COMPARATIVE EFFICENCY ANALYSIS AND EVALUATION OF COMMERCIAL BANKS. THE CASE OF ETHIOPIAN PRIVATE BANKS USING DEA APPROACH

THESIS SUBMITTED to the Department of Accounting and Finance , College of Business and Economics in PARTIAL FULFILLMENT OF THEREQUIREMENTS FOR THE DEGREE OF MASTER OF BUSINESS ADMINISTRATION IN FINANCE

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Statement of Declaration

This is Teshome Feleke Eshete, declaring that this thesis with a topic of "**Comparative Efficiency Analysis and Evaluation of Commercial banks. The case of Ethiopian Private banks using DEA approach**)" is my original work and has not been presented to any other university to earn a degree or diploma.

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Teshome Feleke Eshete

Statement of Certification

This is to certify that the thesis prepared by me, Teshome Feleke, entitled: **"**Comparative Performance Analysis and Evaluation of Commercial banks. The case of Ethiopian Private banks using DEA approach**)"** and submitted in partial fulfillment of requirements for Degree of Master of Business Administration in Finance compiles with the regulation of the Addis Ababa University and meets the accepted standard with respect to originality and quality under the supervision of *Degefe Duressa Obo (PhD) Assistant Professor, Department of Accounting and Finance, Addis Ababa University*

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Abstract

In Ethiopia, Commercial banks are known for their key role in the financial sector, playing vital intermediation roles between lenders and borrowers, hence, they are main economic growth factor in the country; their efficiency should therefore be measured appropriately. The main objective of this study is to measure, evaluate, and analyses comparative efficiency of private commercial banks in Ethiopia for five years period from 2016 to 2020. The study adopted explanatory research design and used secondary data from all 16 private commercial banks` annual report and applies DEA Max pro7 software to extract data and scores. While using the DEA Methodology, the study applies the intermediation approach for an input-oriented data review. The study also selected two inputs and two outputs variables. The inputs variable includes, Total Deposit, and Non-interest Expense, that also encompass, Labour expense, Rent expense and other Operating expenses. The output variable includes, Total loan, Non-Interest Income. During the study, it was found that, the year 2018 had been revealed for having 100% Technical efficiency score for the entire sixteen private banks, the score had proved that all the selected private banks found fully efficient with respect to the selected input and output mix. On the other hand, the study also revealed that larger banks with having more than 18 years of age and those newly joined banks were also 100% efficient banks, these banks can be also taken as a benchmark for they score higher peer frequencies measures, that specify their efficiency. Out of the 16 private banks, 8 of them were the less efficient in terms of resource utilization these were ZB, OIB, CBO, LB, BIB, BUB & AB were among the less efficient banks having some resources underutilized to their peers. The mean efficiency of private commercial banks was 98.8%. According to the outcome of the study mostly the cause of overall technical inefficiency was managerial inefficiency (inefficient utilization of resource such as deposit and non-interest expense) rather than scale inefficiency. The researcher recommends that private banks need to work more towards improving their inefficiency level to ensure equilibrium among peer banks towards technical efficiency and increase their competitiveness at both local and international level.

Keywords: Peer Frequency, Slack, Technical and Scale Efficiency, Data Envelopment Analysis

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Abbreviation and Acronyms

AB	Abay Bank
DIB	Addis international Bank
AWB	Awash bank
BIB	Berhan international bank
BCC	Banker charnes cuper
BOA	Bank of abyssinia
BUB	Bunna international bank
CBE	Commercial bank of ethiopia
CBO	Cooperative bank of oromia
CRS	Constant return to scale
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
OBS	Observation
OIB	Oromia international bank
OTE	Overall technical efficiency
TFA	Thick frontier approach
TOL	Total loan
UB	United bank
VRS	Variable return to scale
WB	Wegagen bank
ZB	Zemen bank

CHAPTER ONE

1. INTRODUCTION

This chapter presents the overall introduction of the paper; it includes the background of the study and background of the organization, followed by statement of the problem, objective of the study, significance of the study, scope, & limitation of the study.

1.1. Background of the study

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). Commercial Banks play an imperative part within the economic improvement of the nations by allocates resource and by interfacing financial specialists with savers (Okoth et al.2013 as cited in Kokobe & Birhanu 2015). A financial sector which allocates resources efficiently is the engine that drives economic growthof any country (Kamau, 2011). Strong financial system promotes investment by financing productive business, mobilizing savings, facilitating trade activities and the financial sector 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).

Generally, 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). And well-functioning banking sector facilitate economic progresses, whereas poorly functioningbanking sector is problem to economic development and aggravate poverty (Rajha2016). The banking sector plays an important role in the mobilization and allocation of savings. Indeed, it plays the role of mediator between the net savers and net borrowers and the gains to the real sector, is dependent on how the financial sector performs their function of intermediation efficiently (Kumar & Singh, 2015). An effective financial intermediation mechanism distributes the credit to more profitable segments in ideal way. Besides, a well-organized financial intermediation mechanism also encourages innovations; this is because of high return on investment, with positive implications for economic development (Luccheti, 2000).

Takbiri et al noted that the banking industry has significant contribution in development of the economies of developing countries (Takbiri et al., 2015). As Kablan, (2010) also disclosed in his study, that, 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.

The banking sector is the only important formal system through which firms can obtain access to external financing in Ethiopia. In light of these, the performance of Ethiopian commercial banks remains to be a compelling agenda of concern for several stakeholders including government, investors, business enterprises, and so on. In Ethiopia, where commercial banks, insurances, and micro-finance institutions are the major financial sectors and indeed commercial banks being dominatingthe financial sector that provide finance to firms in a formal manner. Therefore, here in Ethiopia banks are the only important formal organizations, which can provide source of finance for firms. And in the country, there is no financial Security and/or capital exchange market; the new one is on the way to be functional yet at end of 2022 though. Therefore, bank efficiency in Ethiopia is compelling agenda of concern for most of investors that invests in the industry and for the government and other organizations as a source of reliable finance service (Gamachis, 2016). 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 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).

The Performance of banks is often stated in terms of efficiency. The measured efficiency is interpreted as a difference between observed input and output levels and the corresponding optimal values (Wheelock and Wilson, 1995). 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). Therefore, efficiency scores of banks are indicators of success of individual banks and banking industry as a whole and also help to check the potential impact of government policies on efficiency (Wheelock and Wilson, 1995). However, most traditional evaluators used ratios analysis. Ratio analysis can be misleading as it measures partial efficiency of banks (Rao and Tekeste, 2012). To overcome this problem in the few past decades, researchers are using frontier analysis methods. Muluneh, 2008 and Rao and Tekeste 2012, explored and studied the banks level efficiency using frontier analysis methods in Ethiopia. In their study, Muluneh (2008) surveyed the cost efficiency and its determinant of private commercial banks using parametric stochastic Frontier Analysis (SFA) method. However, the method under this study requires a prior knowledge of weights or prices of inputs and outputs, specification of their functional relationships, but also has no ability to identify the potential improvement for the inefficient banks like DEA. On the other hand, Rao and Tekeste (2012) also surveyed the cost efficiency and ownership structure of commercial banks in Ethiopia using non-parametric DEA and Tobit method. Here again, the cost efficiency by itself cannot reveal the source of inefficiency that helps the bank managers to take corrective action to improve efficiency gain. Therefore, conducting a study on the issue of technical efficiency, Comparative analysis & Evaluation of the Ethiopian commercial banks using DEA is vital for having an insight regarding technical efficiency of each bank and banking sector, to know the inefficient bank and to determine the source of inefficiency, and helpful to identify the potential improvement for the inefficient banks to reach efficiency frontier.

