Technical and Scale Efficiency of Private CommercialBanks in Ethiopia: UsingData Envelopment Analysis (DEA)

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By: Mulualem Gizaw

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Statement of Declaration

I, Mulualem Gizaw declared that this thesis with a topic of “Technical and Scale Efficiency of Private Commercial Banks in Ethiopia: Using Data Envelopment Analysis (DEA)” is my original work and has not been presented to any other university to earn a degree or diploma.

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Mulualem Gizaw

Statement of Certification

This is to certify that the thesis prepared by Mulualem Gizaw, entitled: "Technical and Scale Efficiency of Private Commercial Banks in Ethiopia: Using Data Envelopment Analysis (DEA)" and submitted in partial fulfillment of requirements for Degree of Master of Business Administration in Finance compiles with the regulation of the University and meets the accepted standard with respect to originality and quality under the supervision of Habtamu Berhanu (PhD)

Advisor Habtamu Berhanu (PhD) Signature _____ Date_____

Examiner Alem Hagos (PhD) Signature _____Date _____

Examiner Zenegnaw Abiy (PhD) Signature _____Date_____

Abstract

As banks are the main actors in the financial sector of Ethiopia, their efficiency should be measured appropriately. The main objective of this study is to measure technical and scale efficiency of private commercial banks in Ethiopia for 10 years period from 2009 to 2018. The study adopted descriptive research design and quantitative research approach and the study used secondary source of data observes from all 16 private commercial banks annual report and from the National bank of Ethiopia. To measure technical and scale efficiency of the banks, the study used Data Envelopment Analysis method (DEA). Form the period of 10 years under the study only in one year in 2013 from the entire banks 50% of the sample banks fully efficient. The finding of the study revealed that ADIB, AIB, BB, DGB, EB and ZB were 100% efficient banks and OIB is the least efficient bank in resource utilization and WB were scale inefficient from the entire sample banks. The mean efficiency of PCBs for OTE, PTE, and SE is 91%, 92.33% and 98.56% respectively. Also the finding shows that all inefficient banks need improvement in both input variables, for DEPO the banks slacks values is lies between 3.90% and 23.70%, in case of NON-IE the slack value is lies between 2.70% and 23.70%. For NON-II (output variable) only five banks need improvements which are BOA, BUIB, CBO, NIB and UB with a percentage of 16.85%, 9.23%, 11.53%, 19.31% and 18.48% respectively. According to the outcome of the study mostly the cause of overall technical inefficiency is managerial inefficiency (inefficient utilization of resource) rather than scale inefficiency. The researcher recommends that inefficient banks should learn from the efficient banks especially from ZB and ADIB and banks need to giving updated training to their manager's.

Keywords: Technical Efficiency, Scale Efficiency, Data Envelopment Analysis

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Abbreviation and Acronyms

AB	ABAY BANK
ADIB	ADDIS INTERNATIONAL BANK
AWB	AWASH BANK
BB	BERHAN BANK
BCC	BANKER CHARNES CUPER
BOA	BANK OF ABYSSINIA
BUIB	BUNNA INTERNATIONAL BANK
CBO	COOPERATIVE BANK OF OROMIA
CRS	CONSTANT RETURN TO SCALE
DB	DASHEN BANK
DEA	DATA ENVELOPMENT ANALYSIS
DEPO	DEPOSIT
DFA	DISTRIBUTION FREE APPROACH
DGB	DEBUB GLOBAL BANK
DMU	DECISION MAKING UNIT
EB	ENAT BANK
FDH	FREE DISPOSAL HULL ANALYSIS
FRA	FINANCIAL RATIO ANALYSIS
LIB	LION INTERNATIONAL BANK
MAX	MAXIMUM
MIN	MINIMUM
NIB	NIB INTERNATIONAL BANK
NON-IE	NON-INTEREST EXPENSES

NON-II	NON-INTEREST INCOME
OBS	OBSERVATION
OIB	OROMIA INTERNATIONAL BANK
OTE	OVER ALL TECHNICAL EFFICIENCY
TFA	THICK FRONTIER APPROACH
PCBS	PRIVATE COMMERCIAL BANKS
PTE	PURE TECHNICAL EFFICIENCY
SD	STANDARD DEVIATION
SE	SCALE EFFICIENCY
SFA	STOCHASTIC FRONTIER ANALYSIS
TOL	TOTAL LOAN
UB	UNITED BANK
VRS	VARIABLE RETURN TO SCALE
WB	WEGAGEN BANK
ZB	ZEMEN BANK

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the study

A financial sector which allocates resources efficiently is the engine that drives economic growth of any country (Kamau,2011). Strong financial system promotes investment by financing productive business, mobilizing savings, facilitating trade activities and the financial sector as a whole plays a key role in allocating the economy's financial resources (Kizito, 2012). Banking industry is one of significant sectors of the financial system in most countries (San &Heng, 2013). Commercial Banks plays an imperative part within the economic improvement of the nations by allocates resource and by interfacingfinancial specialists with savers (Okoth et al. 2013 as cited in Kokobe&Birhanu 2015). Evaluating economic performance of banks is important to society because if the financial institutions operate more efficiently, they will earn greater profit and increase liquidity into the economy (Nguyen, 2007).

Well-functioning banking sector facilitate economic progresses, whereas poorly functioning banking sector is problem to economic development and aggravate poverty (Rajha2016). The banking sector is a fundamental component of the financial system and its efficiency is important for promoting access to financial services as well as stability of the economy (Kamau,2011). The sector plays an important role in the mobilization and allocation of savings. It plays the role of mediator between the net savers and net borrowers and the gains to the real sector, is depend on how the financial sector performs their function of intermediation efficiently (Kumar & Singh, 2015). The effectivefinancial intermediation mechanismdistributes the credit to more profitablesegments in ideal way. In addition, this well-organized financial intermediation mechanism also encourages innovations, because of high return on investment, with positive implications for economic development (Luccheti, 2000).

Banking industry has significant contribution in development of the economies of developing countries (Takbiri et al., 2015). As Kablan, (2010) mentioned in his study, in sub-Saharan Africa, banks are the most important element of the financial system. In many countries, other financial structures are underdeveloped or almost nonexistent. In the case of Ethiopia, banks, insurance

companies and micro-finance institutions are the major financial institutions and banks dominate the financial sector.

In Ethiopia banks are the only important formal organization which can provide finance for firms. And Bank efficiency in Ethiopia is compelling agenda of concern for most of investor invests in the industry and for the government and other organizations also (Gamachis, 2016). Efficiency in the banking system shows improved profitability, ensures stability, and enhances public confidence. Also, it increases the volume of funds intermediated, allocates resources efficiently, induces liquidity, and facilitates better quality services for customers (Sufian& Chong, 2008). The intensive and continuously increasing competition in the financial services market creates a need for an access to information that would allow evaluating commercial banks operating in this market. Such evaluations are really essential to both bank owners and customers who expect high-level financial profits (Wozniewska, 2008). In much less monetized countries, like Ethiopia, while monetary area is dominated by using banking industry, efficient and effective functioning of the Banks has vast position in accelerating financial growth (Fentaw& Sharma, 2017).

As banks dominate the financial sector in Ethiopia, ensuring the financial health of these institutions is likely going to ensure the health of the performance of the financial sector of the country (Abebaw and Kapur, 2012).

Therefore this paper intends to measure the intermediation efficiency of Ethiopian private commercial banks, interims of technical and scale efficiency which shows can the banks produced a maximum outputs from a minimum quantity of inputs or not and optimal activity level of the firm respectively. Data Envelopment Analysis (DEA) method is used for the purpose of classifying banks as relative efficient and inefficient. Because DEA is a powerful optimization tool used to measure the efficiency of any sectorial unit in terms of both technical and scale efficiency (Chandrasekar, et al., 2017).

1.2 Overview of banking in Ethiopia

The history of banking in Ethiopia is beginning from 1906. But, earlier than the introduction of the modern banking system, ‘Equb’ and ‘Idir’ which are a kind of traditional financial group helped to growing saving habits and insure the financial want of the society. In 1906 emperor

Menelik II and Ma Gillivray, representative of the British owned National Bank of Egypt, signed an agreement and this agreement has made true the opening of the first financial institution of Ethiopia referred to as Bank of Abyssinia in 1906 (Muhabie, 2015). Until 1931 the financial sector in Ethiopia was dominated by foreign ownership, in 1931 by nationalizing Abyssinian bank and renamed as bank of Ethiopia it become the first nationally owned bank for the country and for the continent also (Belay, 1990, Befekadu, 1995, as cited by Tony and Alemayehu, 2001) In Italian invasion of 1935 put a different complexion on the evolution of banking in Ethiopia. The operations of Bank of Ethiopia were replaced by subsidiaries of the Italian parent banks Banco d' Italia, Banco di Roma Banco, di Napoli and BancoNazionale del Lavaro. After the end of the fascist occupation, it was the turn of a British-based bank, Barclays Bank, to set up shop on Ethiopian soil in 1941; but it was shortly afterwards (1943) replaced by the state Bank of Ethiopia. (TekleBirhan, 2007).

The State Bank of Ethiopia operated as both a commercial and central bank until 1963. After banking proclamation issued in 1963 it divided into central and commercial banking as the National Bank of Ethiopia and the Commercial Bank of Ethiopia. Also the establishment of private local banks and the entry of foreign banks was permitted in the new proclamation (Alemayehu, 2006 & Solomon, 2011, cited in Habtamu, 2015).

All of this changed with the 1974 revolution. Under the Derg regime in January 1 1975 all privately owned financial institutions were nationalized which includes three commercial banks, thirteen insurance companies and two non-bank financial intermediaries (Befekadu, 1995, Harvey 1996 as cited by Tony and Alemayehu, 2001). And the competitive banking circumstances that begun to developin the 1960s and 1974s was changed by the Dergrule over the 1974-1991 periods. After the change of government in 1991, the command economic policy was changed and the financial markets were deregulated (Aderaw& Singh, 2016).

Proclamation No. 84/1994 that allowed the private sector to engage in the banking business marked the beginning of a new era in Ethiopian banking. Now days there are 16 privet commercial banks operating in the country.

1.3 Problem statement

An efficient banking system plays a great role for a progressive economic growth of any country (Kumar & Singh, 2014). In the financial system of the country efficiency of the banking industry is an important issues since the success of the whole monetary system and the stability of the banking sector manly affected by such efficiency (Yilmaz, 2013 as cited in Kocisova, K. 2013). Many researchers conclude that for the performance of the whole economy, for effective implementation of the monetary policy and for effective payment system of any country the efficiency of banking sector has a significant role (Gulati, 2011). A well-functioning financial sector facilitates efficient intermediation of financial resources. Banks are the highest financial intermediaries in the economy. So efficiency analysis is essential for the evaluation of banks' performance (Wozniewska, 2008).

Traditional financial ratio analysis (FRA) and frontier analysis method like data envelopment analysis (DEA) and stochastic frontier analysis (SFA) are mostly used methods to studying bank efficiency (Mousa, 2015). In Ethiopia many of studies on bank efficiency was done in financial ratio analysis (FRA) analysis such as,Dakito, (2015),Melaku, (2017), Gudata, (2015),Adamu and Kenenisa, (2017), and Rahel and Maru, (2015).

Financial ratio analysis regularly helps to examine the financial soundness of the bank and its management quality. Bank regulators, for example, national bank of Ethiopia use financial ratio analysis to evaluating a bank's performance. According to Stainer (1997), as cited in Yannick et al. (2016) this ratio analysis face a fundamental problem if there is external factors which affect their computation and FRA have no relationship to efficient resource usage.

FRA has its own importance for measuring bank efficiency but its major disadvantage is the reliance on benchmark ratios which could be arbitrary and may mislead an analyst (Yeh (1996), as cited in Yannick et al. 2016). Financial Ratios Analysis can be misleading because it's restricted to measure the complete efficiency of banks (Rao and Tekeste, 2012). The other major limitations of FRA are its univariate nature, because of this drawback it's difficult to measures and predict efficiency of firms using such analysis (Mousa, 2015). But DEA allows measurement of efficiency from multiple inputs and multiple outputs within multiple DMUs. DEA is a most accurate technique to measure efficiency given limited number of DMUs (i.e., banks, hospital, airports and so on) (Othman et al., (2016).

Data envelopment analysis (DEA) method is popular in measuring efficiency in the countries with developed banking systems, in our country also there are very few studies in DEA analysis such as, Tesfaye (2014), Fasika (2016), Gamachis (2016), and Yedersal (2018), those studies include commercial bank of Ethiopia in their study, in this study it is not include because, ‘‘commercial bank of Ethiopia get favorable support from the government in creating easy market for deposit, loans and Forex which has contributed a lot in reducing the cost of fund and boosting both interest and non-interest income’’ (Tesfaye, 2014).

Many studies made before focused on deposit mobilization, profitability, and liquidity. Hence detail critical analysis of the efficiency of the banks should have been done. Also analysis at individual banks level will give clear and pertinent information to potential investors in other word “looking on the tree than the forest” is good and timely scenario in the banking sector.

The purpose of this study is to investigate the relative technical and scale efficiency of private commercial banks in Ethiopia using data envelopment analysis (DEA), and studying on the issue of technical and scale efficiency of Ethiopian private commercial banks using DEA is important to know how the banks are using their input mix to produce a given output.

1.4. Objective of the study

1.4.1. General objective

The main objective of the study is to measure the relative efficiency levels of private commercial banks (PCBs).

1.4.2. Specific objective

1. Measuring the technical efficiency scores for private commercial banks operating in Ethiopia.
2. Measuring the scale efficiency scores for private commercial banks operating in Ethiopia.
3. Comparing the mean efficiency scores of private commercial banks operating in Ethiopia.
4. Identifying the proper improvement required on input and output by inefficient private commercial banks operating in Ethiopia.

1.5. Research question

1. Are private commercial banks (PCBs) in Ethiopia utilizes their resources efficiently?
2. Are private commercial banks (PCBs) producing at their most productive scale?
3. What is the mean efficiency of each private commercial banks operating in the country for the period of 10 years?
4. What are the inputs and outputs to be increased or decreased by inefficient bank to become efficient?

1.6. Significance of the study

The study can increase the horizons of the bank manager which may help them in improving the banks' efficiency and help the policy makers in their endeavor to improve the efficiency of banking sector and identify the need for future reforms in private banks. Also assist academics in their search for knowledge and theory and serve as a reference point for further future research.

1.7. Scope of the study

This study conducted to evaluate the efficiency of private banks in Ethiopia. All private commercial banks in Ethiopia included in the study and the dataset was limited to audited financial statement of private commercial banks from the period of2009 to 2018.

1.8. Organization of the study

The remaining part of this study is organized as follows: Chapter two containtheoretical and empirical review of related literature on bank efficiency and efficiency measures. Chapter three focuses on methodology of the study. Chapter four contains data analysis and interpretation.
The final chapter includes summary of findings,conclusion and recommendation.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Introduction

Banks are the most important financial institutions in the financial system and in the economy. Therefore, an efficient and stable banking system is a prerequisite to facilitating economic growth and avoiding financial crises. Banking sector efficiency is important for promoting access to financial services as well as stability of the banking sector as integral component of the financial system. According to (Ikhide, 2009, as cited in Kamau,2011,) Banks play essential role in the proper functioning of payments systems and their efficiency is directly related to improved productivity in the economy.

Efficiency in banking sector has been attracting the attention of a larger number of researchers. In this part of the thesis, both theoretical and empirical literature on bank efficiency will be reviewed

2.2 Efficiency: Concepts and Definitions

Efficiency has been defined differently by scholars. As per Wikipedia efficiency can be described as the extent which, time, effort or cost is well used for intend task or purpose. It is often used with specific purpose of relaying the capability of specific application of effort to produce specific outcome effectively with minimum amount or quantity of waste, or unnecessary effort. Efficiency is related to the ability to produce a result with minimum effort or resources. It measures how close a production unit gets to its production possibility frontier, which is composed of sets of points that optimally combine inputs in order to produce one unit of output (Kablan, 2010).Effectiveness is referring to the ability of the bank to set and achieve its goals and objectives, while efficiency refers to ability of the bank to produce output with minimal resources or input, or commonly defined as the ratio of outputs over inputs (Sherman and Zhu (2006) cited in Othman, et al., (2016). According to (Usman et al., 2010) bank efficiency is the best level of output reached without any changes to the amount of input. Efficiency of a bank refers to the ability of the bank to provide its service with the minimum possible resources, or producing maximum possible products and services using limited amount of inputs (Yidersal, 2018).

From a general point of view, effectiveness describes the capability of an individual, a group or a system to achieve the assigned goals with the disposable resources (Yannick et al. 2016). The idea of efficiency of a production unit was first introduced by Farell (1957), under the concept of "input oriented measure". According to Farell, a technical efficiency measure is defined by one minus the maximum equi-proportionate reduction in all inputs that still allows continuous production of given outputs. Technical efficiency is linked to the possibility of avoiding wasting by producing as much outputs as the use of input allows it (output oriented measure), or by using as less as input that the production objective plans it (input oriented measure). This efficiency is measured by comparing observed and optimal values of production, costs, revenue, profit or all that the production system can follow as objective and which is under appropriate quantities and prices constraints. Therefore, we can analyze technical efficiency, in terms of deviation compared with an idealistic production frontier isoquant (Kablan, 2007). In practice, the value of technical efficiency ranges from 0 to 1, a value of 1 indicating the bank is the most efficient, and as it approaches to 0 means inefficiency is increasing relative to the competitors (Yidersal, 2018).

