.

4.3. Robustness Tests

Table 6 presents the results of the parametric (*t*-test) and nonparametric (Mann-Whitney [Wilcoxon] and Kruskal–Wallis) tests and reveals the significant difference between the productivity levels of Islamic and conventional banks in specific years and regions. As already observed, it appears that Islamic banks are slightly more productive than conventional banks across all regions; however, the difference is only statistically significant during 2016 (Panel I). On the other hand, the *t*-test results, confirmed by the nonparametric tests, in Panels A, C, F, and H suggest that conventional banks were relatively more productive, though only statistically significant in 2010 (Panel C).

In the ME, there was greater productivity progress in Islamic than conventional banks in seven years of the study period, and the results are significant at the 1% level in 2016 (Panel I); however, when the reverse occurred in 2010, 2014, and 2015 (Panels C, G, and H), the greater progression in conventional banks is statistically significant in each year. In addition, Islamic banks experienced relatively more productivity progress than conventional banks: in 2008 (at 1% significance level), 2012, and 2015, 2016 (at 10% significance level), and 2017 (Panels A, E, H, I, and

J) in SEA; and in 2011(at 1% significance level), 2012, 2014, and 2016 (Panels D, E, G, and I) in SA. Nonetheless, in SA, conventional banks exhibited more productivity progress in 2008, (at 10% significance level), 2009, 2010, 2013, 2015, and 2017 (Panels A, B, C, F, H, and J).

Further analysis of the other components of MPI are also shown in Table 6. Greater productivity progress was generated mainly from TCH in both Islamic banks—statistically significant in 2008, 2011. 2013, and 2017 (Panels A, D, F, G, and J)—and conventional banks—statistically significant in 2010, 2012, and, 2015 (Panels C, E, and H). Furthermore, EFCH in Islamic banks was higher in 2009, 2011, 2012, and 2016 (Panels B, D, E, and I), with PECH showing statistical significance in 2016, and lower in 2008, 2010, 2013, 2014, 2015, and 2017 (Panels A, C, F, G, H, and J), where PECH was statistically significant in 2013 and 2017, and SECH in 2014, at the 5% level.

The overall results for all years and regions are provided in Panel K of Table 6, from which it can be inferred that Islamic banks are more productive than conventional banks (mean difference = 0.653) according to not only the *t*-test but also the nonparametric tests, which is attributable to the progress in EFCH (mean difference = 0.589). However, the mean difference in TFPCH between Islamic and conventional banks is not statistically significant in any of the three regions studied. Furthermore, the test for equality of populations rejects the null hypothesis that the difference between Islamic and conventional banks is equal. The findings of the current study thus corroborate those of Yahya, Muhammad, and Hadi (2012) and Doumpos et al. (2017): there is no statistically significant difference between the total factor productivity of Islamic and conventional banks.

There are several reasons for Islamic banks being more productive than conventional banks. First, the risk-sharing paradigm and higher asset quality in Islamic finance is more resilient to financial shocks (Beck et al., 2013; Darrat, 1988); Khan, 1986). Second, Islamic banks carry lower credit and insolvency risks because their bank charges and loan quality are less affected by fluctuations in interest rates (Abedifar, Molyneux, & Tarazi, 2013), which why Islamic banks are more stable than conventional banks. Third, the moral principles underpinning the Islamic financial system facilitate the sustainability of Islamic banks as well as enhance socioeconomic well-being through financial outreach (Aliyu, Yusof, & Naiimi, 2017). Finally, Islamic banks are risk averse in terms of capital investment in the real economy (Abedifar et al., 2016).

5. CONCLUSION

This study aims to contribute to the body of literature on banks' performance. With the rapid increase in Islamic banks, it is imperative to study their productivity; thus, the total factor productivity change in Islamic and conventional banks across 18 countries in the Middle East, South Asia, and South Asia where dual-banking systems exist was analyzed. The data were analyzed using nonparametric DEA-based MPI, and the results tested through parametric (*t*-test) and nonparametric (Mann–Whitney and Kruskal–Wallis) tests. Theoretically, it has been posited that the effect of various productivity determinants (e.g., levels of complexity, agency costs, and maturity and development) are distinctly different between Islamic and conventional banks; however, empirical estimation suggests that there is no statistically significant difference between their total factor productivity.

Following detailed analysis of specific years and individual regions, Islamic banks exhibited slightly greater productivity progress than conventional banks in almost every year in each region. In addition, the productivity progress of all banks could be attributed solely to the increase in efficiency changes, which indicates that both Islamic and conventional banks are managerially efficient.

Table-6. Summary of parametric and nonparametric tests for conventional and Islamic banks.

