Measurement and Decomposition of Productivity Change in Banking: Islamic and Conventional Banks in Pakistan

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The main objective of this paper is to measure and decompose changes in total factor productivity (TFP) and efficiency of banks operating in Pakistan. We apply the intermediation approach to empirically assess the change in productivity and efficiency of banks over the period 2007-2013 and observe whether the TFP and efficiency of banking sector have been increasing or decreasing over time. Specifically, the DEA-based Hicks-Moorsteen TFP index proposed by O'Donnell (2010b) is used to decompose the TFP into technological change, technical efficiency, mix efficiency, and residual scale efficiency. The paper also aims at comparing changes in TFP and efficiency of Islamic banks with that of their conventional counterparts. The estimates suggest that the TFP of both conventional and Islamic banks was on the rise during the period of study. However, we find that the TFP of conventional banks is higher than that of Islamic banks in most of the examined periods. The results also reveal that changes in technology have a significant positive impact on the TFP of both types of banks. Finally, the analysis suggests that scale efficiency has a vital role for efficiency progress in the banking sector. This evidence suggests that Islamic banks would need to increase their size to harvest sustained productivity gains. Growth-oriented polices and large branch network would definitely help Islamic banks to enhance their productivity. Further, government should encourage banks to adopt new cost effective technologies to help the banking industry in overcoming the problems relating to inefficiency and to further increase the productivity. The originality of the paper rests on its various important contributions.

Keywords: TFP; Technical efficiency; Mix efficiency; Residual scale efficiency; Hicks-Moorsteen TFP index; Islamic banks, Pakistan.

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1. Introduction

Productive, well-functioning, and efficient banking sector is considered as the essence of a stable and sound intermediation process.[1] Banks lubricate the channelling of funds from the surplus to deficit part of any economy. Further, they assure the fund availability and facilitate the payment system of the economy. Efficient commercial and investment banks play a vital role in enhancing the effectiveness of monetary policies and hence positively contribute to economic growth of a country. Therefore, it is worthwhile to assess changes in productivity and efficiency of banks. In principle, total factor productivity (TFP) can be decomposed into technical change and efficiency change. The efficiency change is then further disintegrated into three components, namely, technical efficiency, mix efficiency and scale efficiency. Examination of each component and subcomponent of TFP will help understand how, when, and why TFP changes. Further, the comparison of Islamic and conventional banks regarding changes in productivity and efficiency will also enhance our understanding of the role of banking sector in the economy.

Researchers have increasing consensus that financial services provided by financial institutions help attain higher and sustainable economic growth. When we review the literature we find that there are several theories that justify and demonstrate that the presence of financial institutions is significant for any economy. Indeed, some researchers are of the view that an economy cannot work properly without a well-functioning banking system. In the presence of well-functioning banking sector, the economy as a whole becomes more efficient and productive by utilizing scarce resources effectively. Therefore, enhancing efficiency and performance of banking system is one of the core objectives of banking policies across the globe.

Reviewing the empirical literature, we find that several studies have been carried out to gauge and evaluate the performance of banks. In principle, the performance of a bank can be measured in several ways. For instance, it can be measured in term of productivity, profitability, efficiency, credit risk management, liquidity, solvency etc. The studies to evaluate the efficiency of banks can be classified into two groups based on approaches used to carry out the analysis. The first group includes the studies that used traditional financial ratios to assess the performance of

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banks (e.g. Samad, 1999; Bashir, 1999 and Rosly and Bakar, 2003). The second group of studies uses frontier analysis approach to evaluate the performance of banks. This group can further be divided into different categories. The first subcategory includes studies that assess banks' efficiency and productivity by using parametric approach (see, for example, O'Mahony and Timmer, 2009). The second subgroup of studies evaluates efficiency and productivity of banks by using nonparametric Data Envelopment Analysis-based Malmquist index approach. Examples of these studies are Rizvi (2001), Akhter et al. (2005), Percin and Ayan (2006), Akhtar (2010), Sufain (2010), Cox et al. (2013), Casu et al. (2013), Cheng et al. (2013), and Neupane (2013). However, very scant consideration has been given to Hicks-Moorsteen TFP index to measure productivity and efficiency changes in the existing literature. A few studies that appled this method included O'Donnell (2010a, 2012a, 2012b), Epure et al. (2011), Arora and Arora (2012, 2013), and Arjomandi et al. (2012, 2014).

Keeping in view the gap in the existing literature, this paper is an effort to measure the performance of banking sector in Pakistan by analysing its productivity and efficiency progress by adopting Hicks-Moorsteen index. The main reason behind the adoption of Hicks-Moorsteen index is some prevalent inadequacies in the utilization of Malmquist productivity index (MPI). For example, some researchers, such as Grifell-Tatje and Lovell (1995) have argued that under the assumption of variable return to scale, the MPI may not precisely measure changes in productivity. Similarly, some other researchers such as Glass and McKillop (2000), Yoruk and Zaim (2005) and Coelli and Rao (2005) have also argued that there is probability of obtaining infeasible results when the MPI is applied without properly considering underlying assumptions required for the implementation of the MPI. Further, several authors including, *inter alia*, Simar and Wilson (1998), Lovell (2003) and Coelli and Rao (2005) show that the DEA approach for assessing distance functions by using Malmquist indices is problematic. Furthermore, Ray and Desli (1997), Wheelock and Wilson (1999), and O'Donnell (2010b) show that the Malmquist index decomposition proposed by Fare et al. (1994) has no reliability. Last, but not least, Grifell-Tatje and Lovell (1995) and Arjomandi et al. (2012) are of the view that the MPI is likely to yield biased estimations.

