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Evaluating the Technical Efficiency of Commercial Banks in Ethiopia: A Data Envelopment Analysis

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Abstract
Banking companies in the service sector exhibit the problem of distinct results in terms of efficiency. This problem is a cause of concern for many big organizations in the service sector like banks. In particular, the last decade has observed continuous amendments in regulations; technology and competition in the global financial services industry, and Ethiopian banks are no exception. To measure the stability, sustainability and profitability of the banking system, it is therefore crucial to measure the technical efficiency of the sector. A well-organized banking system will provide an extensive way to increase the economic growth in any country. Thus, this study evaluated the technical efficiency of commercial banks in Ethiopia using DEA on a data spanning over the period 2011 to 2014 with three input variables (interest expense, operating expenses and deposit) and three output variables (interest income, noninterest income and loans). Accordingly, it was found that under constant returns to scale (CRS), cooperative bank of Oromia (CBO), Berhan international bank (BrIB) and Dashen bank (DB) were the most efficient commercial banks while commercial bank of Ethiopia (CBE), united bank (UB), lion bank (LIB) and Buna international bank (BuIB) were the least efficient commercial banks. Under the variable returns to scale, BrIB, CBO and nib international bank (NIB) were found to be more efficient banks while CBE, UB and BuIB were the least efficient banks. Considering the scale efficiency/inefficiency score; CBO and DB were characterized as the most scale efficient commercial banks while, the rest of commercial banks in Ethiopia under study experienced both pure technical inefficiency and scale inefficiency.
Keywords: Data Envelopment Analysis, Intermediation Approach, Commercial Banks in Ethiopia, Overall Technical Efficiency, Pure Technical Efficiency, Scale Efficiency,

1. Introduction

Currently, the government of Ethiopia is putting strong emphasis on the development of the banking sector. This might be due to the fact that banks and financial institutions contribute to the economy of a given nation by providing sources of financial resource for enterprises. They favour monetization of the economy and upswing in business activity (Rabtsun, 2003). The financial sector plays a formidable role in economic development (Ahmed and Ahmad 2008). Banks and financial institutions also contribute to economic growth and development by mobilizing rural household savings, channelling a significant share into loans made to training institutions, and funnelling capital to agricultural and other development projects in rural areas (Dong and Featherstone 2006). The Ethiopian financial system consists of 19 banks of which 16 are private banks (Abay Bank [AB], Addis International Bank [AIB], Awash International Bank [AWIB], Bank of Abyssinia [BA], Berhan International Bank [BrIB], Bunna International Bank [BuIB], Cooperative Bank of Oromia [CBO], Dashen Bank [DB], Debub Global Bank [DGB], Enat Bank [EB], Lion International Bank [LIB], Nib International Bank [NIB], Oromia International Bank [OIB], United Bank [UB], Wegagaen Bank [WB] and Zemen Bank [ZB]) and the remaining three are state-owned banks (Commercial Bank of Ethiopia [CBE], Development Bank of Ethiopia [DBE] and Construction and Business Bank [CBB]) (Keatinge 2014).

During the fiscal year 2014-2015 these banks opened 485 new branches raising the total branch network in the country to 2,693 from 2,208 in the fiscal year 2013-2014. As a result, bank branch to population ratio declined from 1:39,833.8 people to 1:33,448.2 during the fiscal year 2014-2015. On the other hand the total capital of the banking industry increased by 19.0 per cent (19%) and reached Birr 31.5 billion by the end of June 2015. Commercial banks in Ethiopia showed improvements in terms of deposit mobilization and financial intermediation. For instance, the total deposits of the banks were Birr 74,547.5 million in the fiscal year 2014/15. The total outstanding borrowing of the banking system at the end of the year 2014-2015 was Birr 31.5 billion up from Birr 17.3 billion a year earlier. Above all, the commercial banks recorded a total capital of Birr 13,716.7 million for public banks and Birr 31,539.5 million for private banks during the fiscal year 2014-2015 (National Bank of Ethiopia, Annual Report 2014-2015). Such improvement in the performance of banks directly contributed to the economic progress of the country.

Despite its astonishing progress and significant contributions to the economy, the banking sector in Ethiopia is still performing below the economic need (Mekonnen, 2015). According to Keatinge (2014), the performance of the banking industry is less than its regional peers and the proportion of the population that has a deposit account is less than eight per cent (8%). As to Keatinge (2014), comparing the level of access to financial services in a neighbouring country such as Kenya, it can be deduced that there was considerable room for

expansion for these service in Ethiopia. Edward (2014) also indicated that the banking penetration in Ethiopia remained low when compared with the Kenyan economy. Nonetheless, it is a challenging job to expand the sector to the level of the economic need given limited resources. Thus, efficient allocation of the existing resources is advisable. To do so, evaluating their efficiency is very essential. The study of measuring technical efficiency (TE) of decision making units (DMUs) is important to know how the banks are using their input mix to produce a given output and to examine if there is wastage of resource.