Region	No. of Obs.	PARAMETRIC TEST t-test $t\ (Prb > t)$					NONPARAMETRIC TEST Mann–Whitney [Wilcoxon rank sum] test $z\ (Prb > z)$					Kruskal–Wallis [equality of populations] test $X^2\ (Prb > X^2)$				
		TFPCH	TCH	EFCH	PECH	SECH	TFPCH	TCH	EFCH	PECH	SECH	TFPCH	TCH	EFCH	PECH	SECH
PANEL A: YEAR 2007–2008																
ALL	338	0.244	-2.290[b]	1.055	0.561	0.609	-1.577	-2.370[b]	-0.597	-0.795	-0.150	2.488	5.617[b]	0.357	0.632	0.022
Mean Diff.		(0.133)	0.146	(0.494)	(0.261)	(0.046)	24.710	38.180	(9.630)	(12.800)	(2.410)	24.710	38.180	(9.630)	(12.800)	(2.410)
ME	142	-0.311	-0.517	0.446	-0.325	-0.313	-0.182	-0.437	-0.216	-1.371	-0.635	0.033	0.191	0.146	1.879	0.404
Mean Diff.		0.097	0.041	(0.137)	0.173	0.029	(1.740)	4.250	(21.000)	(13.330)	6.170	(1.740)	4.250	(21.000)	(13.330)	6.170
SEA	136	-0.618	-4.526[a]	0.537	0.426	0.518	-3.934[a]	-3.504[a]	-0.307	-0.060	-0.535	15.478[a]	12.277[a]	0.094	0.004	0.287
Mean Diff.		0.613	0.463	(0.312)	(0.277)	(0.083)	46.390	43.42	(3.810)	0.740	(6.630)	46.390	43.42	(3.810)	0.740	(6.630)
SA	60	1.832[c]	0.863	0.740	0.677	0.408	-0.100	-0.784	-0.258	-0.615	-0.249	0.010	0.614	0.066	0.378	0.062
Mean Diff.		(1.674)	(0.092)	(1.475)	(1.283)	(0.060)	(0.600)	(4.74)	1.560	3.800	(1.500)	(0.600)	(4.74)	1.560	3.800	(1.500)
PANEL B: YEAR 2008–2009																
ALL	340	-0.540	0.886	-0.041	-0.085	0.266	-0.153	-1.221	-0.840	-0.992	-0.269	0.024	1.490	0.706	0.984	0.072
Mean Diff.		0.430	(0.105)	0.032	0.049	(0.028)	2.420	(19.380)	13.34	15.760	4.270	2.420	(19.380)	13.34	15.760	4.270
ME	142	-0.900	-0.317	-0.150	-0.322	0.587	-0.842	-0.055	-0.606	-1.215	-0.184	0.709	0.003	0.368	1.477	0.034
Mean Diff.		1.341	0.044	0.240	0.340	(0.113)	8.190	0.530	5.890	11.820	(1.780)	8.190	0.530	5.890	11.820	(1.780)
SEA	138	0.397	3.454[a]	0.111	-0.003	-0.129	-0.414	-2.402[b]	-1.133	-0.601	-0.544	0.171	5.768[b]	1.285	0.362	0.296
Mean Diff.		(0.173)	(0.450)	(0.057)	0.001	0.019	(4.760)	(27.990)	13.200	7.010	6.330	(4.760)	(27.990)	13.200	7.010	6.330
SA	60	0.577	-0.341	0.473	0.577	-0.415	-0.706	-0.446	-0.486	-0.893	-0.289	0.498	0.199	0.236	0.797	0.083
Mean Diff.		(1.230)	0.125	(0.825)	(0.940)	0.057	(4.260)	2.700	(2.940)	(5.400)	(1.740)	(4.260)	2.700	(2.940)	(5.400)	(1.740)
PANEL C: YEAR 2009–2010																
ALL	349	3.036[a]	2.235[b]	2.788[a]	1.001	0.376	-2.153[b]	-1.556	-1.505	-1.185	-0.970	4.635	2.420	2.265	1.403	0.941
Mean Diff.		(1.180)	(0.087)	(1.001)	(0.758)	(0.095)	(32.600)	(23.600)	(22.820)	(17.970)	(14.700)	(32.600)	(23.600)	(22.820)	(17.970)	(14.700)
ME	148	2.993[a]	1.673[c]	2.580	1.329	-0.637	-1.635	-0.821	-1.265	-1.056	-0.350	2.674	0.675	1.600	1.115	0.123
Mean Diff.		(0.667)	(0.113)	(0.568)	(0.594)	0.142	(15.14)	(7.61)	(11.71)	(9.780)	(3.240)	(15.14)	(7.61)	(11.71)	(9.780)	(3.240)
SEA	141	0.696	1.031	0.686	0.605	0.698	-0.913	-1.079	-0.549	-0.569	-0.026	0.834	1.164	0.302	0.324	0.001
Mean Diff.		(0.818)	(0.058)	(0.719)	(0.435)	(0.108)	(9.800)	(11.700)	(5.960)	(6.170)	0.280	(9.800)	(11.700)	(5.960)	(6.170)	0.280
SA	60	0.766	1.231	0.699	0.518	0.630	-0.665	-1.547	-0.595	-0.139	-1.660	0.442	2.394	0.354	0.019	2.756
Mean Diff.		(3.323)	(0.081)	(2.781)	(1.977)	(0.793)	(4.0020)	(29.360)	(3.600)	(0.840)	(10.020)	(4.0020)	(29.360)	(3.600)	(0.840)	(10.020)
PANEL D: YEAR 2010–2011																
ALL	352	-0.693	-0.095	-0.181	-0.628	0.431	-0.990	-0.194	-0.985	-1.081	-0.169	0.981	0.038	0.971	1.169	0.029
Mean Diff.		0.274	0.003	0.104	0.223	(0.056)	14.670	(2.880)	14.610	16.030	2.510	14.670	(2.880)	14.610	16.030	2.510
ME	148	-0.799	-0.715	-0.586	-0.659	0.476	-0.010	-0.683	-0.136	-0.265	-0.596	0.000	0.466	0.019	0.070	0.355
Mean Diff.		0.409	0.028	0.387	-0.320	(0.085)	(0.100)	6.320	(1.260)	2.450	(5.510)	(0.100)	6.320	(1.260)	2.450	(5.510)
SEA	144	0.065	-0.773	0.428	-0.122	2.176[b]	-0.474	-0.581	-0.711	-0.047	-0.981	0.225	0.338	0.506	0.002	0.962
Mean Diff.		(0.054)	0.042	(0.598)	0.091	(0.258)	(4.850)	5.970	(7.300)	(0.480)	(10.070)	(4.850)	5.970	(7.300)	(0.480)	(10.070)
SA	60	-1.522	2.237[b]	-2.129[b]	-1.551	-1.330	-2.761	-2.168	-3.210	-2.637	-2.596	7.622[a]	4.702[b]	10.302[a]	6.952[a]	6.737[a]
Mean Diff.		0.623	(0.126)	0.937	0.340	0.365	16.090	(12.640)	18.700	15.370	15.370	16.090	(12.640)	18.700	15.370	15.370