2.3 Efficiency classification

According to Sherman and Zhu (2006) cited in Othman, et al., (2016), overall productivity of a bank depends on four components of efficiency classification and they are:

1. **Technical efficiency**: Also known as global efficiency measures the ability of banks to produce actual outputs with fewer inputs, or less resource used indicates higher efficiency;

2. **Scale efficiency**: Refers to the optimal activity volume level whereby inefficiency may arise if goods or services are produced above or below optimal level that resulted in added fixed cost;

3. **Price efficiency:** Bank could increase its efficiency if it could purchase the inputs (human capital and material) at lower price without sacrificing the quality;

4. **Allocative efficiency:** Measure the optimal mix of several inputs in order to produce products or services, such as banks incorporate automatic teller machines (ATM) and Internet banking for capital labor tradeoffs to increase efficiency.

2.3.1. Technical Efficiency

According to (Farrel, (1957) as cited in Emrouznejad, &Cabanda, (2015) defined technical efficiency as the ability of a firm to obtain optimal output from given inputs. He illustrated this by using two inputs (x1 and x2) to produce a single output (q), under the constant returns to scale. Technical efficiency focuses more on the physical relationship between the levels of inputs to the level of outputs; it requires inputs and outputs without price (Bauer et al. 1998). Technical efficiency, the most common of the efficiency measure, reflects the ability of the firm to obtain maximum output from a set of inputs. That is, it refers to the use of productive resources in the most technologically efficient manner (Worthington, 2004).

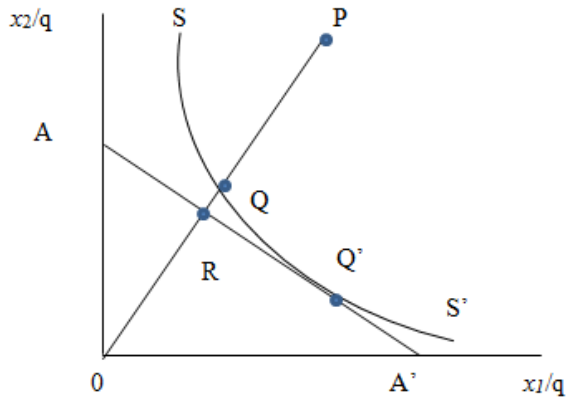


Figure 1: Technical and Allocative Efficiencies (Emrouznejad, &Cabanda, p. 4, 2015)

As Coelli et al. (2005) illustration cited in Emrouznejad, &Cabanda, (2015) in the figure above, "if a firm uses quantities of inputs, defined by the point P, to produce a unit of output, then the distance QP represents the technical inefficiency of that firm, which is the amount by which all inputs can be proportionally reduced while the output remains constant. This is represented by the ratio of QP/0P by which all inputs can be reduced to achieve an efficient production. Thus, technical efficiency (TE) of a firm is expressed as the ratio TE = 0Q/0P, which is equal to one minus QP/0P. It takes an interval value between zero and one as an indicator of the degree of technical efficiency of a firm. A firm is fully technically efficient when a value of one is obtained. In the Figure, point Q is technically efficient because it lies on the efficient frontier in which case TE = 1"

2.3.2. Scale Efficiency

Measures the efficiency of a DMU at a given point with regard to what it could accomplish if it works at the most productive scale size, where the average production reaches a maximum level (Kounetas and Tsekouras, 2007). The scale efficiency of an organization can be determined by comparing the technical efficiency scores of each service producer under constant returns to scale and variable returns to scale. Thus, when efficiency is assessed under the assumption of variable returns to scale, the efficiency scores for each organization indicate only pure technical inefficiency (Pasiouras 2006). According toAdongo et al, (2005) as cited in Tesfaye (2014) Scale Effectivenessfrequentlyemerges from the capacity of expansive firms to distributesettled costs such as promotion costs or cost of technology across a greater volume of output. It also shows whether the decision-making units (e.g. banks) operate at the minimum of their long run average cost curve. It focuses on technical efficiency, which is the ability of a bank to produce maximal output from a given set of inputs over a certain time period

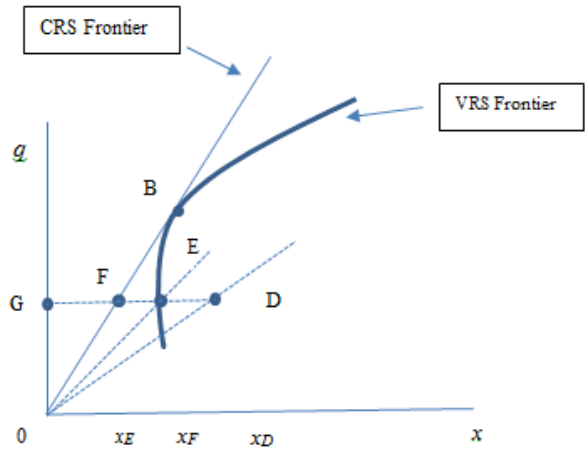


Figure 2: Scale Efficiency (Emrouznejad, &Cabanda, p. 5, 2015)

As Emrouznejad, &Cabanda, (2015) illustrates in the above finger the scale efficiency, where point D is depicted as technically inefficient firm (lies below the production frontier), and can be improved further by moving from point D to point E under the VRS frontier and also from point E to point F under the CRS frontier. Moreover, the scale efficiency (SE) of firm D is expressed as SE = GF/GE, which represents the distance from technical efficiency of point E to the CRS technology.

2.4 Measuring bank efficiency

Efficiency measurement determine how firm can maximize its output and profit and at the same time minimize its cost (Mokhtar et al., 2008). As Balcerzak, et.al, (2017) Stated, Evaluation of efficiency is an integral part of rational behavior of the production units that aims to survive in a challenging competitive environment in a long term. In practice it is possible to apply several methods to verify the level of efficiency. Financial ratio analysis (FRA), data envelopment analysis (DEA), and the stochastic frontier analysis (SFA) are frequently and widely used approaches to analyze the financial performance of the banks. Financial ratio analysis is the simplest technique in banking efficiency measurement; it has also been criticized to encounter many limitations such as not controlling input prices or product mix. Then, a measure that can incorporate all the available inputs and outputs of the bank is needed and the other two techniques meet this demand (Ncube, 2009). In many literatures Data Envelope Approach (DEA) and Stochastic Frontier Analysis (SFA) are the most preferred efficiency measurement techniques form non-parametric and parametric analysis methods. (Usman et al., 2010) concluded that there is no superior method exists to measure bank efficiency. However, according to Nigmonov, (2010) the DEA has been found to have a number of advantages over other methods. First, it does not require specification of any functional relationship between inputs and outputs or a priori specification of weights of inputs and outputs. Second, it easily accommodates multiple inputs and outputs for which are the norm for the banking sector. Third, it is suitable for measuring the efficiency of firms that lack competitive prices as could be the case of a concentrated banking sector (Erasmus &Makina, 2014). DEA is seen as the foremost commonly utilized non – parametric technique in technical efficiency measurement, especially in banking area (Banerjee, 2012).

2.5 Data Envelopment Analysis (DEA)

Efficiency analysis is essential for the evaluation of bank performance. The DEA is non-parametric approach, which is most popular for evaluating efficiency in the banking sector. There are two model of DEA method. The first method was developed by (Charnes et al., 1978) which are based on Farrell's (1957) efficiency measures and is it call CCR (Charnes, Cooper and Rhodes) model. CCR model was developed under the assumption of constant returns to scale (CRS). On the other hand, the second model is BCC (Banker, Charnes and Cooper) model, introduced by Banker et al., (1984) as an extension of the CCR model. BCC model was

developed under the assumption of variable returns to scale (VRS). The primary steps in constructing a DEA method is selecting decision making units (DMU's) that computes a comparative ratio of outputs to inputs for each unit (Othman, et.al., 2016). Avkiran, (2006) stated that: DEA identifies a DMU as either efficient or inefficient compared to other units in its reference set. For evaluating the efficiency of bank performance DEA used two approaches. The first approach is the intermediation approach where bank present oneself as a financial intermediaries. In this approach from perspective of cost-revenue management, where bank's major business activity is to borrow funds from depositors and lends those funds to other for spread. The second approach is production approach where usually as inputs are labor and capital and outputs are loans and deposits. Avkiran, (2000) argued that for analyzing bank efficiency it is better to use intermediation approach. The DEA technique will be considering more detail on the next chapter of the study.

2.6 Empirical Review

Efficiency of a bank refers to the ability of the bank to provide its service with the minimum possible resources, or producing maximum possible products and services using limited amount of inputs. The efficiency of the banking system is the most important issues in the financial market because it affects the stability of the banking industry and then, the effectiveness of the nation's monetary policy (Yilmaz, 2013 as cited in Gamachis, 2016). There are a number of studies that evaluate the efficiency of commercial banks using DEA method; Reviews of these various studies were presented as follows.

An article entitled, technical, scale, and allocative Efficiencies in U.S. banking: An Empirical Investigation, by Alyet al., (1990), applied DEA to explorevarious measures of efficiency for sample 322 banks in 1986. The study employed threeinputs (labor, capital, and loanable funds) and five outputs (commercial andindustrial loans, consumer loans, real estate loans, other loans, and demand deposits).The result indicates a low level of overall efficiency. The main source of inefficiency is technical in nature and on average the bank in the sample is scale efficient.

The Study that examine technical efficiency, pure technical efficiency and scale efficiency of Russia's commercial banks by Yadav, (2015), taking a sample of 131 using a non-parametric approach (data envelopment analysis) form the period of 2007 to 2014. Found that Scores of technical efficiency range from 31% to 51% which implies that banks need to reduce their inputs

from 49% to 69% to be on efficiency frontier. Result also shows that commercial banks in the sample are by and large operating at decreasing returns to scale and also shows that banks underperform in the utilization of inputs (total expenses and deposits) to create optimum outputs (loans and net investment).the study conclude that scores of scale efficiency are higher than the pure technical efficiency, explains that the main reason for the inefficiency of commercial banks in Russia is due to managerial inefficiency.

Karimzadeh, (2012), examines the efficiency of Indian commercial banks during 2000 – 2010 by utilizing Data Envelopment Analysis (DEA). Based on the sample of 8 commercial banks, by using intermediation approach the researchers used loans and investments as output variables and fixed assets, deposits, and number of employees as Inputs the findings reveal that the mean of cost (economic) efficiency, technical efficiency, and allocative efficiency are 0.991, 0.995, and 0.991 in VRS model and 0.936, 0.969 and 0.958 in CRR model, respectively. And he confirmed that selected Public Sector Banks are more efficient than Private sectors during the study period in India.

Thu Huong and Firoz, (2016), evaluating the efficiency of Vietnamese commercial banks using data envelopment analysis during the period 2011 – 2014, with comparison among different groups such as state owned vs. non–state owned banks, listed vs. unlisted banks, and large vs. small banks. The findings indicate larger banks performed better than smaller banks in terms of technical efficiency, but there was not much difference among the groups in terms of average overall technical efficiency. State-owned and listed banks obtained higher efficiency levels than non-state-owned and unlisted banks.

Baidya&Mitra (2012), the study was to measure and evaluate the technical efficiency of 26 Indian public sector banks from the financial year 2009–2010.data envelopment analysis (DEA) models: CCR and Andersen and Petersen's super-efficiency model is employed. The results reveal that average technical efficiency of entire sample is 86.5% and that only seven banks (23%) are found to be fully efficient. So, there is a scope of efficiency improvement of 19 public sector banks in India. The study has found that, the banks which are using more labor for providing their services are relatively more inefficient.

Tahir et al., (2009) used the DEA approach to measure the overall, pure technical, and scale efficiencies of Malaysian commercial banks from 2000-2006. They specified two inputs (total deposits and total overhead expenses), and one output, total earning assets. They found that domestic banks were relatively more efficient than foreign banks. Their results indicated that the domestic banks' inefficiency was attributable to pure technical inefficiency rather than scale inefficiency. On other hand, 20 the inefficiency of foreign banks was attributed to scale inefficiency rather than the pure technical inefficiency.

Kumar & Singh, (2015) studied technical and scale efficiency of India Banks using Data Envelopment Analysis (DEA) from 2006 to 2010. The study observed five private and five public sector commercial banks.They indicate that deregulation of banking sector has led to an increase in the efficiency of commercial banks in India. They show increase in efficiency of banks in India is not only because of increase in pure technical efficiency but also due to increase in its scale efficiency.Also shows that performance of private sector banks has been better than public sector banks during the period and source of inefficiency is mainly due to its scale rather than pure technical inefficiency.

Mongid&Tahir, (2010) this study estimates the technical and scale efficiency of rural banks in Indonesia during the period of 2006 and 2007 by using the non-parametric approach – Data Envelopment Analysis (DEA). They used intermediation approach to select input and output (total deposit and total overhead expenses as input and total earning assets as output). The results suggest that technical efficiency score is lower than scale efficiency score which indicates that portion of overall inefficiency is due to producing below the production frontier rather than producing at an inefficient scale.

Raphael, (2012) investigated the efficiency of commercial banks in Tanzania using a Data Envelopment Analysis (DEA), over the period from 2008 to 2011. The study used three input variables (deposit, interest expenses and operating expenses) and four output variables (loan, investment, interest income and no interest income), the analysis result showed that most commercial banks in Tanzania technically inefficient.In terms of size, large banks showed better performance compared to small banks. As to the study, commercial banks should minimize the use of input resources while maintaining the same level of output to improve technical efficiency.

Yannicka et al., (2016) Study Technical efficiency assessment of banking sector of Côte d'Ivoireusing data envelopment analysis, in the study 14 banks have been evaluated from 2008 to 2010. The outcomes revealed that Ivorian banks do not operate efficiently in terms of creditsassignmentmoreoverfindthat foreign ownership private banks are relatively more efficient than public ownership ones. And Computation of scale efficiency scores proves that on average Ivorian commercial banks scale Inefficiency is 38%. They do not use scale economy to improve their outputs.

Kamau, (2011), using Data Envelopment Analysis (DEA) and Malmquist productivity index (MPI), investigate intermediation efficiency and productivity in the banking sector in the post liberalization period in Kenyan Commercial banks, and the results show that though the banks were not completelyeffective in all perspective, under study period commercial banks efficiency score was not less than 40% at any point. In terms of ownership and size, foreign banks were found to be more efficient than local banks, and in local category local private were more efficient than local public, large sized banks were more efficient than medium and small sized banks. And the inefficiency is mostly because of inefficient use of deposit or keeping excess liquidity.

In Ethiopia also there are few studies conducted using DEA method to measure bank efficiency; Tesfaye, (2014) conducts assessment on the efficiency level of Ethiopian Banks for the period 2008-2012 using the Data Envelopment Analysis. The study found that the industry efficiency level is at modest level but the technical and scale efficiency of Banks is characterized by both inter and intra group variations across different ownership and size.And CBE's efficiency score persistently at the frontier, banks that were recently emerged in the industry were less efficient than the other group.

Fasika, (2016) with the objective of evaluating the technical efficiency of commercial banks in Ethiopia, Employing DEA over the period 2011 to 2014 with the sample of 15 commercial banks in Ethiopia. By using three input variables (interest expense, operating expenses and deposit) and three output variables (interest income, noninterest income and loans) 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. Also found privately owned commercial banks in Ethiopia are more efficient compared to government owned commercial banks considering the scale efficiency/inefficiency score; CBO and DB were characterized as the most scale efficient commercial banks In general, the study found that majority of commercial banks in Ethiopia experienced relative inefficiency both under the CRS and VRS assumptions.

Gamachis, (2016) under the title of ‘‘Technical Efficiency and Productivity of Ethiopian Commercial Banks’’ study adopts DEA to measure efficiency of banks and MPI to measure the productivity gains of banks over time period of 2007 to 2011 by taking a sample of ten commercial banks .and taking Fixed Assets and Labor as input and Total Deposits and Net Loans and Advances as output variables. The study found that, on average, Ethiopian commercial banks were relatively technically inefficient. And Scale inefficiency takes the leading contribution for source of inefficiency.

