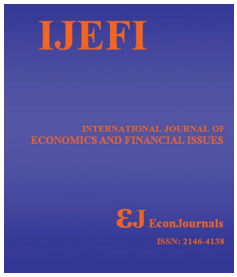

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Productivity Analysis of Commercial Banks of Bangladesh: A Malmquist Productivity Index Approach

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ABSTRACT

This study evaluated the productivity performance of 29 listed commercial banks by employing Malmquist productivity ındex of total factor productivity (TFP) over the period of 2011–2015. Evaluation of productivity performance reveals that Islamic banks, on an average, had relatively higher 5 years cumulative average TFP change index compared to that of Conventional banks. In addition, Islamic banks reported less variability in its TFP change index compared to Conventional banks. Productivity change index of Islamic bank indicate that it's failing to sustain the progress made in some years whereas Conventional banks though reported regress during some years but the trend remained consistent. Evaluation of productivity analysis indicates that progress made in TFP was mainly attributed to the increase in efficiency change rather than technological progress. The decomposition of the efficiency change index revealed that the source of the increment was mainly attributed to scale effect.

Keywords: Malmquist Productivity Index, Total Factor Productivity, Data Envelopment Analysis
JEL Classifications: G210, O470

1. INTRODUCTION

The natural measure of performance for any firm is evaluation of its productivity which is generally a ratio of outputs to inputs, where larger value of this ratio is associated with better performance. Measures of productivity are used to evaluate the efficiency of production and assessing productivity is critical for any firms since all firms' are involve in converting inputs into outputs. Besides productivity growth is important for any firm because providing more goods and services to consumers translates into higher profits for businesses. One of the approaches of modeling banks production function is the intermediation approach where bank is viewed as financial intermediary that pool financial resources from surplus units and allocate them to deficit units which ultimately results in economic growth of a country. Rapid financial deregulation, consolidation, technological advancements and financial innovation are forces that have made revolutionary changes in the banking sector worldwide as well as in Bangladesh during past few decades. Two major categories of banking system, conventional and Islamic, are also incorporating the ongoing changes in banking sector worldwide to remain competitive and efficient. It is certain that relatively inefficient banks lose their market share and get replaced by more efficient ones and the same notion is applicable for a banking system as well. Therefore, to perform the role of financial intermediation more efficiently, the structures of financial institutions are changing towards those that are more efficient in performing the intermediary function. This is visible in the global banking industry as Islamic banking system is fast becoming a widely accepted alternative mode of banking along with conventional banks.

Banks which are considered as the heart of the financial system in Bangladesh, evaluating banks' productivity gives important

indication to their efficiency and adaptability to changing technology. In addition, the increase in productivity is also expected to contribute to the soundness and stability of the banking system by channeling profit towards creation of equity and provisions thus allowing better absorption of risks. It is recognized that only efficient and productive banks are able to generate excellent performance results thus allowing banks to achieve their objective of profit maximization and shareholders wealth maximization. Besides, productivity performance presents a major interest for the regulatory authorities of country because an increase in the productivity level of banks contributes to the productivity level of the entire economy. Against this backdrop, this research is aimed at evaluating the productivity of Islamic and Conventional banks of Bangladesh to identify their competitiveness in the banking sector.

The main objectives of this study are as follows:
First, to evaluate the trend of commercial banks' productivity performance over the selected period.

Second, to identify which banking system is boasting superiority in terms of productivity performance.

Third, to indentify the source of productivity progress and productivity regress over the selected period.

2. REVIEW OF LITERATURE ON PRODUCTIVITY OF COMMERCIAL BANKS

There are substantial studies performed with regard to the efficiency and productivity of financial institutions in developed countries' and also in many developing countries, however, empirical evidences on the banking sector of Bangladesh are limited. The few recent researches that have been undertaken to evaluate efficiency and productivity of financial institutions of Bangladesh are discussed below.