The purpose of the study is to investigate the relative technical efficiency and productivity change of the commercial banks during the study period using DEA approach and contribute baseline information sources to the newly installed Capital/Stok market exchange in the country in general and provide strategic decisions support to board of directors of the Commercial banks. Data Envelopment Analysis (DEA) method is used for 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 Sector in Ethiopia

Modern banking in Ethiopia was introduced in 1905. At the time, an agreement was reached between Emperor Minelik II and a representative of the British owned National Bank of Egypt to open a new bank in Ethiopia. February 15, 1906, marked the beginning of banking in Ethiopia history when the Bank of Abyssinia was inaugurated by Emperor Minelik II. It was a private bank whose shares were sold in Addis Ababa, New York, Paris, London, and Vienna (NBE, 2010). 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 the period up to 1974, several other financial institutions emerged including the state owned as well as private financial institution. Further, as per the NBE (2010), following the declaration of command economy by Derge regime in 1974 the government extended its control and nationalized all previously established private banks and merged into one bank (NBE, 2010). (Refer to https://nbebank.com/history-of-banking/) or Appendix E.

After nationalization, the Derge regime left only three government banks; the National Bank of Ethiopia, Commercial Bank of Ethiopia and Agricultural and Industrial Development Bank (Mortgage Bank) until the socialist regime was overthrown in 1991. Subsequently, the licensing and supervision of Banking Business Proclamation No. 84/1994 was issued in 1994 which led to the beginning of a new era for Ethiopia banking sector. Following the enactment of the banking legislations in the country in the 1990s, a fairly good number of private banks have been established. 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. In the 2012/13 fiscal year the total number of banks already operational in the country reached nineteen. Of these banks, sixteen were private and the other three were government owned. (Sofia L. A. & Seid H.Y. 2014), besides, currently there are about more new banks are waiting the NBE approval to join the sector.

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 (NBE) and the Commercial Bank of Ethiopia (CBE).

1.3. Problem Statement

Kumar and Singh, in their study mentioned that, in a dynamic and competitive financial marketing environment, only efficient banks will survive and maintain their market shares, and inefficient ones will eventually be eliminated. The efficient banks are better able to compete because of their lower operational costs and can steal business away from less efficient banks. In sum, the relative efficiency of banks is always a matter of serious interest to the regulators, customers, stockholders, and managers (Kumar S. et al, 2008).

Kumar and Singh also disclosed that, an efficient banking system plays a great role for a progressive economic growth of any country (Kumar & Singh, 2014). Many researchers conclude that for prompt performance of the whole economy, for effective implementation of monetary policy and for effective financial 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. Therefore, efficiency analysis is essential for the evaluation of banks' performance (Wozniewska, 2008).

In Ethiopia, the banking industry has been populated by the larger and increasing number of new banks entering the sector and expansions of new branches bloom over the last few years. The increase in the number of banks entering into the market is mainly due to the presumption of better profits registered by most of the private banks operating in the country. This doesn't mean, however, that the banks will remain profitable forever nor does it mean all are efficient in-terms of resource utilizations, management skill leverage and so on. As more and more banks join the market, competition is going to be tough and only the efficient ones could keep on enjoying the benefits and survive the computation. Therefore, determining the efficiency of the banks is an important issue which is interest to many stakeholders (Mesay, 2011). In recent literature, it is commonly argued that in Ethiopia the older and larger commercial banks seem efficient than the new smaller one and still there was no clarity on this regard (Tesfaye B.2014).

Tesfaye B. (20214) in the same study also stated that those newly entering banks should benchmark the old once, although his study could not say anything about the middle category of banks that have average capital size and middle age.

Meanwhile, intention of this study is therefore to focus on the efficiency measures of the existing private banks and evaluate their peer efficiencies to support optimal resource utilization agenda and review the resource items that are under slack so that investors, CEO, Top managers, and board of directors can benchmark the performances of the efficient bank and leverage their opportunities to support the sector. This study will also try to address the middle-aged banks and review their efficiencies.

1.4. Objective of the study

1.4.1. General objective

The general objective of the study is to measure the relative efficiency levels of private commercial banks.

1.4.2. Specific objective

Specifically, the study will attain the below five objectives.

1. Measuring and comparing the mean Technical Efficiency Scores for Private Commercial Banks operating in Ethiopia during 2016 to 2020.
2. Measuring and comparing the resource mean Slack Scores for Private Commercial Banks under the selected input & output variables during 20216 to 2020.
3. Explain and provide recommendation on the Mean Efficiency Scores of Private Commercial Banks operating in Ethiopia during the sturdy period.
4. To elucidate the degree of relative performance frequencies, lambda, that influence Efficiencies of private commercial Banks in Ethiopia.
5. Identify, Select, and Recommend the prompt benchmarking category of bank(s) for improvement on resource allocation as Input and Output to those Inefficient Private Commercial Banks.

1.5. Research Question

1. What is the mean efficiency of private commercial banks operating in the country during the period 2016- 2020?
2. Are all private commercial banks in Ethiopia utilizes and/or allocate their Resources Efficiently?
3. Do investors, managers, government, and other entity clearly know whether the private commercial banks producing at their most productive scale or not?
4. Are Large, Middle, or Small private banks, and/or Older, Younger, or Newly joined private Banks, Efficient, which of these categories of private banks ‘or entity have no slack of inputs and what is the level of slack of resources being seen under each category during the study period, at what degree?
5. Which group of private banks can be considered for Benchmarking for their performances under the scoped inputs and outputs?

1.6. Significance of the study

In the current situation for the Ethiopian financial industry, where there is no Capital and/or Security market, and absence investment banks that usually help financial investors in providing the bank`s efficiency information and to this end there is a vivid gap here and hence, analyses the efficiency of our commercial banks is of very critical. Besides, this study will provide a research input to the academic. Lastly this study is also significant to the existing as well as newly entering banks. And promote effective resource allocations and utilizations up to frontier output.

The study will be significant for the following reasons:

i. It helps to evaluate the efficiency of our private commercial banks and allow, Investors, managers or directors, and any other relevant entity in the industry to evaluate productivity, this paper will be valuable to truly evaluate the current profit boom and efficiencies of both the old and new banks.

ii. It provides insight, strategic decision support, by assessment of efficiency of the operating private banks in the respective categories of larger, Medium, and small private banks and help to focus the efficiencies rather than age advantages of the banks and seize the opportunities there on

iii. There was not enough literature on technical efficiency of private bank level in Ethiopia so this study may serve a means of embarking with its approach.

iv. This study helps to find a prompt benchmarking private bank, or group of banks, so that the newly joining one can leverage the situation in much better means.

v. Assist academics intheir search for knowledge and theory and serve as a reference point for further future research.

1.7. Scope of the study

This study focuses on those privately owned commercial banks found in Ethiopia. There are sixteen private banks in Ethiopia; all the sixteen banks are fully engaged in commercial banking activity for more than twelve years. This study scoped to measure and evaluate the efficiency of private commercial banks in Ethiopia using DEA approach. And the DEA approach proposes to use a minimum of five years data to get a meaningful result (Coelli, et, al 1998). Therefore, this study preferred to select the last five years from the recent period. All the sixteen private banks in Ethiopia were included in the study and the data set was limited to audited financial statement of private commercial banks for five years from the period of 2016 to 2020.

1.8. Organization of the study

The paper is organized into five chapters. Chapter one covers about background of the study and organization, statement of the problem, significance of the study, objectives of the study, scope and limitations of the study. Chapter two describes and reviews the theoretical and empirical aspect of the topic under the relevant literatures. Chapter three covers and describes the research methodology. Chapter four presents results and discussion of the study. Finally, Chapter five presents an overview of the study paper, summaries of findings, conclusion and recommendation based on the major findings.

CHAPTER TWO

2. LITERATURE REVIEW

This chapter presents the review of related literature. Hence, the chapter is divided in to three parts the first part presents the theoretical and Conceptual review of literature under related topics of the study; the second part discusses the empirical studies, by different researchers; and the third one on the conceptual framework of this study and it's rational.

2.1. Theoretical Literature

According to the conventional economic efficiency theory states that companies should structure their output to achieve the lowest possible cost per unit produced. Given the combination of fixed and variable costs typical in business, low levels of output are inefficient because fixed costs are shared out across a relatively small number of units. On the other hand, although above-optimal production can, in theory, generate economies of scale, in practice this apparent benefit is often more than offset by additional costs related to the overstressing of existing systems. In the short term, the point of maximum operational efficiency is achieved at the level of output at which all available economies of scale are taken advantage of, yet short of the level at which the diseconomies of overstraining existing systems come into play. However, Over the longer term, still the optimal level of productive efficiency can be raised by increasing the capacity of existing systems (Luccheti R et, al, 2000).