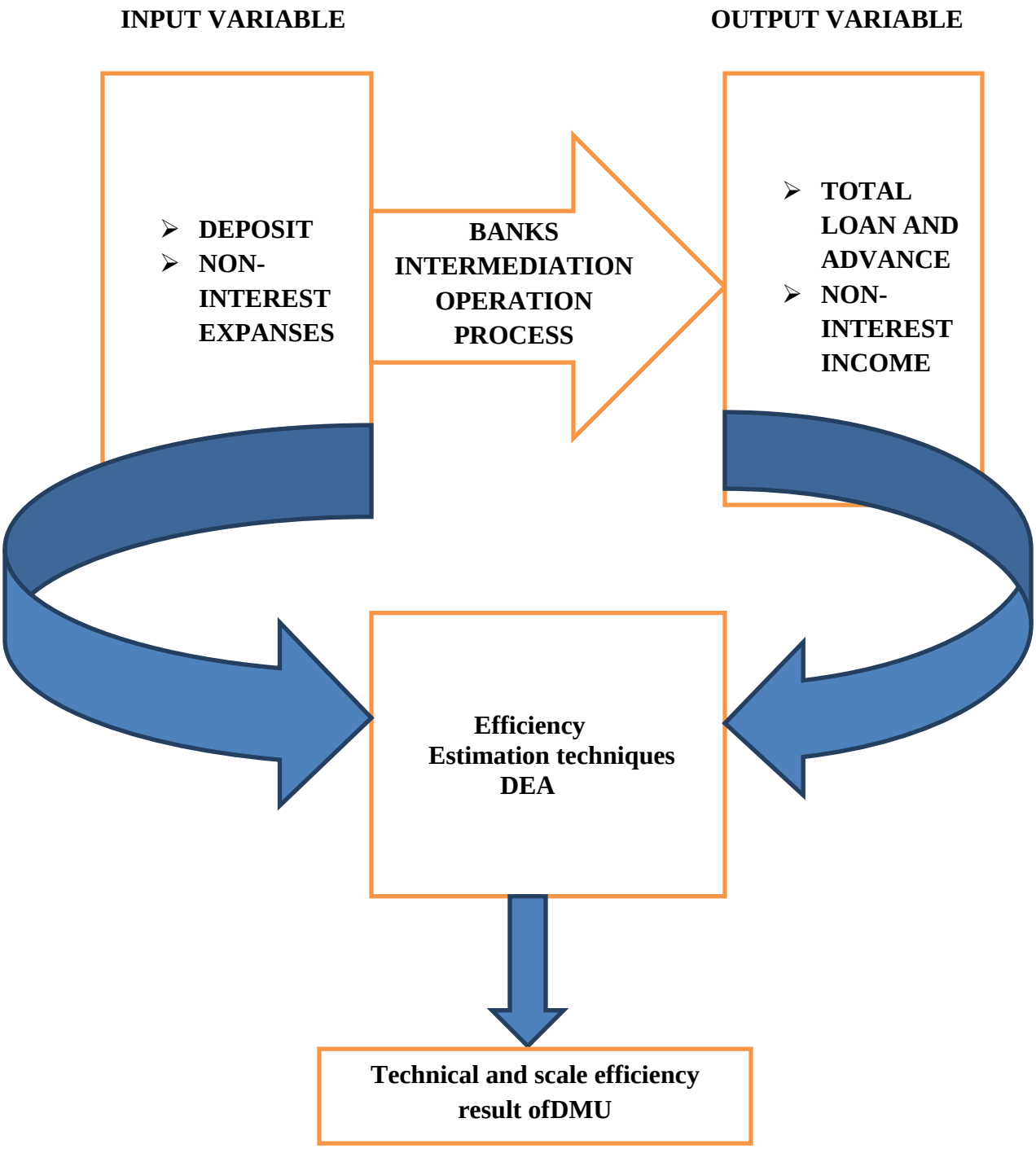
Yidersal, (2018) by employing Data Envelopment Analysis (DEA) Conduct a study to measure the relative technical, cost, revenue, and profit efficiency of the Ethiopian Commercial Banks using data of 18 commercial banks for the period covered 2005 to 2016. The researcher found that four banks namely Commercial bank of Ethiopia, Adis International bank, Zemen bank &Enat bank are the most efficient banks in terms of Technical Efficiency, and are found to be on the DEA frontier under both input & output orientations. Under Cost Efficiency, the giant Commercial Bank of Ethiopia, Adis International Bank and Debub Global Bank are found to be the most efficient ones, and on the DEA frontier. Finally, the research finding shows that Commercial Bank of Ethiopia and Adis International Bank are 100% efficient compared to other participants under both revenue & profit efficiency.

2.7 Summery and Research Gap

This chapter provides a brief overview of theoretical and empirical literature on technical and scale efficiency of banks and those studies were done in DEA.Efficiency studies on banking industry have been conducted form developed and developing countries. However major studies in banking efficiency have been conducted extensively from developed countries, this studies estimate the efficiency of different size banks and banks in different country and make comparison between them the existing research has shown that the efficiency of banks in developed country was well studied and most of the banks in this countries were efficient and the studies on efficiency of banks in the developing country shows most of the banks were in efficient and the area is not sufficiently studied . In Ethiopia most of the studies on the bank efficiency were done on FRA. However, these indicators give an incomplete picture of the banks 'efficiency and performance. In order to have a meaningful overall measure of the bank's efficiency, a more sophisticated method than the traditional efficiency and performance measurement techniques is needed, hence in this study; the Data Envelopment Analysis (DEA) Approach is employed. There are very few studies on bank efficiency that used DEA and those studies concern on the sector efficiency than the individual bank efficiency and this study concern on the individual bank efficiency and the sector also.

2.8. Conceptual framework

The main objective of the study is to measure efficiency of private commercial banks. According to camp, (2001) a conceptual framework is a structure which the researcher believes can best describe the progress of the phenomenon to be studied. This conceptual framework shows that the study used two inputs and two outputs to estimate the intimidation efficiency interims of technical and scale efficiency using DEA as a tool for the analysis.



CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the methodology that used to address the research problem. The chapter describes the research design and approach, population and sample, Data source and collection, Method of data analysis, Model variables (input and output) and Model specification, of the study.

3.2 Research Design and Approach

Research design refers to the overall strategy that one chooses to attack the problem which requires integration of different components of the study in a coherent and logical way, thereby, ensuring to solve the problem in efficient way. It constitutes the blueprint for the collection, measurement, analysis of data, interpretation and reporting of conclusions. Research design is necessary because it makes possible the smooth sailing of the various research procedures, thereby creation research as professional as possible, yielding maximum information with a minimum expenditure of effort, time and money (Islamia, 2016). According to Islamia, (2016) research design generally categorized in to four group based on the purpose of the research; Exploratory Research, Descriptive Research, Explanatory Research and Experimental Research.

This study was conducted using descriptive research. A descriptive study defines a subject by constructing a profile of people, groups or events through tabulation and the collection of data on the frequencies on study variables (Cooper & Schindler, 2007). Descriptive research describes phenomena as they exist and the observer observes and describe what did he find? Descriptive research answers the questions, what, who, where, how and when. It's more common in the social sciences, as in socio-economic survey and job and activity analysis (Islamia, 2016).

There are three types of research Approaches; quantitative: approach of measurements and numbers, qualitative: approach of words and images, and Mixed Methods approach of measurements, numbers, words and images. Creswell, (2014) mentioned that through quantitative research, phenomena are being explained "by collecting numerical data that are analyzed using mathematically based methods (in particular statistics). According to (Kothari,

(2004) Quantitative research is based on the measurement of quantity or amount. It is applicable to phenomena that can be expressed in terms of quantity. This study used secondary source of data (financial reports) which is numerical, therefore quantitative approach was preferred.

3.3 Population and sample

All members who meet the particular condition specified for a research study can be known as a target population (Alvi, m. 2016). All people or items in a given study called population whereas a process of selecting part of the population for investigation known as sampling (Rahi, 2017). For this study the target population is all private commercial banks in Ethiopia. According to national bank of Ethiopia at the end of 2018 there were 16 private commercial banks.

In DEA method there are two important aspects that shows census is more preferable than sampling, the first one is that the result found from a sample cannot generalized for the whole population the other one is the analysis result of DEA is not absolute its relative. This indicates that the efficient DMU score 100 per cent efficiency the other DMUs will be benchmarked against the efficient (Sanjeev, 2006). Thus the study considered all the private commercial banks which were operating in the country as a decision making units.

3.4 Data source and collection

Due to the nature of the study only secondary data is used. The data was found from the audited financial statements of the banks for the period 2009 - 2018. And those data collected from the published audited annual report of the all private commercial banks and from the records held by National bank of Ethiopia. Specifically the data were gathered from the balance sheet and the income statement of commercial banks covered in the study period. The data collected from secondary source were analyzed and presented through Graphs and tables.

3.5 Method of data analysis

As stated in Karimzadeh, (2012) Data Envelopment Analysis (DEA) is a linear programming based method developed by Charnes, Cooper and Rhodes in 1978 sometimes called frontier analysis, which used to measurer performance and it’s used for evaluating the relative efficiency of productive units, having the same multiple inputs and multiple outputs. DEA has been widely used to measure efficiency performance of different financial institutions like banks, insurance and mutual funds. Particularly in the banking sector, it has been applied to benchmark the

efficiency performance of different banks or to study the efficiency estimates of different branches of a particular bank (Debasish, 2006). As stated in previous chapters the study was used Data Envelopment Analysis (DEA) to carrying out this study.

In 1978 Charnes, Cooper and Rhodes generalized Farrell' singe input single output efficiency measure to multiple - input multiple - output situations and operationalized it using mathematical programming(Emrouznejad&Cabanda, 2015). This method is called Data envelopment analysis. DEA is a nonparametric linear programming (LP) technique that permits evaluation of the relative efficiency of decision-making units (DMUs). DEA is used to evaluate the relative efficiency of a number of producers or decision-making unites (DMUs). It allows us to compare the relative efficiency of DMUs which have multiple input and output by determining the efficient DMU as a benchmark, and the efficiency score in the presence of multiple input and output factors is defined as:

Efficiency = weighted sum of outputs / weighted sum of inputs

There are two types of efficiencies in DEA – input oriented and output oriented. Input oriented efficiency aims at reducing input amounts as much as possible while keeping at least the present output levels and output oriented technical efficiency maximizes the output level while using at least the present input levels (Baidya&Mitra, 2012). In an attempt to use both input-oriented and output-oriented models to calculate DEA efficiency score, (Ramanathan, 2007 as cited in Othman, et.al, 2016) discovered that both models generated similar results. This suggested that there is no obvious difference in efficiency score generated by both models. Thus, no misleading interpretations of DEA score if either one model is chosen. As mentioned in the previous chapter, there are also two assumptions under DEA model, the constant return to scale (CRS) and the variable return to scale (VRS). On this study the researcher used input oriented both constant return to scale (CRS) and the variable return to scale (VRS) models.

3.5.1 Constant return to scale (CRS) model: The original DEA approach by Charnes et al. (1978) assumed constant returns to scale of activities by DMUs. The CCR model is the most widely used DEA model. It is used in frontier analysis when a constant return to scale relationship is assumed between inputs and outputs. Being the first DEA model to be developed, this model calculates the overall efficiency for each unit, where both pure technical efficiency and scale efficiency are aggregated into one value. Factors such as

imperfect competition, or limited financial resources, may prevent decision-making units from operating at an optimal scale, this assumption is only appropriate when all DMUs operate at an optimal scale. (Coelli, et. al., 1998). The reason is the technical efficiency obtained from CCR DEA is composed of two constituents which are the result scale inefficiency and pure technical inefficiency (Coelli, et. al., 2005).

3.5.2 Variable return to scale (VRS) Model: The first extension of basic CCR model is called the DEA BCC model developed by BCC in 1984, with other criteria are the same as CCR except it complement the equation to measure input excesses and output shortfalls (Cooper et al., 2006; Ong et al., 2003as cited in Othman, et.al., 2016). The BCC model is the DEA model used in frontier analysis when a variable returns to scale relationship is assumed between inputs and outputs. This model focuses primarily on the technological aspects of production correspondences, and can be used to estimate technical and scale efficiency without requiring estimates of input and output prices. Since the study assessing how efficient DMUs use inputs to produce outputs both CRS and VRS assumptions are necessary.

The study used MAXDEA7 software to conduct the necessary analysis and to measure the technical and scale efficiency of private commercial banks working in the country.

3.6 Model variables (input and output)

DEA is highly sensitive in the choice of input and output variables rather than unit of amount and it is not required advanced assumption about the analytical form of production (Tesfaye, 2014). Regarding the appropriate inputs and outputs variables to be employed by DEA model for banks, as mentioned in several studies, there are two main approaches that can be used to determine the bank inputs and outputs. They are production approaches and intermediation approaches (Mousa**,** 2015).

3.6.1. Production approach: which considers the bank as normal company or producer, and hence the inputs are the physical elements such as labor and capital and all other assets and liabilities are outputs, this approach argued that all deposits (which are assets) should be treated as output since they are produced by capital and labor. According to Johnes et al. (2009, p.14) as cited in Mousa, (2015) in production approach capital and labor inputs which is number of employees and capital expenditures on fixed assets and Output are number of deposit accounts or transactions and loans.

3.6.2. Intermediate approach: by this approach the selection is made based on the bank's assets and liabilities, bank assets including labor represent the inputs and liabilities represent the outputs. On this approach banks are a mediator between borrowers and depositors that accept deposits and offer loans and other investments. Output is measured by interest income, total loans, total deposits and non-interest income, while inputs are usually represented by operating and interest costs (Mousa1, 2015).

According to Avkiran (2000) for analyzing bank efficiency intermediation approach is better one. According to Berger and Humphrey (1997) as cited by Yadav, (2015), intermediation approach is well suited to analyzing firm level efficiency, whereas the production approach is suited to measuring branch level efficiency. And this study followed the intermediation approach to select two inputs and two outputs listed below

Input

I. Total deposit
II. Non-Interest expense

Output

I. Total loan and advance
II. Non-Interest Income

3.7 Model specification

The study measures the relative technical and scale efficiency score for the banks using the DEA approach, the input-oriented CCR and BCC models were used. Based on Horvatova, (2018) the input-oriented CCR-I (Charnes–Cooper–Rhodes) Input model can be written in the form of linear programming problem as follows:

$\max z = \sum_{i=1}^{m} ui.yiq$ (1)

Under the conditions:

$\sum_{i=1}^{m} ui.yiq \leq \sum_{j=1}^{r} vj.xjk;\ k = 1, 2, \ldots . n$ (2)

$\sum_{i=1}^{m} ui.yiq - \sum_{j=1}^{r} vj.xjk; \leq 0 \quad k = 1, 2, \ldots . n$ (3)

$\sum_{j=1}^{m} vj.xjk = 1$ (4)

$ui \geq 0, i = 1,2, \ldots . r$ (5)

$vj \geq 0, i = 1,2, \ldots . m$ (6)

Where:

Z = relative efficiency of the DMU

m = number of output produced by the DMU

r = number of inputs employed by the DMU

Yi, represent output data for DMU

Xj, represent input data for DMU

Ui = output weights

Vj, = input weight

K, represent number of DMU

Based on Horvatova, (2018) the input-oriented BCC-I (Banker–Charnes–Cooper– Input) model can be written in the following form:

$\max z = \sum_{i=1}^{m} ui.yiq + \mu$ (7)

Under the conditions:

$\sum_{i=1}^{m} ui.yiq + \mu \leq \sum_{j=1}^{r} vj.xjk;\ k = 1,2, \ldots . n$ (8)

$\sum_{j=1}^{m} vj.xjk = 1$(9)

$ui \geq 0, i = 1,2, \ldots . r$ (10)

$vj \geq 0, i = 1,2, \ldots . m$ (11)

Where:

Z = relative efficiency of the DMU

m = number of output produced by the DMU

r = number of inputs employed by the DMU

Yi, represent output data for DMU

Xj, represent input data for DMU

Ui = output weights

Vj, = input weight

K, represent number of DMU

CHAPTER FOUR

4. Data Analysis and interpretation

Introduction

This chapter deals with Empirical result and interpretation of the study. On the first subdivision descriptive statistics of variables (input output) and correlation analysis among input output is presented. On the other section the main objective of the study which is efficiency of private commercial banks is discussed and the method that described in chapter three which is data envelopment analysis were used to measured efficiency and inefficiency level of private commercial banks in Ethiopia.

The data envelopment analysis software (MAX DEA 7) is used to measure overall technical efficiency (OTE), pure technical efficiency (PTE) and scale efficiency (SE) of the banks and STATA software (version 11) is used to check the correlation between variables.

4.1 descriptive statistics of input and output variables

DMU (16)	OBS 143		INPUT		OUTPUT	
			DEPO	NON-IE	TLAA	NON-II
AB	8	Min	263	15	158	7
		Max	9566.089	539.817	5898.455	443.062
		Mean	3731.362	218.1621	2302.611	180.5103
		SD	3205.829	179.4498	2000.037	143.1939
ADIB	7	Min	211	21	154.488	23
		Max	2970.377	207.384	2034.996	201.469
		Mean	1354.09	100.0692	914.6033	113.4424
		SD	983.9334	69.83438	683.1338	65.09123
AIB	10	Min	4,962	155	2,713	201
		Max	43,451	1,934	31,049	1,203
		Mean	17,100	723	11,379	711
		SD	12267.1	607.2567	9312.124	335.0781
BA	10	Min	4494.19	145	2708.96	128.92
		Max	25794.54	1452.15	17780.96	789
		Mean	11131.97	498.74	6846.31	371.56
		SD	7059.109	447.3448	5073.402	206.6929

BIB	9	Min	238	12.441	153	2
		Max	10889	694.298	10097.04	476.83
		Mean	3590.536	206.3799	2675.165	180.9079
		SD	3633.958	236.9694	3261.775	183.3072
BUB	9	Min	240	18	192	11
		Max	9848.374	575.787	6841.603	359.861
		Mean	3505.288	199.9763	2399.507	148.2657
		SD	3386.441	194.3634	2355.421	126.0769
CBO	10	Min	789	41	596	11
		Max	25808	1284	15145	658
		Mean	7271	434	4651	282
		SD	7673.826	430.7437	4776.407	215.3985
DB	10	Min	7,925	204	4,452	321
		Max	35,987	1,854	23,058	1,345
		Mean	18,385	763	10,750	895
		SD	8595.941	558.358	5911.898	333.9129
DGB	5	Min	500	44	266.65	40
		Max	2153.322	198.198	1553.712	206.972
		Mean	1155.19	105.6396	705.4652	108.1944
		SD	650.9672	59.9371	516.7448	64.94087
EB	5	Min	929.44	70	506.74	72
		Max	5090.526	222.592	3313.951	261.653
		Mean	2731.101	129.1184	1802.157	148.9306
		SD	1672.677	65.85285	1101.533	81.62977
LIB	10	Min	704	34	470	16
		Max	11,640	603	7,374	368
		Mean	4,075	224	2,555	179
		SD	3715.691	209.494	2398.503	130.2484
NIB	10	Min	3,296	132	2,220	172
		Max	21,619	950	13,499	448
		Mean	9,323	398	5,981	314
		SD	5899.384	272.3538	3740.155	74.96097
OIB	10	Min	184	6	113	2
		Max	19927	987	9969	963
		Mean	6268	338	3333	265

		SD	6381.591	340.4542	3320.855	293.9443
UB	10	Min	3,616	124	2,152	135
		Max	23,080	1,156	14,870	623
		Mean	10,256	478	6,417	347
		SD	6006.888	351.1752	4215.505	137.4002
WB	10	Min	3,728	133	2,112	239
		Max	20,506	1,285	14,785	972
		Mean	9,078	513	5,895	499
		SD	5146.825	377.5688	3999.464	223.172
ZB	10	Min	278	24	189	13
		Max	10241	352	4995	503
		Mean	3633	156	1941	244
		SD	3193.892	114.221	1627.518	147.2299

Table 4.1 is about descriptive statistics of all DMU, input and output variables used in the study. As we see in the above table there is high difference among input output variables in most of DMU. This implies that there is high scale (size) difference between Ethiopia private commercial banks. But this cannot affect DEA method from measuring efficiency of the banks.