Uddin and Suzuki (2011) analyzed income efficiency, cost efficiency, non-perfuming loan and return on asset (ROA) of 38 commercial banks in Bangladesh by applying data envelopment analysis (DEA) approach from 2001 to 2008. They found that both income efficiency and cost efficiency of all sample banks have been increased in 2008 compared to 2001, thus indicating improvement in bank performance during the sample period in Bangladesh. Hoque and Rayhan (2012) applied DEA method to 21 commercial banks in Bangladesh and found that the scores of both the input and output related technical efficiency is similar under constant returns to scale (CRS). This study suggested that the banks with higher technical efficiency possess top ranks in the banking sector; and continuously increases competition in the private commercial banking sector thereby helping to enhance the efficiency of this sector. Bhuia et al. (2012) examined online bank efficiency in Bangladesh applying DEA approach. They considered deposits, capital and labor as input variables and advance, investment and profit are defined as output variables. This study reported that the most efficient banks were Al-Arafh Islami Bank Limted (AAIBL) and ShahaJalal Islami Bank Limited (SJIBL). Abduh et al. (2013) investigated the efficiency and performance of Islamic Banks in Bangladesh applying DEA and ratio analysis. This study concluded that SJIBL is better than other Islamic banks in terms of its ROA, return on equity, capital adequacy ratio, ınterest expenses ratio and asset utilization ratios. On the other hand, with regard to banks' efficiency, all Islamic banks have shown an improvement on their efficiency level.

Ahmed and Liza (2013) adopted DEA method to measure efficiency of 35 commercial banks in Bangladesh from 2002 to 2011. They concluded that most of the second and third generation banks and foreign commercial banks are highly efficient and they are very competitive with each other. These banks maintained not only their efficiency but also the consistency of efficiency level during the period of 2002–2011. Islam et al. (2013) applied DEA to explore the contribution of technical and efficiency change to the growth of productivity in the Islamic banking sector of Bangladesh. This study considered three inputs namely- deposits, overhead cost, total assets; and three outputs - investment and advances, return on ınvestment, ROA respectively to measure efficiency. The study indicated that all the Islamic banks were consistently efficient, both under CRS and variable returns to scale (VRS) except Islami Bank Bangladesh Limited (IBBL), export ımport bank (EXIM) and Shahajalal Islami Bank Limited (SIBL). Meanwhile, IBBL and SIBL are consistently efficient under VRS but not under CRS during the studied period. Moreover, the EXIM bank is the least efficient firm under both CRS and VRS versions respectively.

Sufian and Kamarudin (2014) investigated efficiency and returns to scale of banking sector of Bangladesh applying slack-based DEA method. They attempted to assess the level of profit efficiency of individual banks over the years of 2004–2011. The empirical findings of their study indicated that the Bangladeshi banking sector has exhibited the highest and lowest level of profit efficiency during the year 2004 and 2011 respectively. They also found that most of the Bangladeshi banks have been experiencing economies of scale due to being at less than the optimum size, or diseconomies of scale due to being at more than the optimum size. Thus, decreasing or increasing the scale of production could result in cost savings or efficiencies. The empirical findings also suggested that Export Import Bank (EXIM) has exhibited maximum profit efficiency level. Idris (2014) investigated the technical, pure technical and scale efficiency of the Islamic banks operating in Bangladesh applying a non-parametric DEA method. Data were analyzed in two different phases considering different input-output variables. Analysis in the first phase revealed that technical efficiency of all the Islamic banks were very high, amounting to an average of 98%, 96%, 98% and 96% in 2010, 2011, 2012, and 2013 respectively. Analysis in the second phase revealed that all the Islamic banks were technically efficient in all the period of the study; except in 2012, SIBL, Al-Arafah Islami Bank Limited (AAIBL) and ICB Islamic banks were found to be technically inefficient. Baten el al. (2015) evaluated the technical efficiency change and productivity change of nationalized commercial banks (NCBs) and private banks (PBs) by employing cost DEA,

profit DEA and Malmquist based DEA. They observed that cost efficiency and profit efficiency were slightly higher for PBs than NCBs. They also reported that there exists a huge gap among NCBs in terms of cost efficiency.

The above review of literature clearly reveals that majority of these studies have concentrated on efficiency analysis of banking sector of Bangladesh. To the best of the researcher's knowledge, there were no empirical evidences on the application of Malmquist productivity ındex (MPI) for comparative productivity analysis of conventional and ıslamic banks of Bangladesh. Therefore, the novelty of this research is filling the vacuum within the existing body of literature on bank productivity.