Notes: Obs.: observations; ME: Middle East; SEA: Southeast Asia; SA: South Asia.
[a], [b], [c] indicate 1%, 5%, and 10% significance levels, respectively.
The figures in brackets indicate that the productivity means of conventional banks are higher than those of Islamic banks.

Table-6. *(cont.)*

Region	No of Obs.	PARAMETRIC TEST t-test $t\ (Prb > t)$					NONPARAMETRIC TEST Mann–Whitney [Wilcoxon rank sum] test $z\ (Prb > z)$					Kruskal–Wallis [equality of populations] test $X^2\ (Prb > X^2)$				
		TFPCH	TCH	EFCH	PECH	SECH	TFPCH	TCH	EFCH	PECH	SECH	TFPCH	TCH	EFCH	PECH	SECH
PANEL E: YEAR 2011–2012																
ALL	357	-1.343	1.795[c]	-1.401	-1.112	-1.139	-0.678	-0.527	-1.016	-0.970	-0.518	0.459	0.278	1.033	0.941	0.268
Mean Diff.		3.268	(0.042)	3.222	2.673	0.303	9.960	(7.750)	14.940	14.270	(7.61)	9.960	(7.750)	14.940	14.270	(7.61)
ME	147	-0.878	0.318	-0.929	-0.118	-0.803	-0.439	-0.008	-0.675	-0.645	-0.326	0.193	0.000	0.456	0.416	0.106
Mean Diff.		0.454	(0.013)	0.469	0.041	0.167	4.040	(0.070)	6.220	5.930	(2.990)	4.040	(0.070)	6.220	5.930	(2.990)
SEA	149	-1.280	1.424	-1.327	-1.160	0.119	-1.082	-0.519	-1.353	-1.519	-0.038	1.172	0.269	1.831	2.309	0.001
Mean Diff.		8.624	(0.073)	8.426	7.752	(0.019)	10.980	(5.260)	13.750	15.440	(0.380)	10.980	(5.260)	13.750	15.440	(0.380)
SA	61	-0.042	1.632	-0.143	0.470	-0.939	-0.191	0.218	-0.163	-0.218	-1.203	0.036	0.047	0.027	0.047	1.448
Mean Diff.		0.034	(0.048)	0.124	(0.377)	1.142	(1.080)	(1.240)	0.930	(1.240)	(6.850)	(1.080)	(1.240)	0.930	(1.240)	(6.850)
PANEL F: YEAR 2012–2013																
ALL	367	0.823	-2.090[b]	0.920	2.439[b]	-0.886	-0.076	-1.799[c]	-0.527	-0.570	-0.459	0.006	3.235[c]	0.278	0.324	0.211
Mean Diff.		(0.873)	0.064	0.776	(0.909)	0.074	(1.120)	26.410	(7.740)	(8.370)	6.740	(1.120)	26.410	(7.740)	(8.370)	6.740
ME	149	-0.017	-0.869	0.107	0.499	-1.104	-0.962	-0.989	-0.775	-0.027	-1.516	0.926	0.978	0.601	0.001	2.298
Mean Diff.		0.008	0.041	(0.051)	(0.365)	0.094	8.710	8.950	7.020	0.250	13.700	8.710	8.950	7.020	0.250	13.700
SEA	153	0.521	-1.000	0.528	0.874	-0.562	-0.242	-0.346	-0.281	-0.130	-0.133	0.058	0.120	0.079	0.017	0.018
Mean Diff.		(1.279)	0.054	(0.965)	(1.105)	0.150	(2.460)	3.530	(2.860)	1.330	(1.350)	(2.460)	3.530	(2.860)	1.330	(1.350)
SA	65	0.770	-2.501[b]	0.836	0.830	0.128	-1.353	-2.198[b]	-1.820[c]	-1.804[c]	-0.181	1.831	4.830[b]	3.314[c]	3.255[c]	0.033