To avoid the above-mentioned problems, we use Hicks-Moorsteen productivity index to measure the productively and efficiency of Islamic

and conventional banks in Pakistan. The Hicks-Moorsteen productivity index does not suffer from most of the above-mentioned problems and decomposes productivity into technological change and efficiency change. After measuring the efficiency we decompose efficiency changes into technical efficiency, mix efficiency and residual scale efficiency to determine main components of productivity progress or regress of banks operating in Pakistan. Finally, we do the comparison of Islamic and conventional banks based on estimated changes in productivity and different segments of productivity and efficiency.

Several studies have attempted to compare the performance of Islamic banks with conventional banks in Pakistan. Yet, to the best of our knowledge, none of the studies examines the productivity and efficiency changes in Pakistan's banking sector by using Hicks-Moorsteen total factor productivity index. However, it is important to know whether the total factor productivity of banks is increasing or decreasing over time. It is also worthwhile to explore whether changes in total factor productivity are attributed to changes in technology, relaxing restrictions in banking sector, and/or changes in technical efficiency.

The main objective of this paper is to measure the change in TFP and efficiency of Islamic and conventional banks in Pakistan over the period 2007-2013. The paper contributes to the literature in several aspects. First, it is the first study to use Hicks-Moorsteen TFP index for Pakistan's banking sector. Second, it uses a new linear programming methodology developed by O'Donnell to measure and decompose the TFP into technical change and efficiency change. The efficiency change is then further decomposed into three components: technical efficiency, mix efficiency and scale efficiency. Third, by scrutinizing the different components of change in TFP and efficiency, this paper provides first-hand empirical evidence, which is of a great importance to the regulators and the banks' management for the efficient utilization of available resources and capacities for the enhancement of productivity and efficiency of banking operations. Decomposition analysis of productivity and efficiency allows us to understand more deeply the structure of changes in productivity and efficiency related bank policies.

The rest of the paper is structured as follows. Section 2 presents the review of literature. Empirical framework and data are discussed in Section 3. Section 4 presents the empirical results and their discussion. Finally, Section 5 concludes the paper.

2. Literature Review

Several studies have been carried out to evaluate the performance of banks. Most of them computed the productivity and efficiency change in banking sector without considering price data, by either applying Malmquist productivity index (MPI) or Hicks-Moorsteen productivity index. Further, most of researches who estimated the total factor productivity (TFP) progress of banking sector have used Malmquist productivity index. Several studies including Berg et al. (1992), Worthington (1999), Rizvi (2001),Yeh (2008), Figueira et al. (2009), and Sufain (2010)) have shown the prevalent dominance of the MPI to examine the TFP growth.

Caves et al. (1982) were the first who presented the MPI as a theoretical index. Afterward, Fare et al. (1992) merged the productivity measure developed by Caves et al. (1982) with the measure of efficiency developed by Farrell (1957), and thus developed the MPI which measures changes in productivity. Fare et al. (1992) subsequently demonstrated that the developed TFP index could be easily decomposed into technological and efficiency change. Further, Fare et al. (1994) showed that the efficiency changes could be decomposed into scale efficiency changes, mix efficiency changes and technical efficiency changes. Due to this development, Malmquist index ultimately became the most frequently used index to measure changes in productivity and efficiency.

In spite of the MPI being a dominant approach and its popularity for assessment of productivity changes, pros and cons of the MPI have been widely discussed in the literature. For example, Grifell-Tatjé and Lovell (1995) demonstrated that under the assumption of variable return to scale (VRS), the implementation of MPI does not yield accurate changes in TFP. Therefore, assuming constant return to scale (CRS) becomes imperative for estimation of the MPI. Estimating MPI without assuming the constant return to scale is likely to produce inaccurate measures of the change in TFP.

Ray and Desli (1997) and Wheelock and Wilson (1999) discussed that the MPI decomposition achieved by Fare et al. (1994) had no reliability. Specifically, Ray and Desli (1997) established the importance of implementing CRS technology that indicates the shift in the frontier under CRS, which is expressed by the term technical change, but it may not assess the scale effects at all. Contrary to this, the implementation of variable return to scale (VRS) assumption may not correctly demonstrate

the autonomous frontier shift. Hence, internal consistency problem appears when the same MPI decomposition implies to both CRS and VRS. Thus, Ray and Desli (1997) proposed another decomposition technique, but the problem with such decomposition is that it may not appropriately measure scale efficiency change, which is experienced by a firm/bank between different time periods.

Simar and Wilson (1998) indicated that the model presented by Fare et al. (1994) does not provide a beneficial measurement of technical change and their estimates. They further revealed that all the assessed means of technical change have no significance, whereas "most of the inaccuracies in Fare et al. (1994) are mainly due to their misunderstanding between unknown quantities and evaluations of these quantities". Wheelock and Wilson (1999) expressed that when the location of a firm remains the same in different time periods, then scale efficiency variation is completely attributed to changes in the VRS. However, the imposition of the CRS assumption would indicate no technical change. Under such situations, the CRS evaluation of technology is unreliable.