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. Ikhide, 2009, as cited in Kamau,2011, stated that banks play essential role in the proper functioning of payments systems and their efficiency is directly related to improved productivity in the economy. Generally, efficiency in banking sector has been attracting the attention of a larger number of researchers.

2.2. Bank Efficiency and/or Productivity: Theory and Concepts

2.2.1 Bank`s Efficiency Theory

The foundation of productivity in service industry, specifically in banking sector, generally is measured based on two key concepts, namely effectiveness and efficiency (Sherman and Zhu, 2006). 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; Chen et al, 2008). Thus, many literatures use the terms productivity and efficiency interchangeably. In this thesis, will use the term Efficiency though. The efficiency of financial institutions has been widely and extensively studied in the last few decades. For financial institutions, efficiency implies improved profitability, greater amount of funds channeled in, better prices and service quality for consumers and greater safety in terms of improved capital buffer in absorbing risk (Berger et al., 1993).

Although banks main focuses are to find ways to generate new funds and lending funds at higher rate, they have developed concerns in managing their operational productivity in order to ensure higher profitability and consistently attract more investors (Sherman and Zhu, 2006). Basically, efficiency can be defined as the ratio of output to input; and more output per unit of input indicates greater efficiency while maximum output per unit of input reflects optimum efficiency (Cooper et al., 2006; Sherman and Zhu, 2006). Efficiency measurement determine how firm can maximize its output and profit and at the same time minimize its cost (Mokhtar et al., 2008). The importance of efficiency measurement is to enable managers to benchmark bank performance and define areas of inefficiency for future improvements (Mostafa, 2007). The area of inefficiency is not limited to the result of poor management performance alone, instead it might be due to managerial, technological and socioeconomic (Sherman and Zhu, 2006).

2.2.2. Bank`s Efficiency Classifications

According to Sherman and Zhu (2006), overall productivity of a bank depends on four components of efficiency classification as shown in Figure 1 and they are:

6. **Technical efficiency:** Also known as global efficiency measures the ability of banks to

produce actual outputs with fewer inputs, or less resources used indicates higher efficiency.

7. **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.

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

9. **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 labour tradeoffs to increase efficiency (Sherman and Zhu, 2006).

In addition, and by definition, the term technical efficiency literally refers to the firm ability to maximize output with the given inputs or; produce same level of outputs with minimization of inputs; while allocative efficiency refers to the optimum arrangement of inputs and output at a specific price (Cooper et al., 2006). Technical inefficiency may arise in the conditions where banks produce more outputs with the actual inputs or when bank produce actual output with fewer inputs (Sherman and Zhu, 2006), or technical inefficiency exists when banks are wasting some of inputs (Mester, 2003).

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). According to (Farrell, (1957) as cited in Emrouznejad, &Cabinda, (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).

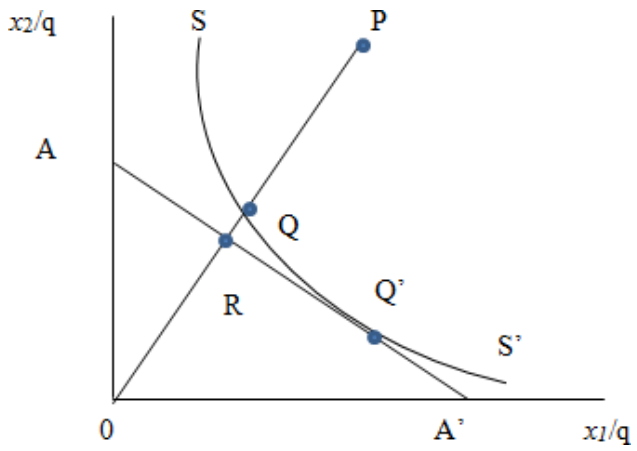


Figure 2.2: Technical and Allocative Efficiencies (Emrouznejad, & Cabinda, Page 4, 2015)

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. Basics of DEA and Application in Efficiency Measure

DEA represents a mathematical programming methodology that can be applied to assess the efficiency of a variety of institutions using a variety of data. This section provides an intuitive explanation of the DEA approach. DEA is based on a concept of efficiency that is widely used

in engineering and the natural sciences. Engineering efficiency is defined as the ratio of the amount of work performed by a machine to the amount of energy consumed in the process. Since machines must be operated according to the law of conservation of energy, their efficiency ratios are always less than or equal to unity.

This concept of engineering efficiency is not immediately applicable to economic production because the value of output is expected to exceed the value of inputs due to the value added in production. Nevertheless, under certain circumstances, an economic efficiency standard like the engineering standard can be defined and used to compare the relative efficiencies of economic entities. For example, a firm can be said to be efficient relative to another if it produces either the same level of output with fewer inputs or more output with the same or fewer inputs. A single firm is considered technically efficient if it cannot increase any output or reduce any input without reducing other outputs or increasing other inputs. Consequently, this concept of technical efficiency is like the engineering concept. (Tanvir A. and Waseem A, 2008). There are two widely used method were employed to measure efficiency of the decision-making unit. These are parametric and non-parametric.

2.3.1 Parametric (Econometric)

The parametric approach is based on the underlying relationship between the parameter under study and various observed independent variables. It is an econometric application in which one specifies some explicit form of the production, cost, or profit function to represent the benchmark technology for efficiency measurement. The validity of the derived measures of efficiency, however, does critically depend on the appropriateness of the functional specification, therefore, requires a specific pre-specified function form of the production or cost function (Gupta etal, 2003).

The econometric approach consists of an econometric estimate of the best practice frontier by its specification in a Cobb-Douglas, cost or production function. The econometric method can be deterministic. In this case, every deviation from the frontier is attributed to inefficiency. It can also be stochastic; it is then possible to separate random errors from the production unit inefficiency. The stochastic frontier method has two principal advantages compared to nonparametric DEA method. First, it allows separating random error from the production unit

inefficiency and takes into account the existence of exogenous shocks. At this purpose, the error term is divided into two components: an inefficiency component and a random one (which is composed of the error measurement and the exogenous shocks). Second, the stochastic frontier analysis is less sensitive to absurd values. The question that we are addressing by using the stochastic frontier analysis is what is the optimal combination of inputs? Which makes, it possible to produce an optimal combination of outputs while minimizing production costs (Kablan, 2007).

2.3.2 Non-parametric

Non-parametric approach is based on the concept of efficiency like one in the parametric approach but differs from it since this approach does not require any pre-specified function. It takes the data of the actual operations of the firms under study and frontier is formed as the piecewise linear combination of the "most efficient observations." Thus, efficiency so determined is relative to the "observed best", rather than an absolute value (Gupta etal, 2003).

Once, the DEA Mothed was first developed by Farrel in 1957, later it had been also modified by Charnes-Cooper-and Rhodes (CCR) in 1978 (Klimberg et al., 2009). This modified version is a non-parametric method that utilizes linear programming to measure the level of efficiency of comparable decision-making units (DMU) by employing multiple inputs and outputs (Klimberg et al., 2009). This technique of measuring efficiency was first introduced by Farrel in 1957 based on the basic theory of production on single input and single output such as "output per work hour" in a form of ratio (Ayadi et al, 1998; Cooper et al., 2006; Sherman and Zhu, 2006).

Efficiency = Output /Input

However, this measurement does not entirely represent efficiency as commonly multiple inputs are used to produce single or more outputs, which lead to the modification of original equation to include measurement of multiple inputs and multiple outputs (Zhu and Sherman, 2006). This concept was further extended into basic CCR DEA model developed by CCR in 1978 by altering the original equation to (Ayadi, 1998; Zhu and Sherman, 2006; Cooper et al., 2006).

Efficiency = Weighted sum of output / Weighted sum of input

In this method, to measure efficiency of DMUs are referred to a group of firms under study such as banks, hospital etc. DEA is a most accurate technique to measure efficiency given limited number of DMUs (i.e., banks) (Cooper et al., 2006; Klimberg et al., 2009; Hassan et al., 2009; Ahmad and Luo, 2010). This non-parametric DEA model was first modified by Sherman to measure banks performance in 1984, and since then, was extensively used by banking industry around the world to measure banks operational efficiency (Sherman and Zhu, 2006). DEA allows measurement of efficiency from multiple inputs and multiple outputs within multiple DMUs (Sherman and Zhu, 2006).

