An Empirical Analysis of Productivity Changes in the Ethiopian Commercial Banks:

Using DEA- Based Malmquist Productivity Index Approach

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Abstract

The rationale of this paper is to measure the productivity change of commercial banks in Ethiopia based on DEA-based Malmquist productivity index approach. For this purpose, this study employed a balanced panel data of eight commercial banks operating from 2006 to 2017. The result shows that the banks under study were found to have reported a slight productivity progress of 0.4% over the whole study period. The productivity improvement is accredited to the technological progress (0.9%) rather than the efficiency loss (0.5%). Meanwhile, the finding suggests that the decline in the technical efficiency of the banks was caused both by pure technical efficiency and scale efficiency. Alternatively, the finding of the study indicates that the productivity performance of all the banks under study, with the exception of AIB and CBE, remain almost constant in spite of their size during the period. AIB and CBE have exhibit an average productivity progress of 2% and 1.4% respectively during the study period. In the study period, AIB was found to be the most inefficient (2.4%) and the most productive one (2%) comparing to other banks in the study due to retrogress in scale efficiency change (2.1%) as well as technical progress (4.5%) in that order. Further, the paper suggests that the productivity performance of the banks under study was not significantly different in the period. So, the banks have to move forwards their technology to increase productivity more and more, while improving the resource utilization efficiency by up grading their managerial practices and scale operations (optimum size).

Keywords: commercial banks, productivity change, malmquist productivity index, DEA, Ethiopia

1. Introduction

The existence of a well organized financial system is vital for the economic development of any country. The financial system is a set of interrelated subsystems that facilitates the exchange of money between lenders and borrowers (Belda, 2016). The major financial institutions operating in Ethiopia are Banks, insurance companies and microfinance institutions. By the end of the year 2017, the number of banks, insurance companies, and microfinance institutions reached 18, 17, and 35 respectively. Concerning the development of the financial sector, Ethiopia has made a remarkable progress. Banking is a rapidly growing sector in the country especially after 1991(that is after the demise of the socialist regime) the banking sector achieved significant growth with the entry of private banks. The commercial banking system dominates the financial sector in Ethiopia (Mengistu, 2015). Now a day, there are about 17 commercial banks in the country, out of which 1 is public owned while the remaining 16 is private-owned banks. The total branch network of the banks reached 4757 showing a growth rate of 12%. Consequently, the bank branch to population ratio stood at 1:20,286.5 people in 2017/18 which is better than that of 2016/17 that was 1:22,164 people where the share of private banks and public bank accounts for 68.8% and 31.2% correspondingly. Moreover, the Total capital of the banking industry increased by 10 percent and reached Birr 85.8 billion by the end of June 2018 of which the share of private banks, as well as public banks, stood at 39.9% and 60.1% respectively. Total resources mobilized by the banks in the form of deposit, borrowing, and loan collection increased by 27.7 percent and reached Birr 298.2 billion at the end of 2017/18. The bank's deposit mobilization capability was increased by 26.6%. The share of private banks in deposit mobilization was improved to 37.8% while 62% of the total deposits

were mobilized by the single public commercial bank. Besides, banks' loan collection reached Birr 111.6 billion (grown at a rate of 14.9% per anum) of which 58.8% was collected by the private banks while the remaining amount was collected by the public bank. In addition, the total outstanding credit of the banks was raised by 22.8% and reached Birr 449 billion at the end of June 2018 (NBE, 2017/18).

