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Efficiency of Private Commercial Banks in Ethiopia: A Data Envelopment Analysis Approach

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Abstract

Efficiency is the most important thing that any firm in business aspires to achieve. The aim of being an efficient firm is to achieve greater outputs with the available inputs. This has continued to be a concern for many banks. This study aims to assess the relative technical efficiency and scale efficiency in 16 Ethiopian private commercial banks during the year 2013/14 by utilizing the single stage Data Envelopment Analysis model. The data are collected from the Annual reports and websites of individual private banks, National Bank of Ethiopia quarter and annual reports, and publications. The findings reveal that 50% of the private banks in operation are technically inefficient in Constant Returns to Scale model. In terms of scale efficiency 44%, private banks are scale inefficient. The result also revealed that the major form of scale inefficiency is Increasing Returns to Scale. NIB bank is found to be the most efficient as compared to other private commercial banks in Ethiopia. The study used input oriented intermediation approach to analyze the input and output variables. The input variables used are total deposits, branch number, staff size, and capital employed and the output variables included Profit and Loan. The study concluded that the source of inefficiency of Ethiopian private commercial banks is poor input-output mix and selecting appropriate scale size. But there is ample scope for improvement in efficiency.

Keywords*: *Data envelopment analysis, efficiency, private banks

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Introduction

The modern banking history of Ethiopia is aged above one century. Since then wide-ranging reforms in banking and financial markets have been carried out in the Ethiopian economy. The major occurrences include co-ownership by foreign and the state (1905-1931), the establishment of private, foreign, and state-owned banks (1931 to 1974), then nationalization of all non-state-owned banks (1975-1994), and then the legalization of domestic private investment in the banking industry(Degefe, 1982; Harvey, 1996; Aredo, 1993).

After two decades, in June 2015, the number of private commercial banks reaches 16 with a total number of branches of 1,528 (NBE, June 2015). Out of the total 2,613 bank branches in the 2014/15 fiscal year, the private banks in total possessed 1,528 or 58.5% branches whereas the remaining 1,085 (41.5%) branch network in the country belongs to the state-owned banks (NBE, June 2015).

Nevertheless, the private banks have still less share than the state-owned banks in the market 28% of the total deposits and 35.1% of total disbursement (NBE, June 2015). This might come from the low efficiency of these privately owned banks in resource utilization and their operation performance. Because banks play an important role in the economy, their success or failure has an impact on the country's economy so their efficiency in transforming their resources for better performance matters and is relevant to their success and the country's economy (Dash & Charles, 2009).

Most of the commercial private banks started the adoption of new technologies, massive branch expansion, employee skill development, and a new line of products. Despite the difference in age, size, capital, and other attributes the competition between the banks is getting stiff. The competition further requires improved efficiency of operation and is ready for the coming new approaches and fierce competition. A number of studies conducted in connection with the performance of financial institutions in Ethiopia. But studies that focus on the efficiency of commercial banks, both private and government are not many. Few studies have directed their attention to analyzing the relative efficiency of Micro Finance Institutions within the country using cross-sectional studies (Gessesse, 2010).

There are, however, many studies that have been conducted in other countries about the efficiency of banks. The studies concentrated on testing efficiency from different perspectives. Some have studied efficiency by ownership; comparing the efficiency of foreign, public, and private banks while others have tried to detect the effects of the size of banks on efficiency yet there were also other researchers who attempted to investigate the age of banks' effect on efficiency. The authors differ in their presumed goals to achieve and in their specification of the bank's role as either provider of service (production approach) or as financial intermediaries (intermediary approach).

Kumar & Gulati (2008), used DEA approach to measure the extent of efficiencies in 27 public sector banks operating in India for year 2004/05. The authors, took the physical capital, Labour, and Loanable funds as a component of the input vector and net interest income and non-interest income as the output vector. The research result shows that there has been poor input utilization and failure to operate at the most productive scale size that resulted in the technical inefficiency of the Indian public sector banks.

Whereas, Khan (2014) attempted to measure the performance of 22 private commercial banks in Pakistan for the period 2006 – 2010 using the input-oriented CCR model of DEA. He found that the average efficiency of the private commercial banks declined during the study period.

Sahoo, Sengupta, & Mandal (2007), attempted to examine the productive performance trends of the Indian commercial banks in terms of technical efficiency, cost efficiency, and scale elasticity; for the period 1997/98 to 2004/05 using DEA. They found that private banks are more cost-efficient than nationalized banks. Sathye (2003), arrived at a different result in his study conducted to measure the productive efficiency of banks in India using the DEA model. He has compared the efficiency difference between public, private, and foreign-owned banks. As per his study, private banks are less efficient than public and foreign sector banks in India during the study period covering 1997 to 1998.

In their study of the technical efficiency of 49 major banks operating in India, Dash & Charles (2009), investigates the ownership role in bank efficiency for the years 2003 to 2008. They used the DEA model with five input variables that constitute borrowing, deposits, fixed assets, net worth, and operating expenses, and four output variables that include advances and loans, investments, net interest income, and non-interest income. The result of the study indicates that foreign banks were somewhat more efficient, but there was less difference between public and private bank's efficiency.

Unlike Dash & Charles (2009), a study conducted to investigate the efficiency of Malaysian commercial banks by Tahir, Abubakar, & Haron (2009) during the period of 2000 to 2006 using DEA methodology revealed domestic banks were relatively more efficient than foreign banks. Likewise, private Banks in West Africa were found efficient to a foreign bank in a study conducted by Kablan (2007). The author measured the technical and cost efficiency of the West African Economic Monetary Union, (WAEMU). He applied DEA to measure the technical efficiency and Stochastic Frontier Analysis (SFA) for cost efficiency measurement. The author studied 35 banks in the zone (West Africa) for the period 1996 to 2004. The result showed that local banks with private capital are the most efficient ones, followed by foreign banks subsidiaries and then state-owned banks.

In connection with the effect of bank size on efficiency, Raphael (2012) attempted to estimate the relative efficiency of 20 commercial banks in Tanzania for the period 2008 to 2011. He has employed DEA and found that small banks in Tanzania were less efficient compared to large banks. A similar result has been obtained by Karimzadeh (2012). The author has conducted a study using DEA to estimate the technical and economic efficiency of Indian commercial banks during 2000 – 2010. He used loans and investments as output and fixed assets, deposits, and a number of employees as part of the input. The study was conducted on 8 commercial banks in India and found that the largest banks are found to be relatively the most cost-efficient than small-size banks. But there were insignificant differences among the banks regarding technical efficiency.

Opposed to the results obtained by Raphael (2012) and Karimzadeh (2012) the study conducted by Repkova (2014) on Czech commercial banks shows small banks were more efficient to large-sized banks. The author applied input-oriented DEA and examined the efficiency based on panel data for the period 2003 to 2012. In his finding, he stated that the large-sized bank was lower efficient than other small-sized banks.