Coelli and Rao (2005) demonstrated the significance of holding CRS assumption for the estimation of the MPI. Their examination reveals that without the assumption of CRS for calculating the MPI we may not appropriately assess changes in TFP due to economies of scale. Similarly, Epure and Prior (2007) indicated that the popular MPI, which employed as a dominant approach in the literature, is multiplicatively incomplete, and its estimates for TFP change are biased. Further, O'Donnell (2012a) also created ambiguity on the MPI as a measure of TFP index and indicated that except from special cases, it cannot be used as a reliable measure of changes in TFP. O'Donnell's views are also similar to those of Kerstens et al. (2010), who indicated that reliable TFP indices do not include the Malmquist index.

Due to the above mentioned inadequacies prevailing in the estimation of MPI, there is a growing interest of researchers for employing Hicks-Moorsteen productivity index to measure productivity of banks. Examples of these studies are O'Donnell (2010a, 2012a, and 2012b), Epure et al. (2011), Arora and Arora (2012, 2013) and Arjomandi et al. (2012, 2014). Epure et al. (2011) measured the productivity growth of 73 private saving banks functioning in Spain for the period 1998–2006 by employing intermediation approach. Their results show that saving banks functioning outside their original markets, attained higher productivity growth. They further show that at the end of the deregulation increasing trend of TFP

has been observed for the banking sector. In the same way, Arora and Arora (2012) used Hicks-Moorsteen index approach to compare productivity enhancement results for Sate Bank of India group (SBIG) and nationalized banks (NBs). His results indicate that, on average, Indian public sector banks have experienced enhancement in productivity after liberalization. His results further show that with regard to productivity growth, a significant difference exists between SBIG and NBs. NBs experienced higher productivity growth as compare to SBIG, which is mostly due to higher level of technological enhancement in NBs rather than higher level of efficiency.

Similarly, Arora and Arora (2013) measured and decomposed the productivity change in Indian banks by using Hicks-Moorsteen index for post liberalization period. Their results show that Indian banks observed no significant productivity change difference in three sub periods and experienced stagnant productivity over the entire study period. However, considerable differences are observed in term of productivity and efficiency changes in Indian private sector and public sector banks in all sub periods. This implies that ownership of Indian banks have an influence on scale efficiency. Further, Indian banks experienced stagnant productivity mainly due to technological regress. The authors suggested that the focus of policy reforms should be on productivity enhancement.

Using Hicks-Moorsteen index, Arjomandi et al. (2012) investigated the impact of reforms on the efficiency and productivity of Iranian banking industry for the period 2003-2008. They found that overall, TFP declines after the reforms which is mostly attributed to scale efficiency change and changes in the production possibility set. Their results further show that technical efficiency that had improving trend over time has substantially deteriorated after the reforms. Furthermore, they show that private banks become less efficient as compared to public banks after the reforms. Arjomandi et al. (2014) examined the performance of Iranian banking sector by applying intermediation and operating approach. Their results are similar to Arjomandi et al. (2012) when they use intermediation approach, but as they use operating approach, they found that private banks are more technically and mix efficient.

Belanès et al. (2015) examined technical, pure technical, scale efficiency of Islamic banks operating in GCC region. They applied a non-parametric DEA approach on panel data covering the period 2011-2015. They found that the Islamic banks of GCC region are very sensitive to subprime crisis. Specifically, they found that like conventional banks, the

efficiency of Islamic banks declined significantly during the financial crisis. Similarly, Ataei and Naserian (2015) examined the technical efficiency of banks in Tehran by applying the DEA. They found that the average efficiency of 97 branches of a bank operating in Tehran was about 38% in the year 2010, which increased to about 46% in 2011; again, it declined to about 36% in the year 2012.

Khan and Khattak (2016) investigated the three different types of efficiency (technical, pure technical, and scale) of 32 Pakistani commercial banks for the year 2009. They measured these efficiencies by implementing non-parametric Data Envelopment Analysis. They found that the commercial banks in Pakistan are operating at about 93% level of technical efficiency. They also documented that 4% technical inefficiency was caused by scale size, whereas the remaining 3% technical inefficiency was the result of the managerial inefficiency. Fan (2016) examined efficiency changes and differences for three types of Chinese banks, after the recent financial crisis. He applied two different methods, namely, DEA and super efficiency DEA method. He found that the efficiency of all kinds of Chinese banks is on the rise. He also found that the growth of technical efficiency is due to improvement in scale efficiency only. Further, he found that state-owned banks having comparative advantage in technology have shown improvements in scale efficiency and started to catch up with other banks. Yet, he showed that commercial banks operating in cities appeared more efficient by dint of system advantages. Ali (2016) examined the determinants of pure technical efficiency of Islamic and conventional banks operating in MENA, East Asia and Pacific, South Asia, and Europe and Central Asia. He found that banks operating in developed and democratic countries are relatively more efficient. He also documented that the determinants of efficiency of Islamic and conventional banks vary across banks functioning in Muslim and non-Muslim countries.