With this fact, the government of Ethiopia expects a lot from the banks to take part in their role in transforming the country's economy. The government is aiming at having a country of a lower-middle-income economy by 2025 (NBE, 2010). For the sake of achieving this ambitious objective, several plans and programs have been put in place. The five-years growth and transformation plan is one; where the first five years growth and transformation plan ended in 2015 while the second one is in action since 2016. Consequently, various huge projects which demand a large number of financial resources are carrying out throughout the nation by individual investors (Ethiopians and foreigners) and by the government. In this case, the role of the Ethiopian commercial banks in financing these projects is irreplaceable while they are still required to perform well. In other words, the banks must, among others, improve their productivity in order to supply the required services. As a result, this paper intends to measure the productivity change of commercial banks in Ethiopia during 2006 to 2017. The rational to choose this time period is due to; 1) the World Bank report in 2016/17 which says Ethiopia is one of the fastest-growing economies in the world registering an average growth of 10% for the last decade where the banks contribution is immense and 2) the Ethiopian Central Statistical Authority (ECSA) annual report in 2016/17 that indicates the performance of the banking sector is increasing constantly.

The rest of the paper is organized as follows: Section two discusses the literature review while section three explains the data and methodological framework of the study. Besides, section four as well as section five shows results, and conclusion and recommendation respectively.

2. Literature Review

This section deals with the review of previous studies related to the productivity change of commercial banks. The following studies could be a source of help in supporting the results of this paper.

Isik et al. (2016) measured the productivity change of the commercial banks in the middle-east economies with the case of Jordan by using data envelopment analysis and input-oriented Malmquist productivity index. As a result, the findings indicated that the overall technological change under the production (intermediation) model was 0% (0.7%) for commercial banks, 1.8% (4.3%) for investment banks and -4.7% (-2.7%) for Islamic banks while the overall technical efficiency change under the production (intermediation) model was 6.5% (1%) for commercial banks, 1.8% (2.8%) for investment banks and -9% (-5%) for Islamic banks. Moreover, the results confirmed that commercial banks dominated other banks in terms of productivity growth and efficiency change in general. Jreisat and Hassan (2016) measured the productivity growth of commercial banks in Egypt based on secondary data collected from a sample of fourteen commercial banks from 1997 to 2013 by employing data envelopment analysis based Malmquist productivity index. Consequently, the findings of the study comprehended that the productivity growth of the Egyptian banks was declined over the whole study period at the rate of 2.55%.

Baten et al (2015) analyzed the efficiency and total factor productivity changes of the banking sector in Bangladesh based on secondary data using the Malmquist based data envelopment analysis method. The findings revealed that state-owned banks registered the highest cost inefficiency and profit efficiency in comparison to the private banks. Moreover, the average technical and allocative efficiency is found to be 75.4% and 35.9%, and 74.0% and 31.8% for the cost DEA and the profit DEA respectively. Meanwhile, the results of the study indicated that on an average bank-wise and year-wise productivity change, efficiency change, and efficiency change are found higher by profit DEA than cost DEA where the average cost and average profit efficiency is observed at 28.7% and 24.2% respectively. In addition, the bank-wise average productivity change and efficiency change have decreased at 4.2% and 5.1% respectively whereas the efficiency change has increased at 0.9% in profit DEA while all the bank-wise productivity change and efficiency change and efficiency change registered regress at 8.4%, 6.2% and 1.8% respectively in cost DEA.

Muvingi and Hotera (2015) evaluated the technical efficiency and total factor productivity of the banking industry in Zimbabwe based on panel data of ten commercial banks from 2002 to 2012 using data envelopment analysis. The findings showed that the banks registered average technical efficiency with values 70.95% and 81.5% correspondingly in line with the Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) assumptions. Meanwhile, the banks were found to score an average scale efficiency of 73.7% per annum. Besides, the statistical analysis showed that the total factor productivity of the banks was progressed at a rate of 13.8% for the study period. Overall, the findings indicated that these banks recorded the highest and lowest productivity growth in 2009 and

2005 at a rate of 0.1% and -52% correspondingly. Chansarn (2014) studied the productivity change of the Thai banks using the growth accounting equation. For the purpose of data analysis, secondary data were gathered from fourteen Thai banks that were functioning over the whole period of 2000 – 2009. The findings of the study seemed to suggest that the banks' productivity was observed to be low and unpredictable during the period of study; the banks registered an average productivity change of -13.35% to 10.06%. Moreover, the result indicated that average negative productivity growth was recorded by most of the Thai banks.