It is also known as a mathematical approach identified under the name of DEA method (Data Envelopment Analysis) consists in estimating the frontier by using non-parametric mathematical linear programming. It offers an analysis based on the relative evaluation of the efficiency in some input/output multiple situations, by considering each bank and measuring its relative efficiency to an envelopment surface made up with the best banks. However, this method doesn't allow for noise treatments. The non-parametric method was usually used by making the assumption of constant return to scale (CRS). But recently, the assumption of variable return to scale (VRS) was used in specifications because this hypothesis is more relevant with the environment of imperfect competition in which banks operate (Kablan, 2007).

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) statedthat: 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

intermediary. 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.

2.4 Empirical Review

An article entitled, technical, scale, and allocative Efficiencies in U.S. banking: An Empirical Investigation, by Alyet al., (1990), applied DEA to explore various measures of efficiency for sample 322 banks in 1986. The study employed three inputs (labor, capital, and loanable funds) and five outputs (commercial and industrial 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.

2.4.1. Global Empirical Review

The Study that examines 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 efficiencies 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 concluded that, scores of scales efficiency is 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), studies the efficiency of Indian commercial banks during 2000 – 2010 by utilizing Data Envelopment Analysis (DEA). In the study, based on the sample of 8 commercial banks, by using intermediation approach the researchers' used loans and investments as output variables andfixed 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. During the study period in India, the selected Public-Sector Banks are more efficient than Private sectors

Thu Huong and Firoz, (2016), assessing the efficiency of Vietnamese commercial banks using data envelopment analysis during the period 2011 – 2014, the 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. The study could not able indicate individual bank efficiency though.

Baidya & Mitra (2012), studied 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 study has found that, the banks which are using more labor for providing their services are relatively more inefficient. 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.

Kumar & Singh, (2015) explained the technical and scale efficiency of India Banks using Data Envelopment Analysis (DEA) from 2006 to 2010. The study included five private and five public sector commercial banks. The study indicate that deregulation of banking sector has led to an increase in the efficiency of commercial banks in India. The study 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. It also shows increase in efficiency of banks in India is not only increase in pure technical efficiency but also to its scale efficiency.

Mongid &Tahir, (2010) estimates the comparative 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) studied the comparative 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.

2.4.2. Country Specific Empirical Review

In Ethiopia, we can find some comparative efficiency studies conducted using DEA method to measure bank`s efficiency; to disclose some of the relevant studies are as in below:

Tesfaye, (2014) studied and assess the comparative efficiency level of Ethiopian Banks for the period 2008-2012 using the Data Envelopment Analysis. The study found that older banks and the government owned CBE are efficient, and 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. In the study CBE's efficiency score persistently at the frontier, however those banks that were recently emerged in the industry were less efficient than the other group.

Getaneh, (2015) investigated the technical efficiency of selected Ethiopian commercial banks in the period of 2007 to 2013 using mixed and integrated approach that includes Data Envelopment Analysis (DEA) and Malmquist index. The study revealed that during the study period BOA were the lowest scorer of overall technical efficiency of 73.4%, i.e., input could be

reduced by 26.6% without sacrificing output if BOA were efficient. The mean Malmquist index of the banks was 94.8% these decrease in overall productivity of banks resulted because of an average 0.01% decrease in scale efficiency and average of 5.1% decrease in technology adaptation by the banks during the study periods. During the study period, AIB and CBB scored lower efficiency 81% and 80.8% respectively.

Fasika, (2016) investigated the overall technical efficiency of commercial banks in Ethiopia, Employing DEA over the period 2011 to 2014 taking sample of fifteen commercial banks in Ethiopia. The study used 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), for CBO, BIB and DB were the most efficient commercial banks while CBE, UB, LIB and BUB were the least efficient commercial banks. Under the variable returns to scale, BIB, CBO and NIB were found to be more efficient banks while CBE, UB and BUB were the least efficient banks. CBO and DB were also 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. The study also found that privately owned commercial banks in Ethiopia are more efficient compared to government owned commercial banks considering the scale efficiency/inefficiency score.

Gamachis, (2016) studied technical efficiency and productivity of Ethiopian commercial banks using DEA to measure efficiency of banks and MPI to measure the productivity gains of banks over time period from 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 & Advances as output variables. The study disclosed that, on average, Ethiopian commercial banks were relatively technically inefficient, and the Scale inefficiency takes the leading contribution for source of inefficiency.

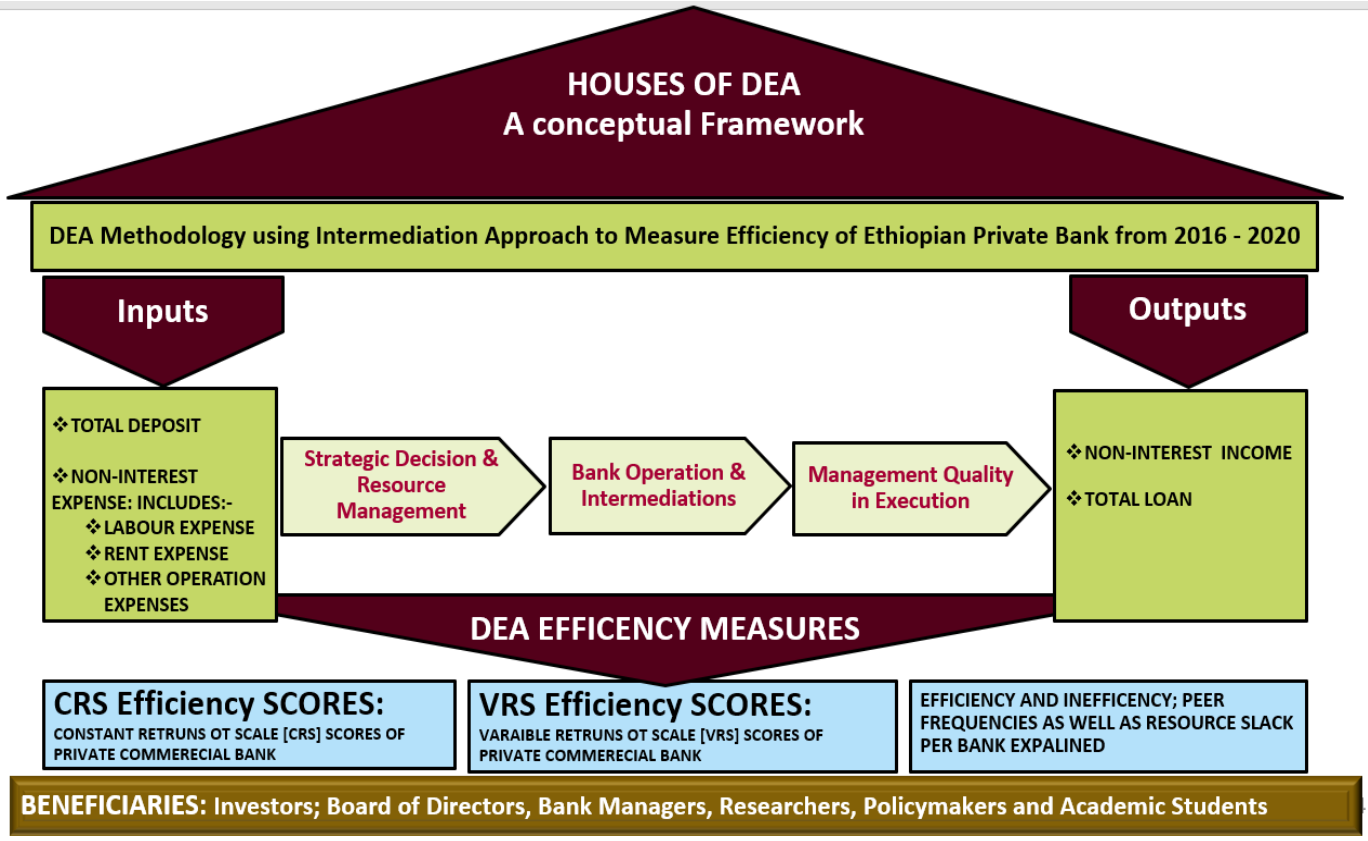
Yidersal, (2018) investigate comparative efficiency using Data Envelopment Analysis (DEA) the study measures the relative technical efficiency in terms of Operation cost, revenue, and profit of the Ethiopian Commercial Banks using data from 18 commercial banks for the period covered 2005 to 2016. The researcher found that 4 banks namely CBE, ADIB, ZB & EB were the most efficient banks in terms of Technical Efficiency and are found to be on the top DEA

frontier both input & output orientations. In Cost Efficiency, the CBE, ADIB and DGB were found to be the most efficient ones, and on the DEA frontier. The study also showed that CBE &ADIBwere 100% efficient.