Mean Diff.		(1.753)	0.140	(1.856)	(1.811)	(0.018)	(7.940)	12.890	(10.67)	(10.580)	(1.060)	(7.940)	12.890	(10.67)	(10.580)	(1.060)
PANEL G: YEAR 2013–2014																
ALL	379	-0.507	-2.082[b]	-0.424	0.111	0.387	-1.243	-1.741[c]	-2.133[b]	-1.213	-2.789[a]	1.544	3.030[c]	4.551[b]	1.471	7.777[a]
Mean Diff.		0.290	0.126	0.426	0.056	(0.037)	(18.550)	25.990	(31.840)	(18.110)	(41.580)	(18.550)	25.990	(31.840)	(18.110)	(41.580)
ME	153	2.483[b]	-1.994[c]	2.976[a]	2.310[b]	1.774[c]	-0.801	-2.372[b]	-1.904[c]	-0.978	-2.238[b]	0.641	5.625[b]	3.625[c]	0.956	5.008[b]
Mean Diff.		(1.022)	0.192	(1.163)	(1.003)	(0.189)	(7.320)	21.680	(17.400)	(8.930)	(20.420)	(7.320)	21.680	(17.400)	(8.930)	(20.420)
SEA	154	0.151	1.145	-0.130	0.191	-0.687	-1.427	-1.199	-1.123	-1.153	-0.672	2.036	1.437	1.261	1.330	0.452
Mean Diff.		(0.096)	(0.063)	0.087	(0.132)	0.247	(14.390)	(12.090)	(11.320)	(11.63)	(6.770)	(14.390)	(12.090)	(11.320)	(11.63)	(6.770)
SA	72	-0.928	-1.777[c]	-0.908	-0.986	1.369	-0.139	-1.530	-0.651	-0.190	-2.307[b]	0.019	2.341	0.424	0.036	5.325[b]
Mean Diff.		3.757	0.328	4.405	2.042	(0.223)	0.890	9.810	(4.170)	(1.220)	(14.79)	0.890	9.810	(4.170)	(1.220)	(14.79)
PANEL H: YEAR 2014–2015																
ALL	377	0.767	2.555[b]	0.664	0.812	-1.438	-0.919	-2.037[b]	-0.034	-1.105	-1.294	0.845	4.149[b]	0.001	1.222	1.674
Mean Diff.		(0.800)	(0.074)	(0.738)	(0.774)	0.148	(13.650)	(30.27)	(0.510)	(16.420)	19.200	(13.650)	(30.27)	(0.510)	(16.420)	19.200
ME	154	0.862	2.489[b]	0.776	0.833	-0.085	-1.721[c]	-2.477[b]	-0.883	-0.964	-0.796	2.963[c]	6.136[b]	0.779	0.929	0.634
Mean Diff.		(1.676)	(0.112)	(1.511)	(1.202)	0.009	(15.82)	(22.770)	(8.120)	(8.860)	(7.310)	(15.82)	(22.770)	(8.120)	(8.860)	(7.310)
SEA	151	-0.772	-0.023	-0.790	-0.564	-0.124	-0.774	-0.616	-0.847	-0.117	-0.684	0.599	0.380	0.717	0.014	0.468
Mean Diff.		0.538	0.001	0.513	0.363	0.014	7.670	6.100	8.390	1.160	6.770	7.670	6.100	8.390	1.160	6.770
SA	72	0.490	2.384[b]	0.412	0.576	-1.856[c]	-0.666	-2.108[b]	-0.007	-1.545	-3.115[a]	0.444	4.444[b]	0.000	2.388	9.704[a]
Mean Diff.		(1.495)	(0.143)	(1.509)	(2.065)	0.712	(4.27)	(13.52)	0.0050	(9.910)	19.950	(4.27)	(13.52)	0.0050	(9.910)	19.950

Notes: Obs.: observations; ME: Middle East; SEA: Southeast Asia; SA: South Asia.
[a], [b], [c] indicate 1%, 5%, and 10% significance levels, respectively.
The figures in brackets indicate that the productivity means of conventional banks are higher than those of Islamic banks.