Thayaparan and Pratheepan (2014) examined the productivity change of the Sri Lankan banking sector over the period of 2009 – 2012 by employing output-oriented data envelopment analysis approach. The findings indicated that the productivity performance of all the banks had decreased as a result of technical deterioration in the study period. Further, the analysis showed that the impact of technical change on the productivity of the Sri Lankan banking industry was high as compared to efficiency change. Meanwhile, the findings comprehended that the efficiency of private-owned banks was larger than their counterparts. Munteanu *et al.* (2013) analyzed the productivity growth of commercial banks in Romania during 2006 to 2011 using data envelopment analysis. The results showed that the banks separately experienced inconsistent efficiency growth whereas the overall movement of productivity growth of these banks was declining. Also, the findings of the study witnessed that the efficiency change of the nondomestic banks was higher in comparison to the Romanian established banks.

Raphael (2013) researched the productivity change of commercial banks in Tanzania by using data envelopment analysis based Malmquist productivity index. The analysis revealed that almost all of these banks registered enhancement in their productivity and its components; efficiency change, technical change, pure technical change, and scale efficiency change were improved by the rate of 67%, 83%, 67%, and 50% respectively. Furthermore, the finding indicated that as compared to the large foreign and small banks, the large domestic banks were found to have higher efficiency change. Besides, the mean total factor of productivity of small banks was higher compared with the rest of the groups by recording productivity improvement of 57.9% exceeding large domestic banks and large foreign banks with 51.4% and 54% respectively. Meanwhile, the result revealed that small banks had invested in Technological innovation to reduce related costs of production.

However, the research works carried out with respect to the productivity change of the banking sector in Ethiopia is a spoon hand. Only Garamu (2016), Lera and Rao (2016), and Lema (2016) tried to analyze the productivity change of the commercial banks in Ethiopia. Garamu (2016) attempted to measure the technical efficiency as well as the productivity change of the banks in Ethiopia by employing a data envelopment analysis based Malmquist productivity index from 2007 - 2011. The results revealed that the banks' total factor productivity performance was decreased with a value of 0.956% mainly due to technical efficiency change regressed by 0.629%. But, the technological change of the banks was progressed by 1.003% over the study period. Lera and Rao (2016) evaluated the productivity change of the commercial banks in Ethiopia by employing a data envelopment analysis based Malmquist productivity index. The findings of the study displayed that the industry recorded a total factor productivity growth as a result of progress in technological change. Moreover, Lema (2016) analyzed the productivity change of the banking industry in Ethiopia by using a data envelopment analysis based Malmquist productivity index from 2011 to 2014. The results of the study indicated that the banking sector registered a total factor productivity progress of 1.038% mainly due to progress in the technical change of 1.042% while the industry recorded a technical efficiency change of 0.996% during the study period. Unlike previous studies, the current study has the following advantages. First, it is undertaken using panel data covering a longer period (2006 - 2017). Second, it presented up to date evidence on the Ethiopian commercial bank's productivity change. Third, it employed a balanced panel data (the pre-requirement to use the DEAP software version 2.1) to estimate the total factor productivity change and indices. This study tries to examine the productivity change and the sources of this change for the Ethiopian commercial banks by using data envelopment analysis based Malmquist productivity index since 2006 to 2017. Moreover, this research endeavoured to fill the gap in productivity literature of the banks in Ethiopia. Besides, this paper intends to offer up to date evidence pertaining to the productivity performance of commercial banks in Ethiopia.

3. Methodology

Measuring the productivity change of the Ethiopian commercial banks is the main purpose of this study. The sections below presented the data type, data sources, and method of data analysis employed to reach this objective.