Mulualem, (2019) conducted a study under the title of `Technical and Scale Efficiency of Private Commercial Banks in Ethiopia: Using Data Envelopment Analysis (DEA)` for the period of ten years, from 2009 to 2018. The study took ten private banks. The finding of the study revealed that six private banks out of ten [ADIB, AIB, BIB, DGB, EB and ZB were 100% efficient banks and two out of ten; [OIB] was 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.

2.5. A 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. The below figure 2.6.1 showed the over all house of DEA a conceptual Framework.



Source: Researcher own framework designed for this research

Figure 2.5.1. House of DEA a conceptual Framework.

Data framework and Variable settings

Different literatures have followed various approaches to specify the input-output variables. The most commonly used approach is the intermediation and production approaches. In addition, there are others including the Value-added approach, User cost approach and Asset approach (Jemric and Vujcic (2002), Pawlowska (2005), Grigorian and Manole (2002)). Since there is no consensus about which of the available approaches to DEA should be used for efficiency scores estimation, the choice of inputs and outputs in this model followed the intermediation approach. The intermediation approach considers the bank's core function of intermediating funds between depositors and borrowers at lowest possible costs. In the Ethiopian context this approach is relevant considering banks highly engagement in the traditional intermediation activities. Hence, the framework assumes that banks use two inputs to produce two outputs.

The inputs consist of: Total Deposit, Non-Interest Expense, of the respective banks that are categorized in relative DMUs and the out puts includes: Total Loan, and Non -Interest Income. The data used for the model are obtained from the publicly available financial accounts of each bank with coverage from 2016-2020.

CHAPTER THREE

3. RESEARCH DESGIN AND METHODOLOGY

In this section, the study presents the research methodology part. The first section states the introduction of our research methods followed by the research design used in the study and then explain the data type & source, sampling method, method of data analysis and finally the disclose procedure, model & variable description used.

3.1. Introduction

Based on the nature of the study, we have applied Explanatory research approach and that includes and supports the application of DEA method of data analysis. And the study principally base on the secondary data that is obtained from the banks` annually financial reports. In this chapter of the study, the detail research methodology is also disclosed, and the below section 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 Philosophy

In the view of Creswell (2007), epistemology and ontology are the two types of research philosophies. Fieldwork is carried out by the researcher for examining the problem in epistemology research philosophy. Field work is not attached to the ontology research philosophy. Here secondary data from the well-known publication will be taken referencing the detail data sources. The researcher's commitment is essential in resolving the research problem in the case of ontology research philosophy. In this research, the secondary data, analysis of the Private commercial bank's annual report for comparative performance analysis and evaluation of the private banks for the period of five years. In this research study, only secondary data will be carried out to investigate the problem mainly basing the investigation on banks annual financial report and the national bank official reports. Therefore, ontology research philosophy will be selected for comparative performance analysis and evaluation of the private banks.

3.3. 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 groups based on the purpose of the research: Exploratory Research, Descriptive Research, Explanatory Research and Experimental Research.

In this study, we plan to use the explanatory research. **Explanatory research** is a research method that explores why something occurs when limited information is available. It can help you increase your understanding of a given topic, ascertain how or why a particular phenomenon is occurring, and predict future occurrences.

Explanatory research can also be explained as a "cause and effect" model, investigating patterns and trends in existing data that haven't been previously investigated. For this reason, it is often considered a type of causal research.

3.4. Research Population and Sampling

Alvi, in 2016, define Population as, those 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 each 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 2020 there were 16 private commercial banks fully functional in the country.

Using DEA method, there are two important aspects that shows census is 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 unit.

3.5. Data Source and Collection

As per the philosophy aligned to be ontology, the study will apply only secondary data. The data was found from the audited financial statements of the banks for the period five years, 2016 - 2020. And those data collected from the published audited annual report of all private commercial banks and from the records held by the Ethiopian national bank. 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.

3.6. Method of Data Analysis

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 were done in financial ratio analysis (FRA) analysis such as, Dakito, (2015), Melaku, (2017), Gudata, (2015), Adamu andKenenisa, (2017), and Rahel and Maru, (2015).

FRA has its own importance for measuring bank efficiency nonetheless 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 limitation of FRA is its univariate nature, because of this weakness it’s awkward and unreliable to measures and to predict efficiency of firms using such analysis (Mousa, 2015).

Therefore, in the study, the DEA model was used for several reasons. First, the DEA model can incorporate multiple inputs and outputs easily. Second, a parametric functional form does not have to be specified for the production function. Third, DEA does not require any price information for dual cost function as is required for parametric approaches. Fourth, DEA has the potential to provide information to the supervisors in improving the productive efficiency of the organization.

Finally, DEA presents a generalization on approach because other assumptions than constant return to scale can be accommodated within a convex piecewise linear best practice frontier. Due to all the captioned reasons DEA Model has better benefits to asses' technical efficiency of commercial banks. Thus, the researcher focused on measuring the efficiency, determinations of inefficiency, selection of benchmark banks, Slack resources, and productivity changes over the stated period of 2016–2020.

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.

3.6.1. 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 that 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). In this study we therefore base and explore our conclusion and recommendation not with this model and adhere to the Variable return to scale (VRS).

3.6.2. 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 return 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. This study will use MAXDEA7 software to conduct the necessary analysis and to measure the technical and scale efficiency of private commercial banks working in the country.

3.7. 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).

3.7.1 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 Johns 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.

3.7.2 Intermediate approach:

In this approach, the process of variable selection is made based on the bank's assets and liabilities, bank assets including labor, Asset, represent the inputs and Total income, Profit after tax and Total loan 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, and labour costs (Mousa1, 2015).

Avkiran (2000) is supporting for analyzing bank efficiency intermediation approach is better one. Berger and Humphrey (1997) as cited by Yadav, (2015), disclosed that the intermediation approach is well suited to analyzing firm level efficiency, whereas the production approach is suited to measuring branch level efficiency. For it had been illustrated and explain in the above chapter two, of the research framework, this research proposal and study therefore followed the intermediation approach and select the below two inputs and two outputs listed as in below:

Inputs

I. Total Deposit

II. Non-Interest Expenses [Labour, Rent and Other Operation Expense]

Outputs

I. Total Loan

II. Non-Interest Income

3.8. 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 oflinear programming problem as follows:

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

Under the conditions:

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

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

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

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

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

Where:

Z = relative efficiency of the DMU

m = number of output produced by the

DMUr = number of inputs employed by the DMU Yi, represent output data for DMU Xj, represent input data for

DMUUi = output weights

Vj, = input weight

K, represent number of DMU

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

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

Under the conditions:

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

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

Where:

Z = relative efficiency of the DMU

m = number of output produced by the

DMUr = 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

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

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

CHAPTER FOUR

4. RESULTS AND DISCUSSIONS

This chapter is divided in to four sections: Section 1: The first section deals about the data framework and structure of variables as well as the description of the secondary data. Section 2: Covers overall technical efficiency of the Ethiopian private commercial banks for the selected period. Section 3: Deals with decomposing overall technical efficiency into two models of CRS and VRS. Section 4: Presents about slack characteristics of banks.