In his study, on the effect of the age of the bank on efficiency, Reddy (2004) found new banks scored higher efficiency to old banks. He examined the competitiveness of 80 Indian commercial banks from 1996 to 2002. He used the intermediation approach of DEA and determined the overall efficiency of all banks has been increased where new private banks scored higher efficiency than public sector banks and old private banks were having less efficiency compared to other banks. On the other hand, pure technical efficiency and Scale efficiency were highest among new private and foreign banks than the old private banks.

The reviewed Empirical studies conducted on the efficiency of banks in Asia, Europe, and Africa come up with diverse results. The findings of the authors are affected by different factors such as the financial policies of the countries, the range of the study period, and the specification of the role of the bank. The studies in general pinpoint that efficiency leads banks to grow more.

This study, however, was conducted using a cross-sectional study that has been done in analyzing the efficiency of Ethiopian private commercial banks using the DEA model. The study provided an answer to the efficiency inquiry of private commercial banks operating in Ethiopia. It measured the extent of technical efficiencies of individual private banks that is their resource utilization, the effect of staying in business and having large bank size on the efficiency of banks, and lastly rank them according to their efficiency scores for the 2013/14 fiscal year. And it tries to fill the research gap in the area of relative technical efficiency of private commercial banks operating in Ethiopia.

Literature on Efficiency in Banks

Efficiency is a measure of the deviation between actual performance and desired performance (Berger, Hunter, & Timme, 1993). Efficiency is determined either from the input side (input utilization) or the output side (output level). If the measurement bases input, the efficiency is comparing the observed level of input with the minimum input that could produce the currently achieved level of output. In the case of basing output, it is comparing the observed output with the maximum output possible for a given input level.

In the Literature on banking efficiency, there are two approaches to select the inputs and outputs for a bank. The first one is the production approach and the second one is the intermediation approach (Kumar & Gulati, 2008). The two approaches mainly differ in the specification of banking activities. As Benston (1965) initiated, the production approach treats banks as the providers of services. In this approach, the output denotes the service provided to the customers. It is measured by the number of transactions made and documents processed in providing the services over a given time period. On the other hand, the input represents physical variables (like labour, material, space) or their associated cost. The weakness of this approach is it focuses only on operating costs while ignoring interest expenses at all (Kumar & Gulati, 2008). The intermediation approach on the other hand treats banks as financial intermediaries channeling funds between depositors and creditors (Sealey, 1977). This approach is distinguished from the production approach in that it adds deposits to inputs, with consideration of both operating and interest costs. It accepts that the funds raised and the expenses incurred in the intermediation process are normally treated as inputs, whereas the funds loaned and income generated are regarded as outputs (Yilmaz, 2013). The criticism of this approach is that the inputs and outputs choice and grouping made by a researcher may not be accepted by others. And the approach admits no mechanisms for resolving such debates.

Researchers pointed out that neither of these two approaches is perfect because they cannot fully capture the dual role of banks as providers of transactions and financial intermediaries. Nevertheless, they suggested the intermediation approach for analyzing bank-level efficiency (Berger & Humphrey, 1997). Their reasons are intermediation approach measures outputs in currency terms that are readily available (Dollar, Birr, Euro...), and unlike the production approach it takes into account both operating expenses and interest expenses. In practice, the availability of flow data required by the production approach is usually exceptional rather than common. Therefore, as in the majority of the empirical literature, the intermediation approach is adopted in this study to select the inputs and outputs of the study.

The recent trend in measuring efficiency is using the frontier analysis method of Data Envelopment Analysis (DEA). The idea comes from the microeconomic theory of production. But unlike the production possibility in microeconomics, the DEA production frontier is not determined by some specific equation instead it is generated from the actual data for the evaluated decision-making units (DMUs). For that reason, the DEA efficiency score of a particular DMU is defined relative to the other DMU in a given sample but not by an absolute standard. This feature differentiates DEA from the parametric approaches that require a specific functional form. In addition, an extra DMU in a DEA cannot result in an increase in the efficiency scores of the existing DMUs implying no correlation exists between the sample size and efficiency (Sherman & . Gold, 1985).

The efficiency of the banking sector has been dealt with for years by several authors. Most authors have found and applied a non-parametric method, DEA to measure the relative efficiency of a set of similar units, usually referred to as decision-making units (DMU), or banks in this case (Sathye, 2003). DEA was first applied to measure banking efficiency (Sherman & . Gold, 1985).

The analysis provides results based on which we can determine how much some banks are inefficient compared to efficient banks in a given sample. For each inefficient bank, DEA identifies a set of corresponding efficient DMUs, known as ‘peers’ that can be used as indicators for improvement. After identifying the 'peer' for the bank DEA estimates efficiency by comparing it with that of the best-performing bank chosen from its peers. The best-performing bank is used as a reference to measure the efficiency of peer banks. These units constitute the referrals (standards) and ‘envelop’ the other banks and form the efficient frontier. The ability of the DEA to identify possible peers or role models as well as simple efficiency scores makes it preferable over other methods (Kumar & Gulati, 2008).

For efficient DMUs, there is no slack. Slacks exist for inefficient DMUs indicating the areas in which an inefficient DMU needs to improve to attain the status of an efficient one. To reach the efficiency frontier an inefficient DMU required improving its technical efficiency. That is proportionally reducing the inputs utilized given output. However, a DMU may not meet its efficient target if there are non-zero slacks. The presence of non-zero slacks for a DMU implies that the DMU under consideration can improve beyond the level implied by the estimate of technical efficiency. In the input-oriented DEA model, the input slack represents the excess input. Thus to reach the efficient target or frontier the DMU should again reduce the leftover portions of inefficiencies, and input Slacks (Jacobs et al., 2006, Kumar & Gulati, 2008).

Method of the Study

This paper intended to measure the efficiency of private commercial banks operating in Ethiopia. It attempted to measure the extent of relative technical efficiency and scale efficiency of individual banks and identified the effects of service age and bank size on efficiency. It also showed the gap in inefficiency and then gave ranks according to efficiency scores. The study adopted the Max DEA Pro software developed by Gang and Zhenhua (2009-2015) and STATA software. The source of the data was Annual reports of individual private banks, National Bank of Ethiopia quarter and annual reports, and publications.

The sample included all 16 private commercial banks currently operating in Ethiopia for the period of 2013/14. The period was chosen to include all private commercial banks in operation. It is possible to measure efficiency by taking one year of data in the case of DEA analysis (Hoque & Rayhan, 2013), using DEA to measure the efficiency of 24 banks in Bangladesh for the year 2010 only.

To ensure meaningful efficiency scores, the number of banks must be large enough to the total number of inputs and output. The number of banks (n) as per (Vassiloglu & Grokas, 1990), should be threefold to the sum of inputs and outputs. In this study, the number of inputs is four and the outputs are two n= 3 (2+4) = 18, but the number of private commercial banks in the country is 16. Thus, all the private commercial banks in Ethiopia, (16) are included in the study to describe the entire banks in the sector.