A number of studies have been undertaken to measure technical efficiencies of banks. For instance (Onour and Abdalla 2010) studied the efficiency of Islamic banks in Sudan using a non-parametric approach and showed that among the twelve banks included in the study, only two banks, the largest government-owned bank in the group and the middle-sized private bank, scored TE level. Obafemi (2012) also studied the TE of Nigerian Banks using data envelopment analysis and showed that on the average, Nigerian banks were not efficient within the periods of study. Raphael (2012) examined the efficiency of commercial banks in Tanzania using a non-parametric approach and concluded that banks were using more resources than what they were producing, meaning they were inefficient. Raphael (2013) studied the efficiency of commercial banks in East Africa employing a non-parametric approach and proved the inefficient utilization of inputs.

There were also studies undertaken in Ethiopia regarding the issue of interest. For instance, (Hailemichael and Aregawi 2013) analysed the relative efficiency of rural saving and credit cooperatives (SACCOs) using data envelopment analysis and found that the average TE score was 21.3% and the extent of TE varied across the geographical location and the scale size of cooperatives. Furthermore, Gebremichael and Rani (2012) examined the total factor productivity change of Ethiopian microfinance institutions (MFIs) using a Malmquist productivity index approach (MPI) and showed that the main source of the total factor productivity (TFP) growth for the MFIs was attributed to the TE change. Despite the fact that efforts have been made to examine the TE of banks in different countries, studies on the issue regarding commercial banks in Ethiopia are rare. Studies in Ethiopia on the issue of interest were limited to Ethiopian microfinance institutions. On the other hand, much of the studies done on efficiency were credited to developed and deregulated economy where the banking sector was highly monetized, dominant private banks, and free entry for foreign competitors. Thus, the findings of these studies cannot be directly applied to the case of Ethiopia where there is low competition, dominant public banks, and banks are closed for foreign competitors. Thus, the objective of this study is to evaluate the TE of commercial banks in Ethiopia. Specifically, effort was made to estimate the TE score of commercial banks in the study and to compare the efficiency score of commercial banks in Ethiopia. Doing so, the study tried to answer basic question which is, whether the banks have used the available input to produce the maximum possible output. For this purpose the data envelopment analysis (DEA) was employed. This is because, unlike the stochastic frontier approach, the DEA approach has the ability to accommodate multiple inputs and outputs. The study considered only 15 commercial banks in Ethiopia because data was not available for the Enat Bank, Debub Global Bank and Addis International Bank. The study also focused on the first growth and transformation plan (GTP I) period from 2011 to 2015. Nonetheless, due to lack of data, the study was limited to the period from 2011 to 2014.

The remaining part of this study is organized as follows. The second section discusses related literature on the subject under consideration. The third section presents the method used in the conduct of the study. The fourth section presents discussions on TE score results from DEA analysis under different assumptions regarding the returns to scale of production. The last section contains the conclusion main findings and recommendations.

2. Review of Related Literature

The term efficiency is a relative concept measured by comparing the actual ratio of outputs to inputs with the optimal ratio of outputs and inputs (Fried, Lovell and Schmidt 2008). Overall efficiency or economic efficiency is classified as TE and allocative efficiency (AE) or price efficiency. AE is defined as the measurement of the success in the selection of the input set among the optimal input set (Tutulmaz 2014). It refers to the ability to choose cost minimizing mix of inputs at a given relative input price and available technology (Onour and Abdalla 2010). If a DMU employs a proper combination of inputs so that cost is at its possible minimum point, the DMU is allocative efficient and vice versa. On the other hand, a production is defined as technical efficient if producers have to decrease one of the outputs or increase one of the inputs in order to increase the output. It can also be defined as, if producers have to increase the inputs or decrease one of the outputs in order to decrease its input (Tutulmaz 2014). Studies have been undertaken to evaluate the TE score of DMUs. Nonetheless, there is no consensus between scholars regarding the issue of to what extent banks are efficient in using the limited resource available. Below is the discussion of those diverse findings of studies conducted in the past on the issue of interest.