4.1. Introduction

In this study, sixteen private banks were selected purposively, namely, Abyssinia Bank, Awash Bank, Dashen Bank, Wegagen Bank, Nib International Bank, United Bank, Lion Bank, Cooperative Bank of Oromia, Oromia International Bank, Zemen Bank, Bunna Bank, Berhan Bank, Abay Bank, Enat Bank, Addis Bank and Debub Global Bank for the period of five years from 2016 to 2020 G.C to assess their technical efficiencies. Technical efficiency can be viewed from two perspectives. The first one is Input-oriented Technical Efficiency which focuses on the possibility of reducing inputs to produce given output levels and the second one is Output-Oriented Technical Efficiency which considers the possible expansion in outputs for a given set of input quantities. In this study, the banks efficiency was measured with input orientation method. Technical efficiency measured under the assumption of Constant Return to Scale (CRS) and of Variable Return to Scale (VRS) which can be achieved using the data envelopment analysis software (MAX DEA Pro7).

4.2. Description of Data Framework

As per the data framework stated above, we have two inputs and two out puts that are applied under the intermediate approach. The inputs consist of: Total Deposit, Non-Interest Expense, of the respective banks that are categorized in relative DMUs and the out puts includes: Total Loan, and Non -Interest Income. The data used for the model are obtained from the publicly available financial accounts of each bank with coverage from 2016-2020. Table 4.1 shows the overall data framework and the observations we have in line with the input and our put variables. (Appendix D shows the full raw data from all the sixteen private banks).

Table 4.1: Tabulation of the DMUs and their Observation for the inputs and outputs

DMU	DMU Category Trait	No. of Banks	No. of OBS	Inputs Variables	Out Put Variables
DMU 1	Large capitalized & aged 18-25 Years Banks.	6	30	1. Total Deposit 2. Non-Interest Expense:- Including: Labour, Rent and other Operation Expenses	1. Total Loan 2. Non-Interest Income
DMU 2	Medium capitalized & aged 15-18 Years Banks	4	20		
DMU 3	Medium capitalized & aged 12-15 Years Banks	3	15		
DMU 4	Small, less capitalized, & aged < 12 Years Banks.	3	15		

Source: Researcher own tabulation of the secondary data sampling framework

4.3 Overall Technical Efficiency of Commercial Banks

The data were collected from secondary source of audited financial statement of selected Commercial Bank of Ethiopia by using DEA computer program which is introduced by Coelli (1996) that is employed for measuring the technical efficiency of Decision-Making Unit (DMU). The researcher used this software for the assessment of technical efficiency of selected commercial bank of Ethiopian by using intermediation approaches based on input orientation.

Here the DMUs have the below representations:

DMU1: Awash Bank, Dashen Bank, Abyssinia Bank, Wegagen Bank, Hibret Bank, and Nib Bank, has the following attributes that help us to categorize in the same DMU. First, all have been operating in the country for more than 18 years; second, the banks have the largest deposit and loan which make then similar among each other and different from all other commercial banks in Ethiopia.

DMU2: Zemen Bank, Oromia International Bank, Lion Bank, and Cooperative Bank of Oromia, these banks have the following attributes that help us to categorize in the same DMU. First, all are operating in the country for 15 to 18 years; second the banks have the medium deposit and loan ranges which make then similar among each other and different from all other commercial banks in Ethiopia.

DMU3: Berhan Bank, Bunna Bank, and Abay Bank, these banks have the following attributes than help us to categorize in the same DMU. First all are operating in the country for 12 to 15 years, second the banks have the smaller amount deposit and loan ranges which make then similar among each other and different from all other commercial banks in Ethiopia.

DMU4: Enat Bank, Addis Bank, and Debub Global Bank, these are known as new entrant banks having the following attributes than help us to categorize in the same DMU. First all are operating in the country for less than 12 years, second the banks have the smallest amount deposit and loan ranges which make then similar among each other and different from all other commercial banks in Ethiopia.

4.3.1 Overall Technical Efficiency Using CCR Model (Constant Return to Scale, CRS)

The CRS efficiency score results of the banks, which are under consideration for this study, was displayed using DEA software. Table 4.3 indicates that those banks which are relative efficient having efficiency score of 1. On the other hand, those banks with relative inefficiencies do have scores less than 1. If the efficiency scores are less than 1, it means they can achieve the existing level of output with less amount of input (as it is an input-oriented approach).

Table 4.3 Overall Technical Efficiency(Constant Return to Scale, CRS) MAX DEAPro7

Period	DMU Category	CRS Efficiency Score	CRS Lambdas / Efficiency boundaries /			
			DMU1	DMU2	DMU3	DMU4
2016	DMU1	1	1	0	0	0
	DMU2	0.978	0.186	0	0.787	0.106
	DMU3	1	0	0	1	0
	DMU4	1	0	0	0	1
2017	DMU1	1	1	0	0	0
	DMU2	0.912	0.357	0	0	0.877
	DMU3	1	0	0	1	0
	DMU4	1	0	0	0	1
2018	DMU1	1	1	0	0	0
	DMU2	1	0	1	0	0
	DMU3	0.949	0.093	0	0	2.097
	DMU4	1	0	0	0	1
2019	DMU1	1	1	0	0	0
	DMU2	0.931	0.466	0	0	0.474
	DMU3	1	0	0	1	0
	DMU4	1	0	0	0	1
2020	DMU1	1	1	0	0	0
	DMU2	1	0	1	0	0
	DMU3	0.966	0	0	0	2.476
	DMU4	1	0	0	0	1

Source: Researcher Computation using MAX DEA Pro 7 Software

During the year 2016, 2017, and 2019 all the DMUs were efficiency having an efficient score result of 1. The only inefficient DMU was DMU2 which represent Zemen bank, Oromia International Bank, Lion Bank and Cooperative bank of Oromia, having an average technical efficiency score of 0.978, 0.912 and 0.931 respectively for the period of 2016,2017 and 2019. This implies that on average those banks under DMU2, that are Zemen Bank, Oromia International Bank, Lion Bank and Cooperative bank of Oromia, are respectively 97.8% , 91.2% and 93.1% efficient in those respective years as compared to its peers and the rest of the private banks industry remain 100% efficient with the respective to their inputs and out puts. Meanwhile, during the same period of 2016, 2017, and 2019 those banks under DMU2 to become efficient they all must reduce their inputs by 2.2%, 8.8% and 6.9% respectively to achieve equivalent output of their peers during the same years (See from appendix).

On the other hand, during the year 2018, and 2020 all the DMUs were also efficiency having an efficient result of 1. The only inefficient DMU was scored by the category of DMU3 which represent Berhan bank, Bunna Bank, and Abay Bank, having an average technical efficiency score of 0.949 and 0.966 respectively. This implies that on average those banks, under DMU3 categories, Berhan Bank, Bunna Bank, and Aba banks, on average are 94.9% and 96.6% efficient in these years as compared to its peers and the rest of the banks industry remain 100% efficient with the respective inputs and out puts. Meanwhile, during the same period of 2018 and 2020 those banks under DMU3 to become efficient they all must reduce their input by 5.1% and 3.4% to achieve equivalent output of their peers during the same years. Generally, all the sixteen commercial banks become better in their efficiency during 2016 and showed a declined trend to 2020.

4.3.2 Overall Technical Efficiency Using BCC Model (Variable Return to Scale, VRS)

Under the constant returns scale the average and overall efficiency score is 0.986 and under variable return to scale it is 0.991, for many researchers prefer to presume the VRS to be more closer to reality than the former, that is in line with the assumption of which the variable return to scale is always tolerates higher efficiency score because of its considerations for banks operating under both the increasing and decreasing returns to scale, the industry average has increased substantially to 0.991. The Variable Return scale, VRS, appears to be realistic approximations of the efficiency score of banks because the Constant Returns to scale, CRS assumes that all banks are operating at an optimal scale. However, various factors like imperfect competition and internal factors may constrain a bank not to be operating at optimal scale.

The VRS efficiency score results of the banks, which are under consideration for this study, were displayed using DEA software. Table 4.3.3 below indicates that those banks which are relative efficient having efficiency score of 1. On the other hand, those banks with relative inefficiencies do have scores less than 1. If the efficiency scores are less than 1, it means they can achieve the existing level of output with less amount of input (as it is an input-oriented approach).