DEA is one of the most used non-parametric approaches. It is implemented in this study to estimate the relative technical efficiency and inefficiency of Ethiopian private commercial banks. DEA is found the best fit for this study due to, among others, its importance to working well for small sample size data. In this study, a single stage DEA approach is implemented. As in the majority of the empirical literature, regarding the input and defining the bank's role the study adopts the input-oriented intermediation approach.

In the banking sector, multiple inputs are employed to produce multiple outputs. A long-sustaining debate by authors in this regard is what should constitute the input and output part

(Casu & Girardone, 2002, Sathye, 2003). Many base their area and target of study to classify what should be input and which one should be categorized as output. The very debatable one is a deposit. Though it is commonly classified as output in the production approach, authors implementing intermediary approach are ambivalent in determining the role of deposit. Some authors categorizes it as input (Karimzadeh, 2012; Maletic, Kreca, & Maletic, 2013; Dash & Charles, 2009). But others treat it as the output such (Saha & Ravisankar, 2000; Mukherjee, Nath, & Nath Pal, 2002). Even some other authors take a deposit as both; input and output (Berger & Humphrey, 1997).

To measure the technical relative efficiency of the banks under consideration and to capture as many important factors of banks' inputs and outputs within the available data, four input variables, and two output variables were sought, as shown in Table 1.

Table 1

Input and Output Variables Used

Inputs	Output
Total deposits: Total deposits mobilized	**Loan:** Total loans and advances availed
Branch number: bank size or Number of branches opened by the banks	**Profit:** Gross Profit before tax
Staff size: number of employees of the bank	
Capital employed: Total capital	

Source: Researcher’s elaboration

Using multiple inputs and multiple outputs to determine efficiency is a recent phenomenon of the 1970s. Farrell (1957), states utilizing single input and a single output to estimate the relative technical efficiency of DMU by adopting the Linear Programming method. This was later developed considering multiple inputs and output by Charnes A (1978) assuming constant returns to scale (CRS) and then further expanded by R. D. Banker (1984) considering variable returns to scale (VRS).

Under the input-oriented approach, which this study applied, the two basic models of Data Envelopment Analysis CCR and BCC models seek to minimize inputs at the given level of output. The linear mathematical formulation used to calculate scores efficiency with the input-oriented CRS model is presented as follows:

Let us consider there are m input items and s output items for every DMU (N). The input and output for DMUj be (x1j, X2j..., Xmj) and (y1j, y2j…,ysj), respectively.

Where; DMUj where j = 1,….,N

Input (x): m number of input items: xi where i = 1,…,m

Output (y): s number of output items: yr where r = 1,…,s

Thus the input X and the output Y data matrixes can be arranged as:

$$
\boxed{\text{X (input) } =} \quad \begin{pmatrix} x11 & x12 & \ldots\ldots\ X1N \\ x21 & x22 & \ldots\ldots x2N \\ . & . & . \\ . & . & . \\ xm1 & xm2 & \ldots\ldots xmN \end{pmatrix}
$$

$$
\boxed{\text{Y (output) } =} \quad \begin{pmatrix} y11 & y12 & \ldots\ldots\ y1N \\ y21 & y22 & \ldots\ldots y2N \\ . & . & . \\ . & . & . \\ ys1 & ys2 & \ldots\ldots ysN \end{pmatrix}
$$

Where X is (m * N) matrix and Y is a (s*N). So in the case of this study there are four inputs x1j, Branch Number (BR), x2j, Staff size (SS), x3j,Deposit (DP), and x4j, Capital (CP) and two outputs y1j, Loan and Advances (LA), y2j, Profit (Pft) and the number of DMUs (banks) under study are 16. The input-output data matrix represents the data of all DMUs can be presented as:

$$\text{Input)} = \begin{pmatrix} BR1 & BR2 & BR3 & BR4 & BR5 \ldots\ldots. BR16 \\ SS1 & SS2 & SS3 & SS4 & SS5 \ldots\ldots.SS16 \\ DP1 & DP2 & DP3 & DP4 & DP5\ldots\ldots.DP16 \\ CP1 & CP2 & CP3 & CP4 & CP5 \ldots\ldots. CP16 \end{pmatrix}$$

$$\text{Output)} = \begin{pmatrix} LA1 & LA2 & LA3 & LA4 & LA5 \ldots\ldots. LA16 \\ Pft1 & Pft2 & Pft3 & Pft4 & Pft\ 5 \ldots\ldots.Pft\ 16 \end{pmatrix}$$

Efficiency is measured as the ratio of all outputs to all inputs. For each DMU, a measure of the ratio of all outputs over all inputs such as u'y⁄v'x as efficiency score should be obtained. Then to select the optimal weights the mathematical programming problem is written as follows:

$$\text{Max}_{\,ur,vi}\ (u_r'y_{rj}/v_I'x_{ij}), \qquad (1)$$

$$\text{Subject to: } u'y_r/v'x_j \leq 1,$$

$$j=1,2,\ldots,N$$

$$u, v \geq 0$$

Where,

ur = weights of output r: where r = 1,…,s

vi = weights of input i: where i = 1,…,m

yrj = amount of r produced by DMUj

xij = amount of input i used by DMUj

The purpose is to obtain weights (vi) and (ur) that maximize the ratio of DMUj, the DMU being evaluated, subject to the constraint that all efficiency measures must be less than or equal to one. Efficiency value takes the values between zero and one.

The problem attached with this ratio formulation is that it has an infinite number of solutions. To avoid this, the constraint v'xi =1 is imposed which provides:

$$\mathrm{Max}_{\mu,\sigma}\ (\mu' yi)\ , \qquad (2)$$
$$\mathrm{S.t.}\ \sigma ixi = 1$$
$$\mu' yj - \sigma' xj \leq 0,\ j=1, 2, \ldots, N$$
$$u, v \geq 0$$

Where u's and v's are replaced with μ's and σ's. This change reflects the transformation, called the multiplier form of the linear programming problem. Using the duality property of this linear programming problem it is possible to derive an equivalent envelopment form of this problem:

$$\mathrm{Min}\ \boldsymbol{\theta}\lambda\boldsymbol{\theta}, \qquad (3)$$
$$\mathrm{St} - yi + Y\lambda \geq 0,$$
$$\boldsymbol{\theta} xi - X\lambda \geq 0,$$
$$\lambda \geq 0,$$

Where Y is a vector of all outputs of every DMU and X is the vector of all inputs of every DMU; **θ** is a scalar and **λ** is an N*1vector of constants. The value of **θ** obtained will be the efficiency score for the i^{th} DMU.