3.1 Data Type and Sources of Data

For the sake of arriving at the aforesaid objective, this paper uses a balanced panel data of eight commercial banks including Awash International Bank (AIB), Bank of Abyssinia (BoA), Commercial Bank of Ethiopia (CBE),

Cooperative Bank of Oromia (CoBO), Dashen Bank (DB), Nib International Bank (NIB), United Bank (UB), and Wogagen Bank (WoB) operating over the period of 2006 to 2017. The rationale for selecting these banks is because they represent almost 85% of total deposits of the Ethiopian banking sector. All of these banks have deposits of 761.93 billion Ethiopian birr during the fiscal year of 2016/17. Besides, these banks are chosen due to their period of the establishment; all of these banks are established before 2006 and because balanced panel data is required to apply the data envelopment analysis deep software 2.1 versions to analyze the bank's productivity change using the linear programming method Data Envelopment Analysis based Malmquist Productivity Index. Secondary data regarding the input-output variables used to gauge the productivity change of the banks included in this paper was collected from the audited annual financial statements of the respective banks. Besides, the productivity change of the banks under study is appraised by using an output-oriented DEA – based Malmquist productivity index approach.

3.2 Input-Output Variables for the DEA Model

The definition of the appropriate input-output variables is vital to evaluate the productivity change of the banks. Intermediation approach and production approach are the two most important approaches used to identify these variables (Sharma *et al.,* 2012*.).* But, in the present paper intermediation approach is employed as a base to specify the inputs and output variables for two reasons. First, because Ethiopian commercial banks act as intermediaries between savers and borrowers; they take deposits from surplus units and transfer it to deficit units (Keatinge, 2014). Second, for production approach is appropriate for evaluating the efficiencies and/or productivities of branches of financial institutions (Berger & Humphrey, 1997). In the intermediation approach, the outputs measure the desired outcome or revenue of banks (measured in dollars) while the inputs represent resources used to operate the banks (Sealey and Lindley, 1977; Guo, 2017). The appropriate number of input-output variables is determined in light of the available data and based on previous DEA studies. Hence, this study specifies two inputs (Fixed Assets and Deposits) and three outputs (Investments, Noninterest income, and Loans and advances). Definition of the input-output variables is in line with prior studies by Narwal and Pathneja (2016).

Table 1. Description of the variables in the DEA model (These are variables useful to estimate the total factor productivity change and its indices.)

Variable	Description
Input Variables	
Fixed Assets	Related to physical capital (book value of physical capital and Premises).
Deposits	The sum of demand, time and saving deposit (include deposits from customers and other banks).
Output Variables	
Loans and advances	Total customer loans and advances (include real estate loan, commercial loan, industrial loan and consumer loan or loans given to customers and other banks).
Noninterest income	Income earned from other services (includes Fees and commission income, Income from card payment, Net gains from dealing in foreign currencies, etc.).
Investments	Which include the total amount of money on investment securities held for trading, investment securities available for sale (AFS), and investment securities held to maturity.

Source: Narwal and Pathneja, 2016

3.3 The Malmquist Productivity Index (MPI)

The MPI is an application of DEA to a panel data to calculate the indices of total factor productivity change (Tfpch); technology changes (Tech), efficiency change (Effch), Pure efficiency change (Pech), and Scale efficiency change (Sech) (Sharma and Dalip, 2014). MPI uses to measure the productivity change of the banks under study at periods t and (t + 1) using period t technology as a benchmark.