Table 4.4 Overall Technical Efficiency (Variable Return to Scale, VRS) MAX DEPro7 software

Period	DMU Category	Efficiency	Lambdas / Efficiency boundaries /			
			DMU1	DMU2	DMU3	DMU4
2016	DMU1	1	1	0	0	0
	DMU2	0.998	0.202	0	0.798	0
	DMU3	1	0	0	1	0
	DMU4	1	0	0	0	1
2017	DMU1	1	1	0	0	0
	DMU2	0.919	0.171	0	0.829	0
	DMU3	1	0	0	1	0
	DMU4	1	0	0	0	1
2018	DMU1	1	1	0	0	0
	DMU2	1	0	1	0	0
	DMU3	1	0	0	1	0
	DMU4	1	0	0	0	1
2019	DMU1	1	1	0	0	0
	DMU2	0.935	0.457	0	0	0.543
	DMU3	1	0	0	1	0
	DMU4	1	0	0	0	1
2020	DMU1	1	1	0	0	0
	DMU2	1	0	1	0	0
	DMU3	0.982	0.232	0	0	0.768
	DMU4	1	0	0	0	1

Source: Researcher Computation using MAX DEA Pro 7 Software

During the year 2016, 2017, and 2019 all the DMUs were efficiency having an efficient result of 1. The only inefficient DMU was DMU2 which represent Zemen bank, Oromia International Bank, Lion Bank and Cooperative bank of Oromia, having an average technical efficiency score of 0.998, 0.919 and 0.935 respectively. This implies that on average those banks, Zemen Bank, Oromia International Bank, Lion Bank and Cooperative bank of Oromia, are respectively 99.8%, 91.9% and 93.5% efficient in those years as compared to its peers and the rest of the banks industry remain 100% efficient with the respective inputs and outputs. Meanwhile, during the same period 2016, 2017, and 2019 those banks under DMU2 to become efficient, they all must reduce their inputs by 0.2%, 8.0% and 6.5% respectively to achieve equivalent output of their peers during the same years.

On the other hand, during the year 2018, all the DMUs without exception were also efficiency having an efficient result of 1. This is an exemplar period that all of the sixteen private commercial banks in Ethiopia remain efficient as per the selected input and outputs. Then again, during the year 2020, all the DMUs were also efficient except the DMU3. The inefficient DMU 3 that includes Berhan Bank, Bunna Bank and Abay Bank were having an average efficiency score of 0.982, implying that they were only 98.2% efficient and to become efficient these banks need to reduce their input by 1.8% to achieve equivalent output of their peers during the same years.

4.4. Slack Characteristics of the Private Commercial Banks

The slack characteristics provide an insight to the areas which banks needs to improve and became efficient as its peers (reference). Slacks are existed only for inefficient banks which need improvement in their input and output mixes. In this study the two DMUs that are more frequently inefficient were DMU2 and DMU3 that means that those banks under these categories like: Zemen Bank, Oromia Bank, Cooperative bank of Oromia, and lion banks from DMU2 and Berhan Bank, Bunna Bank and Abay Bank from DMU3 are inefficient during different periods of this study times. Therefore, the below Table 4.4 represent DEA Max pro extracts of these slacks for its respective input and out puts and this slack represents only the portion of inefficiency that is needed to push the banks to efficient frontier.

In input-oriented DEA model, input slacks represent the input excess used that are required to reduce and the output slack represents the output which is under produced by Collie B.(1996). Technically inefficient banks to be relatively efficient, either they should decrease their excess level of inputs without changing their outputs or increase insufficient level of outputs without altering their level of inputs.

In the period 2016, at DMU 2 both the input and output of Non-interest Expense and Total loan have about a slack of 3.8 and 78.496 respectively. This means that those banks under DMU2, that are Zemen Bank, Oromia Bank, Cooperative Bank of Oromia and Lion Bank could utilize the slack value of forgone average cost of 3.8 million ETB and could potentially generate an average outcome of 78.496 million ETB with execution of some degree of efficiency.

In the below Table 4.4 we can also see that the year 2018 is the most efficient year of performances for all private banks and the only slack observed were on DMU3 that was in CRS score of the data. In the same period, the slack was scored at non-interest income with amount of 134.15 units of output. This means that those banks DMU3 still can generate further out put on non-interest income with an average the amount of 134.15 million ETB. In short, those banks under DMU3, that are Berhan Bank, Bunna Bank and Abay Bank can leverage their resources to gain additional non-interest income of 134.15 million ETB during the period of 2018.

Table 4.5. Overall DMUs` Slacks under both CRS and VRS using MAX DEA Pro7 software

Period	DMU Category	CRS Score of Slack input and output				VRS Score of Slack input and output			
		Input slacks		Output slacks		Input slacks		Output slacks	
		Total Deposit	Non-Interest Expense	Total Loan	Non-Interest Income	Total Deposit	Non-Interest Expense	Total Loan	Non-Interest Income
2016	DMU1	0	0	0	0	0	0	0	0
	DMU2	0	0	0	0	0	3.8	78.496	0
	DMU3	0	0	0	0	0	0	0	0
	DMU4	0	0	0	0	0	0	0	0
2017	DMU1	0	0	0	0	0	0	0	0
	DMU2	183.221	0	0	0	323.383	0	62.636	0
	DMU3	0	0	0	0	0	0	0	0
	DMU4	0	0	0	0	0	0	0	0
2018	DMU1	0	0	0	0	0	0	0	0
	DMU2	0	0	0	0	0	0	0	0
	DMU3	0	0	0	134.18	0	0	0	0
	DMU4	0	0	0	0	0	0	0	0
2019	DMU1	0	0	0	0	0	0	0	0
	DMU2	1917.65	0	0	0	1962.87	0	0	9.571
	DMU3	0	0	0	0	0	0	0	0
	DMU4	0	0	0	0	0	0	0	0
2020	DMU1	0	0	0	0	0	0	0	0
	DMU2	0	0	0	0	0	0	0	0
	DMU3	0	5.967	0	255.211	0	169.356	0	83.71
	DMU4	0	0	0	0	0	0	0	0

Source: Researcher Computation using MAX DEA Pro **7** Software

In the period 2019, at DMU2 both the inputs and output of Total Deposit and Non-interest income have about a slack of 1917.65 and 9.571 respectively. This means that those banks under DMU2 categories, which are Zemen Bank, Oromia Bank, Cooperative Bank of Oromia and Lion Bank, could utilize the slack value of an average idle deposit of 1,917,650 ETB that could potentially generate an average outcome of 8,571,000 ETB with execution of some degree of management efficiency. This can easily be achieved by provision of loan and/or investment in some other facilities to boost non-interest income of the banks.

In the period 2020, at DMU3 both the input of Non-interest Expense and an out of non-interest income have about a slack of 5.967 and 255.221 respectively. This means that those banks, Berhan Bank, Bunna Bank and Abay Bank could utilize the slack value of forgone cost of 5.967 million ETB and could potentially generate an outcome of 255.211 million ETB with execution of some degree of efficiency.

4.5. Peers Characteristics of the Private Commercial Banks

Furthermore, the DEA technique is also a best tool for benchmarking as it allows the discovery of most efficient DMU for each inefficient DMU. The discovery of the most frequent reference set or peers for inefficient banks indicates to which of the efficient banks an inefficient bank is closest in its combination of inputs and outputs. A bank, which appears frequently in the reference set is likely to be a bank which is efficient bank that appear seldom in the reference set of other banks are likely to possess a very uncommon input and output mix and are thus not suitable examples for other inefficient banks. Table 4.5 illustrates the overall peers' frequencies that were indeed highly linked with the efficiency of the DMUs.