The above approach takes into consideration the CRS that is applicable when all banks are operating at an optimal scale. But in reality, banks operate at un-optimal scale because they are in imperfect competition market environment. To take into account changes in scale economies (VRS) the above approach can be modified by adding the convexity constraint N1' λ = 1:

$$\mathrm{Min}\ \boldsymbol{\theta}\lambda\boldsymbol{\theta}, \qquad (4)$$
$$\mathrm{St} - yi + Y\lambda \geq 0,$$
$$\boldsymbol{\theta} xi - X\lambda \geq 0,$$
$$N1'\lambda = 1$$
$$\lambda \geq 0,$$

Where N1’ is a N*1vector of 1. This condition ensures that an inefficient bank is “benchmarked” against similarly sized banks. As a result, VRS method envelops the data more closely than CRS method. So that VRS efficiency scores are greater than or equal to CRS efficiency scores.

Result and Discussion

Data Analysis and Interpretation

The data from all private banks operating in Ethiopia is collected on the selected input and output variables such as staff size, branch number, deposit, capital employed, loan and profit before tax and other factors. Here below the statistical summary of the collected data is presented using STATA.

Table 2

Statistical Summary

Variable	Obs	Mean	Std. Dev.	Min	Max
bank	0				
yearest	16	2004.5	6.772493	1994	2013
serviceyear	16	9.5	6.772493	1	20
branch	16	72.25	44.7072	4	150
efficiency	16	.943125	.0761331	.78	1
staff	16	1672.125	1460.961	103	4787
capital	16	1111.375	837.6154	181	2598
deposit	16	5866.563	5256.844	500	17681
ineff	16	.056875	.0761331	0	.22
profit	16	294.875	277.8899	19	957
loan	16	3348.75	2949.512	270	9570

Source: Researcher’s Calculation from data collected

In fact, DEA is not a central tendency type of approach as regression. And no need to form a single estimated equation to applied to each observation vector. In DEA, each DMU analyzed separately to produce individual efficiency measures.

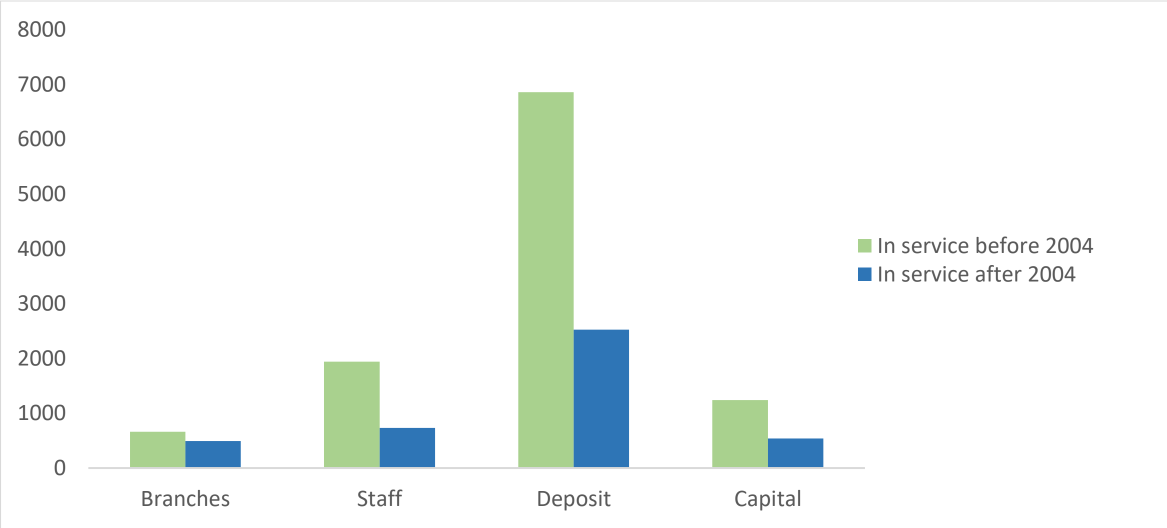
When comparing the resource mobilization of those banks taking the mean year, 2004 as a benchmark; comparing those operating for above 10 years against the young banks that gave service for less than a decade. There are six banks AIB, DB, BoA, WB, UB, and NIB, which are established before 2004, the mean year. These banks together grabbed the major share of resources in the sector than the resources held by the other 10 banks in total.

In almost all the inputs considered in this study, these six banks have taken the lion's share among the 16 private banks in the sector. As it is indicated, the six banks in total seized 57% of branches opened throughout the country by private banks, the other 10 banks that are established after the mean year could possess 43% of the total branches. Among the total personnel working in the private banking sector, 73% are employed by these six banks and the rest 27% got employment chance at the other 10 banks.

Out of the total deposit mobilized and loans and advances availed in 2014, the six banks took the share of 73% in both cases and 27% by other banks. Regarding the Capital accumulated as at 2014, 70% belonged to the preceding six banks and 30% was seized by the rest banks. In connection with the profit earned during the year 2014, 71% was grasped by the six preceding banks and 29% of the profit was generated by the banks established after the mean year, 2004. Here in Figure, the share of resources with these two categories is portrayed by taking the four input resources; branch size, staff size, deposit mobilized and capital accumulated. It is clearly seen that there is totally dominance in all of the four major resources.

Fig1

Share of Bank Resources



Source: Researcher's elaboration

DEA analysis results

In this part, the technical efficiency difference between Ethiopian private commercial banks is analyzed using the input-oriented CCR model, assuming Constant Returns to Scale – CRS and BCC model, assuming Variable Returns to Scale. All the CRS (input-oriented), VRS (input-oriented), and scale efficiency scores of the banks along with the peers are tabulated herewith.

Table 3

Summary of DEA Software Result of Input-Oriented CRS, VRS And NIRS Returns to Scale

Property	Value	Value	Value
Model Type	Envelopment Model	Envelopment Model	Envelopment Model
Number of DMUs	16	16	16
Number of Inputs	4	4	4
Number of Outputs	2	2	2
Distance	Radial	Radial	Radial
Orientation	Input-oriented	Input-oriented	Input-oriented
Returns to Scale	Constant	Variable	Non-increasing
Slack Computation	1 Stage	1 Stage	1 Stage
Elapsed Time	1 Seconds	1 Seconds	0 Seconds

Source: Stata Output

CRS- Input

Under the CRS-input results, eight banks are found technically efficient (scores 1) - AIB, DB, NIB, CoBO, ZB, ABB, AdIB, and ENB. The other eight banks are found technically inefficient. The highest technical inefficiency is observed in DGB (0.78), WB (0.83), and BeIB (0.84). And the least technical inefficiency is shown on BIB (0.98), BoA (0.97) and UB (0.93).

It indicates that the highest inefficient bank DGB is able to reduce the consumption of all inputs by 22%, (i.e. 1-0.78) without reducing its output. Similarly those technically inefficient banks need to reduce their consumption of all inputs with 1- their efficiency scores. The average efficiency level of the private banks under study is 94.31%. This depicts that the inputs utilized could be reduced by 5.69% without affecting the current output produced.