4.2 Input Output correlation analysis

. Corr

(Obs=10)

	depo	nonie	tlaa	noni
depo	1.0000			
nonie	0.9944	1.0000		
tlaa	0.9990	0.9957	1.0000	
nonii	0.9704	0.9775	0.9688	1.0000

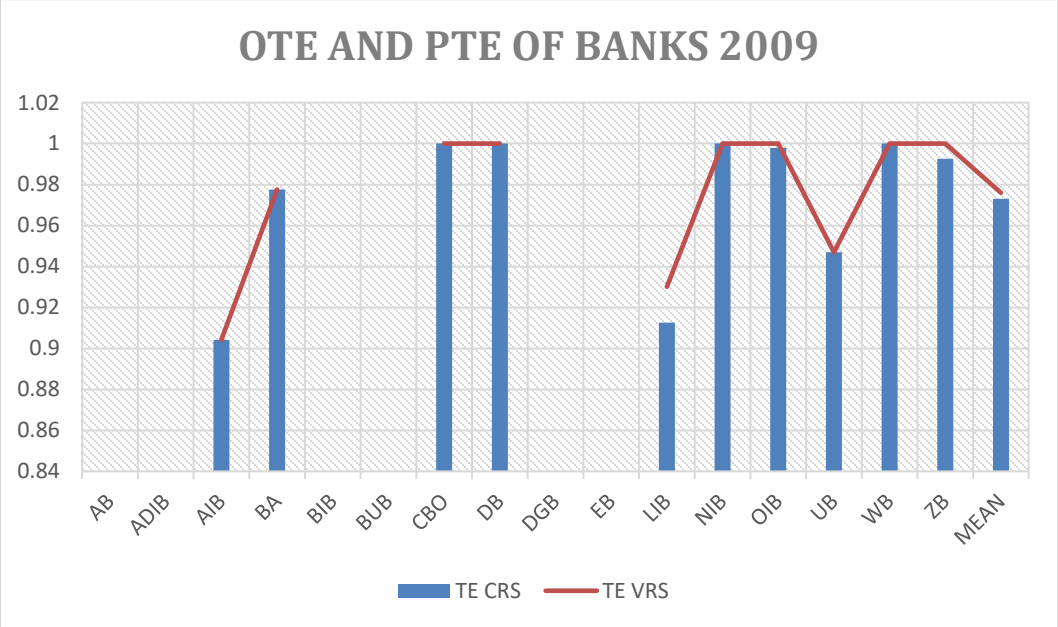
Table 4.2 correlation between variables yearly mean of ten years period

The suitability of the variables (input and output) used for measuring efficiency should have correlation between them, if the selected input and output have high correlation coefficient between them they are suitable for measuring efficiency (Avikran, 1999 as cited by Marjanovic et al. 2018). As the correlation analysis result show there is high correlation among all input and output. The correlation coefficient lies between, 99.44% and 96.88%. For instance a correlation coefficient of DEPO and TOL equals 99.9% and DEPO and NON-IE have 99.4%, DEPO and NON-II have 97% correlation coefficient and TLO and NON-IE have 99.6% and TOL and NON-II have 96.9% correlation coefficient. NON-IE and NON-II also have high correlation coefficient of 97.8%.

4.3. Efficiency score of Ethiopian private commercial bank from 2009 to 2018

The analysis result of overall technical and pure technical efficiency of all PCBs for each of 10 years is presented and discussed below

Figure 4.1: efficiency of PCBs in CRS and VRS models for the year 2009

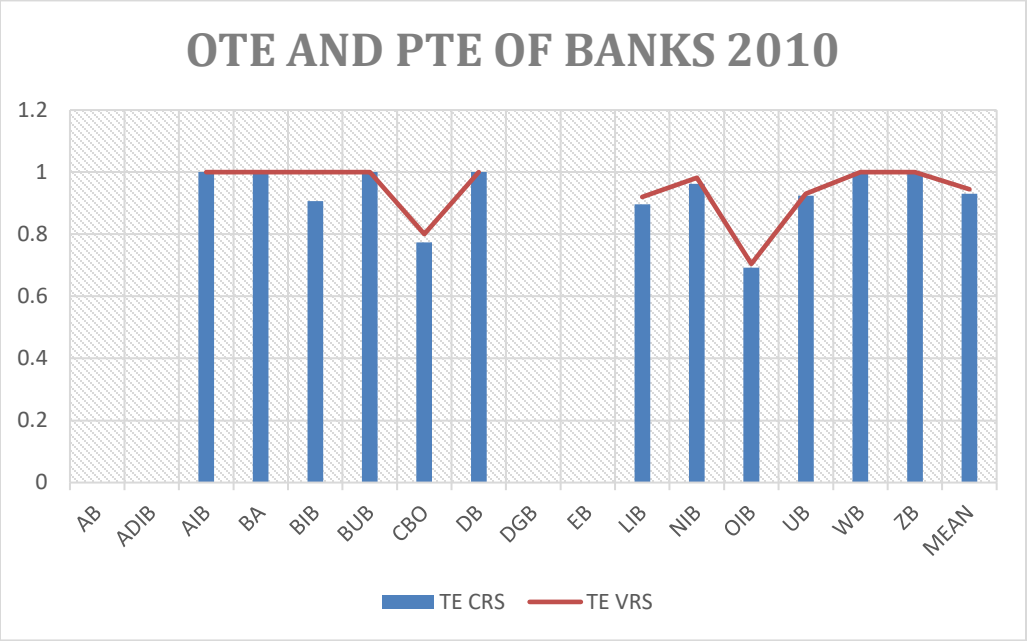


Source: author own computation from the data

In 2009 from the sample of 10 banks, four banks (CBO, DB. NIB and WB) were 100% efficient in both CRS and VRS method and OIB and ZB were efficient only in VRS method. In VRS method only BA and in CRS method three banks (BA, OIB and ZB) were above 95% efficient

and their efficiency ratio is lies between 0.978 and 0.998. The other three banks (AIB, LIB and UB) were above 90% efficient in both CRS and VRS methods. The mean efficiency for the year was 0.973 and 0.976 for CRS and VRS respectively and 7 of the sample banks performed above the mean and 3 of the banks fell below the mean efficiency.

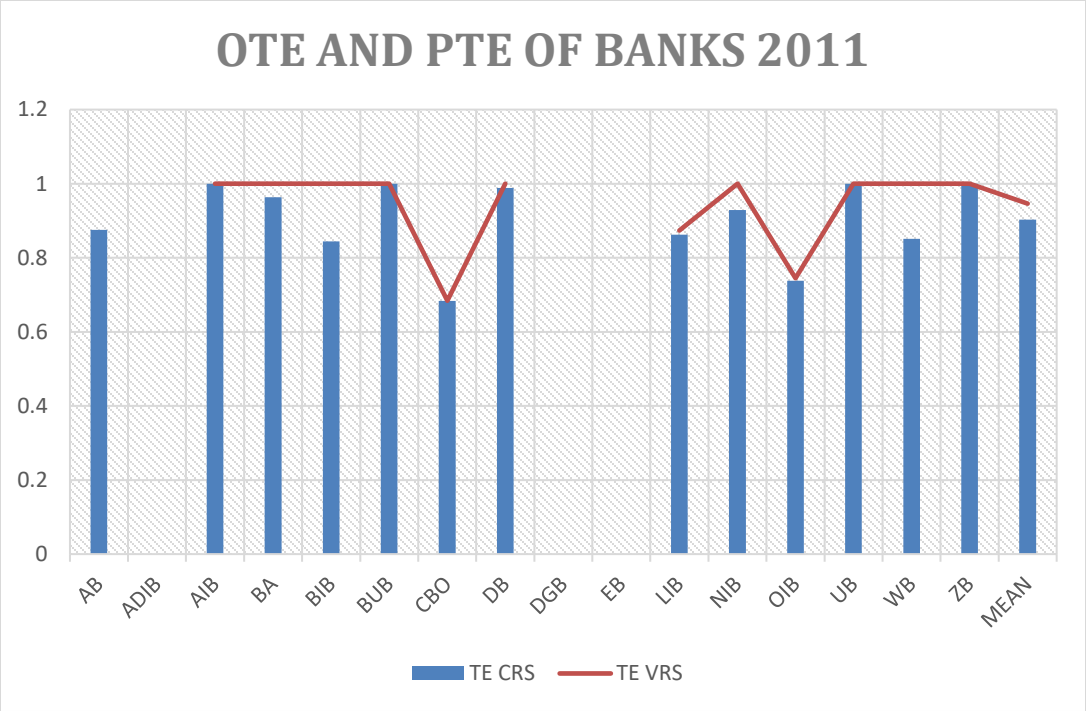
Figure 4.2: efficiency of PCBs in CRS and VRS models for the year 2010



Source: author own computation from the data

In 2010 from the sample of 12 banks, six banks (AIB, BA, BUB, DB, WB and ZB) were 100% efficient in both CRS and VRS method and BB were efficient only in VRS method. In VRS method three banks (LIB, NIB and UB) and in CRS method also three banks (BB, NIB and UB) were above 90% efficient and their efficiency ratio is lies between 0.906 and 0.962. The other three banks (CBO, LIB and OIB) was below 90% efficient in CRS method and in VRS methods two banks (CBO and OIB) was below 90% efficiency score . The mean efficiency for the year was 0.93 and 0.945 for CRS and VRS respectively and 7 of the sample banks performed above the mean and 5 of the banks fell below the mean efficiency in CRS method and in VRS method 8 of the sample banks performed above the mean and 4 of the banks fell below the mean efficiency.

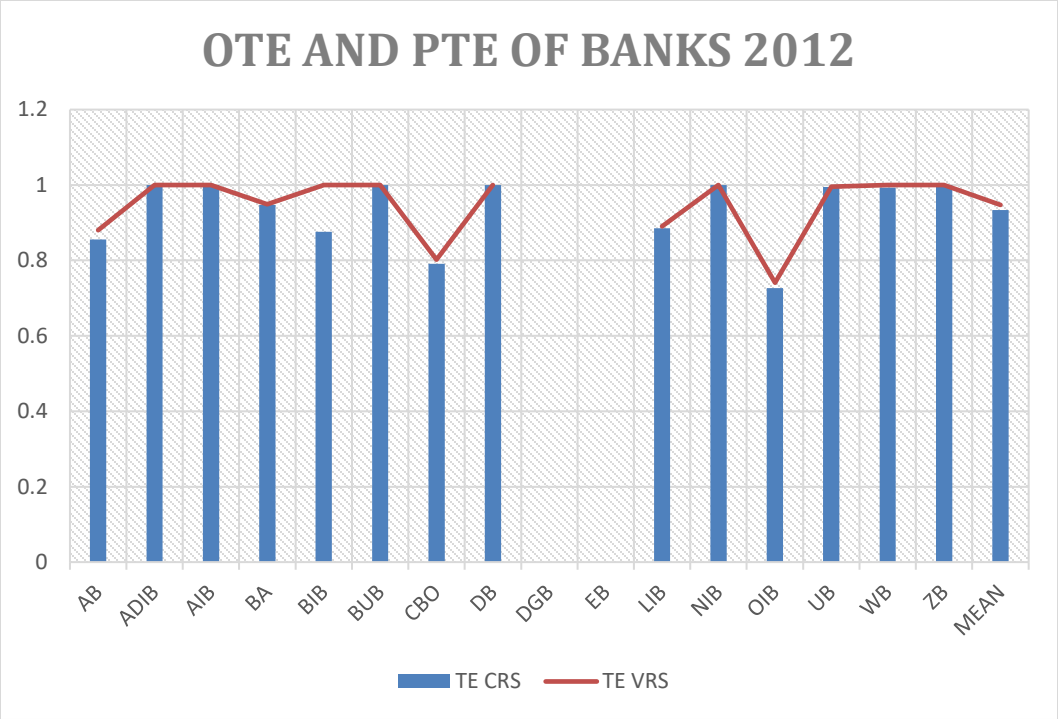
Figure 4.3: efficiency of PCBs in CRS and VRS models for the year 2011



Source: author own computation from the data

In 2011 from the sample of 13 banks, in CRS method four banks (AIB, BUB, UB and ZB) were 100% efficient and three banks (BA, DB and NIB) was above 90% efficient and six banks (AB, BIB, CBO, LIB, OIB and WB) were below 90%and their efficiency ratio is lies between 0.683 and 0.875. In VRS method most of the banks were efficient only three banks (CBO, LIB and OIB) were inefficient and their efficiency score is below 90% and it was 0.684, 0.873 and 0.745 respectively .The mean efficiency for the year was 0.903 and 0.946 for CRS and VRS respectively and 7 of the sample banks performed above the mean and 6 of the banks fell below the mean efficiency in case of CRS and10 of the sample banks performed above the mean and 3 of the banks fell below the mean efficiency in VRS method.

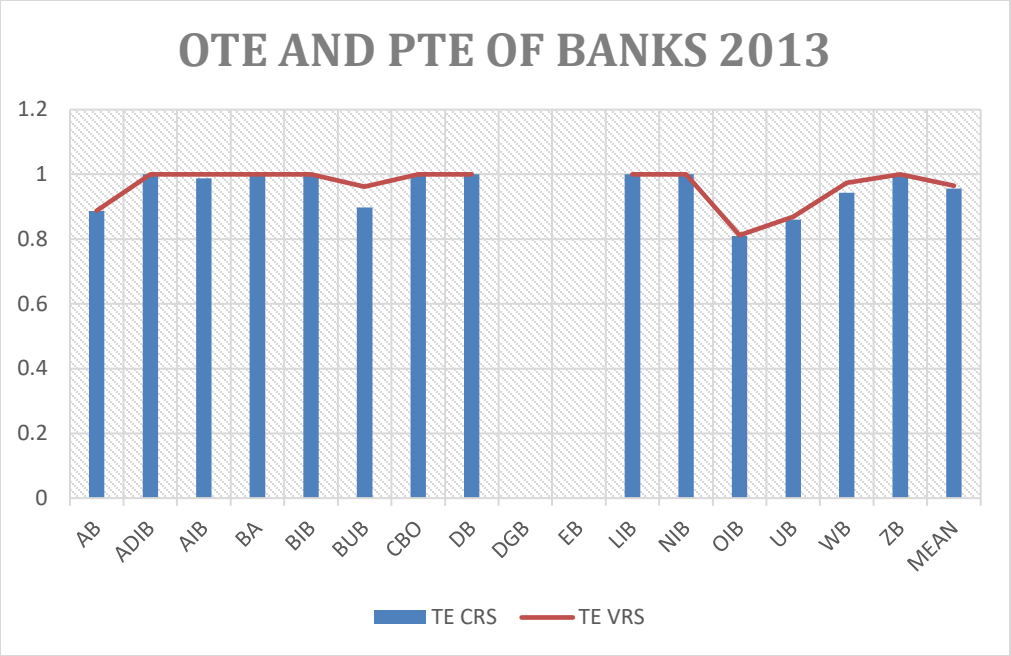
Figure 4.4: efficiency of PCBs in CRS and VRS models for the year 2012



Source: author own computation from the data

In 2012 from the sample of 14 banks, six banks (ADIB, AIB, BUB, DB, NIB and ZB) were 100% efficient in both CRS and VRS method and BIB and WB were efficient only in VRS method. In VRS method two banks (BA and UB) and in CRS method three banks (BA, UB and WB) were above 90% efficient and their efficiency ratio is lies between 0.948 and 0.996. The other five banks (AB, BIB, CBO, LIB and OIB) was below 90% efficiency score in CRS method and in VRS method except BIB all the other efficiency score were below 90%. The mean efficiency for the year was 0.934 and 0.947 for CRS and VRS respectively and 9 of the sample banks performed above the mean and 5 of the banks fell below the mean efficiency in CRS method and in VRS method 10 of the sample banks performed above the mean and 4 of the banks fell below the mean efficiency.