Obafemi (2012) examined the TE of Nigerian banks over the period 1984-1985, 1994-1995, 1999-2000, and 2003-2004. Employing DEA on input variables (labour, capital and purchased funds) and output variables (loans and advances [demand deposits], time and savings deposits), the study showed that some banks

had their efficiency scores continuously increasing; others had theirs continuously decreasing; while a third group had fluctuating efficiency scores. As to the study of privately owned banks, they tended to be more efficient than publicly owned banks. On the other hand, big banks like the First Bank and the Union Bank showed higher levels of efficiency than smaller banks. The percentage of efficient banks was on the decline within the periods of the study, and output loss and underutilization of resources among Nigerian banks were observed. Raphael (2012) also investigated the efficiency of commercial banks in Tanzania using a non-parametric approach, DEA, over the period from 2008 to 2011. Based on input variables (deposit, interest expenses and operating expenses) and output variables (loan, investment, interest income and no interest income), the analysis result proved that most commercial banks in Tanzania still have a chance of improvement. In terms of size, large banks showed better performance compared to the counterpart small banks. As to the study, commercial banks should minimize the use of input resources while maintaining the same level of output to improve TE

Sangeetha and Jain (2013) studied the TE of public sector banks in India using DEA or using interest expense and operating expense as input variables and interest income and other income as output variables. The study showed that the Corporation Bank, the State Bank of India and the IDBI performed consistently and efficiently in all the years under study. On the other hand, around 40 per cent (40%) to 50 per cent (50%) of public sector banks performed below the mean score during the study period implying the possibility of performance increment by improving the efficiency of resources use. The study recommended that efficient banks could be used as a reference or base by other banks to adjust their input use and improve efficiency. Raphael (2013) also studied the efficiency of commercial banks in East Africa (Tanzania, Kenya, Uganda, Rwanda and Burundi, excluding Ethiopia) using a non- parametric approach, DEA, over the period from 2008 to 2011. Employing DEA on input variables (capital and labour) and output variables (deposits and loan accounts) the study indicated that banks recorded a sharp decline of TE from 0.81 (2008) to 0.56 (2009) after showing an increasing trend of TE in 0.73 (2011). It also showed that most commercial banks in east Africa were operating under a DRS. To improve efficiency, the study recommended commercial banks to minimize the use of input resources while maintaining the same level of output. By improving the handling of operating expenses, advances, capital and by boosting banking investment operation, the less efficient banks can successfully endorse resource utilization efficiency.

Erasmus and Makina (2014) studied the efficiency of banks in South Africa over the period from 2006 to 2012. Employing the standard and alternative approaches to DEA on input variables (deposits, their liabilities, shareholders' equity, staff costs, non-interest expense and fixed assets) and output variables (loans, overdrafts and non-interest income), the study showed that under both approaches the majority of South African banks were observed to be DEA efficient. Such differing results might be due to different variables employed, countries under study, years of study, and models employed.

There were also studies undertaken in Ethiopia on the issue of interest. Hailemichael and Aregawi (2013) analyzed the relative efficiency of rural savings and credit cooperatives in Ethiopia employing DEA on input variables (savings, and total expenses) and output variables (loans and total income). Doing so, Hailemichael and Aregawi (2013) showed that the extent of TE varies across geographical location and scale size of cooperatives. Also, from the total of 329 (SACCOs), compared to their respective peers, only 18 (5.5%) were identified as relatively efficient with the maximum efficiency score of one. Furthermore, the study indicated that the average efficiency was 21.3% which indicated that there was substantial amount of inefficiency among rural SACCOs in the study area. A study by Gebremichael and Rani (2012) examined the total factor productivity change of Ethiopian microfinance institutions (MFIs) using a Malmquist productivity index approach. For this purpose, they employed input variables (number of employees and operating expenses) and output variables (interests and fee income, gross loan portfolio, and number of outstanding loans). Doing so, they indicated that the Ethiopian MFIs experienced mainly an increment of pure technical efficiency (PTE) and improvement in management practices rather than improvement in optimum size (scale efficiency change).

Overall, the findings of the aforementioned studies showed that most banks in developing countries were inefficient while some were efficient in the use of resources. Nonetheless, as was indicated in the introduction part, the findings from studies in other countries might not be applicable for commercial banks in Ethiopia because banking in Ethiopia is characterized by low competition, dominance of public banks and banks closed for foreign competitors, and thus, differentiating it from the banks in the rest of the world. By employing the DEA, this study tried to measure the TE of commercial banks in Ethiopia over the GTP I period.

3. Methodology of the study

The aim of this study is to measure the TE of commercial banks in Ethiopia over the GTP I period (from 2011 to 2015). However, due to data limitation of some commercial banks in the country for the year 2015, only the period from 2011 to 2014 was considered. To attain the objective the DEA was employed. Below are discussions on the source of data, type of data, model specification and the method used to analyze the data.

3.1 Data Type and Source of Data

The study used panel data to measure the TE of commercial banks in Ethiopia for the operating years from 2011 to 2014. For this purpose secondary data was used. Secondary data was obtained from the balance sheet and the income statement of commercial banks covered in the study.