3. Empirical Framework and Data

3.1 Estimation Method

Following the previous studies such as Jorgenson and Grilliches (1967) and O'Donnell (2010), in this paper, we define the total factor productivity (TFP) as $TFP_{nt} = Q_{nt}/X_{nt}$, where TFP_{nt} denotes the TFP of bank 'n' in period t, $Q_{nt} = Q(q_{nt})$ denotes an aggregate output, and $X_{nt} = X(x_{nt})$ indicates aggregate input. Same equation may be used for another bank

'm' in period 's'. The index number which relates the TFP of bank 'n' in period 't' with the TFP of bank 'm' in period 's' is defined as

$$TFP_{ms,nt} = \frac{TFP_{nt}}{TFP_{nt}} = \frac{Q_{nt}/X_{nt}}{Q_{ms}/X_{ms}} = \frac{Q_{nt}/Q_{ms}}{X_{nt}/X_{ms}}$$

where $Q_{ms,nt} = Q_{nt}/Q_{ms}$ and $X_{ms,nt} = X_{nt}/X_{ms}$ are output and input quantity index, respectively. This definition allows us to define the index number that measures TFP changes as the ratio of an output to an input quantity index. The Hicks-Moorsteen TFP proved by O' Donnell (2008) is the only well-known and well-accepted index that is consistent with the abovementioned definition and can be calculated without price data.

Specifically, the Hicks-Moorsteen TFP index can be described as follows:

$$TFP^{HM}_{ms,nt} = \left(\frac{D^t_o(x_{nt},q_{nt})\ D^s_o(x_{ms},q_{nt})}{D^t_o(x_{nt},q_{ms})\ D^s_o(x_{ms},q_{ms})} \times \frac{D^t_I(x_{ms},q_{nt}) D^s_I(x_{ms},q_{ms})}{D^t_I(x_{nt},q_{ms})\ D^s_I(x_{nt},q_{ms})} \right)^{1/2}$$

where $D^T_o(x,q) = min\ (\delta > 0: (x,q/\delta) \in P^T)$ represents output distance function, $D^T_I(x,q) = max\ (p > 0: (x/p,q) \in P^T)$ denotes input distance function, and P^T represents the period-T production possibilities set. We adopted the non-parametric DEA method proposed by O'Donnell and empirically implemented by Arora and Arora (2012, 2013) and Arjomandi et al. (2012, 2014) to compute these distance functions. The DEA being a nonparametric method does not require any assumption concerning the behaviour of banks and efficiency dissemination.

O'Donnell (2010b) demonstrated that the overall production efficiency of a bank is described as the ratio of observed TFP to maximum TFP that is achieved by utilizing the technology available in time t. Hence, the TFP efficiency (TFPE) of bank 'n' in period t can be described as:

$$TFPE_t = \frac{TFP_{nt}}{TFP_t^*} = \frac{Q_{nt}/X_{nt}}{Q^*_{nt}/X^*_{nt}}$$

Where TFP_t^* represents the maximum TFP and Q^*_{nt} and X^*_{nt} represents maximum point of aggregate output and input, respectively. O'Donnell (2010b) shows that various efficiency measures can be used for decomposition of TFP efficiency. Specifically, the TFP efficiency decomposition can be done as below:

$$TFPE_{nt} = \frac{TFP_{nt}}{TFP_t^*} = OTE_{nt} \times OME_{nt} \times ROSE_{nt}$$

This can be simplified as follows.

$$TFP_{nt} = TFP_t^* \times OTE_{nt} \times OME_{nt} \times ROSE_{nt}$$

Where OTE_{nt}, OME_{nt} *and* $ROSE_{nt}$ represent the output-oriented pure technical efficiency, output-oriented mix efficiency, and the residual oriented scale efficiency, respectively, while OTE_{nt} determines growth in TFP. The growth of TFP can be achieved by keeping input mix, output mix, and output level fixed. OME_{nt} shows the growth in TFP due to relaxing restrictions on output mix while keeping input fixed. Finally, $ROSE_{nt}$ (Residual Oriented Scale Efficiency) determines the growth in TFP due to movement of a bank from technically efficient point to possible maximum productivity point on production frontier.

An identical equation may be held for another bank like bank m in period s. Then, the index quantity, which relates the TFP of bank 'n' in period t with the TFP of bank 'm' in period s, is defined as:

$$TFP_{ms,nt} = \frac{TFP_{nt}}{TFP_{ms}} = \left(\frac{TFP_t^*}{TFP_s^*}\right)\left(\frac{OTE_{nt}}{OTE_{ms}} \times \frac{OTE_{nt}}{OME_{ms}} \times \frac{ROSE_{nt}}{ROSE_{ms}}\right)$$

The first parenthesis on the right-hand side of the above equation describes the technical change since the time period s to t, measuring the differences of the maximum TFP by using the available technology in periods t and s respectively, contingent on whether TFP_t^* / TFP_s^* is less than or greater than one. Through this equation, we can measure the technical decline or technical improvement. The terms in the second parenthesis on the right-hand side measure technical efficiency, mix efficiency, and residual scale efficiency change, respectively.

3.2 Data and Sample

There is no harmony among the researchers as how to specify inputs and outputs for financial institutions. However, to define inputs and outputs, mainly three approaches are used in the literature (Arjomandi et al, 2012; 2014), Sufian (2007), Giokas (2008), and Akhtar 2010). These approaches are production approach, operating approach and intermediation approach. In this study, we employ intermediation approach in which banks are regarded as an intermediary for financial services. The value of loans and securities are measured as output, whereas capital, labour, and deposits are

considered as inputs. This approach, proposed by Sealey and Lindley (1977), has been used by many researchers (Wheelock and Wilson, 1999; Sufian, 2007; Akhtar 2010; Sufian and Habibullah, 2010; and Arjomandi et al; 2012). It includes three inputs and three outputs. The first input is labour that is defined as the number of fulltime employees on payroll at the end of each period. The second input is physical capital, which we measured as the book value of premises and fixed assets. The third input is the amount of acquired funds that we define as the sum of borrowed funds, time, and saving deposits. Three outputs used in the analysis include demand deposits, public sector organisations loans, where we consider loans for agriculture, manufacturing, mining and services, and finally private loans.