Though the 8 banks have a technically efficient score of one, NIB is taken as the most efficient bank because it is referred to 7 times as a benchmark for other banks than any of the other seven technically efficient banks. Whereas AdIB bank has no peer (Zero frequency count), though they are technically efficient. This characteristic is termed in DEAs 'efficient by default' because the bank does not possess the characteristics to be taken as reference by other inefficient banks. The technical efficient banks are the peer themselves only. It is, therefore, possible to rank the banks according to the number of peer counts.

VRS-Input

Under the VRS input results, 10 banks are observed to be technically efficient with a score one that includes AIB, DB, NIB, CoBO, ZB, BIB, ABB, AdIB, DGB, and ENB. The other 6 banks, BoA, WB, UB, LIB, OIB, and BeIB are technically inefficient. They score technical efficiency less than unity. The number of efficient banks is high in VRS than in CRS because in the VRS method, inefficient banks are benchmarked against similarly sized banks. This brings the two banks BIB and DGB that were classified as inefficient in CRS assumption to join the technical efficiency in the case of VRS assumption by scoring one.

The CoBO bank in the VRS-input analysis is found the most referred bank than any of the other efficient banks. It is referred to seven times by the inefficient banks in the sample. Thus, it is taken as the most efficient bank in the case of VRS-input followed by NIB bank which appeared five times in the reference set. The most inefficient bank in VRS input analysis was WB followed by LIB and BeIB. AIB and BIB have Zero frequency count and are efficient by default. That means the banks are not efficient enough to be taken as a role model by other inefficient banks.

Scale Efficiency

The input scale efficiency (SE) score is obtained from the CRS and VRS efficiency scores. The SE score is the ratio of CRS score to VRS Score. If the input scale efficiency score of a DMU is equal to one then it is considered as scale efficient. From this perspective 9 banks; AIB, DB, BoA, NIB, CoBO, ZB, ABB, AdIB, and ENB are scale efficient as their input scale efficiency scores are equal to one.

Out of the scale efficient banks the 6 banks DB, NIB, CoBO, ZB, ABB, and ENB are found to fulfilling technical efficiency in both CRS and VRS measures and have one and more peer counts. The banks are also scale efficient meaning they are operating at optimal scale, CRS. On the other hand, AIB and AdIB banks are technically efficient in both measurements and are scale efficient, but they have no peer counts in CRS measures for AdIB and VRS measures for AIB. The such seldom appearance of efficient banks in the reference set of inefficient banks is likely to possess a very uncommon input/output mix. Thus, they are not suitable examples to share for other inefficient banks.

Whereas 7 banks; DGB, BIB, WB, UB, LIB, OIB, and BeIB are scale inefficient. DGB is inefficient in CRS measures and is scale inefficient, but found efficient from VRS measures point of view. The rest five banks - WB, UB, LIB, OIB, BeIB, and AdIB are inefficient in all cases (CRS, VRS, and SE).

A mere measure of scale efficiency (SE) does not indicate whether the DMU under consideration is operating in the area of increasing returns to scale (IRS) or decreasing returns-to-scale (DRS). The non-increasing returns to scale (NIRS), is used to check the return to Scale (RTS) area of operation. It helps to know whether the bank is operating in increasing returns to scale (IRS) or Decreasing returns to scale (DRS) area (Coelli, 1996).

The NIRS technical efficiency scores show that eight banks listed in Table below and are operating in un-optimal scale size and experiencing variable returns to scale. IRS exists for DGB, BIB, BoA, UB, LIB, OIB, and BeIB banks. But the DRS exists for WB bank only.

Slacks

The movements toward efficiency involve scaling up or down of size based on the efficiency of the best practice reference unit. This pinpoints that the excess inputs utilized by the inefficient banks should be reduced. This information can be identified from the value of the slack in the DEA analysis (Kumar & Gulati, 2008). There are no input and output slacks for efficient banks that are supposed to use the inputs efficiently to produce their current output. So that no need of changing inputs and outputs for the 8 efficient banks; AIB, DB, NIB, CoBO, ZB, ABB, AdIB, and ENT.

There exist input and output slacks for inefficient banks. Some of the banks have input slacks and others faced output slacks. There are certain banks that exhibited both input and output slacks. Out of the 8 inefficient banks WB, OIB, and BeIB banks have only input slacks and UB has output slacks. Whereas, BoA, LIB, BIB, and DGB banks have faced both input and output slacks.

Tables 4 presented the details of areas of efficiency improvement needed for the inefficient banks exhibiting input slacks to reach their efficiency target.

Table 4

Input Slacks and Targets for Inefficient Banks (CRS Input)

DMU	Input Slack				Efficient Input Target			
	Branch	Staff	Capital	Deposit	branch	Staff	Capital	Deposit
BOA	0	-90.51	0	0	100	2,709	1529	9,096
WB	0	-401	-146.97	0	95	2,376	1,997.03	8400
UB	0	0	0	0	94	2,424	1575	9402
LIB	-22	-13.45	0	0	40.46	803	628	2687
OIB	-29	-531	0	-30.14	77.1	1352	748	4,973.86
BIB	-34	0	0	0	25.55	550	517	2152
BeIB	-12	-80	-90.22	0	33	613	463.78	2012
DGB	-10	-140	-44	0	8.57	189	137	500.2

*Note that branch number and staff size rounded to the nearest value
Source: Researcher's calculation

Table 5 presented the details of areas of efficiency improvement needed for the inefficient banks exhibiting output slacks to reach their efficiency target.

Table 5

Output slacks and targets for inefficient banks (CRS input)

DMU	Output Slack	Efficient Output Target		
	Profit	deposit	Loan	Profit
BOA	152.95	9,096	5,153	504
WB	0	8,400	4,604	414
UB	162.07	9,402	5,070	523
LIB	15.07	2,687	1,562	142
OIB	0	4,974	2,517	205
BIB	11.02	2,152	1,360	119.02
BeIB	0	2,012	1,185	122
DGB	1.82	500	270	20.82

Source: Researcher's calculation

To sum up the slacks analysis of the 8 inefficient banks, Table 4, and Table 5 depict that among the input variables, 5 banks have non-zero slacks for branch size, 6 banks have non-zero slacks for Staff size and 3 banks have non-zero slack for capital and one bank for deposit. Regarding non-zero slacks for output variables, it has been observed that 5 banks have nonzero slacks for profit but no non-zero slack has been observed for Loan.

Input-output slacks and the frontier line

Banks on the efficiency frontier line are taken as efficient, but any deviation above and to the right of the frontier line is taken as inefficiency. This is portrayed graphically using the four inputs utilized. It is presented in two parts by combining two inputs and single outputs at a time for demonstration purposes. This is because of the difficulty to show multi-input – multi-output variables in a two-way graph at once. Thus, in the first party, the input variables used are branch size and staff size, with the output variable profit and in the second part, the input variables taken are Deposit and Capital with the out variable, profit. The Loan is not taken as an output in the demonstration because there was no non-zero slack value.

In the first part the staff size and branch, combination to get the profit is portrayed in figure 2. As it is discussed previously in Table 4, the branch and staff exhibited the highest input slack. The branch slack exhibited has been five, and the staff slacks six. In the output slack Table 5, there was slack only for profit (five non-zero slack). Whereas there was no non-zero slack for the loan.