Caves et al. (1982) proposed that output-based Malmquist productivity index between time's t and (t + 1) can be defined as:

$$M_{o\,(x^t,\ y^t,\ x^{t+1},\ y^{t+1})} = \left[\frac{Do^t\,(x^{t+1},\ y^{t+1})}{Do^t\,(x^t,\ y^t)} \times \frac{Do^{t+1}\,(x^{t+1},\ y^{t+1})}{Do^{t+1}(x^t,\ y^t)}\right]^{1/2} \tag{1}$$

The notation Do represents the distance function while M_o, x, and y indicate the Malmquist productivity index, inputs, and outputs respectively. The first ratio represents the period t Malmquist index. It measures productivity change from period t to period (t+1) using period t technology as a benchmark. The subsequent ratio is the time (t + 1) Malmquist index as well as indicators of productivity change as of time t to the period (t + 1) employing time (t + 1) technology as a standard. A value of M greater than one indicates productivity growth, while a value of M less than one indicates productivity decline, and M equal to one shows no productivity change.

As per Grifell-Tatjé and Lovell (1997), the output-oriented Malmquist productivity index between time periods t and (t + 1) can be decomposed into two components which are the same to index (1) above, as:

$$Mo(x^t,y^t,x^{t+1},y^{t+1}) = \frac{Do^t(x^{t+1},y^{t+1})}{Do^t(x^t,y^t)} \; X \; \left[\left[\frac{Do^t(x^{t+1},y^{t+1})}{Do^{t+1}(x^{t+1},y^{t+1})}\right]\left[\frac{Do^t(x^t,y^t)}{Do^{t+1}(x^t,y^t)}\right]\right]^{1/2} \tag{2}$$

$$\qquad\qquad\qquad\text{Effch}\qquad\qquad\qquad\qquad\text{Tech}$$

Effch measures the change in how far the observed production is from maximum potential production (or the relative efficiency change) between years t and t + 1 whereas Techch reveals the movements of the frontier function itself between the two periods measured at x^t and x^{t+1} (that is the technological shift). In other words, while Effch is a ratio of two distance functions, Tech is the geometric mean of the two ratios (Coelli *et al*., 2005 and Neupane, 2013.) as cited in Zenebe (2016). This is shown below, as:

$$\text{Effch} = \frac{Do^t(x^{t+1},y^{t+1})}{Do^t(x^t,y^t)} \tag{3}$$

$$\text{Tech} = \left[\left[\frac{Do^t(x^{t+1},y^{t+1})}{Do^{t+1}(x^{t+1},y^{t+1})}\right]\left[\frac{Do^t(x^t,y^t)}{Do^{t+1}(x^t,y^t)}\right]\right]^{1/2} \tag{4}$$

Equation 3 examines how well the production process converts inputs into outputs (catching up to the frontier) whereas Equation 4 depicts the shift in technology (Coelli et al., 2005.). As explained in Fare *et al* (1994), technological progress results in Malmquist index values greater than one while the decline in performance is linked with a Malmquist index values less than one. The same understanding pertains to the values taken by the elements of the general TFP index.

But because all of the above explanations are based on the assumption of constant returns to scale (CRS), the efficiency change in equation (3) above can be disintegrated in to pure efficiency change as well as scale efficiency change based the variable returns to scale assumptions (Gebremichael and Rani, 2012) in below equations.

$$Mo(x^t,y^t,x^{t+1},y^{t+1}) = \left[\frac{Do^{t+1}(x^t,y^t)}{Do^t(x^t,y^t)}\right]\left[\frac{Do^{t+1}(x^t,y^t)}{Do^t(x^{t+1},y^{t+1})}\right]^{1/2} \qquad X \qquad \left[\frac{Do^t(x^t,y^t)}{Do^{t+1}(x^{t+1},y^{t+1})}\right] \qquad X$$

$$\left[\frac{Dco^{t+1}(x^t,y^t)}{Do^{t+1}(x^t,y^t)} \; \frac{Do^{t+1}(x^{t+1},y^{t+1})}{Dco^{t+1}(x^{t+1},y^{t+1})} \; \frac{Dco^t(x^t,y^t)}{Do^t(x^t,y^t)} \; \frac{Do^t(x^{t+1},y^{t+1})}{Dco^t(x^{t+1},y^{t+1})}\right]^{1/2}$$