The data on required variables are obtained from banks' annual reports. All the amounts used for inputs and outputs are in thousand rupees. This study covers the period 2007-2013. The selection of banks and time period depended upon the availability of data. Our sample includes 4 Islamic banks and 20 conventional banks operating in Pakistan. We use the software named DPIN developed by O'Donnell (2010b) for carrying out the empirical analysis.

4. Empirical Results

We estimate total factor productivity and its components by assuming variable returns to scale for all banks, Islamic banks, and their conventional peers. Changes in TFP, technical change, and changes in efficiency are estimated for full sample as well as for both groups of banks separately. Changes in efficiency are further divided into three components, namely i) output-oriented technical efficiency change; ii) output-oriented mix efficiency change; and iii) the residual scale efficiency change. The estimates are given in Table 1. The estimated values greater than 1 depict an improvement in productivity, whereas, the values less than 1 indicate deterioration in productivity during the period of study. The results given in the table suggest that Islamic banks experienced TFP deterioration in 2008/2007, which is mainly attributed to technological regress during that period. This piece of evidence suggests that the productivity of Islamic banks is negatively affected by the financial crisis 2007-08. However, the results also reveal that TFPE of Islamic banks increased by about 3.2 per cent during the period 2008/2007, which is mainly due to improvements in ROSE.

Quite opposite to the case of Islamic banks, conventional banks show a significant progress in TFP. This progress is mainly attributed to technological improvements. On the other hand, the results indicate that TFPE of conventional banks deteriorated in 2008/2007. The estimates for the period 2009/2008 indicate that technological regress is one of the major reasons behind TFP shortfall in Islamic banks as well as in the case of their conventional counterparts. Nevertheless, the results suggest that ROSE progress leads TFPE progress of both streams of banks; yet, the progress of TFPE does not offset the adverse effect of technological regress. The possible reason as to why conventional banks appear more productive than Islamic banks is that conventional banks have better professionals and well-trained staff, which help efficient utilization of resources and effective management of deposits. Further, conventional banks are less obliged to obey regulatory guidelines for the management of inputs and outputs in the banking system and in the lending process. Finally, conventional banks are generally large in size and thus, they may harvest benefits of economies of scale.

The score of changes in TFPE reveals that there is generally a decline in the efficiency during the period 2010/2009, which is mainly due to declines in ROSE. The results show that Islamic banks are 4.72 per cent, whereas, conventional banks are 11.58 per cent less efficient. However, the progress observed in the productivity is mainly attributed to a significant technological progress, and it offsets the effect of regress in efficiency. Once again, in 2011/2010, the estimates of the change in TFPE indicate that there is a regress in the efficiency change, which is mainly attributed to a sharp decline in ROSE. Specifically, Islamic banks are 15.29 per cent and conventional banks are 2.68 per cent less efficient. From the table, we can observe technological progress over the period in both streams of banking. The technological progress of conventional banks offsets the adverse effect of efficiency regress, and overall, there is considerable growth in their productivity over the time. Contrary to this, the technological progress in Islamic banks does not offset the effect of efficiency regress, and as a whole, the productivity of Islamic banks declined during the examined period. Yet, the estimates for the year 2012/2011 indicate a significant positive technological progress as well as efficiency progress in Islamic banks, which ultimately indicates a considerable progress in the productivity of Islamic banks. The values given in the table also indicate that conventional banks observed huge technological progress, in particular, nearly 11.12 per cent over 2012/2011, which offsets the efficiency regress of 5.14 per cent.

The values of TFPE change reveal that overall there is a substantial efficiency progress for Islamic banks during the study period. Specifically, Islamic banks exhibited about 22.83 per cent efficiency progress during the year 2013/2012. However, the conventional banks experienced about 1.45 per cent efficiency regress during the same period. As regards technological progress, both Islamic and conventional banks showed technological progress over the year, which, in turn, indicates productivity progress for both types of bank. However, Islamic banks showed more productivity progress, about 27 per cent as compared to their conventional counterparts, showing only 0.14 per cent productivity growth during the same period. This evidence suggests that Islamic banks appear more productive in the year 2013/2012 compared to their conventional peers. The overall banking sector also showed a significant progress in TFPE (10.44 per cent) in 2013/2012. Similarly, there is a rise in total factor productivity over the examined period. It was 1.34 per cent in 2008/2007, which increased to 13.57 per cent in 2013/2012.