3. RESEARCH METHODOLOGY

3.1. Philosophical Position of this Study

The research design for this study is empirical and the researcher's view is positivist and post-positivist where the aim is explanation, prediction and control; analyzed through quantitative methods. Quantitative data are collected through structured procedure and statistical tools and techniques used also reflect the philosophy of positivism. The present study follows deductive approach to carry out the research. Descriptive statistics such as yearly average, cumulative average, maximum, minimum, standard deviation, coefficient of variation (CV) are used for data analysis. The non-parametric measure i.e., MPI of total factor productivity (TFP) is employed for estimation of productivity.

3.2. Measurement of Productivity

3.2.1. TFP

Productivity of a firm is a ratio of output to inputs and larger value of this ratio is associated with better performance. When the production process involves a single input and a single output, this calculation is a trivial matter. However, when there is more than one input and one output which is often the case, then a method known as TFP is used which is a as an overall productivity measure that encompasses the productivity of all production factors and outputs (Coelli et al., 1998). When the overall productivity of a decision making unit (DMU) or a whole industry is considered, distinction must be made between TFP and other commonly used partial measure of productivity such as labor and capital productivity. This is because a DMU usually transforms multiple inputs into multiple outputs. The evaluation of partial productivity measures alone can be misleading and could result in inconsistent and inaccurate conclusions.

3.2.2. The MPI

To assess productivity growth in economic units, researchers typically employs two different indices, namely the parametric Törnqvist (1936) or the non-parametric Malmquist (1953) MPI. In this study, the non-parametric MPI method introduced by Caves et al. (1982) is adopted to estimate and evaluate the TFP change ındex of commercial banks of Bangladesh. Besides, to fully account for the effects of technical efficiency change, scale efficiency change and technical change on TFP, this study also includes the MPI decomposition as suggested by Fare et al. (1994). The MPI method uses exclusively quantity information and thus requires neither problematic price information nor a restrictive behavioral assumption in its calculation. The MPI is capable of being defined as either an output quantity index or as an input quantity index. To maintain consistency with the majority of related studies, this paper also follows an output quantity index approach (Jaffry et al., 2007 and Chowdhary et al. 2009). The non-parametric linear programming DEA technique is adopted here to compute the output distance functions. Specifically, the output-orientated DEA model is employed because it is assumed that the sample banks do not have full control over their inputs. This linear programming method developed by Charnes et al. (1978) is employed to estimate various components of MPI. Occasionally it is termed as frontier analysis because it can be used for analyzing the relative efficiency of DMUs having multiple inputs and outputs.

MPI allows this study to distinguish between shifts in the production frontier indicated by technology or technical change [TECHCH] and movements of firms towards the frontier accounted by technical efficiency change [EFCH]. Thus, the MPI of TFP is simply the product of technical efficiency change and technology change. The technology change and efficiency change indices are estimated under the assumption of constant return to scale (CRS) that assumes that banks operate at an optimum scale, i.e., most productive scale size (MPSS), for cost minimization. CRS assumes that if all inputs are doubled, output will also be doubled. But it is argued that, in reality, the phenomenon of CRS is a very temporary one and hence, banks could face scale inefficiencies due to decreasing returns to scale (DRS) or increasing returns to scale (IRS) in their operations. To address this issues, this study relaxes the CRS assumption and adopt the more realistic VRS assumption. By doing so, this study is able to decompose the technical efficiency change index (EFCH) into pure technical efficiency change (PTEEFCH) and scale efficiency change (SECH) indices.

The pure technical efficiency change index measures changes in the proximity of firms to the production frontier, devoiding the scale effects. In contrast, the scale efficiency change index shows whether the movements inside the frontier are in the right direction to attain CRS point i.e., MPSS, where changes in input levels results in proportional changes in output. The pure technical efficiency change index is entirely under the control of and results directly due to management errors and it is also termed as managerial efficiency in the literature. It occurs when more of each input is used than should be required to produce a given level of output. In contrast, a scale efficient firm produces where there exists CRS. If IRS is observed in a firm, then efficiency gains could be obtained by expanding the production levels. If decreasing returns to scale (DRS) is observed in a firm, efficiency gains could be achieved by reducing the production levels (Batchelor, 2005). Hence, total inefficiency could be due to pure technical inefficiency or scale inefficiency or both.

In summary, TFP change = Technical Change [TECHCH] × Technical Efficiency Change [TEEFCH] and Technical efficiency change = Pure Technical Efficiency Change (PTEEFCH) × Scale Efficiency Change (SECH).