3.2 Method of Data Analysis

The approaches to measure bank efficiency included the parametric and the non-parametric approaches. In literature, both the parametric and the non-parametric approaches have been widely used but there is no consensus which of these major approaches is superior (Erkoc, 2012). The stochastic frontier approach, (SFA) sometimes also referred to as the econometric approach (EA), was developed by Aigner, Lovell and Schmidt (1977) and Meeusen & van den Broeck (1977) (Parmeter & Kumbhakar, 2014). In this approach, the SFA specifies a functional form for the cost, profit or the production frontier and allows for random error. The SFA modifies a standard cost (production) function to allow inefficiencies to be included in the error term. Unlike the parametric approach, the non-parametric approach assumes that random error is zero so that all unexplained variations are treated as reflecting inefficiencies. In this study the DEA model ~~is~~ was employed because this approach can deal with relatively small samples when compared to parametric approach. Also, the DEA approach requires no specification of the functional form of production function, handles multiple inputs and output, needs no assumption as to the relative importance of the inputs and output, and provides target for the enhancement of efficient units. Specifically, this study used input-oriented DEA measure of efficiency since the managers of the banks have more discretion in controlling the inputs than the outputs.

3.3 Model Specification

Consider a general situation where we have n DMUs that convert m inputs into *s* outputs, where m can be larger, equal or smaller than s and assuming CRS, the relative efficiency score of a given DMU *p* can be calculated by solving the Charnes-Cooper-Rhodes (CCR) model (Talluri 2000) described as follows:

$$Max \quad \frac{\sum_{k=1}^{s} V_k Y_{kp}}{\sum_{j=1}^{m} U_j X_{jp}} \quad ---------- (3.1)$$

$$s.t$$

$$\frac{\sum_{k=1}^{s} V_k Y_{ki}}{\sum_{j=1}^{m} U_j X_{ji}} \leq 1 \; \forall i \; (i = 1,2 \ldots . n)$$

$$V_k, U_j \geq 0 \quad \forall k,j \; (k = 1,2 \ldots . s, j = 1,2 \ldots . m)$$

Where, $k -$ index for outputs$(k = 1, \ldots, s)$, $j -$ index for inputs$(j = 1, \ldots, m)$, $i -$ index for DMUs $(i = 1, \ldots, n)$, $yki -$ amount of output k produced by $DMU\ i$, $xji -$ amount of input j utilized by $DMU\ i$, $vk -$ weight given to output k, $uj -$weight given to input j. To measure the efficiency score of DMUs equation (3.1) is converted into a linear programming problem. The linear programming problem is given in equation (3.2) where the denominator is a set of constant and the numerator is maximized and is given as:

$$Max \quad \sum_{k=1}^{s} V_k Y_{kp} \quad ---------- (3.2)$$

$$s.t$$

$$\sum_{j=1}^{m} U_j X_{jp} = 1$$

$$\sum_{k=1}^{s} V_k Y_{ki} - \sum_{j=1}^{m} U_j X_{ji} \leq 0 \qquad \forall i \; (i = 1,2 \ldots . n)$$

$$V_k, U_j \geq 0 \qquad \forall k,j \; (k = 1,2 \ldots . s, j = 1,2 \ldots . m)$$

In each of the iterations, the DEA evaluates the efficiency of each unit through the system of weights. In particular, it identifies input and output weights that maximize each DMU's efficiency score. The resulting efficiency score lies between zero and one. Using the concept of duality in linear programming, the equivalent envelopment form of the linear programming model expressed in Equation (3.2) is given as:

$$Min\ \theta \quad ---------- (3.3)$$

$$s.t$$

$$\sum_{i=1}^{n} \lambda_i X_{ji} - \theta X_{jp} \leq 0 \qquad \forall j \; (j = 1,2 \ldots . m)$$

$$\sum_{i=1}^{n} \lambda_i Y_{ki} - Y_{kp} \geq 0 \qquad \forall k \; (k = 1,2 \ldots . s)$$

$$\lambda_i \geq 0 \qquad \forall i \; (j = 1,2 \ldots . n)$$

Like Equation (3.2), Equation (3.3) is run *n* times, i.e., once for each DMU in the sample. In practical terms, a DMU in question, say DMU *p*, is inefficient if there exists a composite DMU (i.e., a linear combination of

DMUs in the sample), which uses less input than DMU *p* while maintaining at least the same levels of output. The units that comprise such composite DMU are regarded as benchmarks or peers for improving the inefficient DMU in question (Talluri 2000).