Table 1: Changes in Total Factor Productivity and its components assuming VRS

Financial Institutions	Period	dTFP	dTech	dTFPE	dOTE	dOME	dROSE
Islamic Banks	2008/2007	0.9840	0.9528	1.0328	1.000	1.000	1.0328
	2009/2008	0.9790	0.8617	1.1361	1.000	1.000	1.1361
	2010/2009	1.0564	1.1088	0.9528	1.000	1.000	0.9528
	2011/2010	0.9862	1.1642	0.8471	1.000	1.000	0.8471
	2012/2011	1.0705	1.0131	1.0566	1.000	1.000	1.0566
	2013/2012	1.2700	1.0339	1.2283	1.000	1.000	1.2283
Conventional Banks	2008/2007	1.0427	1.0872	0.9591	1.000	1.000	0.9591
	2009/2008	0.9937	0.9864	1.0074	1.000	1.000	1.0074
	2010/2009	1.1309	1.2790	0.8842	1.000	1.000	0.8842
	2011/2010	1.0269	1.0545	0.9738	1.000	1.000	0.9738
	2012/2011	1.0542	1.1112	0.9486	1.000	1.000	0.9486
	2013/2012	1.0014	1.0213	0.9805	1.000	1.000	0.9805
All Banks	2008/2007	1.0134	1.0200	0.9960	1.000	1.000	0.9960
	2009/2008	0.9864	0.9241	1.0718	1.000	1.000	1.0718
	2010/2009	1.0937	1.1939	0.9185	1.000	1.000	0.9185
	2011/2010	1.0066	1.1094	0.9105	1.000	1.000	0.9105
	2012/2011	1.0624	1.0622	1.0026	1.000	1.000	1.0026
	2013/2012	1.1357	1.0276	1.1044	1.000	1.000	1.1044

Note: dTFP = change in total factor productivity, dTech = change in technology, dTFPE = change in total factor productivity efficiency, dOTE = change in output-oriented technical efficiency, dOME = change in output-oriented mix efficiency, and dROSE = change in residual-oriented scale efficiency.

Our results also suggest that Islamic banks had been less productive during the years 2008/2007, 2009/2008, and 2011/2010. However, there is a clear evidence of Islamic banks showing productivity growth in the years 2010/2009, 2012/2011, and 2013/2012. One of the interesting finding is that Islamic banks showed more productivity growth in 2012/2011 and 2013/2012 compared to their conventional counterparts. It has also been observed that conventional banks exhibited a considerable growth in productivity during the period of study, except the period 2009/2008, in which, they showed decline in productivity. Further, year-to-year comparison suggests that conventional banks are more productive as compared to Islamic banks over the examined period. Our findings regarding productivity of Islamic and conventional banks are consistent with previous empirical work of Samad (1999), who found the similar results for Malaysian banks.

Based on empirical analysis, we can say that banking industry showed a significant productivity growth during the examined period, except the year 2009/2008 in which it experienced productivity regress. This regress is mainly attributed to technological regress during 2009/2008. In case of Islamic banks, technical inefficiency was 13.83 per cent, whereas, during the same period, conventional banks were only 1.36 per cent technically inefficient. This implies that during the period of 2009/2008, both types of banks were managerially inefficient in utilizing available resources to the optimum level. Improvements in the productivity of both Islamic and conventional banks may be partly attributed to improvement in the central bank regulations and government policies. It may also be noted that with the passage of time, staff of both Islamic and conventional banks is better and increasingly trained and professional efficiently utilizing their resources, which, in turn, leads to increase in the productivity and efficiency of banks.

These findings are consistent with the findings of Casu et al. (2013), Arora and Arora (2012), Akthar (2010), Sufain (2008), Figueria et al. (2009), Sufain (2008), Zaho et al. (2008) and Chen (2005). These results indicate that the main reason behind the productivity growth is technological progress. In most of the examined periods, the progress in productivity has been observed and it appears that the important

component behind this progress is technological progress. This finding is consistent with the existing literature including Casu et al. (2013), Arora and Arora (2012), Akthar (2010), Figueria et al. (2009), Sufain (2008), Zaho et al. (2008) and Chen (2005). In particular, these studies documented similar results for Indian, Malaysian, Saudi Arabian and European banks. Our results also suggest that there is a considerable expansion of efficiency frontier, which can be attributed to technological advancement in banking industry that may include increasing number of automated teller machines, credit cards, debit cards, online branches, etc.

5. Summary and Conclusion

We have applied intermediation approach to empirically assess the change in productivity and efficiency of banks in Pakistan over the period 2007-2013. For this, we used the DEA-based Hicks-Moorsteen TFP index decomposition method proposed by O'Donnell (2010b). The main advantage of this approach, which makes it superior, compared to the MPI, is that it does not require any restrictive assumptions regarding behaviour of banks, market structure and return to scale in multiple output and input case. Decompositions allow a broad understanding of change in productivity and related policies.

The main findings are summarized here. First, in general, the TFP of banks is on the rise during the period of study. Second, although both types of banks show progress in TFP, the positive change in TFP of conventional banks is greater than that of Islamic banks. Third, our results reveal that changes in technology have a significant positive impact on TFP. This finding holds for both Islamic and conventional banks. Finally, there is a significant role of scale efficiency in enhancing the TFP of Islamic banks.

Our analysis reveals that there is an increasing trend in the TFP progress for both Islamic and conventional banks during the study period. The results also suggest that scale efficiency has a vital role behind efficiency progress in the banking sector. Therefore, Islamic banks would need to increase their size to reap sustained productivity gains. Growth-oriented polices and large branch network would definitely help Islamic banks to enhance their productivity. Further, government should encourage banks to adopt new cost effective technologies to help the banking industry in overcoming the problem relating to inefficiency and to further increase the productivity.

The findings of this paper contribute to the existing literature on measurement and decomposition of changes in TFP and efficiency of Islamic and conventional banks in Pakistan. Further, the paper extends our existing knowledge of the operating performance of both types of banks. The findings of the paper are of significance to bank managers and the policymakers to design policies in order to make efficient allocation of available resources, attain optimum utilization of available capacities, enhance managerial skills, expand the size of business to reap sustained productivity gains, improve sustainable competitiveness, and achieve the banks' most productive scale of operation. Productivity improvement in financial institutions has two essential components: technical enhancement and efficiency progress. Technical enhancement represents the expansion in the production possibilities set, which is initiated by adopting new / innovated technology. On the other hand, efficiency progress represents the progress in input-output ratios. Banks can achieve such progress by minimizing or fully avoiding the inaccuracies in production process by providing effective training to both works and managers.