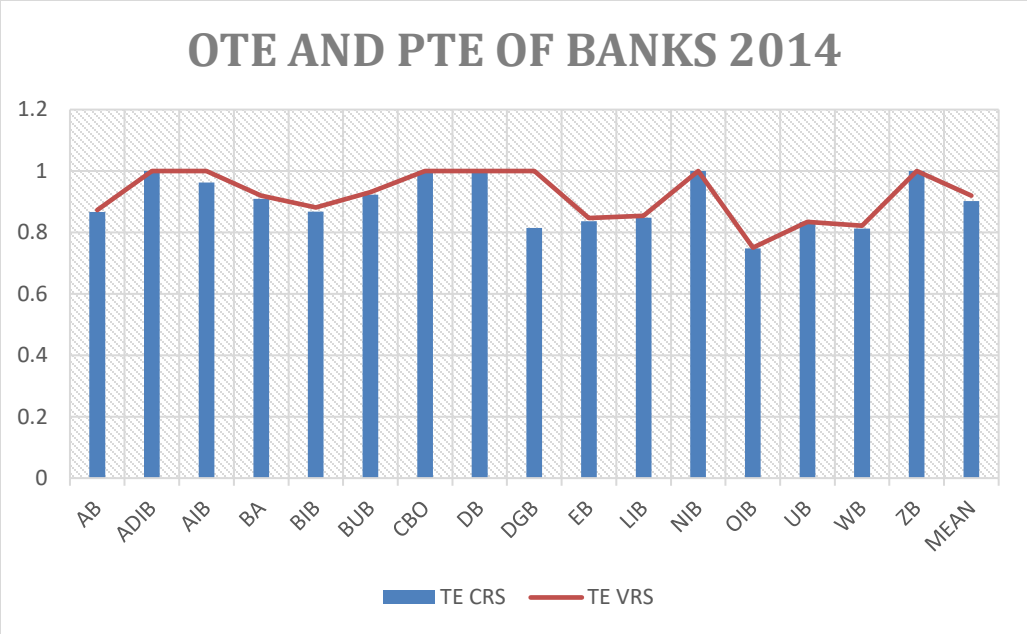
Figure 4.5: efficiency of PCBs in CRS and VRS models for the year 2013



Source: author own computation from the data

In 2013 from the sample of 14 banks, eight banks (ADIB, BA, BIB, CBO, DB, LIB, NIB and ZB) were 100% efficient in both CRS and VRS method and AIB were efficient only in VRS method. In VRS method two banks (BUB and WB) and in CRS method three banks (AIB and WB) were above 90% efficient and their efficiency ratio is lies between 0.943 and 0.988. The other four banks (AB, BUB, OIB and UB) was below 90% efficiency score in CRS method and in VRS method except BUB all the other efficiency score were below 90%. The mean efficiency for the year was 0.956 and 0.965 for CRS and VRS respectively and 9 of the sample banks performed above the mean and 5 of the banks fell below the mean efficiency in CRS method and in VRS method 10 of the sample banks performed above the mean and 4 of the banks fell below the mean efficiency.

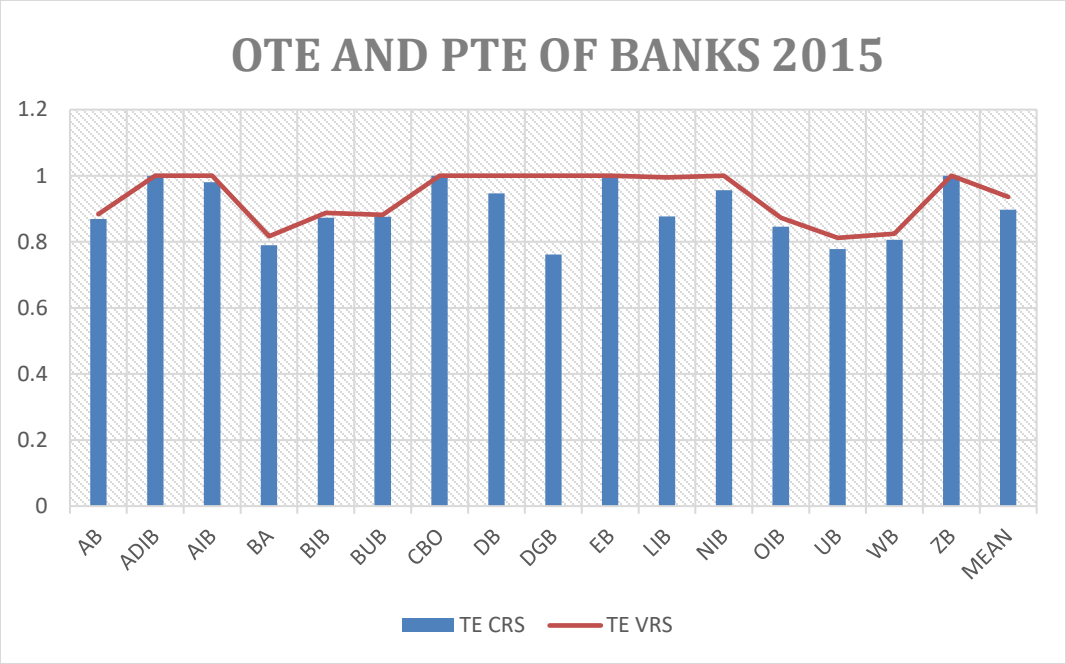
Figure 4.6: efficiency of PCBs in CRS and VRS models for the year 2014



Source: author own computation from the data

In 2014 from the sample of 16 banks, five banks (ADIB, CBO, DB, NIB and ZB) were 100% efficient in both CRS and VRS method and AIB and DGB were efficient only in VRS method. In VRS method two banks (BIB and BUB) and in CRS method three banks (AIB, BIB and BUB) were above 90% efficient and their efficiency ratio is lies between 0.909 and 0.963. The other eight banks (AB, BIB, DGB, EB, LIB, OIB,UB and WB) was below 90% efficiency score in CRS method and in VRS method except DGB all the other efficiency score were below 90%. The mean efficiency for the year was 0.902and 0.92 for CRS and VRS respectively and 8 of the sample banks performed above the mean and 8 of the banks fell below the mean efficiency in both CRS and VRS methods

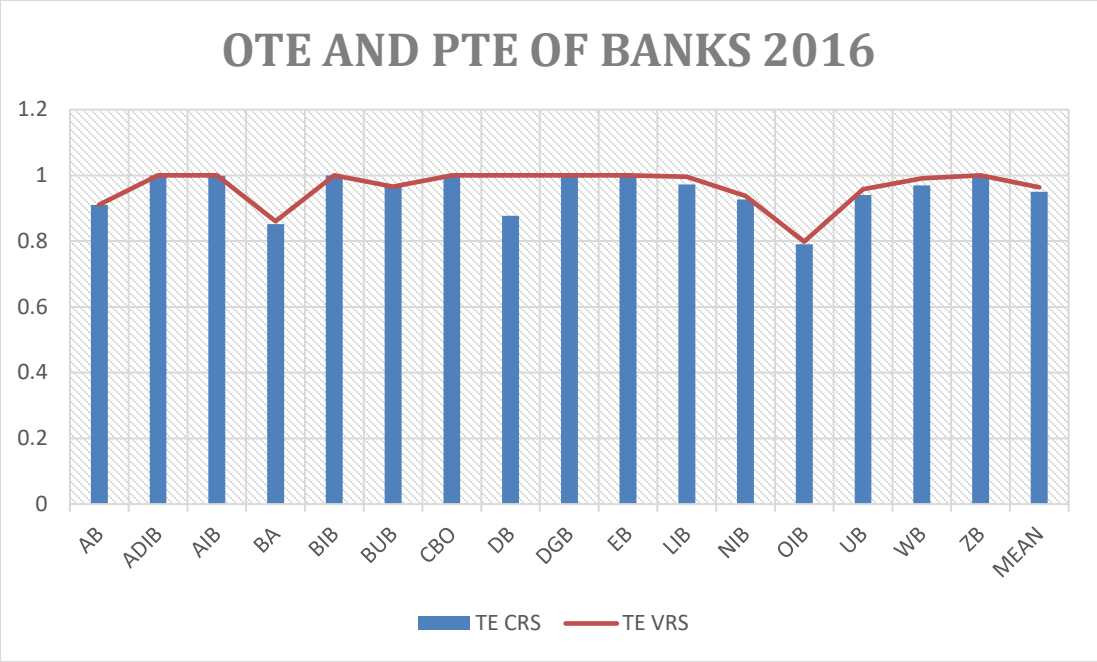
Figure 4.7: efficiency of PCBs in CRS and VRS models for the year 2015



Source: author own computation from the data

In 2015 from the sample of 16 banks, only four banks (ADIB, CBO, EB and ZB) were 100% efficient in both CRS and VRS method and the other four banks (AIB, DB, DGB and NIB) were efficient only in VRS method. In CRS method three banks (AIB, DB and NIB) and in VRS method only LIB, were their efficiency was above 90% and their efficiency ratio is lies between 0.946 and 0.995. The other nine banks (AB, BA, BIB, BUB, DGB, LIB, OIB, UB and WB) was below 90% efficiency score in CRS method and in VRS method except DGB and LIB all the other efficiency score were below 90%. The mean efficiency for the year was 0.897 and 0.936 for CRS and VRS respectively and 7 of the sample banks performed above the mean and 9 of the banks fell below the mean efficiency in CRS method and in VRS methods 9 of the sample banks performed above the mean and 7 them fell below the mean efficiency.

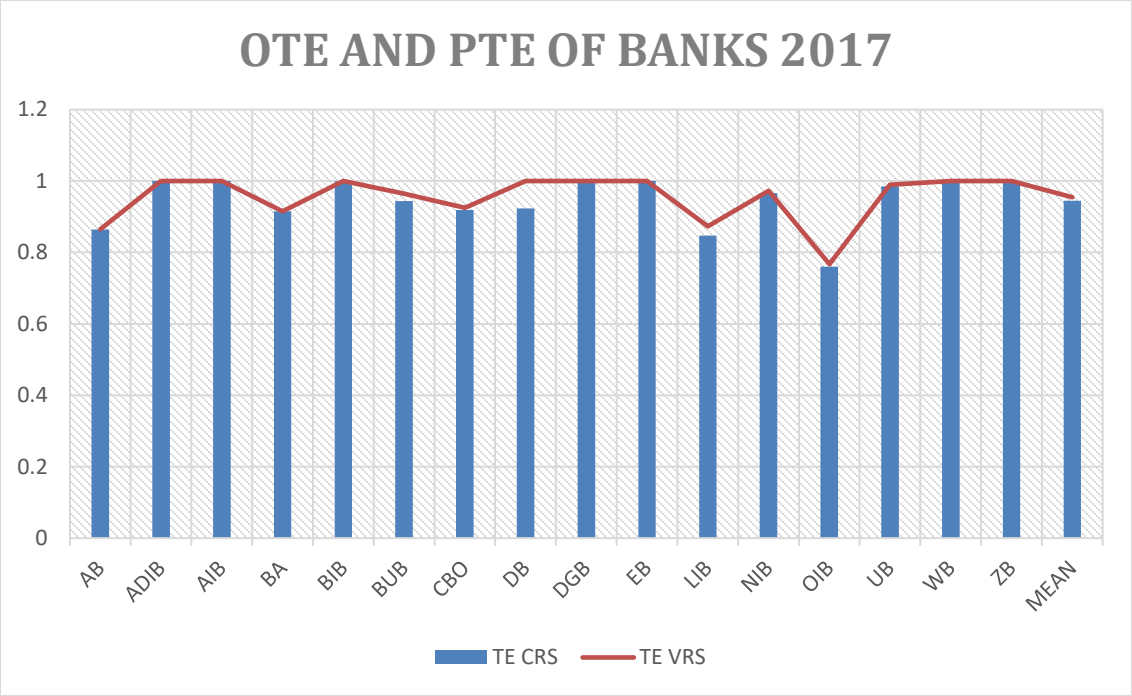
Figure 4.8: efficiency of PCBs in CRS and VRS models for the year 2016



Source: author own computation from the data

In 2016 from the sample of 16 banks, only five banks (ADIB, BIB, DGB, EB and ZB) were 100% efficient in both CRS and VRS method and the other three banks (AIB, COB, and DB) were efficient only in VRS method. In CRS method eight banks (AB, AIB, BUB, CBO, LIB, NIB, UB and WB) and in VRS method (AB, BUB, LIB, NIB, UB and WB), were their efficiency was above 90% and their efficiency ratio is lies between 0.91 and 0.999. The other three banks (BA, DB, and OIB) was below 90% efficiency score in CRS method and in VRS method two banks (BA and OIB) efficiency score were below 90%. The mean efficiency for the year was 0.95 and 0.964 for CRS and VRS respectively and 10 of the sample banks performed above the mean and 6 of the banks fell below the mean efficiency in CRS method and in VRS methods 11 of the sample banks performed above the mean and 5 them fell below the mean efficiency.

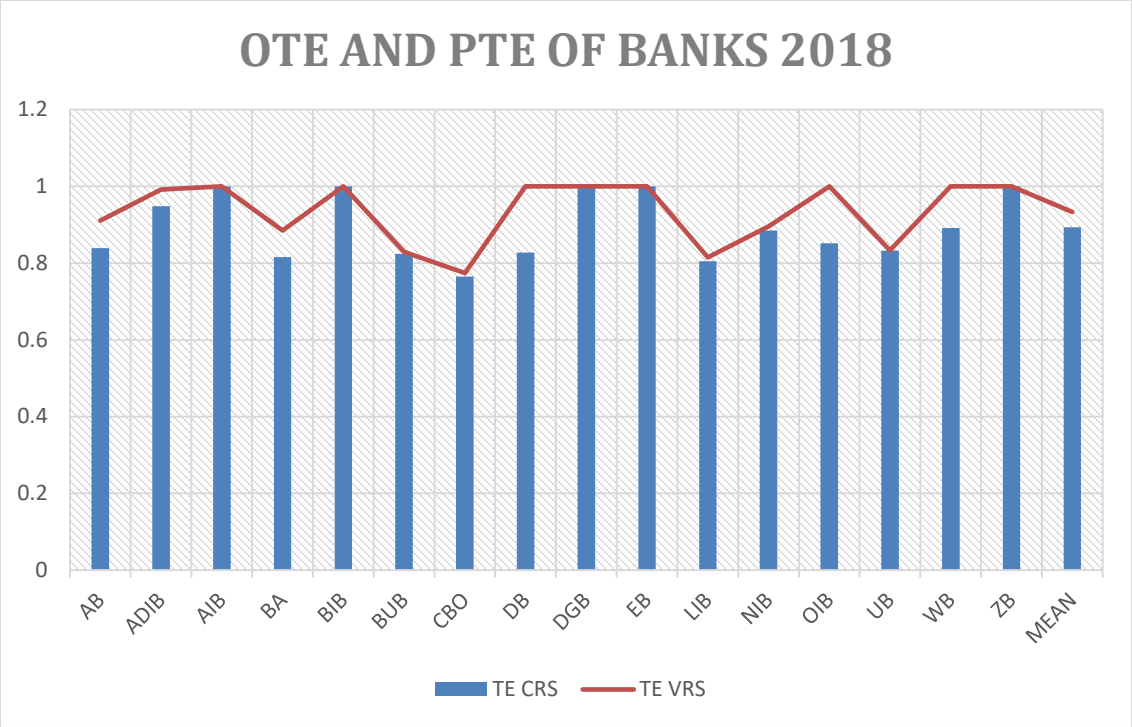
Figure 4.9: efficiency of PCBs in CRS and VRS models for the year 2017



Source: author own computation from the data

In 2017 from the sample of 16 banks, seven banks (ADIB, AIB, BIB, DGB, EB, WB and ZB) were 100% efficient in both CRS and VRS method and DB were efficient only in VRS method. In CRS method six banks (BA, BUB, CBO, DB, NIB, and UB) and in VRS method (BA, BUB, CBO, NIB, and UB) were their efficiency was above 90% and their efficiency ratio is lies between 0.919 and 0.99. The other three banks (AB, LIB, and OIB) were with the efficiency score of below 90% in both CRS and VRS method. The mean efficiency for the year was 0.945 and 0.955 for CRS and VRS respectively and 9 of the sample banks performed above the mean and 7 of the banks fell below the mean efficiency in CRS method and in VRS methods 11 of the sample banks performed above the mean and 5 them fell below the mean efficiency.

Figure 4.10: efficiency of PCBs in CRS and VRS models for the year 2018



Source: author own computation from the data

In 2018 from the sample of 16 banks, five banks (AIB, BIB, DGB, EB and ZB) were 100% efficient in both CRS and VRS method and DB, OIB and WB were efficient only in VRS method. In CRS method only ADIB and in VRS method AB and ADIB were their efficiency was above 90% and their efficiency ratio is lies between 0.911 and 0.948. The other ten banks (AB, BA, BUB, CBO, DB, LIB, NIB, OIB, UB and WB) were with the efficiency score of below 90% in CRS method and VRS method six banks (BA, BUB, CBO, LIB, NIB and UB). The mean efficiency for the year was 0.893 and 0.933 for CRS and VRS respectively and 6 of the sample banks performed above the mean and 10 of the banks fell below the mean efficiency in CRS method and in VRS methods 9 of the sample banks performed above the mean and 7 them fell below the mean efficiency.

4.4 Scale efficiency of Ethiopian private commercial banks

Table 4.4 shows scale efficiency of Ethiopian private commercial banks for the period of ten years.