A DEA model can be expressed as an input-orientated model or output-orientated model. If a CRS is assumed, efficiency score under each model orientation is the same. But, under VRS framework, the efficiency measure will vary. However, the set of DMUs identified as inefficient under VRS will be the same regardless of the orientation adopted (Thanassoulis et al. 2009). As indicted above, this study employed the input oriented model. On the other hand both VRS and CRS were considered for the purpose of determining TE. The input-oriented model under the VRS is given by equation 3.4.

$$Min\ \theta k \quad \text{----------} \quad (3.4)$$

$$s.t$$

$$Y_{rk} - \sum_{j=1}^{n} \lambda_j Y_{rj} \leq 0 \qquad r = 1,2 \ldots . s$$

$$\theta k X_{ik} - \sum_{i=1}^{n} \lambda_j X_{ij} \geq 0 \qquad i = 1,2 \ldots \ldots . m$$

$$\sum_{j=1}^{n} \lambda_j = 1,\ \lambda_j \geq 0 \qquad j = 1,2 \ldots . . n$$

Being introduced by Banker et.al (1984), the BCC model which assumes a VRS helps split overall technical efficiency (OTE) into PTE and SE. TE score not devoid of SE is the OTE score or TE score under a CRS. According to Thanassoulis et al (2009), the overall efficiency of DMU *k* is represented by the expression: $E_k = \theta k$. On the other hand, SE of DMU *k* is given by the ratio of TE score under CRS or OTE to that of TE score under VRS. That is, $SCE_k = \frac{E_{k,CRS}}{E_{k,VRS}}$

Where E*k,CRS* and E*k,VRS* is the efficiency score obtained under CRS and VRS, respectively. There are two approaches for selecting input and output variables for DEA model, namely, the production approach and the intermediation approach (Karimzadeh 2012 and Ncube 2009). The intermediation approach is appropriate for analyzing bank level efficiency studies (Tahir & Bakar 2009) and thus, it was employed for this study. Accordingly, input variables include interest expense, operating expense and deposit, while output variables include interest income, non-interest income and loan.

4. Results and Discussions

This study evaluated the technical efficiency of commercial banks in Ethiopia. The following section presents the results from DEA both under CRS and VRS assumptions.

4.1 Technical Efficiency of Commercial Banks in Ethiopia Under CRS

The CCR model assumes a CRS in which the PTE and SE are combined into a single value called OTE. To get the efficiency scores for each bank, it is required that the model specified in chapter three be formulated and solved for each commercial bank.

Table 4.1 Technical Efficiency of Commercial Banks in Ethiopia under CRS

S.No.	DMUs	Year				Mean	Std. dev.	Min	Max
		2011	2012	2013	2014				
1	**AB**	1.000	0.871	0.864	0.837	0.893	0.073	0.837	1.000
2	**AWIB**	0.790	0.963	0.860	0.823	0.859	0.075	0.790	0.963
3	**BA**	0.845	0.903	0.910	0.921	0.895	0.034	0.845	0.921
4	**BrIB**	0.909	1.000	1.000	0.980	0.972	0.043	0.909	1.000
5	**BuIB**	0.921	0.899	0.784	0.730	0.834	0.091	0.730	0.921
6	**CBE**	0.813	0.767	0.717	0.681	0.745	0.058	0.681	0.813
7	**CBB**	0.666	1.000	0.817	0.958	0.860	0.151	0.666	1.000
8	**CBO**	1.000	0.925	1.000	1.000	0.981	0.038	0.925	1.000
9	**DB**	1.000	1.000	1.000	0.867	0.967	0.067	0.867	1.000
10	**LIB**	0.878	0.706	0.752	0.975	0.828	0.122	0.706	0.975
11	**NIB**	0.855	0.924	0.985	0.959	0.931	0.056	0.855	0.985
12	**OIB**	0.869	0.825	0.899	1.000	0.898	0.074	0.825	1.000
13	**UB**	0.993	0.782	0.738	0.736	0.812	0.122	0.736	0.993
14	**WB**	0.731	0.817	1.000	0.958	0.877	0.125	0.731	1.000
15	**ZB**	0.898	0.901	0.848	1.000	0.912	0.064	0.848	1.000

Source: Author's computation based on data collected from the banks` annual report (2011-2014)

Based on this, we utilized data envelopment analysis program (DEAP) 2.1 computer program to conduct the DEA. Accordingly, as it can be seen from Table 4.1 the Cooperative Bank of Oromia, Berhan International Bank and Dashen Bank were found to be more efficient than the rest of the banks under study with a TE score of 98.1%, 97.2% and 96.7%, respectively. It means that the banks could have used only 1.9%, 2.8% and 3.3% fewer inputs to produce the same level of outputs. Commercial banks with lower TE score under CRS included; the Commercial Bank of Ethiopia, United Bank, Lion International Bank and Buna International Bank, with a TE score of 74.5%, 81.5%, 82.8% and 83.4%, respectively. Thus, compared to other banks under study, these banks were producing actual outputs with lower efficiency. That is, they could have used 25.5%, 18.5%, 17.2% and 16.6% fewer inputs to produce the same level of outputs, respectively.