3.2.3. Selection of inputs and outputs for MPI

To derive the MPI through an output orientated DEA model requires data on inputs and outputs to be fed into the model. There appears to be no consensus among researchers into banking efficiency and productivity literature about the selection of inputs and outputs. There are mainly two approaches in modeling bank behavior which are - the production approach and the intermediation approach. The production approach is the traditional banking approach and introduced by Benston (1965). According to production approach banks use three input factors; namely labor, capital and banking funds to produce a vector of three outputs in the form of short-term loans, long-term loans and other earning assets.

The intermediation approach is viewed as non-traditional approach that suggests bank borrows depositor's funds and channels them to deficit units as loans and other assets in the intermediation approach. Avkiran (1999) using the intermediation approach identified four inputs which are number of staff, deposits, interest expense, and non-interest expense; and three outputs which are net loans, net interest income and non-interest income. intermediation approach is also adopted in this study because most of the literature on bank efficiency favors the intermediation approach including Wheelock and Wilson (1995), Hefferman (1996), Aly et al. (1990), Elysiani and Mehdian (1995) and Berger and Humphrey (1991). When selecting the input and output for estimating MPI through an output oriented DEA model, care is taken to account for the specific characteristics of Islamic banks. This study employed input and output variables of Batchelor (2005) for estimation of MPI of TFP. The input and output variables are listed in Table 1.

3.2.4. Same and time period of the study

This study analyzed the productivity growth of 29 commercial banks over the period of 2011–2015. Among these 29 commercial banks, 23 are Conventional and 6 are Islamic banks. For computation of Malmquist productivity ındices the study constituted a balanced panel database of input and output variables for 29 commercial banks over the period of 2010–2016.

3.2.5. Statistical tools used for analysis

This study tabulated and computed different measures of descriptive statistics by "MS-Excel." This study employed DEAP version 2.1 developed by Coelli (1996) to estimate the MPI in the form of indices. Based on the calculation of output distance function, five MPI indices relative to the previous periods are produced for each bank. The indices are namely: The Technical Efficiency (TEEFCH) Change index with its two sub indices - the Pure Technical Efficiency (PTEEFCH) Change index and the Scale Efficiency (SECH) Change index; and the Technical Change index (TECHCH). Finally, a product of Technical Efficiency (TEEFCH) Change index and the Technical Change (TECHCH) index derives the TFP or TFP change index. All the indices are calculated relative to both contemporaneous and previous year frontiers. Values of index above 1 indicate productivity progress between periods t-1 and t, while index values below 1 indicate productivity regress and unitary value, 1, signify no productivity changes between two periods.

Table 1: Input and output variables for MPI

Variable	Conventional banking variable	Islamic banking comparable variable
Inputs	Interest expense	Profit paid on deposits
	Non-interest expense	Operating expense
Outputs	Interest income	Income from investment
	Non-interest income	Non-investment income

Source: Batchelor (2005). MPI: Malmquist productivity index

4. FINDINGS AND ANALYSIS

4.1. Descriptive Statistics of Input and Output Variables

The descriptive statistics of input and output variables used in calculation of (TFP) index under MPI TFPframework using the DEA model is reported in Table 2. This table reports maximum, minimum, mean and standard deviation of two inputs - interest expense and non-interest expense and two outputs-interest income and non-interest income over the selected period for 29 listed commercial banks and here n = 174 bank-years observation.

4.2. Trend Analysis of TFP

The evaluation of bank's productivity performance is done by trend analysis of all listed commercial banks inclusive of two banking groups in terms of estimating TFP and its sub indices which are technical efficiency change (TEEFCH), pure technical efficiency change (PTEEFCH), scale efficiency (SECH) change and technical change (TECHCH). The trend of TFP change of all listed commercial banks over the period of 2011–2015 is presented in Table 3. This table presents the yearly TFP change index for 5 years period; yearly average TFP change index of all listed commercial banks, 5 years cumulative average, variation in yearly TFP change index of Conventional banks and Islamic banks by standard deviation and CV. Table 3 also reports the maximum and minimum values of yearly TFP change index and the standard deviation and CV of yearly average TFP change index of all listed commercial banks of Bangladesh.