Table-6. *(cont.)*

Region	No of Obs.	PARAMETRIC TEST					NONPARAMETRIC TEST									
		t-test					Mann–Whitney [Wilcoxon rank sum] test					Kruskal–Wallis [equality of populations] test				
		$t\ (Prb > t)$					$z\ (Prb > z)$					$X^2\ (Prb > X^2)$				
		TFPCH	TCH	EFCH	PECH	SECH	TFPCH	TCH	EFCH	PECH	SECH	TFPCH	TCH	EFCH	PECH	SECH
PANEL I: YEAR 2015–2016																
ALL	375	-1.044	-1.547	-1.028	-1.096	-0.190	-3.819[a]	-1.558	-3.040[a]	-3.596[a]	-0.159	14.584[a]	2.429	9.240[a]	12.933[a]	0.025
Mean Diff.		4.551	0.041	4.907	5.063	0.015	57.180	23.330	45.520	53.830	2.380	57.180	23.330	45.520	53.830	2.380
ME	154	-0.601	-1.900[c]	-0.333	-0.677	-0.432	-3.260[a]	-1.825[c]	-2.623[a]	-3.006[a]	-0.379	10.630[a]	3.332[c]	6.879[a]	9.039[a]	0.144
Mean Diff.		0.831	0.084	0.603	0.982	0.061	29.970	16.78	24.110	27.630	(3.490)	29.970	16.78	24.110	27.630	(3.490)
SEA	150	0.468	0.083	0.478	0.250	0.881	-1.857[c]	-0.824	-1.785[c]	-2.162[b]	-0.114	3.447[c]	0.678	3.186[c]	4.675[b]	0.013
Mean Diff.		(0.809)	(0.002)	(0.813)	(0.213)	(0.138)	18.620	8.260	17.890	21.680	(1.150)	18.620	8.260	17.890	21.680	(1.150)
SA	71	-1.027	-0.225	-1.033	-1.012	-1.007	-1.028	-0.637	-0.560	-0.138	-1.130	1.057	0.406	0.314	0.019	1.278
Mean Diff.		23.352	0.013	25.695	24.409	0.186	6.720	(4.160)	3.660	0.900	7.380	6.720	(4.160)	3.660	0.900	7.380
PANEL J: YEAR 2016–2017																
ALL	370	-0.345	-2.562	0.773	2.708[a]	0.727	-0.387	-2.021[b]	-1.147	-1.247	-0.129	0.150	4.086[b]	1.316	1.554	0.017
Mean Diff.		0.132	0.119	(0.539)	(1.052)	(0.094)	(5.720)	29.900	(16.970)	(18.44)	(1.920)	(5.720)	29.900	(16.970)	(18.44)	(1.920)
ME	151	-0.341	-1.580	0.163	1.841[c]	0.014	-0.751	-1.592	-1.297	-1.264	-0.307	0.564	2.534	1.681	1.597	0.094
Mean Diff.		0.237	0.089	(0.218)	(1.427)	(0.003)	(6.780)	14.380	(11.72)	(11.41)	(2.770)	(6.780)	14.380	(11.72)	(11.41)	(2.770)
SEA	149	-0.333	-3.408[a]	1.994[b]	1.755[c]	1.858[c]	-0.578	-2.502[b]	-0.040	-0.161	-0.388	0.334	6.258[b]	0.002	0.026	0.151
Mean Diff.		0.193	0.274	(1.050)	(0.860)	(2.257)	5.760	24.930	0.400	1.600	(3.870)	5.760	24.930	0.400	1.600	(3.870)
SA	70	0.628	0.216	0.965	2.334[b]	-0.072	-0.709	-0.125	-1.114	-1.356	-0.577	0.503	0.016	1.242	1.838	0.332
Mean Diff.		(0.290)	(0.022)	(0.661)	(0.849)	0.009	(4.570)	0.810	(7.190)	(8.750)	3.720	(4.570)	0.810	(7.190)	(8.750)	3.720
PANEL K: ALL YEARS AND REGIONS																
ALL	3604	-1.151	-.0.884	-0.974	-0.825	-0.601	-0.638	-.0727	-0.088	-0.233	-0.573	0.407	0.529	0.008	0.054	0.328
Mean Diff.		0.653	0.015	0.589	0.478	0.024	30.240	34.500	4.180	11.070	(27.150)	30.240	34.500	4.180	11.070	(27.150)
ME	1488	0.098	-1.005	-.543	1.335	-0.257	-0.153	-1.046	-0.287	-0.128	-0.694	0.023	1.094	0.083	0.016	0.482
Mean Diff.		(0.031)	0.024	(0.199)	(0.281)	0.012	4.460	30.500	(8.380)	3.730	(20.23)	4.460	30.500	(8.380)	3.730	(20.23)
SEA	1465	-0.983	-0.415	-0.754	-0.804	0.559	-1.010	-0.925	-0.496	-0.683	-0.520	1.021	0.856	0.246	0.467	0.270
Mean Diff.		0.763	0.009	0.552	0.606	0.033	33.040	30.310	16.260	22.380	(17.020)	33.040	30.310	16.260	22.380	(17.020)
SA	651	-0.808	-0.280	-0.889	-0.732	-1.033	-0.089	-1.316	-0.020	-0.859	-0.381	0.008	1.731	0.000	0.738	0.145
Mean Diff.		1.927	0.013	2.360	1.853	0.156	(1.720)	(25.35)	(3.260)	(16.550)	7.330	(1.720)	(25.35)	(3.260)	(16.550)	7.330

Notes: Obs.: observations; ME: Middle East; SEA: Southeast Asia; SA: South Asia.
[a], [b], [c] indicate 1%, 5%, and 10% significance levels, respectively.
The figures in brackets indicate that the productivity means of conventional banks are higher than those of Islamic banks.