	YEAR									
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
DMU	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE
AB			0.875	0.972	0.999	0.993	0.983	0.999	0.999	0.921
ADIB				1	1	1	1	1	1	0.957
AIB	1	1	1	1	0.988	0.963	0.981	0.999	1	1
BA	1	1	0.964	0.998	1	0.989	0.966	0.99	1	0.922
BIB		0.906	0.844	0.876	1	0.984	0.984	1	1	1
BUB		1	1	1	0.934	0.991	0.993	1	0.979	0.994
CBO	1	0.966	0.999	0.986	1	1	1	0.997	0.993	0.988
DB	1	1	0.988	1	1	1	0.946	0.877	0.923	0.827
DGB						0.815	0.762	1	1	1
EB						0.987	1	1	1	1
LIB	0.981	0.974	0.988	0.994	1	0.993	0.881	0.976	0.97	0.987
NIB	1	0.98	0.929	1	1	1	0.956	0.989	0.993	0.988
OIB	0.998	0.982	0.99	0.98	0.997	0.997	0.969	0.99	0.991	0.851
UB	1	0.994	1	0.999	0.989	1	0.958	0.982	0.995	1
WB	1	1	0.851	0.993	0.969	0.99	0.977	0.979	1	0.892
ZB	0.993	1	1	1	1	1	1	1	1	1
MEAN	0.997	0.984	0.956	0.986	0.991	0.981	0.96	0.986	0.99	0.958
MAX	1	1	1	1	1	1	1	1	1	1
MIN	0.981	0.906	0.844	0.876	0.934	0.815	0.762	0.877	0.923	0.827

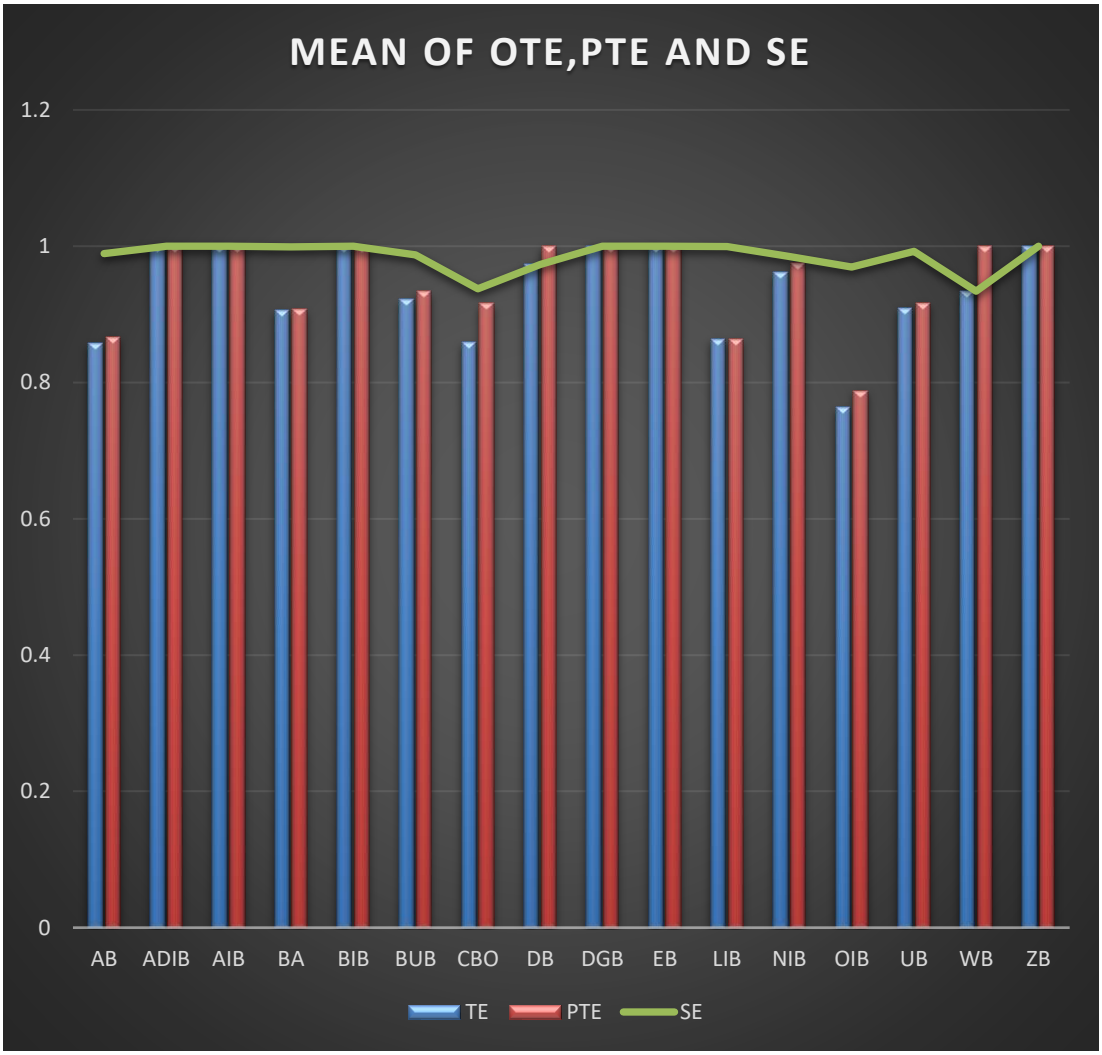
Note: some parts of the table are blank because the particulars bank were not start operating in respect year and the data were not found for the blanked year.

The table shows that the mean scale efficiency of Ethiopian private commercial banks is above 95%, it lies between 95.6% and 99.7%. The maximum score of SE is 100% and 76.2% is the lists SE score of the ten years period. From the whole observed banks ZB, EB and ADIB were the most scale efficient banks. In general the bank should increase or decreased there scale of

operation from 4.4% to 0.03%. For example if we see LIB it was inefficient for all period except 2013. When we see the inefficiency score of 2018, it was 1.3%, so that LIB should increase its scale of operation in 1.3%.

4.5. Mean efficiency score of overall technical, pure technical and scale for each bank

Graph 4.1 a presentation of mean OTE, PTE and SE Efficiency score of Ethiopian private commercial bank for the period of 2009 to 2018



This graph described in the table below in detail, it shows OTE, PTE and SE of all the observed banks for the study period using mean of input and output. A DMU rich a line in point one is 100% efficient.

Table 4.5: mean efficiency table

mean OTE, PTE and SE				
DMU	OTE	PTE	SE	RTS
AB	0.8571	0.866337	0.989339	Decr
ADIB	1	1	1	Cons
AIB	1	1	1	cons
BA	0.906231	0.906962	0.999193	Incr
BIB	1	1	1	Cons
BUB	0.92155	0.933366	0.987341	Incr
CBO	0.858541	0.915594	0.937687	Decr
DB	0.973114	1	0.973114	Decr
DGB	1	1	1	Cons
EB	1	1	1	Cons
LIB	0.863809	0.864182	0.999569	Decr
NIB	0.960976	0.975522	0.985089	Incr
OIB	0.763015	0.787078	0.969427	Decr
UB	0.909286	0.916375	0.992264	Decr
WB	0.933956	1	0.933956	Decr
ZB	1	1	1	Cons
MEAN	0.910063	0.923394	0.985563	Decr
MXA	1	1	1	
MIN	0.763015	0.787078	0.933956	
SD	0.07104	0.066296	0.021703	

Table 4.5 shows the result of input oriented analysis of all DMU input output mean efficiency score from the period of 2009 to 2018. The banks with the perfect score of 1 are efficient and those less than 1 are inefficient.

AB

According to the result obtained from the mean efficiency table AB (ABAY BANK) were inefficient with the efficiency score of 0.8571, 0.8663 and 0.9893 for OTE, PTE and SE respectively.

These implies that on average AB should have used 14.29% less resources to produce the same level of output under CRS method and 13.37% less resources under VRS method this implies that there were managerial inefficiency in the bank (inefficiency in resource utilization). In case of scale efficiency, AB scale inefficiency was 1.07% and in decrease return to scale this means that the bank was too large in its size and not operate at most productive scale.

ADIB

As of the mean efficiency table ADIB (ADDIS INTERNATIONAL BANK) was in the efficiency frontier with the efficiency score of 100% for OTE, PTE and SE at all.

These implies that ADIB was fully efficient in using its resources (the bank used minimum input to produce the current level of output) in both CRS and VRS method this implies that there were good managerial performance in the bank (proper resource utilization). In case of scale efficiency, ADIB scale efficiency was 100% and in constant return to scale this means that the bank was at optimal scale size and operate at most productive scale.

AWB

The mean efficiency of AWB (AWASH BANK) was in the efficiency frontier with the efficiency score of 100% for OTE, PTE and SE at all.

These implies that AWB was fully efficient in using its resources (the bank used minimum input to produce the current level of output) in both CRS and VRS method this implies that there were good managerial performance in the bank (proper resource utilization). In case of scale efficiency, AWB scale efficiency was 100% and in constant return to scale this means that the bank was at optimal scale size and operate at most productive scale.

BOA

According to the result obtained from the mean efficiency table BOA (BANK OF ABYSSINIA) were inefficient with the efficiency score of 0.9062, 0.9069 and 0.9991 for OTE, PTE and SE respectively.

These implies that on average BOA should have used 9.38% fewer resources to produce the same level of output under CRS method and 9.31% fewer resources under VRS method this implies that there were managerial inefficiency in the bank (inefficiency in resource utilization). In case of scale efficiency, BOA scale inefficiency was 0.09% and in increase return to scale this means that the bank was small in its size. And in general the scale inefficiency is insignificant.

BB

The mean efficiency score of BB (BERHAN BANK) was 100% for OTE, PTE and SE at all and the bank is in the efficiency frontier.

These implies that BB was fully efficient in using its resources (the bank used minimum input to produce the current level of output) in both CRS and VRS method this implies that there were good managerial performance in the bank (proper resource utilization). In case of scale efficiency, BB scale efficiency was 100% and in constant return to scale this means that the bank was at optimal scale size and operate at most productive scale.

BUIB

As showed in the mean efficiency table BUIB (BUNNA INTERNATIONAL BANK) were inefficient with the efficiency score of 0.9215, 0.9333 and 0.9873 for OTE, PTE and SE respectively.

These indicates that on average BUIB should have used 7.85% less resources to produce the same level of output under CRS method and 6.67% less resources under VRS method this implies that there were managerial inefficiency in the bank (inefficiency in resource utilization). In case of scale efficiency, BUIB scale inefficiency was 1.27% and in increase return to scale this means that the bank was too small in its size and not operate at most productive scale.

CBO

According to the result obtained from the mean efficiency table CBO (COOPERATIVE BANK OF OROMIA) were inefficient with the efficiency score of 0.8585, 0.9155 and 0.9376 for OTE, PTE and SE respectively.

These shows that on average CBO should have used 14.15% fewer resources to produce the same level of output under CRS method and 8.44% fewer resources under VRS method this implies that there were managerial inefficiency in the bank (inefficiency in resource utilization). In case of scale efficiency, CBO scale inefficiency was 6.23% and in decrease return to scale this means that the bank was too large in its size and not operate at most productive scale.

DB

The mean efficiency of DB (DASHEN BANK) was inefficient with the efficiency score of 0.9731, 1 and 0.9731 for OTE, PTE and SE respectively. The CRS inefficiency of the bank is not in case of technical inefficiency it was only scale inefficiency since DB PTE was 100%, this shows there is no managerial inefficiency (the bank used minimum input to produce the current level of output). In case of scale efficiency, DB scale inefficiency was 2.69% and in decrease return to scale this means that the bank was too large in its size and not operate at most productive scale.

DGB

The mean efficiency of DGB (DEBUB GLOBAL BANK) was in the efficiency frontier with the efficiency score of 100% for OTE, PTE and SE at all.

These implies that DGB was fully efficient in using its resources (the bank used minimum input to produce the current level of output) in both CRS and VRS method this implies that there were good managerial performance in the bank (proper resource utilization). In case of scale efficiency, DGB scale efficiency was 100% and in constant return to scale this means that the bank was at optimal scale size and operate at most productive scale.

EB

As of the mean efficiency table EB (ENAT BANK) was in the efficiency frontier with the efficiency score of 100% for OTE, PTE and SE at all.

These implies that EB was fully efficient in using its resources (the bank used minimum input to produce the current level of output) in both CRS and VRS method this implies that there were good managerial performance in the bank (proper resource utilization). In case of scale efficiency, EB scale efficiency was 100% and in constant return to scale this means that the bank was at optimal scale size and operate at most productive scale.

LIB

According to the result obtained from the mean efficiency table LIB (LION INTERNATIONAL BANK) were inefficient with the efficiency score of 0.8638, 0.8641 and 0.9995 for OTE, PTE and SE respectively.

These implies that on average LIB should have used 13.62% fewer resources to produce the same level of output under CRS method and 13.59% less resources under VRS method this implies that there were managerial inefficiency in the bank (inefficiency in resource utilization). In case of scale efficiency, LIB scale inefficiency was 0.05% and in decrease return to scale this means that the bank was large in its size. And in general the scale inefficiency is insignificant.

NIB

As showed in the mean efficiency table NIB (NIB INTERNATIONAL BANK) were inefficient with the efficiency score of 0.9609, 0.9755 and 0.9850 for OTE, PTE and SE respectively.

These indicates that on average NIB should have used 3.91% less resources to produce the same level of output under CRS method and 2.45% less resources under VRS method this implies that there were some managerial inefficiency in the bank (inefficiency in resource utilization). In case of scale efficiency, NIB scale inefficiency was 1.5% and in increase return to scale this means that the bank was too small in its size and not operate at most productive scale.

OIB

According to the result obtained from the mean efficiency table OIB (OROMIA INTERNATIONAL BANK) were inefficient with the efficiency score of 0.7630, 0.7870 and 0.9694 for OTE, PTE and SE respectively.

These shows that on average OIB should have used 23.7% less resources to produce the same level of output under CRS method and 21.3% less resources under VRS method this implies that there were high managerial inefficiency in the bank (inefficient in resource utilization) relative to the observed banks . In case of scale efficiency, OIB scale inefficiency was 3.06% and in decrease return to scale this means that the bank was too large in its size and not operate at most productive scale.

UB

As showed in the mean efficiency table UB (UNITED BANK) were inefficient with the efficiency score of 0.9092, 0.9163 and 0.9922 for OTE, PTE and SE respectively.

These indicates that on average UB should have used 9.08% fewer resources to produce the same level of output under CRS method and 8.37% fewer resources under VRS method this implies that there were managerial inefficiency in the bank (inefficiency in resource utilization). In case of scale efficiency, UB scale inefficiency was 0.78% and in decrease return to scale this means that the bank was large in its size. And in general the scale inefficiency is insignificant.

WB

As of the mean efficiency result WB (WEGAGEN BANK) were inefficient with the efficiency score of 0.9339, 1 and 0.9339 for OTE, PTE and SE respectively. The CRS inefficiency of the bank is not in case of technical inefficiency it was only scale inefficiency as WB PTE was 100%, this shows there was no managerial inefficiency (the bank used minimum input to produce the current level of output).

In case of scale efficiency, WB is the most scale inefficient bank among the observed banks with the inefficiency score of 6.61% and it was in decrease return to scale this means that the bank was too large in its size and not operate at most productive scale.

ZB

The mean efficiency of ZB (ZEMEN BANK) was in the efficiency frontier with the efficiency score of 100% for OTE, PTE and SE at all.

These implies that ZB was fully efficient in using its resources (the bank used minimum input to produce the current level of output) in both CRS and VRS method this implies that there were good managerial performance in the bank (proper resource utilization). In case of scale efficiency, ZB scale efficiency was 100% and in constant return to scale this means that the bank was at optimal scale size and operate at most productive scale.

As the shows from the evaluated 16 banks Only 6 banks were technically efficient in CCR model and the rest 10 banks are technically inefficient with the score of 0.763 to 0.973 and in VRS model 8 banks were technically efficient and half of the banks were technically inefficient with the score of 0.787 to 0.975. DB and WB are technically efficient in VRS model but technically inefficient in CCR model it's because of scale inefficiency. In case of DB this result is in line with Yedersal (2018) in his study also DB inefficiency is because of scale inefficiency.

OIB is the least efficient bank in both CCR and VRS with the score of 0.763015 and 0.787078 respectively. In case of scale efficiency only 6 banks were efficient and the other 10 banks are inefficient with the score of 0.933 to 0.999. The least efficient bank in scale efficiency is WB with the score of 0.933956.

The mean efficiency of the Ethiopian private commercial banks during the study period is 0.910063, 0.923394 and 0.985563 for OTE, PTE and SE respectively. This implies that on average the banks could have saved 9% and 7.66% of input from the present consumption of input to produce the present level of output for CRS and VRS method respectively. And in case of SE the banks were inefficient and in decreasing return to scale, these implies that banks are not in proper size (they are too large) and not operate at most productive scale (operate over productive scale).

In general Only 6 banks were 100% efficient in the evaluation period and the result shows that most of the banks are inefficient this means the banks were inefficient in resource utilization and not operate at most productive scale. According to the result the inefficiency of Ethiopian private commercial banks is mostly managerial inefficiency (inefficient utilization of resource) rather than scale inefficiency. And this result is unlike to Gamachis (2016) and inline to Fasika (2016)

and Yedersal (2018) the result of this two study show that mean SE of the banks in Ethiopia is better than PTE under their study period.