The focus of this paper is entirely on measuring and decomposing the change in productivity and efficiency of Islamic and conventional banks. However, it could be extended in a verity of ways. First, one can extend our analysis by examining the determinants of the change in TFP and changes in each component of efficiency change. We have considered only full-fledged Islamic banks versus conventional banks. Yet, examination of changes in TFP and efficiency for Islamic stand-alone branches and windows would definitely help enhance understanding of the role of different types of efficiencies in TFP change. The scope of paper could also be extended to measuring and exploring the interlinkages between cost efficiency, allocative efficiency and economic efficiency. Considering all financial institutions could also further extend the scope of this paper. Our paper can also be replicated on branch level data to see which specific branch is utilizing more efficiently the available resources. Finally, investigation of changes in TFP and efficiency based on quarterly data could be another extension of the paper.

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References

Akhtar, M. H. (2010). Are Saudi banks productive and efficient? *International Journal of Islamic and Middle Eastern Finance and Management, 3*(2), 95-112.

Akhtar, M. H., Bokhari, H., & Director, J. J. (2005). X-efficiency analysis of commercial banks in Pakistan: A preliminary Investigation. *European Journal of Scientific Research, 10*(2), 78-91.

Arjomandi, A., Harvie, C., & Valadkhani, A. (2012). An emperical analysis of Iran's banking performance. *Studies in Economics and Finance, 29*(4), 287-300.

Arjomandi, A., Valadkhani, A., & O'Brien, M. (2014). Analysing banks' intermediation and operational performance using the Hicks-Moorsteen TFP index: The case of Iran. *Resarch in International Business and Finance, 30*, 111-125.

Arora, H., & Arora, p. (2012). Bank productivity measurement using Hicks-Moorsteen indices: Evidence from Indian public sector banks. *International Journal of Business Performance Management, 13*(3), 386-407.

Arora, H., & Arora, P. (2013). Measuring and decomposing productivity change using Hicks-Moorsteen index numbers: Evidence from Indian banks. *International Journal of Productivity and Quality Managment, 11*(1), 73-95.

Ataei, M., & Naserian, S. (2015). An Assessment Study on the Efficiency of Banks through Data Envelopment Analysis (DEA). Case Study: A Bank Based in Tehran. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, *5*(4), 105-110.

Bashir, A. H. (1999). Risk and profitability measure in Islamic banks: The case of two Sudanese banks. *Islamic Economic Studies, 6*(2), 1-24.

Belanès, A., Ftiti, Z., & Regaïeg, R. (2015). What can we learn about Islamic banks efficiency under the subprime crisis? Evidence from GCC Region. *Pacific-Basin Finance Journal*, *33(6)*, 81-92.

Berg, S. A., Forsund, F. R., & Jansen, E. S. (1992). Malmaquist indices of productivity growth during the deregulation of Norwegian banking, 1980-1989. *Scandinavian Journal of Economics, 94*, 211-228.

Casu, B., Ferrari, A., & Zhao, T. (2013). Regulatory reform and productivity change in Indian banking. *Review of Economics and Statistics, 95*(3), 1066-1077.

Caves, D. W., Christensen, L. R., & Diewert , W. E. (1982). The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity. *Journal of the Econometric Society, 50*(6), 1393-1414.

Chen, T. Y. (2005). A measurement of Taiwan's bank efficiency and productivity change during the Asian financial crisis. *International Journal of Services and Management, 6*(6), 525-543.

Cheng, H., Lu, Y. C., & Mukashev, U. (2013). Productivity of the banking sector: A case study in Kyrgyz Republic. *Innovative Computing Technology (INTECH), 2013 Third International Conference on*, 173-180.

Coelli, T. J., & Rao, D. S. (2005). Total factor productivity growth in agriculture: A Malmquist index analysis of 93 countries, 1980-2000. *Agriculture Economics, 32*(1), 115-134.

Cox, J., Ghulam, Y., & Jaffry, S. (2013). Trends in efficiency in response to regulatory reforms: The case of Indian and Pakistani commercial banks. *European Journal of Operational Research, 226*(1), 122-131.

Epure, M. and Prior, D. (2007).Strategic paths and productivity in the Spanish savings banks: in improving business reporting: new rules, new opportunities, new trends. Giuffre Editore, Milano, ISBN: 88-14-13580-0, Chapter 25, 661-689.

Epure, M., Kerstens, K., & Prior, D. (2011). Technology-based total factor productivity and benchmarking: New proposals and an application. *Omega-international Journal of Management Science, 39*(6), 608-619.

Fan, X. (2016). Efficiency research of Chinese commercial banks based on super-efficiency DEA method. *American Journal of Industrial and Business Management*, 6(1), 526-534.

Fare, R., & Grosskopf, S. (1992). Malmquist productivity indexes and Fisher ideal indexes. *The Economic Journal, 102*(410), 158-160.

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

Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society, 120*(3), 253-290.

Figueira, C., Nellis, J., & Parker, D. (2009). Banking performance and technological change in non-core EU countries: A study of Spain and Portugal. *Studies in Economics and Finance, 26*(3), 155-170.