In the context of the serious concerns over the performance of banks in the banking and wider finance world, this study has important implications for policy and business practices. Determining the overall level of productivity level in Islamic banks can instigate not only policy makers to improve managerial performance but also investors and clients to review their decisions on investment and service quality. Moreover, progression in productivity will improve banks' profitability: providing a high-quality service at a minimum cost. Therefore, the banking and financial sectors should implement a range of mechanisms, such as policy and workforce training, to raise productivity levels. This is especially pertinent because the findings of the current study confirm those in the existing financial development literature. Nevertheless, there are limitations to this study, which should be taken as a starting point and incentive to seeking a more comprehensive understanding of productivity levels in Islamic and conventional banks. Future research studies should consider other tools for measuring productivity, such as the production or profit/revenue approaches, apart from the intermediation approach used in this study. Also, by combining parametric stochastic frontier analysis with nonparametric data envelopment analysis, more robust empirical evidence would be acquired by future studies. Consequently, the current study provides the motivation for financial institutions to develop strategies that will escalate productivity.

6. ABBREVIATIONS

i.	CRS	Constant Returns to Scale.
ii.	DEA	Data Envelopment Analysis.
iii.	DMU	Decision-Making Unit.
iv.	EFCH	Efficiency Change.
v.	GCC	Gulf Cooperation Council.
vi.	GFC	Global Financial Crisis.
vii.	ME	Middle East.
viii.	MPI	Malmquist Productivity Index.
ix.	OIC	Organisation of Islamic Cooperation.
x.	PTECH	Pure Technical Efficiency Change.
xi.	SA	South Asia.
xii.	SAC	Shariah Advisory Council.
xiii.	SEA	Southeast Asia.
xiv.	SECH	Scale Efficiency Change.
xv.	SFA	Stochastic Frontier Analysis.
xvi.	TCH	Technical Change.
xvii.	TFP	Total Factor Productivity.
xviii.	TFPCH	TFP Change.
xix.	VRS	Variable Returns to Scale.

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REFERENCES

Abedifar, P., Hasan, I., & Tarazi, A. (2016). Finance-growth nexus and dual-banking systems: Relative importance of Islamic banks. *Journal of Economic Behavior & Organization*, *132*, 198-215. Available at: https://doi.org/10.1016/j.jebo.2016.03.005.

Abedifar, P., Molyneux, P., & Tarazi, A. (2013). Risk in Islamic banking. *Review of Finance*, *17*(6), 2035-2096.

Alaeddin O., Altounjy, R., Zainudin Z. & Kamarudin, F. (2018). From physical to digital: Investigating consumer behaviour of switching to mobile wallet. *Polish Journal of Management Studies*, 17(2), 18-30. Available at: https://doi.org/10.17512/pjms.2018.17.2.02

Alexakis, C., Izzeldin, M., Johnes, J., & Pappas, V. (2018). Performance and productivity in Islamic and conventional banks: Evidence from the global financial crisis. *Economic Modelling*, *79*, 1-14. Available at: https://doi.org/10.1016/j.econmod.2018.09.030.

Aliyu, S., Yusof, R. M., & Naiimi, N. (2017). The role of moral transaction mode for sustainability of banking business: A proposed conceptual model for Islamic microfinance banks in Nigeria. *International Journal of Social Economics*, *44*(12), 2238-2256. Available at: https://doi.org/10.1108/ijse-07-2016-0205.

Aluko, O. A., & Ajayi, M. A. (2018). Determinants of banking sector development: Evidence from Sub-Saharan African countries. *Borsa Istanbul Review*, *18*(2), 122-139. Available at: https://doi.org/10.1016/j.bir.2017.11.002.

Ang, J., Cole, R., & Lin, J. (2000). Agency costs and ownership structure. *The Journal of Finance*, *55*(1), 1-39.

Ariss, R. T. (2010). Competitive conditions in Islamic and conventional banking: A global perspective. *Review of Financial Economics*, *19*(3), 101-108. Available at: https://doi.org/10.1016/j.rfe.2010.03.002.

Asian Development Bank. (2017). *Meeting Asia's infrastructure needs*. Manila: Asian Development Bank.

Banker, R. D., & Datar, S. M. (1989). Sensitivity, precision, and linear aggregation of signals for performance evaluation. *Journal of Accounting Research*, *27*(1), 21-39. Available at: https://doi.org/10.2307/2491205.

Beck, T., Demirgüç-Kunt, A., & Merrouche, O. (2013). Islamic vs. Conventional banking: Business model, efficiency and stability. *Journal of Banking and Finance*, *37*(2), 433-447. Available at: https://doi.org/10.1016/j.jbankfin.2012.09.016.