Table 3 indicates that, the trend in TFP change index exhibits an increasing pattern for all listed commercial banks and Conventional banking operations over the selected period of this study. Conventional banking groups report a trend similar to that of all listed commercial banks with a regress in productivity from 2011 till 2014 and finally reporting a modest TFP progress of 1.09830 during the period of 2014 to 2015. However, the 5 years average TFP change index reporting a regress of 0.97861 for these banks is still below the 5 years average of all listed commercial banks. Islamic banks reported a TFP regress of 0.99420 during the beginning of selected period 2010-2010 but enjoyed a rather short-lived TFP progress of 1.02467 during 2011-2012 followed by a subsequent regress in TFP of 0.92833 in 2013–2013. However, in 2013-2014 productivity progressed with a reported TFP growth of 1.0067 for Islamic banks but again experienced a subsequent regress in TFP during the end of the studied period. However, the 5 years average TFP change index reporting a regress of 0.98867 for Islamic banks is above the 5 years average of all listed banks and Conventional banking operations. Thus, on an average all the listed commercial banks experienced a TFP regress over the selected period with Islamic banking group enjoying a rather

Table 2: Descriptive statistics of input and output variables of total factor productivity

Input and output variable	n	Minimum	Maximum	Mean±SD
Interest income	174	1269	49109	13627.477±7258.03070
Non-interest income	174	658	10779	4034.7874±2199.39351
Interest expense	174	2435	30975	9621.4080±4879.57478
Non-interest expense	174	882	13466	3717.9828±2090.07733
year	174	2010	2015	2012.50±1.713
Bank	174	1	29	14.97±8.339
Valid N (listwise)	174			

Source: Author's own calculation. SD: Standard deviation, CV: Coefficient of variation

Table 3: Trend of annual TFP change index

TFP change	2010–2011	2011–2012	2012–2013	2013–2014	2014–2015	Fiveyear's average	SD	CV
Conv.	0.90020	0.93248	0.96539	0.99670	1.09830	0.97861	0.07600	0.07766
Islamic	0.99420	1.02467	0.92833	1.00667	0.98950	0.98867	0.03637	0.03679
All banks								
Maximum	1.15300	1.11100	1.049	1.11700	2.99300			
Minimum	0.61900	0.67100	0.825	0.32300	0.89700			
Yearly average	0.91962	0.95155	0.9577	0.99876	1.07579	0.98069	0.06016	0.06134
SD	0.11476	0.07963	0.05218	0.13979	0.37349			
CV	0.12479	0.08368	0.00046	0.13997	0.34717			

Source: Author's own calculation. TFP: Total factor productivity, SD: Standard deviation, CV: Coefficient of variation

Table 4: Trend of technical efficiency change index

Technical efficiency change	2010–2011	2011–2012	2012–2013	2013–2014	2014–2015	5 year's average	SD	CV
Conv.	0.97220	1.02970	1.00096	0.97383	1.09109	1.01355	0.04929	0.04863
Islamic	0.96120	1.06217	0.97900	0.99883	1.01167	1.00257	0.03846	0.03836
All banks								
Max	1.15900	1.14100	1.09800	1.10700	2.91200			
Min	0.82400	0.79000	0.87500	0.30800	0.89700			
Yearly average	0.96993	1.03641	0.99641	0.97900	1.07466	1.01128	0.04365	0.04316
SD	0.08935	0.07610	0.05087	0.13745	0.35660			
CV	0.09212	0.07343	0.00045	0.14039	0.33183			

Source: Author's own calculation. SD: Standard deviation, CV: Coefficient of variation

short-lived TFP growth for a while. However, it is noticeable that productivity of all commercial banks displayed a trend towards TFP progress with the reported narrowing of range between TFP progress and regress over the selected period.

High volatility in TFP change index denoted by CV of 34.17% is recorded during the period of 2014-2015 for all listed commercial banks while the lowest volatility is recorded in 2012–2013 with CV of 0.046%. Between the two banking group, Islamic banking operations is showing less annual volatility in TFP change index indicated by CV of 3.679% compared to Conventional banks' CV of 7.766%. Though, both the Islamic and Conventional banking group is showing a 5 years of average regression in TFP change index; however, the volatility in productivity growth is less in Islamic banks as indicated by the reported standard deviation (SD) and CV; and in addition, Islamic banks also experienced a modest TFP progress in some periods. Though, TFP change of Conventional banks is more volatile but these banks reported a steady trend towards progression of TFP change index over the selected period compared to inconsistent trend of growth and plunge of Islamic banks TFP change index.