Where, $\left[\frac{Do^{t+1}(x^t,y^t)}{Do^t(x^t,y^t)}\right]\left[\frac{Do^{t+1}(x^t,y^t)}{Do^t(x^{t+1},y^{t+1})}\right]^{1/2}$ = Tech

$$\left[\frac{Do^t(x^t,y^t)}{Do^{t+1}(x^{t+1},y^{t+1})}\right] = Pech \tag{5}$$

$$\left[\frac{Dco^{t+1}(x^t,y^t)}{Do^{t+1}(x^t,y^t)} \; \frac{Do^{t+1}(x^{t+1},y^{t+1})}{Dco^{t+1}(x^{t+1},y^{t+1})} \; \frac{Dco^t(x^t,y^t)}{Do^t(x^t,y^t)} \; \frac{Do^t(x^{t+1},y^{t+1})}{Dco^t(x^{t+1},y^{t+1})}\right]^{1/2} = Sech \tag{6}$$

Whereas Pech measures the relative ability of operators to convert inputs into outputs, Sech determines the capability of the operators to take benefit of returns to scale by changing its volume towards the most favourable scale.

4. Empirical Results

As aforementioned, this study is carried out to measure the productivity change of commercial banks in Ethiopia. Meanwhile, this section depicts discussions on the descriptive statistics as well as the Malmquist productivity index results.

4.1 Descriptive Statistics

Table 2 below depicts the descriptive statistics of the input (fixed assets and deposits) as well as the output (loans and advances, non-interest income and investments) variables used in the DEA model. Hence, the results showed that the banks understudy was capable of recording average fixed assets of value 373 million birrs with a standard deviation value of birr 496.3 million. Meanwhile, the average number of deposits mobilized over the study period by the banks under study was birr 21 385.4 million with a standard deviation of birr 45 412.8 million. Concerning the output variables, the banks under study provided an average loan of birr 10 710.9 million and a standard deviation of birr 20 074.6 million. Besides, the mean investment amount of the banks during the study period was firm at birr11 085.4 million. Alternatively, the commercial banks in Ethiopia were able to generate a non-interest income of birr 2283.3 million on an average over the study period with a standard deviation of Birr 9567.1 million.

Table 2. Descriptive Statistics of input-output variables (in million birrs)

Variable	Observations	Mean	Std. Dev	Minimum	Maximum
Fixed Assets	96	373	496.3	1	2598
Deposits	96	21 385.4	45 412.8	98	23 0263
Total Loans & Advance	96	10 710.9	20 074.6	127	99 279
Non-Interest Income	96	2283.3	9567.1	0	57 792
Investment	96	11 085.4	32 460.7	0	19 5286

4.2 Total Factor Productivity of the Ethiopian Commercial Banks

As Table 3 below illustrates, the commercial banks in Ethiopia have registered slight progress in TFP over the study period with an average value of 0.4%. Meanwhile, the finding suggests that the banks have recorded the highest TFP growth (1.6%) as well as the highest TFP decline (2.1%) in the years 2010 and 2009 correspondingly. Also, the result reveals that all the banks under study except for BoA and UB recorded growth in TFP during the study period. BoA and UB banks have experienced a decline in TFP from 2006 to 2017. Moreover the finding shows that AIB has exhibited the highest annual TFP growth (2%) whereas UB recorded the utmost TFP regress (1.5% per annum).