Bhatia, V., Basu, S., Mitra, S. K., & Dash, P. (2018). A review of bank efficiency and productivity. *Opsearch*, *55*(3-4), 557-600.

Bottazzi, G., Secchi, A., & Tamagni, F. (2008). Productivity, profitability and financial performance. *Industrial and Corporate Change*, *17*(4), 711-751. Available at: https://doi.org/10.1093/icc/dtn027.

Boukhatem, J., & Moussa, F. B. (2018). The effect of Islamic banks on GDP growth: Some evidence from selected MENA countries. *Borsa Istanbul Review*, *18*(3), 231-247. Available at: https://doi.org/10.1016/j.bir.2017.11.004.

Casu, B., & Girardone, C. (2006). Bank competition, concentration and efficiency in the single European market. *The Manchester School*, *74*(4), 441-468. Available at: https://doi.org/10.1111/j.1467-9957.2006.00503.x.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, *2*(6), 429-444. Available at: https://doi.org/10.1016/0377-2217(78)90138-8.

Colwell, R., & Davis, E. (1992). Output and productivity in banking. *The Acandinavian Journal of Economics*, *94*, S111-S129. Available at: https://doi.org/10.2307/3440252.

Cooper, W., Seiford, L., & Tone, K. (2002). *Data envelopment analysis: A comprehensive text with models, applications, references and DEA-solver software*. Boston: Kluwer Academic Publishers.

Darrat, A. F. (1988). The Islamic interest-free banking system: Some empirical evidence. *Applied Economics*, *20*(3), 417-425. Available at: https://doi.org/10.1080/00036848800000054.

Doumpos, M., Hasan, I., & Pasiouras, F. (2017). Bank overall financial strength: Islamic versus conventional banks. *Economic Modelling*, *64*(C), 513-523. Available at: https://doi.org/10.1016/j.econmod.2017.03.026.

Emrouznejad, A., & Yang, G.-l. (2018). A survey and analysis of the first 40 years of scholarly literature in DEA: 1978-2016. *Socio- Economic Planning Sciences*, *61*, 4-8. Available at: https://doi.org/10.1016/j.seps.2017.01.008.

Fare, R., Grosskopf, S., Norris, M., & Zhang, Z. (1994). Productivity growth, technical progress, and efficiency change in industrialized countries. *American Economic Review*, *84*(1), 66-83.

Ghosh, A. (2016). Banking sector globalization and bank performance: A comparative analysis of low income countries with emerging markets and advanced economies. *Review of Development Finance*, *6*(1), 58-70. Available at: https://doi.org/10.1016/j.rdf.2016.05.003.

Habib, S. F. (2018). Chapter 3: Islamic banking versus conventional banking. In S. F. Habib, Fundamentals of Islamic Finance and Banking (pp. 47-78): John Wiley & Sons.

Hassan, M. K., & Aliyu, S. (2018). A contemporary survey of Islamic banking literature. *Journal of Financial Stability*, *34*(C), 12-43. Available at: https://doi.org/10.1016/j.jfs.2017.11.006.

Houben, V. J. (2003). Southeast Asia and Islam. *The ANNALS of the American Academy of Political and Social Science*, *588*(1), 149-170.

Hussain, H.I., Kamarudin, F., Thaker, H.M.T., & Salem, M.A. (2019). Artificial Neural Network to model managerial timing decision: Non-linear evidence of deviation from target leverage. *International Journal of Computational Intelligence Systems*, 12(2), 1282-1294. Available at: https://doi.org/10.2991/ijcis.d.191101.002

Imam, P., & Kpodar, K. (2016). Islamic banking: Good for growth? *Economic Modelling*, *100*(59), 387-401. Available at: https://doi.org/10.1016/j.econmod.2016.08.004.

International Monetary Fund. (2015). IMF annual Report 2015: Tackling challenges together. *International Monetary Fund.*

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, *3*(4), 305-360. Available at: https://doi.org/10.1016/0304-405x(76)90026-x.

Kamarudin, F., Hue, C. Z., Sufian, F., & Anwar, N. A. M. (2017b). Does productivity of Islamic banks endure progress or regress?: Empirical evidence using data envelopment analysis based Malmquist Productivity Index. *Humanomics: The International Journal of Systems and Ethics*, *33*(1), 84-118. Available at: https://doi.org/10.1108/h-08-2016-0059.

Kamarudin, F., Nordin, B. A. A., Muhammad, J., & Hamid, M. A. A. (2014). Cost, revenue and profit efficiency of Islamic and conventional banking sector: Empirical evidence from gulf cooperative council countries. *Global Business Review*, *15*(1), 1-24. Available at: https://doi.org/10.1177/0972150913515579.

Kamarudin, F., Sufian, F., Loong, F. W., & Anwar, N. A. M. (2017a). Assessing the domestic and foreign Islamic banks efficiency: Insights from selected Southeast Asian countries. *Future Business Journal*, *3*(1), 33-46. Available at: https://doi.org/10.1016/j.fbj.2017.01.005.