4.2.1. Technical Efficiency (TEEFCH) Change

Technical Efficiency (TEEFCH) Change index reported in Table 4 is one of the sub indices of TFP change index. In terms of technical efficiency change, Table 4 suggests that collectively, all banks reported progress in technical efficiency (TE) change index during the period 2011-2012 and 2014-2015. Both the conventional and Islamic banking group reported progression during the same period. The yearly means indicates that both the Conventional and Islamic banking groups are recovering from their lowest TE change reported in 2010–2011 and registering a sustained Technical Efficiency growth which is reflected in the reported 5 years average; which are 1.01355 and 1.00257 respectively. Though Islamic banks reported lowest 5 years average TE change compared to that of Conventional banks but the yearly volatility of TE change index reported by CV of 3.836% for Islamic banks is less compared to CV of Conventional banks and all listed commercial banks. This is consistent with the findings of TFP change index where Islamic banks had the least volatile performance. Overall, Conventional banks seem to have outperformed Islamic banks in terms of TE change except with a negligibly higher relative volatility Technical Efficiency change index over the years.

4.2.2. Pure Technical Efficiency (PTEEFCH) Change

Pure Technical Efficiency (PTEEFCH) Change index is one of the sub indices of Technical Efficiency (TEEFCH) Change index reported in Table 5. Table 5 indicates that, overcoming the poor growth of PTE during 2010–2011, on the whole, all the commercial

banks reported a steady progress in Pure Technical Efficiency change index over the study period with a minor regress in the same during 2013–2014. 5 years average PTE change index of all commercial banks' also reported a growth of 1.00740. Conventional banking group reported a trend identical to that of all listed commercial banks and reporting a growth of 1.00877 in 5 years average PTE change index which is relatively a little higher than all banks average. The PTE change index of Islamic banks indicates that these banks are failing to keep up the growth at the same rate as Conventional banks or on an average with the growth of listed commercial banks. However, these banks manage to show a progression in that index in 2011–2012 and at the end of selected period 2014–2015. Furthermore, 5 years average PTE change index of 1.00217 reported for Islamic bank is relatively lower than that of Conventional banks and all listed commercial banks. Though Islamic banks reported a little lower value for 5 years aggregate PTE change index compared to Conventional banks but the annual volatility of this index reported by CV of 1.218% for Islamic banks is less compared to Conventional banks CV of 4.03%. This is consistent with the findings of TFP change index and Technical Efficiency change index where Islamic banks also had the least volatile performance. Overall, Conventional banks apparently outperformed Islamic banks in terms of Pure Technical Efficiency change, however with a relatively higher volatility in PTE change index over the years.

4.2.3. Scale Efficiency (SE) Change

Scale Efficiency (SEFFCH) Change index is one of the sub indices of Technical Efficiency (TEEFCH) Change index reported in Table 6. Table 6 reports that, on the whole all the commercial banks recovered from the poor growth of SE change recorded in 2010–2011, and showed a steady progression in scale efficiency over the selected period with a minor regress during 2012–2013. 5 years average SE change index of all commercial banks reported a growth of 1.00275. Conventional banking group reported a trend identical to that of all listed commercial banks and reporting a growth of 1.00331 in 5 years average SE change index which is relatively a little higher than all banks average and Islamic banks average. Furthermore, 5 years average SE change index of 1.00063 reported for Islamic banks is relatively lower than that of Conventional banks which is consistent with the findings of TE change and PTE change index. However, the yearly volatility of SE change index reported by CV of 3.48% for Islamic banks is higher compared to Conventional banks CV of 1.778%. Therefore, Conventional banks have outperformed Islamic banks in terms of scale efficiency change with less volatility compared to the TE change and PTE change index of the same banks.