4.2 Technical Efficiency of Commercial Banks in Ethiopia Under VRS

The above discussion assumed a CRS to evaluate the TE of commercial banks understudy. Nonetheless, the CRS hypothesis works under the assumption that all commercial banks in Ethiopia under study are functioning at an optimal scale. However, these commercial banks in Ethiopia might face either economies of scale or diseconomies of scale. As a result under CRS, TE will be mixed up with PTE and SE. To address this problem, the Banker, Charnes and Cooper model (BCC model), was used which assumes a VRS. Under this assumption TE score will be decomposed into the PTE score and SE score. If the TE score under CRS is different from that of under VRS, then the DMUs have scale inefficiency. However, if the TE score under the two assumptions is the same DMUs will be scale efficient. In this section the TE score under the CRS is decomposed to PTE (TE score under VRS) and the SE (the ratio of TE under CRS to the TE under VRS). In this first section, the pure TE score of commercial banks in Ethiopia was considered while the scale efficiency is considered in the next section. Table 4.2 presents descriptive statistics of the commercial banks in the study. Assuming VRS, it was found that the average TE score of Abay Bank was 90.2%, which implied that on average the bank could have used 10% fewer resources to produce the same amount of output. The average TE score of Awash International Bank was also found to be 89.7%. That is, Awash International Bank could have used 10.3% fewer inputs to produce the same amount of outputs. On the other hand, the average TE score of the Bank of Abyssinia was 93.8%. This indicated that the Commercial Bank of Ethiopia could have produced the same output using 6.2% less resources, for TE to be achieved. The average TE score of the Berhan International Bank over the period under study was found to be 98.7%. That is, the banks could have used 2.3% fewer resources to produce the same level of output, which implied that the Berhan International Bank was near full efficiency over the period from 2011 to 2014.

Table 4.2 Technical Efficiency under Input Oriented Variable Returns to Scale (VRS)

S.No.	DMUs	Year				Mean	Std. dev.	Min	Max
		2011	2012	2013	2014				
1	**AB**	1.000	0.875	0.872	0.862	0.902	0.065	0.862	1.000
2	**AWIB**	0.804	0.996	0.890	0.896	0.897	0.079	0.804	0.996
3	**BA**	0.897	1.000	0.931	0.922	0.938	0.044	0.897	1.000
4	**BrIB**	0.947	1.000	1.000	1.000	0.987	0.027	0.947	1.000
5	**BuIB**	0.932	0.915	0.792	0.731	0.843	0.097	0.731	0.932
6	**CBE**	0.818	0.785	0.730	0.696	0.757	0.055	0.696	0.818
7	**CBB**	0.704	1.000	0.958	0.964	0.907	0.136	0.704	1.000
8	**CBO**	1.000	0.933	1.000	1.000	0.983	0.034	0.933	1.000
9	**DB**	1.000	1.000	1.000	0.871	0.968	0.065	0.871	1.000
10	**LIB**	0.972	0.760	1.000	1.000	0.933	0.116	0.760	1.000
11	**NIB**	0.913	0.996	1.000	1.000	0.977	0.043	0.913	1.000
12	**OIB**	0.911	0.836	0.913	1.000	0.915	0.067	0.836	1.000
13	**UB**	1.000	0.846	0.762	0.744	0.838	0.117	0.744	1.000
14	**WB**	0.743	0.884	1.000	0.988	0.904	0.119	0.743	1.000
15	**ZB**	0.899	0.909	0.974	1.000	0.946	0.049	0.899	1.000

Source: Author's computation based on data collected from the banks` annual report (2011-2014)

There was also a list of banks in the study that recorded comparable TE score with that of the Berhan International Bank, which included the Cooperative Bank of Oromia, Dashen Bank and Nib International Bank with an average TE score of 98.3%, 96.8% and 97.7%, respectively. Commercial banks characterized with the lowest average TE score over the period under study included the Commercial Bank of Ethiopia, United Bank, and Buna International Bank with an average TE score of 75.7%, 83.8% and 84.3%, respectively.