Table 3. Total Factor Productivity (TFP) of the Ethiopian commercial banks

Years/Banks	AIB	BoA	CBE	CoBE	DB	NIB	UB	WoB	Mean
2007	1.033	1.046	1.130	0.913	1.074	0.945	0.920	1.023	1.008
2008	1.008	1.008	0.980	0.992	0.983	0.980	1.012	1.000	0.995
2009	0.984	1.088	0.996	1.044	0.771	1.055	0.994	0.938	0.979
2010	1.019	0.996	0.936	0.987	1.012	1.052	1.058	1.076	1.016
2011	1.009	0.955	0.990	1.085	1.051	0.931	1.026	1.076	1.014
2012	1.067	0.924	1.052	0.924	1.100	1.164	0.919	0.978	1.012
2013	1.101	1.078	1.022	0.941	0.994	0.989	0.955	0.938	1.001
2014	1.005	0.947	0.949	1.120	1.026	0.949	0.980	1.041	1.001
2015	1.005	0.950	1.062	1.036	1.052	1.011	1.000	0.996	1.013
2016	0.997	1.018	1.024	0.990	1.027	0.964	1.000	0.964	0.998
2017	0.996	0.997	1.024	1.018	1.013	1.027	0.966	0.995	1.004
Mean	1.020	0.993	1.015	1.005	1.009	1.006	0.985	1.002	1.004

4.3 Total Factor Productivity Change and its Sources

In this paper, a DEA-based Malmquist productivity index is used to assign the sources of productivity change for the banks under study. Total factor productivity change (Tfpch) is the product of efficiency change (Effch) and

technological change (Tech) (Sharma and Dalip, 2014). Therefore, the major source for the Tfpch can be discovered by determining the values of Effch and Techch. Likewise, Effch can be further decomposed into pure efficiency change as well as scale efficiency change. As a result, the reason for the Effch (rise or decline) can be one or both of these two components. As it is already mentioned in this study, there can be progress or regress or no change in these indices when their score is greater than one or less than one or equal to one respectively. The subsequent tables 4 and 5 below indicate the year wise and the firm wise Malmquist index summary of the banks under study.

Table 4. Malmquist Index Summary of Annual (year wise) Means

Years	Effch	Tech	Effch Decomposition		Tfpch
			Pech	Sech	
2007	1.005	1.003	0.990	1.015	1.008
2008	1.012	0.984	1.010	1.002	0.995
2009	0.979	1.000	0.991	0.987	0.979
2010	0.988	1.028	1.010	0.978	1.016
2011	0.974	1.041	0.967	1.007	1.014
2012	1.039	0.974	1.015	1.024	1.012
2013	1.013	0.988	1.029	0.984	1.001
2014	0.998	1.003	0.997	1.001	1.001
2015	0.931	1.088	0.948	0.983	1.013
2016	1.042	0.957	1.053	0.990	0.998
2017	0.970	1.036	0.982	0.988	1.004
Mean	0.995	1.009	0.999	0.996	1.004

Table 4 above presented the year wise (annual) means of Malmquist productivity index (MPI) for the banks under study. The finding shows that the productivity of the Ethiopian banks progressed on an average at 0.4% from 2006 to 2017. This result is much higher as compared to Garamu's (2016) and much lower than those discovered by Lema (2016). According to Garamu (2016) and Lema (2016), the average productivity of the Ethiopian banks was retrogressed by 3.5% and progressed by 3.8% throughout 2007 to 2011 as well as 2011 to 2014 in that order. Also, the result reveals that, except for the years 2008, 2009, and 2016, the banks under study reported progress in their total factor productivity during the years 2007, 2010, 2011, 2012, 2013, 2014, 2015, and 2017 determined at a rate of 0.8%, 1.6%, 1.4%, 1.2%, 0.1%, 0.1%, 1.3%, and 0.4% correspondingly. The years 2008, 2009, as well as 2016 resulted in productivity regress for the Ethiopian banks due to the fact that the world financial market, which Ethiopia is no exception, was highly hit by financial crises that occurred in 2008 and lasts up to the late 2009 as well as because of the existence of political unrest which starts in the early 2016 caused by the social strike that happened almost all over the country demanding for governmental change. Meanwhile, the findings suggest that the overall average productivity increment (0.4%) over the study period was attributable to the mean technological progress (upward move) of 0.9% as well as the mean efficiency loss of 0.5%. This result corroborates the finding by Garamu (2016).