4.2.4. Technical change

Technical change index (TECHCH) reported in Table 7 is one of the sub indices of TFP change index. Technical change index inflict the changes in TFP change index resulting from shifts of the efficient frontier. Table 7 summarizes that between the period of 2010 and 2015, on the whole, all the listed commercial banks, on an average, suffered from technical regress over the stated period except for 2013-2014. 5 years average of all banks also reporting regress in technical change by 0.97001. Conventional banking group suffered a decline in technical change index till 2013 with a reported shift in the efficient frontier thereby indicating a progression in technical change during 2013-2015. However, 5 years average technical change index of 0.96555 for Conventional banks also indicates a technological setback over the selected period. Islamic banks began with a technical progress of 1.0343 during 2010-2011 signaling a shift in frontier but failed to keep up the progress and falling into a period of technical regress over the period of 2011 to 2013. Both the Conventional and Islamic banks are reporting technical regress and progress at somewhat different time period and at different rate, signaling

Table 5: Trend of pure technical efficiency change

Pure technical efficiency change	2010–2011	2011–2012	2012–2013	2013–2014	2014–2015	5 year's average	SD	CV
Conv.	0.98810	1.01443	1.02122	0.95530	1.06478	1.00877	0.04065	0.04030
Islamic	0.99700	1.00433	0.98900	0.99883	1.02167	1.00217	0.01221	0.01218
All banks								
Maximum	1.15200	1.14900	1.27500	1.05800	2.52000			
Minimum	0.80700	0.91200	0.86900	0.33300	0.90600			
Yearly average	0.98993	1.01234	1.01455	0.96431	1.05586	1.00740	0.03386	0.03361
SD	0.08233	0.04798	0.07311	0.12736	0.28521			
CV	0.08317	0.04739	0.00064	0.13207	0.27012			

Source: Author's own calculation. SD: Standard deviation, CV: Coefficient of variation

Table 6: Trend of scale efficiency change

Scale efficiency change	2010–2011	2011-2012	2012-2013	2013-2014	2014-2015	5 year's average	SD	CV
Conv.	0.98510	1.01526	0.98252	1.01717	1.01648	1.00331	0.01783	0.01778
Islamic	0.96380	1.05800	0.99000	1.00017	0.99117	1.00063	0.03482	0.03480
All banks								
Max	1.09550	1.15900	1.05800	1.13400	1.15500			
Min	0.85500	0.83700	0.86100	0.92500	0.92600			
Yearly average	0.98067	1.02410	0.98407	1.01366	1.01124	1.00275	0.01926	0.01920
SD	0.05280	0.06706	0.03766	0.04391	0.04852			
CV	0.05384	0.06549	0.00033	0.04332	0.04798			

Source: Author's own calculation. SD: Standard deviation, CV: Coefficient of variation

Table 7: Trend of technical change

Technical change	2010–2011	2011–2012	2012–2013	2013–2014	2014–2015	5 year's average	SD	CV
Conv.	0.92750	0.90617	0.96465	1.02465	1.00478	0.96555	0.05002	0.05180
Islamic	1.03430	0.96667	0.94783	1.00800	0.97850	0.98706	0.03427	0.03472
All banks								
Max	1.11300	1.04300	0.99900	1.10700	1.10900			
Min	0.70600	0.81100	0.92800	0.96800	0.89700			
Yearly average	0.94962	0.91869	0.96117	1.02121	0.99934	0.97001	0.04065	0.04191
SD	0.10037	0.05259	0.02022	0.02729	0.03550			
CV	0.10569	0.05725	0.00018	0.02672	0.03552			

Source: Author's own calculation. SD: Standard deviation, CV: Coefficient of variation

that some banks are pushing the efficient frontier at different paces whilst some banks were left behind. Lastly, 5 years average technical change index of 0.98706 for Islamic banks is higher than Conventional banks. Furthermore, Islamic banks also reported less volatility in technical change index by CV of 3.472% compared to Conventional banks and all listed commercial banks. Henceforth, this result is apparently consistent with result of TFP change index thus indicating that technical change index trails the changes in TFP resulting from shifts of the efficient frontier.

4.3. Discussion on Productivity Performance

Evaluation of productivity performance of commercial banks of Bangladesh reveals that Islamic banks, on an average, had relatively higher cumulative average TFP change index (0.988) compared to that of Conventional banks (0.9786) over the studied period. In addition, Islamic banks reported less variability in its TFP change index with lower CV (0.03679) compared to CV (0.07766) of Conventional banks. However, it should be noted that, the trend of TFP change index of Islamic bank indicate that its failing to sustain the progress made in some years and thus reporting score of <1 during 2011, 2013 and 2015. But the trend of TFP change index of conventional banks though reported regress during the year 2011–2014 but the trend is consistent and rising; and finally reporting progress at the end of the selected period. On an average, productivity regress was recorded initially for all listed commercial banks and Conventional banking group but at the end of the studied period all listed banks and Conventional banking group recovered and recorded a modest productivity growth of 1.07579 and 1.09830, respectively, during 2015.