4.3 Scale Efficiency

The SE measure was used to examine if banks were producing at their most productive scale or not. As can be seen from Table 4.3, the Abay Bank and Buna International Bank were found to be equally scale efficient with

an average SE score of 99%. This implied that on the average the actual scale of production has diverged from the most productive scale size by only 1%. The Commercial Bank in Ethiopia under study with best SE score was the Cooperative Bank of Oromia and Dashen Bank. The average SE scores of these Banks were found to be 99.8% and 99.9%, respectively, which means that the actual scale of production has diverged from the most productive scale size by less than 1%. Thus, the commercial banks above managed to produce their outputs at their most productive scale. On the other hand, the Awash International Bank, Bank of Abyssinia and Nib International Bank recorded comparable SE score with an average SE score of 95.9%, 95.6% and 95.2%, respectively. That is, the actual scale of production of these commercial banks on average diverged from the most productive scale by more than 4%. The commercial banks in Ethiopia, with minimal SE score included the Construction and Business Bank of Ethiopia and Lion International Bank. The average SE scores of these commercial banks were found to be 94.8% and 89%, respectively. This means that these commercial banks actual scale of production diverged from the most productive scale by 5.2% and 11% respectively.

Table 4.3 Scale Efficiency under Input Oriented

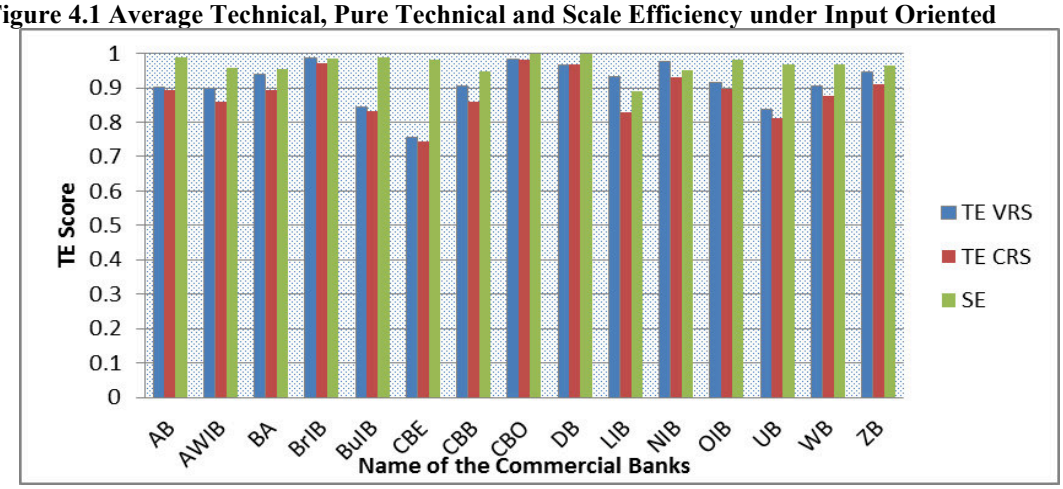
S.No.	DMU	Year				Mean	Std. dev.	Min	Max
		2011	2012	2013	2014				
1	**AB**	1.000	0.996	0.991	0.972	0.990	0.012	0.972	1.000
2	**AWIB**	0.982	0.967	0.967	0.919	0.959	0.027	0.919	0.982
3	**BA**	0.943	0.903	0.978	0.999	0.956	0.042	0.903	0.999
4	**BrIB**	0.960	1.000	1.000	0.980	0.985	0.019	0.960	1.000
5	**BuIB**	0.989	0.982	0.990	0.999	0.990	0.007	0.982	0.999
6	**CBE**	0.995	0.977	0.982	0.978	0.983	0.008	0.977	0.995
7	**CBB**	0.945	1.000	0.853	0.994	0.948	0.068	0.853	1.000
8	**CBO**	1.000	0.991	1.000	1.000	0.998	0.005	0.991	1.000
9	**DB**	1.000	1.000	1.000	0.996	0.999	0.002	0.996	1.000
10	**LIB**	0.904	0.928	0.752	0.975	0.890	0.096	0.752	0.975
11	**NIB**	0.936	0.927	0.985	0.959	0.952	0.026	0.927	0.985
12	**OIB**	0.954	0.986	0.985	1.000	0.981	0.019	0.954	1.000
13	**UB**	0.993	0.924	0.969	0.989	0.969	0.032	0.924	0.993
14	**WB**	0.984	0.923	1.000	0.969	0.969	0.033	0.923	1.000
15	**ZB**	0.999	0.992	0.870	1.000	0.965	0.064	0.870	1.000

Source: Author's computation based on data collected from the banks` annual report (2011-2014)

4.4 Technical efficiency, Pure Technical Efficiency and Scale efficiency

As discussed above the TE score under CRS (OTE) measured the combined TE score. This score can be split into PTE and SE. The pure technical efficiency/inefficiency score measures efficiency or inefficiency that resulted from poor input utilization or managerial underperformance. On the other hand, the scale efficiency/inefficiency scores measures, efficiency or inefficiency that resulted from the failure to produce at the most productive scale.