Moreover, it is possible to determine the main source/s of efficiency change (progress or regress or no change) by disintegrating it into its pure technical efficiency as well as scale efficiency change components and comparing their scores. Hence, the analysis suggests that the efficiency decline for the banks under study was caused by the regress both in pure technical efficiency and scale efficiency change.

Table 5. Malmquist Index Summary of Firm Means

Banks	Effch	Tech	Effch Decomposition		Tfpch
			Pech	Sech	
AIB	0.976	1.045	0.997	0.979	1.020
BoA	0.990	1.009	1.000	0.991	0.999
CBE	1.000	1.014	1.000	1.000	1.014
CoBE	0.994	1.009	1.000	0.994	1.003
DB	1.007	0.998	1.000	1.007	1.005
NIB	1.000	1.004	1.000	1.000	1.004
UB	0.993	0.990	0.994	0.999	0.984
WoB	1.000	1.001	1.000	1.000	1.001
Mean	0.995	1.009	0.999	0.996	1.004

Table 5 above presents the Ethiopian bank's performance over the study period. The finding indicates that only two banks (AIB and CBE) reported productivity progress of 2% and 1.4% respectively during 2006 – 2017 while the productivity of all the other banks remains almost constant in spite of their size. As well, the result reveals that AIB and CBE were found to have registered technological improvement (innovation) of 4.5% and 1.4% correspondingly whereas BoA, CoBO, DB, NIB and WoB exhibited a nearly constant technological change in the period. Otherwise, UB reported technical retrogress from 22006 to 2017. In addition, the results show that DB was found to have recorded marginal efficiency progress determined at 0.7% while CBE, NIB, and WoB reported no efficiency change (constant) through the study period. But AIB was found to report an efficiency regress of 2.4% mainly due to scale efficiency retrogress of 2.1% as it exhibited almost unchanged pure technical efficiency performance during the period.

5. Conclusion

This study attempted to measure the productivity change of Ethiopian commercial banks using the DEA-based Malmquist productivity index approach. For this purpose, the paper used a balanced panel dataset of eight banks operating from 2006 to 2017 with a total of 96 observations. Moreover, this paper applied the intermediation approach to defining the input-output variables required to estimate the Malmquist productivity indices. Hence, two inputs (fixed assets and deposits) as well as three outputs (total loans and advances, non-interest income and investment) were identified for the purpose of this study. The findings of the study indicate that on an average the banks under study have exhibited a marginal increment on their total factor productivity performance by 0.4% from 2006 to 2017. This was only due to the slight improvement in technology (0.9%) rather than the efficiency decline (0.5%) in the period. This implies that the Ethiopian banks are investing in banking technology such as internet banking, mobile banking, and ATM cards or have at least more due to consideration on the importance of innovative banking operations to upgrade their productivity performance while they are enabled to properly utilize their input resources. Besides, the decomposition of Effch into its pech and sech components, the results of the statistical analysis reveal that retrogress in technical efficiency is mainly caused by the decline in scale efficiency (scale operation) during the study period. Further, the results indicate that except for AIB and CBE that were found to report average productivity progress of 2% and 1.4% respectively, the productivity performance of all the other banks remains almost constant in spite of their size during the period. The reason for the productivity increment of these banks (AIB and CBE) was the progress in technology (creating new innovations rather than adopting existing ones). Alternatively, the findings suggest that AIB exhibited an efficiency regress of 2.4% mainly due to scale efficiency retrogress of 2.1% over the study period.

Therefore, based on this finding, it is recommended that the Ethiopian commercial banks have to work more on the implementation of innovative technologies than the use of existing technologies to advance their productivity. Besides, the banks need to improve their resource utilization capabilities (or improve their technical efficiency.) by upgrading their managerial practices in different ways like giving various managerial capacity building training as well as by regulating their finest size to increase their productivity.

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