TFP change Index of Islamic banking operations' reports that productivity growth was more dominant relative to Conventional banks during 2012 and 2014 due to progress recorded on those years for Islamic banks in terms of technical efficiency change. Though, TFP change index was found to be higher for Islamic banks but Conventional banks' TFP change index reported a steady increment reporting a productivity progress i.e., more than 1 at the end of the studied period. However, as stated earlier, for both the banking group a 5 years mean reported an overall productivity regress. The reason behind TFP index of Conventional banks to report a regress from 2011 to 2014, plus recording an aggregate mean regress, can be inflicted to its declining technical change index for the same period. This suggests that Conventional banks initially failed to incorporate technological innovation, however, these banks managed to streamline their operation between 2014 and 2015 in order to adapt to the competitive environment as indicated by the progress in technological change index on that same period. In unison to this, this study also finds that Conventional banks' reported yearly progress and also aggregate mean progress on technical efficiency change, pure technical efficiency change and technical change index; and these indices remained relatively higher than Islamic banks over the studied period. Hence, failing to adapt to changing technology is the reason for relative decline or regress of TFP index of Conventional banks. Furthermore, examination of technical efficiency change index with its sub indices - pure technical efficiency change index and scale efficiency change index; and technical change index reveals that the reason behind all listed commercial banks of Bangladesh inclusive of conventional and Islamic banks reporting a TFP regress in some periods are largely inflicted upon by the unadaptability to technical change.

5. CONCLUSION AND POLICY IMPLICATIONS

In this paper, productivity performance of commercial banks in Bangladesh is evaluated by MPI of TFP to make the productivity analysis more meaningful. Evaluation of productivity performance of commercial banks clearly indicate that progress made in TFP was mainly attributed to the increase in efficiency change rather than technological progress. The decomposition of the efficiency change into its pure technical and scale efficiency change components revealed that the source of the increment in banking sector's technical efficiency change was mainly attributed to scale rather than pure technical or managerial. Furthermore, analysis of TFP change index of commercial banks of Bangladesh has exhibited marginal TFP progress attributed mainly to the increase in technical efficiency. Examination of technical efficiency change index with it sub indices including pure technical efficiency change index and scale efficiency change index; and technical change index reveals that the reason behind all listed commercial banks of Bangladesh reporting TFP regress in some periods are largely inflicted upon by the technical change. The probable reason could be that banking sector is failing to keep up a steady pace in adaption of technologically innovative products, services and operations, while growing in terms assets, deposits, financing and also widening their network of branches and operations. This finding is in line with past researches where it is evident that the growing operations need to be supported by the latest technological advancements to enhance the processing efficiency of growing transaction volumes in order to succeed in the era technological diffusion (Sufian, 2010). Furthermore, investments in technology have important ramifications since it could help to

reduce the negative effect of macroeconomic shocks and to utilize its changes to acquire or retain competitive advantage (Žvirblis and Buračas, 2010).

Therefore, this study identified that commercial banks of Bangladesh are falling behind in productivity performance due to their delayed compliance to technological developments whilst financial innovation assisted by technological advancements are globally transforming the role of financial intermediaries by intensifying competition. Hence commercial banks of Bangladesh must respond to technological changes at the pace they are adapted globally by engaging in financial innovation assisted by advancements in technology to offer new financial solutions to customer for better investment opportunities, and returns and risk management, thus helping to maintain their competitive position. Hence technological investments geared towards resilience building, enhancing cost efficiencies and also as a preparatory measure to integrate and coordinate future operations in anticipation of the competitive environment, are emphasized in this study. The researcher believes that, the performance of banks depends on how efficient and productive banks are in a liberalized and competitive financial environment where lots of financial institutions are serving similar functions of intermediation. Hence, it is expected that the policies and directives of Bangladesh Bank would be directed towards enhancing the efficiency and productivity of banks with the aim of achieving major financial goals of profit and shareholders wealth maximization in order to build resilience and retain stability in the country's financial system.

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