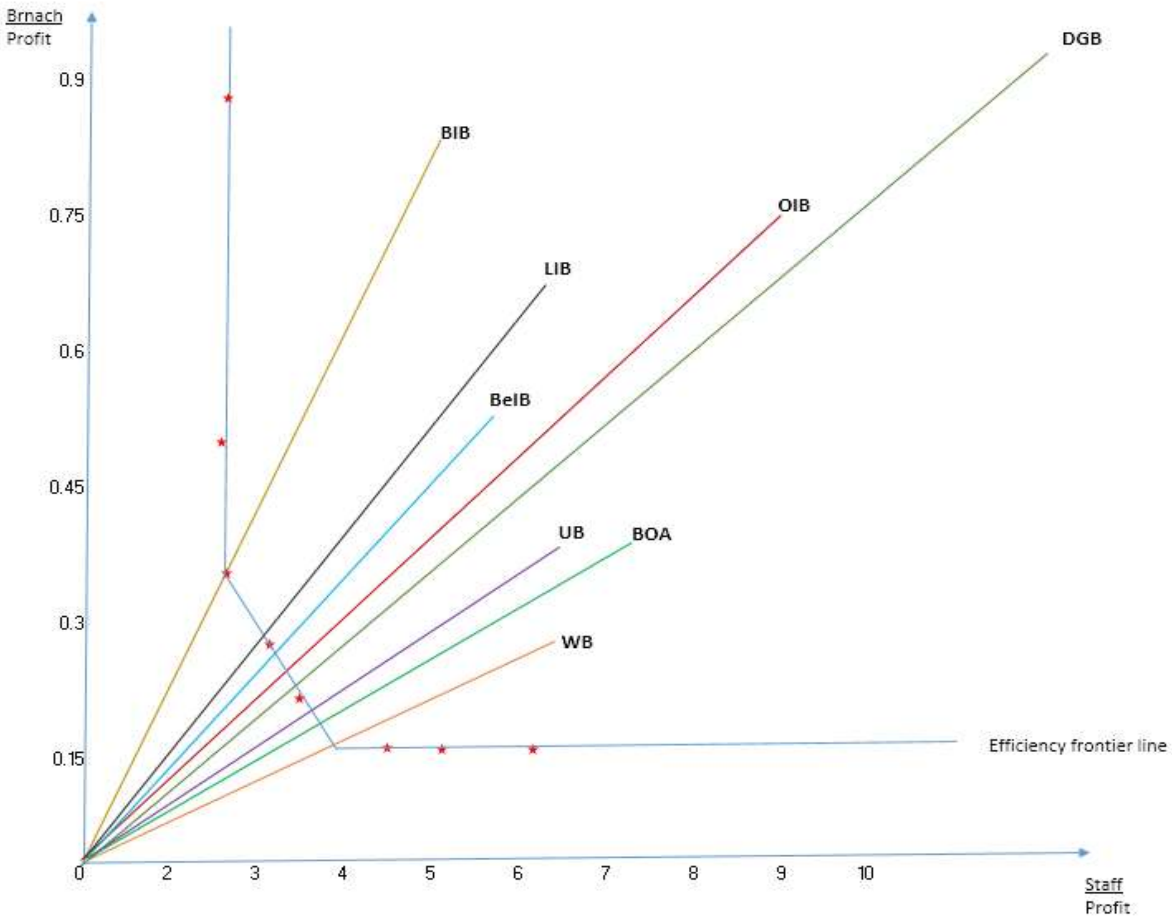
As it is depicted in Figure 2, using the two input combinations the eight banks AIB, DB, NIB, CoBO, ZB, ABB, AdIB, and ENB are the efficient banks that defined the frontier. The other eight banks BoA, UB, WB, LIB, OIB, BIB, BeIB, and DGB are the inefficient banks that lie off (above and to the right of) the efficiency frontier. For an inefficient bank, the distance from the origin to the frontier line shows technical efficiency.

For the inefficient banks, the line from the origin passes the efficient frontier line to the point above and to the right of the frontier. The distance from the frontier to the above points shows technical inefficiency. It denotes excess input utilized by the particular bank to produce the same output. The bank could proportionally reduce all inputs utilized (by the ratio of excess input utilized to total input) but still could produce the same output.

The figure below clearly depicted that there is high inefficiency in DGB bank. The bank is ranked last in efficiency with the lowest efficiency score of 0.78. It has exhibited a 22% excess input utilization than is required for producing the current output.