4.6. Slack value

DMU	Score	Slack (DEPO)	Slack (NON-IE)	Slack (TLAA)	Slack (NON-II)	Reduction and addition in input output			
						DEPO	NON-IE	TLAA	NON-II
AB	0.8571	0	0	0	0	14.29%	14.29%	0	0
ADIB	1	0	0	0	0	0	0	0	0
AWB	1	0	0	0	0	0	0	0	0
BOA	0.906231	0	0	0	62.63372	9.38%	9.38%	0	16.85 %
BB	1	0	0	0	0	0	0	0	0
BUIB	0.92155	0	0	0	13.6889	7.85%	7.85%	0	9.23%
CBO	0.858541	0	-13.7978	0	32.52364	14.15%	17.33%	0	11.53 %
DB	0.973114	-432.868	0	0	0	5.05%	2.70%	0	0
DGB	1	0	0	0	0	0	0	0	0
EB	1	0	0	0	0	0	0	0	0
LIB	0.863809	0	0	0	0	13.62%	13.62%	0	0
NIB	0.960976	0	0	0	60.63848	3.90%	3.90%	0	19.31 %
OIB	0.763015	0	0	0	0	23.70%	23.70%	0	0
UB	0.909286	0	0	0	64.12547	9.07%	9.07%	0	18.48 %
WB	0.933956	0	0	0	0	6.60%	6.60%	0	0
ZB	1	0	0	0	0	0	0	0	0

Table 4.6 shows the slack value for inefficient banks and the required improvements in each input and output variables

Kumar.S and Gulati. R (2008) as stated in their study, Slack occur for inefficient DMU only in a particular DEA run. These slack give information about the parts which an incompetent DMU needs to improve.

For these study model which is input oriented, the input slack indicate the excess amount of input used and the output slack shows the amount of under produced output.

The above table indicating that from the observed 16 banks all inefficient banks need improvement in both input variables, for DEPO the banks slacks (the deposit money need to decreased) is lies between 3.90% and 23.70%, in case of NON-IE (the non-interest expenses need to decreased) the slack is lies between 2.70% and 23.70%.in case of output variables all DMU have zero slack of TLAA so no need of enhancement in this output variable and for NON-II (the other output variable) only five banks need improvement which are BOA, BUIB, CBO, NIB and UB with a percentage of 16.85%, 9.23%, 11.53%, 19.31% and 18.48% respectively. Unlike to the others CBO and DB need to decrease additional amount from their input in addition to inefficient percentage. CBO need to decrease 13,797,800 birr from non-interest expenses and DB need to decrease 432,868,000 from its deposit.

CHAPTER FIVE

5. SUMMARY OF FINDING CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter presents the main finding of the analysis in the summary of the finding section, and conclusion, recommendation and suggestion for future research is presents in the other sections.

5.2 Summary of findings

This part of the chapter summarized the major findings of the analysis that obtained from MAXDEA 7, which is overall technical, pure technical and scale efficiency of PCBs and input output slack of DMU.

The finding from the analysis reveal that Form the period of 10 years under the study only in one years in 2013 from the entire banks 50% of the sample banks were fully efficient.

AB and OIB did not have any full efficiency in overall technical and scale efficiency score in any of the ten years period and ZB and ADIB were inefficient only in one year from the entire period of the study.

Generally the efficiency score of each bank during the study period is inconsistent except ADIB, DGB, EB and ZB.

The outcome of the mean efficiency of the banks shows that from the sample of 16 banks only 6 banks were efficient in overall technical, pure technical and scale efficiency. From the inefficient banks eight of them (AB, BOA, BUIB, CBO, LIB, NIB, OIB and UB) inefficiency were mostly caused in technical inefficiency.

DB and WB were efficient in pure technical efficiency and the inefficiency of these two banks is because of scale inefficiency. OIB were the least efficient bank in overall technical and pure technical efficiency score and WB is least efficient bank in scale efficiency score.

The mean efficiency of PCBs during the study period is 91%, 92.33% and 98.56% for OTE, PTE and SE respectively. This implies that on average the banks could have to save 9% and 7.66% of input from the present consumption of input to produce the present level of output for CRS and

VRS method respectively. In scale efficiency also the banks were inefficient and in decreasing return to scale, these implies that banks are not in proper size (they are too large).

According to the result the inefficiency of Ethiopian private commercial banks is mostly managerial inefficiency (inefficient utilization of resource) rather than scale inefficiency.

Based on the slack value result from the observed 16 banks all inefficient banks need improvement in both input variables, for DEPO the banks slacks (the deposit money need to decreased) is lies between 3.90% and 23.70%, in case of NON-IE (the non-interest expenses need to decreased) the slack is lies between 2.70% and 23.70%.in case of output variables all DMU have zero slack of TOL so no need of enhancement in this output variable and for NON-II (the other output variable) only five banks need improvement which are BOA, BUIB, CBO, NIB and UB with a percentage of 16.85%, 9.23%, 11.53%, 19.31% and 18.48% respectively. And specifically CBO need to decrease 13,797,800 birr from non-interest expenses and DB need to decrease 432,868,000 from its deposit in addition to the inefficiency ratio of decreasing.

5.3 Conclusion

This study is about measuring of technical and scale efficiency of Ethiopian private commercial banks. The study used DEA method to analysis to measure the efficiency of the banks for a period of 10 years from 2009 to 2018. Both CRS and VRS models of DEA were used to analysis OTE, PTE and SE of 16 PCBs and to select the input and output variables the researcher followed the intermediation approach based on this the input variables are deposit and non-interest expenses and the output variables are total loan and non-interest income.

The result indicated that the level of OTE, PTE, and SE of PCBs is 91%, 92.33% and 98.56% respectively

From the sampled 16 banks 6 banks (ADIB, AIB, BB, DGB, EB and ZB) were in the efficiency frontier and OIB is the least efficient bank in resource utilization and WB were scale inefficient from the entire sample banks.

According to the outcome of the study most of private commercial banks in Ethiopia during the study period were inefficient and this inefficiency is caused on both pure technical inefficiency (managerial inefficiency) and scale inefficiency (not operate at most productive scale). Still in

most of the inefficient banks (8 banks) the source of overall technical inefficiency is pure technical inefficiency.

In general According to the result the inefficiency of Ethiopian private commercial banks is mostly managerial inefficiency (inefficient utilization of resource) rather than scale inefficiency.

In case of input output improvements the inefficient banks should decreased deposit money from a minimum of 3.9% to a maximum of 23.7%, non-interest expenses need to decreased a minimum of 2.7% to a maximum of 23.7% and need to enhancement non-interest income. In addition to that CBO need to decrease 13,797,800 birr from non-interest expenses and DB need to decrease 432,868,000 from its deposit.

5.4 Recommendation

To be OT efficient most of the inefficient banks need to improve their resources utilization. For this the inefficient banks should learn from the efficient banks especially from ZB and ADIB.

Most of the inefficient bank should revise their business strategy and/or used properly their business strategy. Since most of the banks were in decrease return to scale rather than expansion better to offer services like agency banking and electronic banking system.

As a result of the analysis the study conclude that the inefficiency of Ethiopian private commercial banks is mostly managerial inefficiency so that, banks need to develop their manager’s capacity. Through experience sharing and giving updated training.

BOA, BUIB, CBO, NIB and UB need to focus on income diversifying from fee based and commotion based incomes.

The recommendation for National Bank of Ethiopia is that to adopt DEA method of analysis to evaluate the banking sector, this will help NBE in order to get new insight about the sector and its efficiency this will support for regulation and policy making.

5.5 Suggestion for feature research

Feature researchers can apply DEA method of analysis using production approach to evaluate branch level efficiency of each bank this will help the bank in strategic planning

Feature researchers can apply DEA method using different input and outputs for evaluating the financial sectors, such as banks and insurances.

References

Adamu, T. K. &Kenenisa, L. D. (2017). Financial performance of commercial banks in Ethiopia: an application of camel model. Zenith international journal of multidisciplinary research, vol.7 (12), pp. 208-221

Aderaw, G., &Singh. M., (2016) Development of Financial Sector in Ethiopia: Literature Review, Development of Financial Sector in Ethiopia: Literature Review, Vol.7, No.7, 2016

Agu c.c., (2004), Efficiency of Commercial Banking in the Gambia: African Review of Money Finance and Banking pp31-50.

Akhtar, M.H., &Nishat, M., (2002), X-efficiency analysis of commercial banks in Pakistan: A preliminary investigation, The Pakistan Development Review, 567-580.

Alvi, m. (2016) A Manual for Selecting Sampling Techniques in Research. Munich Personal RePEc Archive, University of Karachi, Iqra University, MPRA Paper No. 70218,

Aly, H.Y., Grabowski, R., Pasurka, C. and Rangan, N. (1990).Technical, Scale, and Allocative Efficiencies in U.S. banking: An Empirical Investigation, Review of Economics and Statistics, DOI: 10.2307/2109710, https://www.researchgate.net/publication/24094832.

Avikaran N. K., (2006), Productivity Analysis in the service sector with Data Envelopment Analysis, Third Edition, University of Queensland QLD 4072 Australia.

Avkiran, (2000) Avkiran, N.K. (2000) 'Rising productivity of Australian trading banks under deregulation 1986–1995', Journal of Economic & Finance, Vol. 24,No.2,pp.122–140

Baidya, M. K. &Mitra, D. (2012), An analysis of the technical efficiency of Indian public sector banks through DEA approach. Int. J. Business Performance Management, Vol. 13, Nos. 3/4, 2012

Balcerzak, A. P., Kliestik, T., Streimikiene, D., &Smrcka, L. (2017). Non-Parametric Approach to Measuring the Efficiency of Banking Sectors in European Union Countries, Acta Polytechnic Hungarica,Vol. 14, No. 7, 2017

Banker, R. D., Charnes, A., Cooper, W.W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. Management Science, Vol. 30, No.9

Bauer, P. W., Berger, A. N., Ferrier, G. D., & Humphrey, D. B. (1998). Consistency conditions for regulatory analysis of financial institutions: a comparison of frontier efficiency methods. Journal of Economics and business, 50(2), 85-114.

Camp, W. G. (2001). Formulating and Evaluating Theoretical Frameworks for Career and Technical Education Research. Journal of Vocational Educational Research, 26 (1), 27-39.

Chandrasekar, Sendhil, R., &Ramasundaram, P. (2017).e Compendium of Training-cum-Workshop on Data Analysis Tools and Approaches (DATA) in Agricultural Sciences, March 2017

Charnes, A., Cooper, W., E. (1978). Measuring efficiency of decision making units. European Journal of operational Research, 429-444.

Coelli, T.J et al (1998) An Introduction to Efficiency and Productivity Analysis,Boston, Dodrecht, London, Kluwer Academic Publishers.

Creswell, J.W., (2014). Research design: qualitative, quantitative, and mixed methods approaches / 4th Ed. Thousand Oaks, California: Sage Publications

Dakito, A. (2015). Assessment of Banking Performance Using Capital Adequacy in Ethiopia.Economics. Vol. 4, No. 6, 2015, pp. 106-111.

Debasish, S.S. (2006). Efficiency Performance in Indian Banking, Use of Data Envelopment Analysis. Global business review, 7: 2, Sage Publications New Delhi/Thousand Oaks/London, DOI: 10.1177/097215090600700209

Emrouznejad, A., &Cabanda, E. (2015).Introduction to Data Envelopment Analysis and its Applications, Handbook of Research on Strategic Performance Management and Measurement Using Data Envelopment Analysis: 235 255. IGI Global, USA.

Erasmus, C., &Makina, D. (2014).An Empirical Study of Bank Efficiency in South Africa Using the Standard and Alternative Approaches to Data Envelopment Analysis (DEA), Journal of Economics and Behavioral Studies Vol. 6, No. 4, pp. 310-317, Apr 2014 (ISSN: 2220-6140)

Fasika, Z. A. (2016). Evaluating the Technical Efficiency of Commercial Banks in Ethiopia: A Data Envelopment Analysis.European Journal of Business and Management, Vol.8, No.28, 2016.

Fentaw, L. &Sharma, D. (2017). Determinants of Banks Profitability: Review and Assessment. International Journal of Management & Business Studies, Vol. 7.Issue 1, Jan - March 2017

Gamachis, G. (2016).Technical Efficiency and Productivity of Ethiopian Commercial Banks: Data Envelopment Analysis (DEA). International Journal of Scientific and Research Publications, Volume 6, Issue 9, September 2016 860 ISSN 2250-3153

Grover, V. K. (2015) Research Approach: An overview. Golden Research Thoughts, Volume-4 (8) ISSN 2231-5063

Gudata, A. (2015). Financial performance analysis in banking sector (in selected commercial banks in Ethiopia). International Journal of Current Research Vol. 7, Issue, 10, pp.21883-21886

Gulati, R. (2011). Evaluation of technical, pure technical and scale efficiencies of Indian banks: An analysis from cross-sectional perspective.presentation in The 13th Annual Conference on Money and Finance in the Indian Economy on 25-26th February, 2011Indira Gandhi Institute of Development Research, Mumbai

Habtamu, B. A. (2015). Financial Performance of the Ethiopian Banking Sector.International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Index Copernicus Value (2013): 6.14

Horvatova, E. (2018). Technical Efficiency of Banks in Central and Eastern Europe.International Journal of Financial Stud, 6, 66; doi: 10.3390/ijfs6030066

Islamia, J. M. (2016). Research Design, Research in Social Science: Interdisciplinary Perspectives, New Delhi

Kablan, S. (2007).Measuring bank efficiency in developing countries: the case of WAEMU (West African economic monetary union).African Economic Research Consortium, may 2007

Kablan, S. (2010).Banking Efficiency and Financial Development in Sub-Saharan Africa. IMF Working Paper African Department June 2010, JEL Classification Numbers: G21, O16, O55

Kamau,A. W. (2011). Intermediation efficiency and productivity of the banking sector in Kenya.Interdisciplinary Journal of Research in Business, Vol 1, Issue 9 pp12 26.

Kapur,D. and Abebaw, K. G. (2012). Financial performance and ownership structure of Ethiopian commercial banks. Journal of Economics and International Finance, Vol. 4 (1), pp. 1–8, 7, DOI: 10.5897/JEIF11.036

Karimzadeh, M. (2012). Efficiency Analysis by using Data Envelop Analysis Model: Evidence from Indian Banks. International Journal of Latest Trends in Finance & Economic Sciences, Vol-2 No. 3 September, 2012

Kizito, E.U. (2012).The Place of Financial Markets in the Development Process: Evidence from Nigeria. Journal of Economics and Behavioral Studies, Vol. 4, No. 11, pp. 649-659, Nov 2012 (ISSN: 2220-6140)

Kocisova, K. (2013). Technical efficiency of top 50 world banks, Journal of Applied Economic Sciences, Volume VIII, Issue 3(25), Fall 2013 Technical University of Kosice Faculty of Economics, Slovak Republic

Kokobe, S. A. &Birhanu, D. N. (2015).Determinants of Financial Performance of Commercial Banks in Ethiopia.Journal of Business Management and Economics, 3: 11 November (2015).

Kothari, C.R. (2004). Research Methodology; methods and Techniques. University of Rajasthan Jaipur (India); New Age International (P) Ltd,

Kounetas, K., &Tsekouras, K.(2007). Measuring Scale Efficiency Change Using a Translog Distance Function.International Journal of Business and Economics, 6(1), 63-69.

Kumar, N. & Singh, A. (2015), Measuring Technical and Scale Efficiency of Banks in India Using DEA. IOSR Journal of Business and Management, Volume 17, Issue 1.Ver. II (Jan. 2015), PP 66-71

Kumar.S and Gulati.R (2008). An Examination of Technical, Pure Technical, and Scale Efficiencies in Indian Public Sector Banks using Data Envelopment Analysis. Eurasian Journal of Business and Economics, 1 (2), 33-69.

Luccheti, R., L. Papi, and A. Zazzaro (2000) Banks' Efficiency and Economic Growth: A Micro-macro Approach. Italy: Universita di Ancona

Marjanovic.I, Stankovic. J. J and Popovic. Z (2018). Efficiency estimation of commercial banks based on financial performance: input oriented DEA CRS/VRS models. Economic Themes, 56(2): 239-252

Melaku, A. (2017). Financial performance analysis of private commercial banks of Ethiopia: camel ratings. International journal of scientific and research publications, volume 7, issue 10, Issn 2250-3153

Mokhtar, H.S.A., Abdullah, N. &Alhabshi, S.M. (2008).Efficiency and competition of Islamic banking in Malaysia.Humanomics, Vol. 24 No. 1, 2008 pp. 28-48, 0828-8666, DOI 10.1108/08288660810851450

Mongid, A., &Tahir, I. M. (2010). Technical and scale efficiency of Indonesian rural banks. Journal of Banks and Bank Systems, Volume 5, Issue 3, 2010

Mousa, G. A. (2015). Financial Ratios versus Data Envelopment Analysis: The Efficiency Assessment of Banking Sector in Bahrain Bourse. International Journal of Business and Statistical Analysis, vol 2.(2), ISSN (2384-4663). July-2015

Muhabie, M. M. (2015). Evaluation of the Financial Performance of Banking Sectors in Ethiopia: The Case of Zemen Bank. Global Journal of Management and Business Research: C Finance, Volume 15 Issue 9 Version 1.0 Year 2015

Nand, 2014 Review. International Journal of Advance Research and Innovation, ISSN 2347 – 3258, Volume 1 (2014) 120-126

Ncube, M. (2009), Efficiency of banking sector in South Africa. "African Economic conference" 11 – 13 November 2009 • United Nations Conference Centre, Addis Ababa-Ethiopia.