Figure 4.1 Average Technical, Pure Technical and Scale Efficiency under Input Oriented



Source: Author's computation based on data collected from the banks` annual report (2011-2014)
Note: TE VRS represents TE Score under VRS; TE CRS represents TE score under CRS and SE.

Figure 4.1 compares the OTE score; the PTE score and SE score of the commercial bank under study. As it is shown in the figure 4.4, the SE of cooperative bank of Oromia and the Dashen Bank can be approximated to one, thus implying that for the two banks, TE is entirely due to the managerial under

performance or poor input utilization. The rest of commercial banks under study, 13 commercial banks (86.67%) are producing below their productive scale. That is, the commercial banks are both pure technical inefficient and scale inefficient. Thus, for these commercial banks technical inefficiency is due to both managerial under performance and poor input utilization.

4.5 Efficiency Comparison of Private and Government Banks

As shown in Table 4.4 regarding the average OTE of commercial banks in Ethiopia during 2011 to 2014, private commercial banks in Ethiopia were found to be more technical efficient representing 89.97%. Government owned commercial banks in Ethiopia on the other hand recorded a relatively lower OTE score representing 80.28%. The implication of this finding is that privately owned commercial banks in Ethiopia were more technical efficient than commercial banks owned by the government. In terms of PTE measure, private commercial banks under study outperformed government commercial banks. The average PTE score over the period was 92.5% for private commercial banks under investigation while the average PTE score was 83.2% for their government counterparts. Nonetheless, the SE score under the period of interest tend to be comparable. Both, government owned and private commercial banks in the country on average recorded similar SE scores implying that commercial banks deviation from the optimal production sale was almost equal. Thus, it can be inferred that ownership had strong implication towards the TE score of commercial banks.

Table 4.4 Efficiency Comparison of Private and Government Banks

Banks	Year	Efficiency Score Under		
		CRS Assumption	VRS Assumption	Scale Efficiency
Private Commercial Banks	**2011**	0.899	0.924	0.973
	2012	0.886	0.919	0.963
	2013	0.895	0.933	0.961
	2014	0.907	0.924	0.981
Government Commercial Banks	**2011**	0.740	0.761	0.970
	2012	0.884	0.893	0.989
	2013	0.767	0.844	0.918
	2014	0.820	0.830	0.986

Source: Author's computation based on data collected from the banks` annual report (2011-2014)

Looking at the average TE of commercial banks in each year during the period under study, the OTE score of private commercial banks showed stable trend while that of government-owned commercial banks showed unstable trend. For instance, the average OTE score of government-owned commercial banks in the year 2011 was 74% while it increased to 88.4% in the year 2012. The score decreased to 76.7% in the year 2013 and again increased to 82% in the year 2014. The PTE score for private commercial banks like that of the OTE score showed stable trend while government owned commercial banks still showed unstable trend. As shown in Table 4.4, government commercial banks had recorded rapid increase in PTE from 76.1% in 2011 to 89.3% in the year 2012. Slight decrease in the score was recorded the following two years. Despite the fact that both government and private commercial banks recorded comparable average SE score; still the trend of SE for government-owned banks was less stable. The SE score was 97% in the year 2011 and increased to 98.9% in the year 2012 and then decreased to 91.8% in the year 2013 and again a significant increase was recorded in the year 2014.

5. Conclusion and Recommendations

In general, majority of commercial banks in Ethiopia experienced relative inefficiency both under the CRS and VRS assumptions. On the other hand, given the fact that privately owned commercial banks in Ethiopia are more efficient compared to government owned commercial banks, it can be inferred that ownership matters for the efficient performance of banks. Furthermore, commercial banks in Ethiopia like Abay Bank, Awash International Bank, Bank of Abyssinia, Berhan International Bank, Buna International Bank, Construction and Business Bank of Ethiopia, Commercial Bank of Ethiopia, Lion International Bank, Nib International Bank, Oromia International Bank, United Bank, Wegagen Bank and Zemen Bank are pure technical and scale inefficient. This indicates that inefficiency is not only due to the inefficient use of resources but also due to production which is below the optimal scale of production. Therefore, to address the problem of inefficiency the following recommendations are vital.

- There should be an effort to reduce government ownership of commercial banks.
- For majority of commercial banks under study, inefficiency is due to both the managerial under performance and poor input utilization. Thus, it is advisable to improve their input utilization and improve the managerial capacity of their managers through trainings.

5.1 Suggestion for Future Research

The study is limited to the period 2011-2014 due to data limitation for some of the commercial banks in Ethiopia included in the study for the year 2015. Thus, future studies could consider the full period of the growth and transformation plan period (from 2011 to 2015).

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