Fig. 2

Branch-Staff Combination to Generate Profit



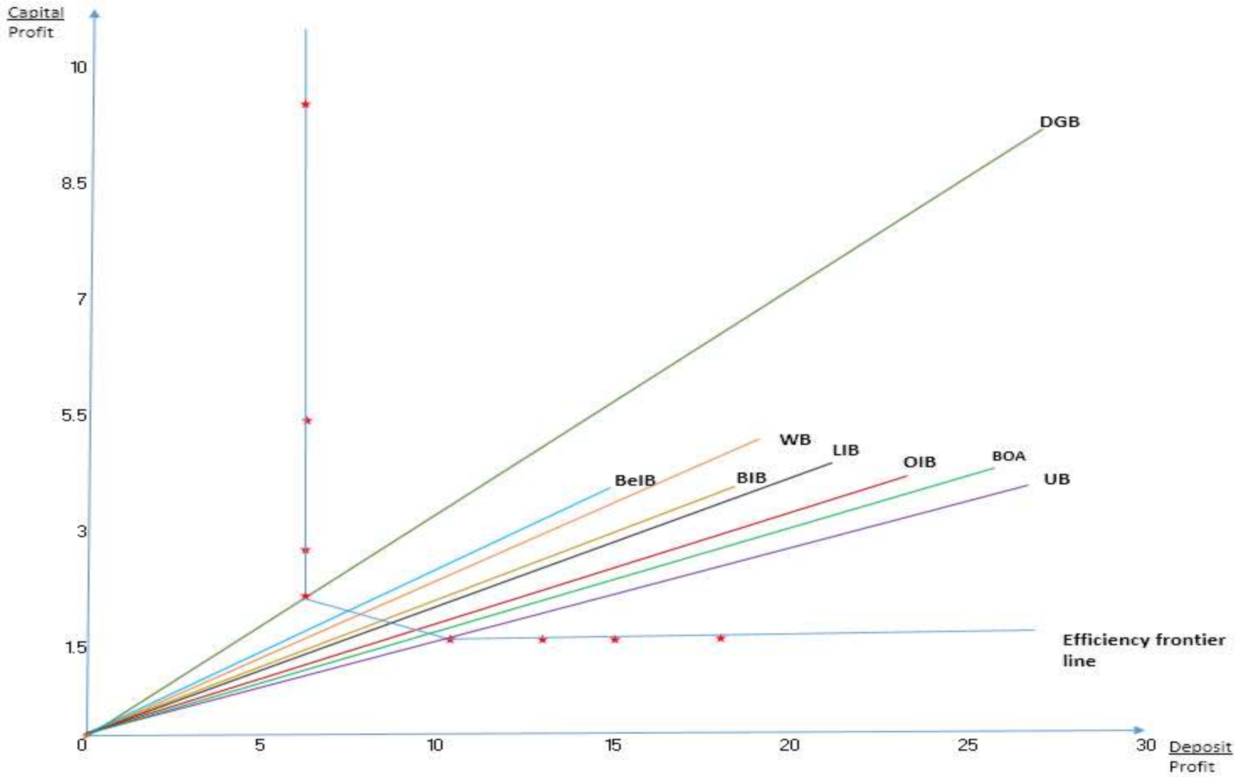
Source: Researchers' elaboration

The second part used the other two inputs, the Deposit and Capital combination in generating profit. The two inputs had non-zero slacks as it was depicted in Table 4. There was three non-zero slack for capital in connection with WB, BeIB, and DGB banks. While Deposit had only one non-zero slack from OIB bank. The output variable taken is profit. The result shows five banks (BoA, UB, LIB, BIB, and DGB) have a profit slack. The inefficiency in the combination of the two inputs (Capital and Deposit) to produce the output is portrayed in figure 3 below.

Alike the result obtained from the branch and staff combination in generating profit, the DGB bank still found it inefficient in capital and deposit combination to generate profit. The bank's position is found inefficient with higher inefficiency than presented in any other banks.

Fig. 4

Capital-Deposit Combination to Generate Profit



Source: Researchers' elaboration

Efficiency to Service year and bank size

In this study, private commercial banks with service years of 1 to 20 years and branch sizes of a minimum of 4 and a maximum of 150 are included. From the efficiency result discussed above it is found that banks with various sizes and service years have been found in both technical efficiency and inefficiency groups. As it is depicted in Table 6., CoBo, ZB, ABB, AdIB, and ENB banks achieved efficiency despite staying less than the mean service year (9.5 years) in the banking industry. On the contrary BoA, WB, and UB banks with a long year in service (above the mean year, 9.5) were inefficient.

On the other hand, as the longest-staying banks are efficient the last entrant banks are also found to be efficient. From the long staying banks; AIB (20 years), DB (19 years), and NIB (15 years) are efficient. The same efficiency score of unity was achieved by the last entrant banks despite their staying in the banking industry for 5 and a few years. Such banks include ZB (5 years), ABB (4 years), AdIB (4 years), and ENB (1 year).

Inefficiency has also appeared regardless of the age of the banks. From old banks BoA (18 years in service), WB (17 years), and UB (16 Years) were inefficient. There was also inefficiency in the young banks. Among the young banks with inefficiency were LIB (8 years in service), OIB (6 years), BIB (5 years), BeIB (4 years), and DGB (2 years). These banks have scored less than unity and are found inefficient irrespective of their staying in the banking business.

Table 6

Efficiency Difference Between Banks as Per Their Service Year and Branch Size (CCR Model)

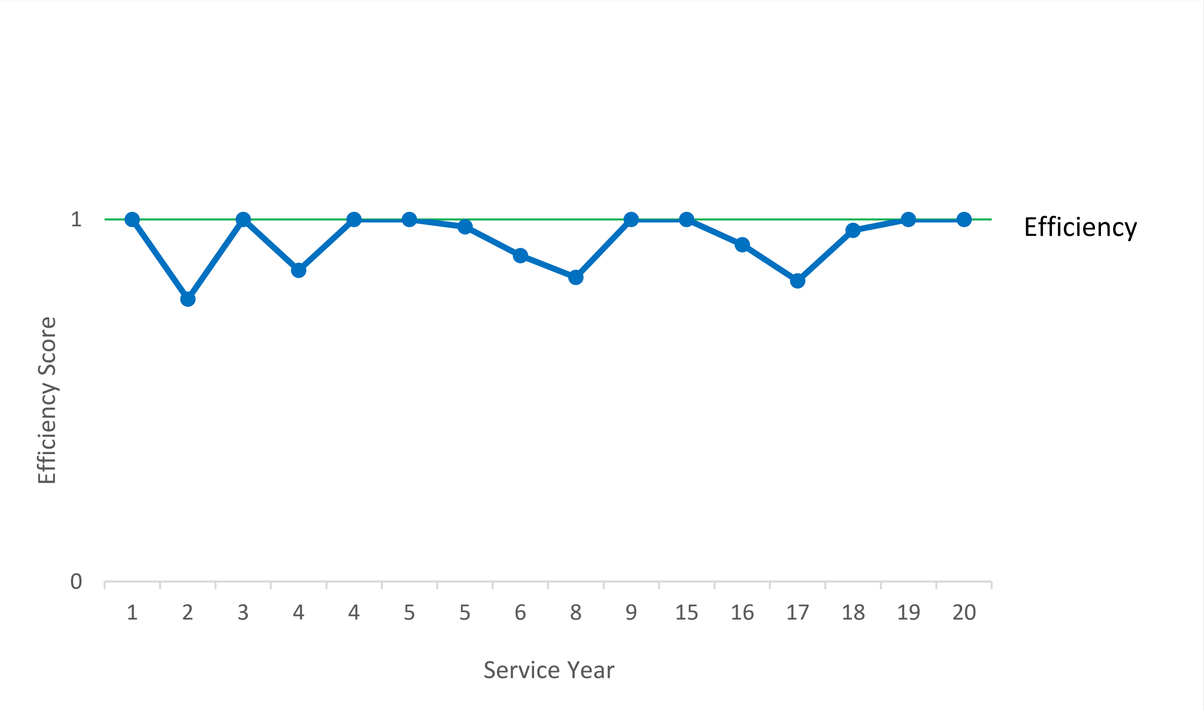
Bank	Branch	Service Year (up to 2014)	Efficiency score (CCR Model)
AIB	150	20	1
DB	133	19	1
BoA	100	18	0.97
WB	95	17	0.83
UB	94	16	0.93
NIB	88	15	1
CoBO	106	9	1
LIB	62	8	0.84
ZB	5	5	1
OIB	106	6	0.9
BIB	60	5	0.98
BeIB	45	4	0.86
ABB	71	4	1
AdIB	18	3	1
DGB	19	2	0.78
ENB	4	1	1

Source: Researcher's calculation

The Fig 4. below, shows that the service year effect on efficiency is not constant and unevenly distributed. There are points that touch the efficiency line (Score 1) representing efficient banks irrespective of their age or year of service in operation. Similarly, there are points far apart from the efficiency line from both categories, young banks and old banks.