Giokas, D. I. (2008). Assessing the efficiency in operations of a large Greek bank branch network adopting different economic behaviors. *Economic Modelling, 25*(3), 559-574.

Glass, J. C., & McKillop, D. G. (2000). A post deregulation analysis of the sources of productivity growth in UK building societies. *Manchester School, 68*(3), 360-385.

Grifell-Tatje, E., & Lovell, C. A. (1995). A note on the Malmquist productivity index. *Economics Letters, 47*(2), 75-169.

Grifell-Tatjé, E., & Lovell, C. K. (1997). The sources of productivity change in Spanish banking. *European Journal of Operational Research, 98*(2), 364-380.

Haque, A., & Tariq, A. (2012). Efficiency of banks in Pakistan: A non parametric approach. *Business and Economic Research, 2*(1), 1-12.

Hayek, Ali (2016) *An evaluation of Islamic versus conventional banks' efficiency: A global study.* Doctoral thesis, University of Huddersfield.

Kerstens, K., Hachem, B. A., & Woestyne , I. V. (2010). Malmquist and Hicks-Moorsteen Productivity Indices: An Empirical Comparison Focusing on Infeasibilities.

King, R. G., & Levine, R. (1993). Finance, entrepreneurship and growth. *Jouranl of monetary Economics, 32*(3), 513-542.

Khan, F. U., & Khattak, B. K. (2016). An empirical investigation of commercial banks' efficiency in Pakistan: A non parametric data envelopment approach. *Gomal University Journal of Research*, *32*(1), 21-32.

Lovell, C. A. (2003). The decomposition of Malmquist productivity index. *Journal of Productivity Analysis, 20*(3), 437-458.

Neupane, B. (2013). Efficiency and Productivity of Commercial Banks in Nepal: A Malmquist Index Approach. *Asian Journal of Finance & Accounting, 5*(2), 220-243.

O'Donnell, C. J. (2010a). Measuring and decomposing agricultural productivity and profitability change. *Australian Journal of Agricultural and Resource Economics, 54*(4), 527-560.

O'Donnell, C. J. (2010b). DPIN version 1.0: A program for decomposing productivity index numbers. Working Paper. Center for Efficiency and Productivity analysis, university of Queensland.

O'Donnell, C. J. (2012a). An aggregate quantity framework for measuring and decomposing productivity change. *Journal of Productivity Analysis, 38*(3), 255-272.

O'Donnell, C. J. (2012b). Nonparametric estimates of the components of productivity and profitability change in U.S. agriculture. *American Journal of Agricultural Economics, 94*(4), 873-890.

O'Mahony, M. and Timmer, M.P. (2009). Output, input and productivity measures at the industry level: the EU KLEMS database. *Economic Journal*, *119*(538), 374-403.

Percin, S., & Ayan, T. Y. (2006). Measuring efficiency of commercial banks in developing economy: The case of Turkey. *Investment Management and Financial Innovation, 3*(2), 217-231.

Ray, S. C., &Desli, E. (1997). Productivity growth, technical progress, and efficiency change in Industrialized countries: Comment. *The American Economic Review, 87*(5), 1033-1039.

Rizvi, S. F. (2001). Post-liberalisation efficiency and productivity of the banking sector in Pakistan. *The Pakistan Development Review, 40*(4), 605-632.

Rosly, S. A., & Bakar, M. A. (2003). Performance of Islamic and mainstream banks in Malaysia. *International Journal of Social Economics, 30*(12), 1249-1265.

Samad, A. (1999). Comparative efficency of the Islamic banks vis-a-vis conventional banks in Malaysia. *IIUM Journal of Economics and Finance, 7*(1), 1-27.

Sealey, C. W., & Lindley, J. (1977). Inputs, outputs and a thorey fo production and cost at depository financial institutions. *Journal of Finance, 32*(4), 1251-1266.

Simar, L., & Wilson, P. W. (1998). Sensitivity analysis of efficiency scores: How to bootstrap in nonparametric frontier models. *Management Science, 44*(1), 49-61.

Sufian, F. (2007). Determinants of bank efficiency during unstable macroeconomic environment: Empirical evidence from Malaysia. *Research in International Business and Finance, 23*(1), 54-77.

Sufian, F. (2008). Revenue shifts and non-bank financial institutions' productivity: Empirical evidence from Malaysia. *Studies in Economics and Finance, 25*(2), 76-92.

Sufian, F. (2010). Productivity, efficiency and technological change in banking: Empirical evidence from the Chinese banking sector.

International Journal of Economics and Business Research, 2(5), 427-445.

Sufian, F., & Habibullah, M. S. (2010). Does forign banks entry fosters bank efficiency? Emperical evidence from Malaysia. *Inzinerine Ekonomika-Engineering Economics, 21*(5), 464-474.

Wheelock, D. C., & Wilson, P. W. (1999). Technical progress, inefficency, and productivity change in U.S. banking,1984-1993. *Journal of Money, Credit, and Banking, 31*(2), 212-234.

Yeh, T. L. (2008). Efficiency and productivity growth in Taiwanese banking. *International Journal of Financial Services Management, 3*(3), 269-282.

Yoruk, B. K., & Zaim, O. (2005). Productivity growth in OECD countries: A comparison with Malmquist indices. *Journal of Comparative Economics, 33*(2), 401-420.

Zhao, T., Casu, B., & Ferrari, A. (2008). Deregulation and productivity growth: A study of the Indian commercial banking industry. *International Journal of Business Performance Management, 10*(4), 318-343.