Nguyen, Viet H. (2007), Measuring Efficiency of Vietnamese Commercial Banks: An Application of Data Envelopment Analysis (DEA), in Khac Minh Nguyen and Thanh Long Giang (ed.), Technical Efficiency and Productivity Growth in Vietnam, Publishing House of Social Labor, Tokyo

Nigmonov, A. (2010). Bank Performance and Efficiency in Uzbekistan Eurasian. Journal of Business and Economics, 3 (5), 1-25

Othman, F. M., Mohd-Zamil**, N. A**., Abdul Rasid, S. Z., Vakilbashi**, A. &**Mokhber**, M.**(2016).Data Envelopment Analysis: A Tool of Measuring Efficiency in Banking Sector, International Journal of Economics and Financial Issues, 2016, 6(3), 911-916.

Pasiouras, F. (2006) Estimating the Technical and Scale Efficiency of the Greek Commercial Banks, 2006, School of Management, University of Bath.Performance of conventional banks in Singapore", Journal of Banking and Finance, 26, 79-98.

Rahel, T.&Maru S. (2015).Determinants of the Financial Performance of a Private Commercial Bank in Ethiopia. Journal of Business and Administrative Studies (JBAS) Vol. 7 No. 2

Rahi, S. (2017).Research Design and Methods: A Systematic Review of Research Paradigms, Sampling Issues and Instruments Development. International Journal of Economics & Management Sciences, Volume 6 • Issue 2 • 1000403, ISSN: 2162-6359

Rajha K. S. (2016). Determinants of Non-Performing Loans: Evidence from the Jordanian Banking Sector. Journal of Finance and Bank Management, Vol. 4, No. 1, pp. 125-136

Rao, M. and Tekeste, B. (2012). Cost Efficiency and Ownership Structure of Commercial Banks in Ethiopia: An application of non-parametric approach, European Journal of Business and Management Vol. 4, No.10

Raphael, G. (2012). Commercial banks efficiency in Tanzania: A non-parametric approach. European Journal of Business and Management, Vol. 4. (21), 2012.

San, O. T. &Heng, T. B. (2013).Factor affecting the profitability of Malaysian commercial bank, African Journal of Business Management, 7(8). 649-660

Sanjeev, G.M. (2006). Data Envelopment Analysis (DEA): For Measuring Technical Efficiency of Banks. Journal of Business Perspective, Vol 10 (1)

Sufian, F. and Chong, R.R., 2008. Determinants of bank profitability in a developing economy: Empirical evidence from the Philippines. Asian academy of management journal of accounting and finance, 4(2), pp.91-112.

Tahir, I.M., Abu Bakar, N.M. &Haron, S. (2009). Estimating Technical and Scale Efficiency of Malaysian Commercial Banks: A Non-Parametric Approach. International Review of Business Research Papers, Vol.5 No. 1 January 2009 Pp. 113- 123

Takbiri, O., Mohammadi, M., &Naderi, B. (2015).The efficiency of bank branches: Management Science Letters, 5 (2015) 1111–1116 , Department of Industrial Engineering, Faculty of Engineering, Kharazmi University, Tehran, Iran

Tesfaye, B. L. (2014). Efficiency in the Ethiopian Banking System: An Application of Data Envelopment Analysis. European Journal of Business and Management, Vol.6, No.23, 2014

Thu Huong, T. T. &Firoz, B. (2016). Evaluating the Efficiency of Vietnamese Commercial Banks using Data Envelopment Analysis, In: 6th Annual International Conference on Accounting and Finance, Singapore, 30th to 31st May 2016.

Tony, A., &Alemayehu, G. (2001).Ethiopia's new financial sector and its regulation, Finance and Development Research Program. Working paper series paper no 39 August 2001

Wozniewska, G.(2008).Methods of measuring the efficiency of commercial banks: an example of Polish banks. Banking Department Wroclaw University of Economics, 53–345 Wroclaw, ul. Komandorska,118/120, Poland

Yadav, R. (2015). Technical efficiency, pure technical efficiency and scale efficiency of Russian commercial banks: an empirical analysis (2007-2014),Int.J.Eco.Res. ISSN: 2229-6158 2015, v 6 i6, 52 - 59

Yannick, G. S., Hongzhong, Z. & Thierry, B. (2016). 12th International Strategic Management Conference, ISMC 2016, 28-30 October 2016, Antalya, Turkey Wuhan University of Technology, Wuhan, China

Yidersal, D. D. (2018). Measurement of Commercial Bank Efficiency in Ethiopia: an Application to Data Envelopment Analysis (DEA). European Journal of Business and Management, ISSN 2222-2839 (Online) Vol.10, No.13, 201

DMU	YEAR																			
	2009		2010		2011		2012		2013		2014		2015		2016		2017		2018	
	TE CRS	TE VRS	TE CRS	TE VRS	TE CRS	TE VRS	TE CRS	TE VRS	TE CRS	TE VRS	TE CRS	TE VRS	TE CRS	TE VRS	TE CRS	TE VRS	TE CRS	TE VRS	TE CRS	TE VRS
AB					0.875	1	0.855	0.88	0.887	0.888	0.867	0.873	0.869	0.884	0.91	0.911	0.864	0.865	0.839	0.911
ADIB							1	1	1	1	1	1	1	1	1	1	1	1	0.948	0.992
AIB	0.904	0.904	1	1	1	1	1	1	0.988	1	0.963	1	0.981	1	0.999	1	1	1	1	1
BA	0.978	0.978	1	1	0.964	1	0.948	0.949	1	1	0.909	0.92	0.789	0.817	0.851	0.86	0.915	0.915	0.816	0.885
BIB			0.906	1	0.844	1	0.876	1	1	1	0.868	0.881	0.873	0.887	1	1	1	1	1	1
BUB			1	1	1	1	1	1	0.898	0.962	0.923	0.931	0.875	0.881	0.965	0.965	0.944	0.965	0.824	0.829
CBO	1	1	0.774	0.8	0.683	0.684	0.791	0.802	1	1	1	1	1	1	0.997	1	0.919	0.925	0.765	0.774
DB	1	1	1	1	0.988	1	1	1	1	1	1	1	0.946	1	0.877	1	0.923	1	0.827	1
DGB											0.815	1	0.762	1	1	1	1	1	1	1
EB											0.836	0.847	1	1	1	1	1	1	1	1
LIB	0.913	0.93	0.896	0.92	0.863	0.873	0.885	0.891	1	1	0.848	0.854	0.876	0.995	0.972	0.996	0.847	0.873	0.805	0.815
NIB	1	1	0.962	0.982	0.929	1	1	1	1	1	1	1	0.956	1	0.927	0.937	0.966	0.973	0.885	0.896
OIB	0.998	1	0.692	0.704	0.738	0.745	0.726	0.741	0.809	0.812	0.748	0.75	0.845	0.873	0.791	0.798	0.76	0.767	0.851	1
UB	0.947	0.947	0.925	0.93	1	1	0.994	0.996	0.86	0.869	0.834	0.834	0.778	0.812	0.94	0.958	0.985	0.99	0.833	0.833
WB	1	1	1	1	0.851	1	0.993	1	0.943	0.974	0.813	0.822	0.806	0.825	0.969	0.99	1	1	0.892	1
ZB	0.993	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
MEAN	0.973	0.976	0.93	0.945	0.903	0.946	0.934	0.947	0.956	0.965	0.902	0.92	0.897	0.936	0.95	0.964	0.945	0.955	0.893	0.933
MAX	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
MIN	0.904	0.904	0.692	0.704	0.683	0.684	0.726	0.741	0.809	0.812	0.748	0.75	0.762	0.812	0.791	0.798	0.76	0.767	0.765	0.774
NO.EF.BA	4	6	6	7	4	10	6	8	8	9	5	7	4	8	5	8	7	8	5	8
PERC	0.4	0.6	0.5	0.583	0.308	0.769	0.429	0.571	0.571	0.643	0.313	0.438	0.25	0.5	0.313	0.5	0.438	0.5	0.313	0.5

Appendix Two

All banks data for each year

COMPANY	DEPO	NON-IE	TLO	NON-II
AB	**263**	15	158	7
AB	**779**	50	452	54
AB	**1476**	90	843	82
AB	**2,518.22**	154.53	1,474.83	130.43
AB	**3,623.81**	222.4	2,311.34	213.2
AB	**4,832.58**	293.36	3,073.69	215.69
AB	**6,792.20**	380.19	4,209.57	298.7
AB	9566.089	539.817	5898.455	443.062
SD	3205.8287	179.4498	2000.037	143.1939
min	263	15	158	7
max	9566.089	539.817	5898.455	443.062
mean	3731.3624	218.1621	2302.611	180.5103
ADIB	**211**	21	154.488	23
ADIB	**561**	34.10043	328	52.62766
ADIB	**792.41**	60	511.04	85
ADIB	**1109.6**	88	762.35	112
ADIB	**1562.54**	119	1049.789	142
ADIB	**2271.7**	171	1561.56	178
ADIB	2970.377	207.384	2034.996	201.469
SD	983.93339	69.83438	683.1338	65.09123
min	211	21	154.488	23
max	2970.377	207.384	2034.996	201.469
mean	1354.0896	100.0692	914.6033	113.4424
AIB	**4,962**	155	2,713	201
AIB	**6106**	181	3146	383
AIB	**7744**	213	3986.464	533
AIB	**9204**	295	5504.61	442
AIB	**12,545**	474	7,710	598
AIB	**15,040**	617.05	9,176.36	832.07
AIB	**18,520.42**	800.91	12,482.04	839.49
AIB	**22,832.03**	1056.23	15450.78	901.42
AIB	**30,590.90**	1499.13	22576.34	1176.18
AIB	43451.38	1933.975	31049.06	1203.116
SD	12267.1	607.2567	9312.124	335.0781
min	4,962	155	2,713	201
max	43,451	1,934	31,049	1,203
mean	17,100	723	11,379	711
BA	**4494.19**	147.25	2708.96	128.92
BA	**5,139**	145	3153	207

BA	**6,075**	196	3315.687	246
BA	**6,771**	226	3897.406	226
BA	**8,496**	226	4,702	226
BA	**9,096**	345	5,061	451
BA	**11,118.17**	462	5,905.22	354
BA	**13,634.96**	713	8011.609	535
BA	**20,700.81**	1075	13927.24	789
BA	25794.54	1452.147	17780.96	552.709
SD	7059.1091	447.3448	5073.402	206.6929
min	4494.19	145.00	2708.96	128.92
max	25794.54	1452.15	17780.96	789.00
mean	11131.97	498.74	6846.31	371.56
BIB	**238**	12.441	153	2
BIB	**694**	23	331.818	33
BIB	**932**	34.57	499.55	51.5
BIB	**1,593**	50.19	979	55.29
BIB	**2,012**	116.16	1184.695	86.37
BIB	**3067.9**	161.97	1875.49	162.38
BIB	**5296.52**	298.9	3701.651	325.83
BIB	**7592.4**	465.89	5254.245	476.83
BIB	10889	694.298	10097.04	434.971
SD	3633.9576	236.9694	3261.775	183.3072
min	238	12.441	153	2
max	10889	694.298	10097.04	476.83
mean	3590.5356	206.3799	2675.165	180.9079
BUB	**240**	18	192	11
BUB	**491**	34	366.261	39
BUB	**903**	48	651.94	47
BUB	**1,548**	65	949	51
BUB	**2,152**	133.12	1,343.30	115.58
BUB	**3,501.04**	210.28	2,417.94	173.81
BUB	**5,384.60**	309.78	3631.844	243.8
BUB	**7,479.58**	405.82	5201.673	293.34
BUB	9848.374	575.787	6841.603	359.861
SD	3386.4412	194.3634	2355.421	126.0769
min	240	18	192	11
nax	9848.374	575.787	6841.603	359.861
mean	3505.2882	199.9763	2399.507	148.2657
CBO	**789**	40.7	596	11
CBO	**1372**	65	722	54
CBO	**1,980**	81	802	97
CBO	**2798**	104.97	1384	131.94

CBO	**4465**	189	2,116	301
CBO	**5450**	306	3644.115	460
CBO	**7368**	608	6566.04	524
CBO	**8402**	808	5851.657	250
CBO	**14277**	855	9679.602	331
CBO	25807.59	1283.908	15144.93	657.988
SD	7673.8263	430.7437	4776.407	215.3985
min	789	41	596	11
max	25808	1284	15145	658
mean	7271	434	4651	282
DB	**7,925**	204	4,452	321
DB	**10,144.55**	257.89	5,048.84	481.67
DB	**11,841.24**	327.04	6,217.54	678.51
DB	**14,065.60**	421.86	8,123.81	827.63
DB	**15,851.26**	513.98	8,862.32	796.05
DB	**17,681.34**	614.25	9,429.63	1004.17
DB	**19,814.11**	884.17	11,526.99	1101.05
DB	**22,758.50**	1041.85	12695.12	1211.64
DB	**27,782.52**	1514.08	18082.89	1344.72
DB	35986.8	1854.385	23057.53	1186.689
SD	8595.9411	558.358	5911.898	333.9129
min	7,925	204	4,452	321
max	35,987	1,854	23,058	1,345
mean	18,385	763	10,750	895
DGB	**500**	44	266.65	40
DGB	**819.34**	67	334.91	63
DGB	**871.76**	94	591.284	103
DGB	**1,431.53**	125	780.77	128
DGB	2153.322	198.198	1553.712	206.972
SD	650.96717	59.9371	516.7448	64.94087
min	500	44	266.65	40
max	2153.322	198.198	1553.712	206.972
mean	1155.1904	105.6396	705.4652	108.1944
EB	**929.44**	74	506.74	78
EB	**1,565.22**	70	1133.607	72
EB	**2,389.27**	109	1615.515	132
EB	**3,681.05**	170	2440.97	201
EB	5090.526	222.592	3313.951	261.653
SD	1672.6774	65.85285	1101.533	81.62977
min	929.44	70	506.74	72
max	5090.526	222.592	3313.951	261.653
mean	2731.1012	129.1184	1802.157	148.9306

LIB	704	34	470	16
LIB	1018	41	584	55
LIB	1,297	52	676	65
LIB	1,737	75	970.663	104
LIB	2106	91	1318	128
LIB	2687	141	1,541.17	133
LIB	4457	307	2,831	312
LIB	6333.56	440.91	4303.39	367.6
LIB	8774.85	451.04	5485.68	279.07
LIB	11639.59	602.884	7374.041	334.33
SD	3715.6912	209.494	2398.503	130.2484
min	704	34	470	16
max	11,640	603	7,374	368
mean	4,075	224	2,555	179
NIB	3,296	132	2220	172
NIB	4,127	182	2,546	290
NIB	5,157	193	2,767	324
NIB	5,838	218	3709	326
NIB	6,655	275	4543	281
NIB	7,923.29	276	5,407.74	281
NIB	9,774.11	467	6,894.04	321
NIB	12,423.02	547	7511.984	290
NIB	16,416.44	736	10711.3	448
NIB	21619.236	949.847	13498.65	407.965
SD	5899.3841	272.3538	3740.155	74.96097
min	3,296	132	2,220	172
max	21,619	950	13,499	448
mean	9,323	398	5,981	314
OIB	184	6	113	2
OIB	821	44	369	50
OIB	1526	64	662	91
OIB	2117	109	1020	107
OIB	3050	178	1,621	138
OIB	5004	239	2,531.61	219
OIB	7290	391	4,706.57	247
OIB	9348	579	5165.747	247
OIB	13414.13	787	7175.54	583
OIB	19927.02	986.933	9968.573	962.839
SD	6381.591	340.4542	3320.855	293.9443
min	184	6	113	2
max	19927	987	9969	963
mean	6268	338	3333	265
UB	3,616	124	2,152	135

UB	4725	159	2614	260
UB	6,066	163	3,277	292
UB	6758	226	4085	313
UB	8,063	353	4,711	305
UB	8,904.98	400.76	5,069.62	243.98
UB	11,804.36	589.84	6,860.08	385.85
UB	13037.64	719.26	8534.36	447.64
UB	16505.15	887.31	11996.31	461.76
UB	23079.65	1156.432	14869.89	622.738
SD	6006.8876	351.1752	4215.505	137.4002
min	3,616	124	2,152	135
max	23,080	1,156	14,870	623
mean	10,256	478	6,417	347
WB	3,728	133	2,112	239
WB	3,923	172	2474	318
WB	5957	257	2910	500
WB	5758	252	3565.674	408
WB	7,550.66	326	4,690	366
WB	8,384.48	438	4,604.42	409
WB	9,870.94	582	6071.915	473
WB	11,078.55	712	7506.215	509
WB	14,018.23	968	10235.07	798
WB	20506.13	1285.468	14785.04	971.909
SD	5146.8245	377.5688	3999.464	223.172
min	3,728	133	2,112	239
max	20,506	1,285	14,785	972
mean	9,078	513	5,895	499
ZB	278	24.2	189	13
ZB	688	42	384	103
ZB	1,163	55	645.225	157
ZB	1,793	77	1012.69	164
ZB	2,506	181	1,370	255
ZB	3,031	120	1,429.96	250
ZB	3,823	165	2,156.69	239
ZB	5,487	227	3253.942	336
ZB	7,323	315	3970.61	503
ZB	10241.32	351.666	4995.01	423.312
SD	3193.8921	114.221	1627.518	147.2299
min	278	24	189	13
max	10241	352	4995	503
mean	3633	156	1941	244