Fig. 4

Efficiency on Service Year



Source: Researchers' elaboration

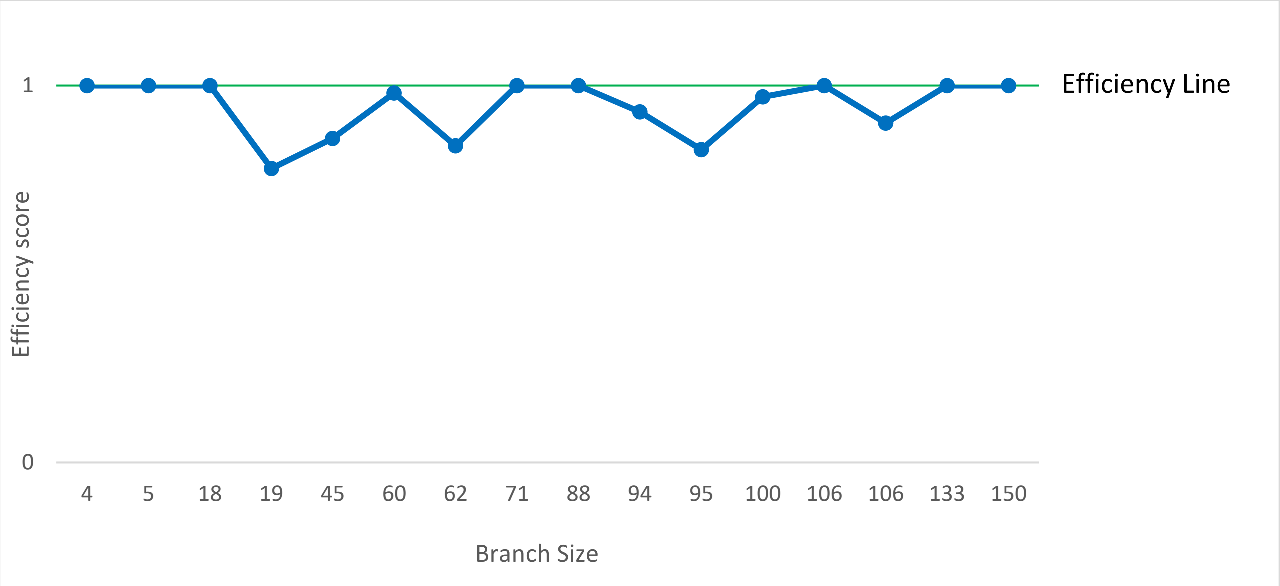
The same result was obtained when comparing the efficiency result of banks with branch numbers. The previous Table 6, shows that there were banks with a large number of branches that was found inefficient. Conversely, there were banks, which are efficient, despite having few numbers of branches. Using the mean branch size 72 (Table 2.), as a benchmark half of the banks in the sample have above the mean branch size, and the other half possessed below 72 branches.

Among the banks with large branch sizes four banks, AIB (with a branch size of 150), DB (133 branches), NIB (88 branches), and CoBO (106 branches) were efficient. But BoA (100 branches), WB (95 branches), and UB 94 branches found inefficient though they have large branch sizes. Regarding banks with few branch numbers, who possessed less than the average 72 branches, four banks ZB (5 branches), ABB (71 branches), AdIB (18 branches), and ENB with 4 branches achieved efficiency. Of course, there were also four branches with less than the mean branch level that encountered inefficiency. It includes LIB (62 branches), BIB (60 branches), BeIB (45 branches), and DGB (19 branches).

The branch size to efficiency relation is portrayed in fig 5, which shows that at both ends there are banks that scored unity and touched the efficiency line regardless of the branch number they possessed.

Fig 5

Efficiency on Branch



Source: Researcher's elaboration

Conclusions and Recommendations

This thesis endeavors to evaluate the extent of technical efficiencies in Ethiopian private commercial banks using cross-sectional data for 16 private banks in the year 2013/14. The study included private commercial banks with service years of 1 to 20 years and branch sizes of a minimum of 4 and a maximum of 150. To realize the research objectives, a single-stage DEA approach has been applied in which the estimates of technical efficiencies for individual private banks have been obtained by CRS assumptions of the CCR model. The study followed an input-oriented intermediation approach to select input and output variables. The input vector contains four inputs; Branch number, Staff size, Capital, and Deposit, while the output vector contains two outputs; Profit and Loan.

The results indicate that out of the 16 Private commercial banks operating in Ethiopia, 50% of them (eight banks), AIB, DB, NIB, CoBO, ZB, ABB, AdIB, and ENB are technically efficient and the other half, or eight banks, BIB, BoA, UB, OIB, BeIB, LIB, WB and DGB are found technically inefficient. On the basis of peer count in the reference set of inefficient banks, NIB bank is the most efficient bank (CRS-Input) followed by CoBO and DB banks. On the contrary, the worst performer banks in the sample have been noticed to be DGB, followed by WB and LIB banks.

From the CRS-Input analysis result, the average efficiency level of Ethiopian private commercial banks is found to be 0.94 implying a 5% inefficiency in input utilization. The sources of the technical inefficiency of Ethiopian commercial private banks have been poor input utilization; particularly there is high inefficiency in branch expansion and staff utilization. A scale inefficiency that is a failure to operate at the most productive scale size is also observed. The most scale-inefficient private commercial bank was DGB.

The study tried to exhibit areas of efficiency improvement needed for the inefficient banks exhibiting input slacks to reach their efficiency target. The direction for improvement in the operations of inefficient banks was assessed by carrying out Slacks and targets setting exercises. The result indicated there were several banks that require scaling up and some scaling down their size. From the analysis of returns-to-scale, it has been noticed that only WB bank operates in the zone of DRS, and should downsize its input utilization to reduce input cost and then observe efficiency gains. The other 7 banks, DGB, BIB, BoA, UB, LIB, OIB, and BeIB operate in a zone of increasing returns to scale. This implies the banks were operating below their optimal scale size, therefore, they should scale up their size of operations.

The assessment of the effects of having to stay for ages in the banking business revealed it has less contribution to efficiency. The youngest banks could achieve efficiency as the old banks.

ENB bank which is the last entrant with only one year in service has been efficient as the oldest private commercial bank, AIB that stayed in for 20 years in the banking business. This implies that efficiency is not determined by the age of the bank. The longest staying in the banking industry might not end up in achieving efficiency.

Regarding having a large branch size, the study revealed that, as the two largest banks AIB (branch number 150) and DB (branch number 133) are efficient, the two smallest banks ZB (branch number 5), and ENB (branch number 4) are also found efficient, scoring efficiency result of one. Likewise, BoA with branch number 100 and DGB with branch number 19 are both inefficient irrespective of their branch size. Therefore, in the case of Ethiopian private commercial banks possessing many branches is not a guarantee to secure efficiency.

On the whole, the study suggested that there is ample scope for improvement in the performance of inefficient banks by choosing a correct input-output mix and selecting an appropriate scale size. Banks should give due concern in their branch expansion plan, loan their excess deposit to reduce inefficiency thereby augmenting their profit, reconsider their staff concentration size and adopt technologies to improve their efficiency, and, regulate their scale of operations by investigating their operation level.

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