Kamarudin, F., Sufian, F., & Nassir, A. M. (2016). Does country governance foster revenue efficiency of Islamic and conventional banks in GCC countries? *EuroMed Journal of Business*, *11*(2), 181 - 211. Available at: https://doi.org/10.1108/emjb-06-2015-0026.

Khan, M. M., & Bhatti, M. I. (2008). Islamic banking and finance: On its way to globalization. *Managerial Finance*, *34*(10), 708-725. Available at: https://doi.org/10.1108/03074350810891029.

Khan, M. S. (1986). Islamic interest-free banking: A theoretical analysis. *Staff Papers*, *33*(1), 1-27.

Komijani, A., & Hesary, F. T. (2018). An overview of Islamic banking and finance in Asia. *ADBI Working Paper Series*, *853*, 1-14.

Kopleman, R. (1986). *Managing productivity in organizations: A practical, people-oriented perspective.* New Delhi: McGraw Hill Book Company.

Maredza, A., & Ikhide, P. (2013). Measuring the impact of the global financial crisis on efficiency and productivity of the banking system in South Africa. *Mediterranean Journal of Social Sciences*, *4*(6), 553-568.

Mobarek, A., & Kalonov, A. (2014). Comparative performance analysis between conventional and Islamic banks: Empirical evidence from OIC countries. *Applied Economics*, *46*(3), 253-270. Available at: https://doi.org/10.1080/00036846.2013.839863.

Rodoni, A., Salim, M. A., Amalia, E., & Rakhmadi, R. S. (2017). Comparing efficiency and productivity in Islamic banking: Case study Indonesia, Malaysia and Pakistan. *Al-Iqtishad: Jurnal Ilmu Ekonomi Syariah*, *9*(2), 227-242. Available at: https://doi.org/10.15408/aiq.v9i2.5153.

Rosman, R., Wahab, N., & Zainol, Z. (2014). Efficiency of Islamic banks during the financial crisis: An analysis of Middle Eastern and Asian countries. *Pacific-Basin Finance Journal*, *28*, 76-90. Available at: https://doi.org/10.1016/j.pacfin.2013.11.001.

Said, A. (2013). Risks and efficiency in the Islamic banking systems: The case of selected Islamic banks in MENA region. *International Journal of Economics and Financial Issues*, *3*(1), 66-73.

Siddiqi, M. (2006). Islamic banking and finance in theory and practice: A survey ofstate of the art. *Islamic Economic Studies*, *13*(2), 2-48.

Sufian, F. (2012). For which option is credit risk more representative on China banks' total factor productivity: Efficiency change or technological progress? *China Finance Review International*, *2*(2), 180-202.

Sufian, F., & Habibullah, M. S. (2014). Banks' total factor productivity growth in a developing economy: Does globalisation matter? *Journal of International Development*, *26*(6), 821-852. Available at: https://doi.org/10.1002/jid.2897.

Sufian, F., & Kamarudin, F. (2014). The impact of ownership structure on bank productivity and efficiency: Evidence from semi-parametric malmquist productivity index. *Cogent Economics and Finance*, *2*(1), 1-27. Available at: http://dx.doi.org/10.1080/23322039.2014.932700.

Sufian, F., & Kamarudin, F. (2015). Determinants of revenue efficiency of Islamic banks: Empirical evidence from the Southeast Asian countries. *International Journal of Islamic and Middle Eastern Finance and Management*, *8*(1), 36-63. Available at: https://doi.org/10.1108/imefm-12-2012-0114.

Sufian, F., & Kamarudin, F. (2017). Forced mergers on bank efficiency and productivity: Evidence from semi-parametric Malmquist productivity index. *Global Business Review*, *18*(1), 19-44. Available at: https://doi.org/10.1177/0972150916666850.

Sufian, F., Kamarudin, F., & Md. Nassir, A. (2017). Globalization and bank efficiency nexus: Empirical evidence from the Malaysian banking sector. *Benchmarking: An International Journal*, *24*(5), 1-8.

Toumi, K., Louhichi, W., & Vivian, J.-L. (2012). *Alternative financial decision principles: Theoretical foundations of Islamic banks' capital structure. In W. Barnett, & F. Jawadi, recent developments in alternative finance: Empirical assessments and economic implications (international symposia in economic theory and econometrics*: Emerald Group Publishing Limited.

Wanke, P., Azad, M., Kalam, A., Barros, C., & Hassan, M. K. (2016). Predicting efficiency in Islamic banks: An integrated multi criteria decision making approach. *Journal of International Financial Markets, Institutions and Money*, *45*(C), 126-141. Available at: https://doi.org/10.1016/j.intfin.2016.07.004.

Yahya, M. H., Muhammad, J., & Hadi, A. R. A. (2012). A comparative study on the level of efficiency between Islamic and conventional banking systems in Malaysia. *International Journal of Islamic and Middle Eastern Finance and Management*, *5*(1), 48-62. Available at: https://doi.org/10.1108/17538391211216820.