Table 4.6 Overall Peers Frequencies of DMUs under both CRS and VRS using MAX DEA Pro7

Period	Peer Frequencies using VRS Data Extract		Peer Frequencies using CRS Data Extract		Total Peer Frequencies	Overall Frequencies 2016 -2020			
	DMU Frequency	Frequency Rates	DMU Frequency	Frequency Rates	Frequency Rates	DMU s			
						DMU1	DMU2	DMU3	DMU4
2016	DMU1	2	DMU1	2	4	19	4	9	13
	DMU3	2	DMU3	2	4				
	DMU4	1	DMU4	2	3				
2017	DMU1	2	DMU1	2	4				
	DMU3	2	DMU3	1	3				
	DMU4	1	DMU4	2	3				
2018	DMU1	1	DMU1	3	4				
	DMU2	1	DMU2	1	2				
	DMU3	1	DMU4	2	3				
	DMU4	1		0	1				
2019	DMU1	2	DMU1	2	4				
	DMU3	1	DMU3	1	2				
	DMU4	2	DMU4	2	4				
2020	DMU1	2	DMU1	1	3				
	DMU2	1	DMU2	1	2				
	DMU4	2	DMU4	2	4				

Source: Researcher Computation using MAX DEA Pro **7** Software.

In the whole period of 2016 to 2020 the below DMUs have the relative and total peer frequencies, 19, 4, 9, and 13 respectively for DMU1, DMU2, DMU3 and DMU4. Out of four DMUs, only DM2 have the lowest peer frequencies of 4 showing that those banks under these categories are not only inefficient but also could not be taken as a benchmarking for other private banks to measure the inefficiencies in them.

On the other hand, DMU1 have scored that highest peer frequencies proving that those banks under these categories are not only efficient during the study period but also can be taken as the most valid benchmarks to evaluate the performance of other private banks. This implied that those banks under DMU1, such as Awash Bank, Dashen Bank, Abyssinia Bank, Wegagen Bank, Hibret Bank, and Nib Bank were in average efficient and showed very lower slack scores in their inputs and output variables and therefore can be taken as the benchmark private commercial banks in Ethiopia. These private banks are also known for their larger size, highly

capitalized, older, and higher profit market shares in the industry.

Alternatively, the relative peer frequencies of DMU4 scores 13 it is the second most peer frequencies in our data, under table 4.4. This DMU 4 is relatively better efficient than the rest of the DMUs. Those banks under DMU4 are known as the newly entrant and very small banks that are Enat bank, Addis Bank, and Debub Global Banks. These banks despite being new to the industry they relatively have better efficiencies and could be consider as a benchmark bank for any other newly entering and prospectus banks. Besides, their lower capital and market exposure do not hinder them to gain relatively average performance efficiencies.

Finally, those banks under DMU 2, are Zemen bank, Oromia Bank, and Cooperative bank of Oromia are not relatively better performing banks with respect to the input and output variables used in this study under the stated period. However, unlike the inefficiency's features noted in this study, their profit shares in the market looks above average and that could be dealt in depth for its root causes but under the scope of this study those group of banks showed lower efficiencies and/or performances. And future study could reveal the means of their other incomes and can continue the intent of performance evaluation of private banks in Ethiopia there on.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

This chapter comprises the last section of the paper. That is, conclusions extracted from the result and discussion and forwarded possible recommendations based on the conclusions.

5.1. Conclusions

Intermediation approach has been followed to select input and output variables for attainment of technical efficiency. The input variables included: i. Total Deposit and ii. Non-interest expense, while output variables contain i. Total Loan and ii. Non-interest Income. The level of overall technical efficiencies of the banks during the year 2016 to 2020 indicated that for almost all private banks were having an overall efficiency of 0.988. Where the old and larger banks (DMU1), as well as the newly entrants and small private banks (DMU4), are purely efficient, having score of 1.0. This implies that during the study period the private commercial bank were 98.8% efficient in these years as compared to its peers. For these categories of private banks to become purely efficient those banks must reduce their input by 1.2% to increase the output in an efficient manner.

From this, it may be concluded that the overall technically inefficient banks should have made an adjustment efficient as their peers by reducing and adjusting their input and output mix to became on the efficient frontier. Generally, the bank with overall Technical Efficiency score of less than 1 is then to be relatively inefficient. Banks which have Technical Efficiency score of 1 are used as a best practice or efficient frontier and form the reference set for inefficient banks. The input utilization process in these efficient banks is functioning well. This means that the production process of these banks was characterizing relatively good input utilization. Decomposing technical efficiency provides an insight about the source of inefficiency. Based on analysis made by decomposing technical efficiency into pure technical efficiency and scale efficiency, during the study period was due to poor input utilization (i.e., managerial inefficiency) and failure to operate at most productive scale size (i.e., scale inefficiency).

From this study it be concluded that the major source of banks inefficiency in the year 2016, 2017,201 and 2020 were due to scale efficiency. This means that the banks were relatively efficient in management than their scale of operation. To discover the most frequent reference set or peers for inefficient banks indicates to which of the efficient banks an inefficient bank is closest in its combination of inputs and outputs. Out of the sixteen private commercial banks only nine of them were of the one that appear more frequently as their peers (benchmark) these banks were Awash Bank, Abyssinia bank, Dashen Bank, Wegagen bank, Hibret Bank, Nib bank, Enat Bank, Addis Bank and Debub Global Bank. This implies that, the peer count number can be considered as a measure of the extent to which the performance of an efficient bank can be a useful for the inefficient banks.

The slack characteristics of banks provide a conclusion about the excess input utilized (input slack) or the outputs under produced by the banks. Based on the slack data in Table 4.4, the researcher found that the main biggest Slack occurrence observed at DMU2 and DMU3 only that is happening with the following banks, Zemen Bank, Oromia Bank, Cooperative bank of Oromia, Lion Bank, Berhan Bank, Bunna Bank, Abay Bank That is to say, with some adjustments to their input mix there is higher potential to maximize the output of those banks. This can be achieved by leveraging the idle Total deposits and non-interest expense to gain some advantages of Total loan as well as Non- interest Income for the respective period.

5.2 Recommendations

Based on findings and conclusions made in above sections, the following possible recommendations are forwarded. Managerial relevance of the research is quite important. And it is widely accepted that for a company to succeed it should perform well and leverage all the opportunities to its possible frontier. Moreover, the bank`s board, Top directors and management officials should pay more attention to deposit mobilization and expense management. On the other hand, the quality of investment that is normally implied by the non-interest income management shall be focused and shall be done in such resourceful direction to support the outcome and exhausted all the possible income of the bank. To this end, having larger deposit mean two risk and/or opportunities for every bank and if promptly managed in efficient execution it can lead to key success of the bank. Moreover, Age of the bank, size of deposit, and prior link system to loan, expansion of branches and business activities is done by

keeping the existing input levels and shall involve careful planning, evaluation, and control of operating expenditure among the input variables. The excess amount of deposit balances for those larger and middle banks should be reinvest in different investment opportunities like (stock and bond) and proportionally disbursed to the existing loans among the expected output variables. Furthermore, Board directors, Bank CEO, Top managers can use DEA techniques to compare, evaluate the performance for their strategic business units with their peers.

Other important suggestion is implementing appropriate strategies to improve management inefficiency and technical efficiency of an inefficient bank. The management inefficiency can be eliminated by the following mechanisms: by delivering training courses for managers, establishing a gratifying system based on managers benefit, reviewing skilled human resources etc. Regarding the return to scale, the researcher recommends that the bank management official should consider the type of return to scale of the banks. This may be done by allocating some budget and resources.

From the peer results, the researcher wants to recommend that the inefficient banks should adopt the practices of the peer banks in the utilizations of their inputs to be relatively efficient .The reason behind the inefficiency of banks during the study period was lower leverage of their inputs and outputs Finally, the trends of efficiency in the commercial banks in this study were superior but their attitudes towards technological changes were declining. In today‘s world the one which have a high technology in its system than others lead to dominate the competitors and accommodate more customers. As a result of this, it earns more incomes. To this end, the researcher recommends to those private banks to have some degree of technological advancement to leverage and improve all the opportunities and threat and hence they shall a benchmark one another as well as that of the foreign banks.

5.3 Recommendation for Future Research

As part of limitation to this study, the researcher wants to pass a guideline that shall be considered for the next research under such subject matter. For this study only used one approach (intermediation approach) to look at the inefficiencies of selected commercial private banks. There is need to apply other approaches such as production and operating approaches and compares the results and possibly checks if there are any deviations in the technical

efficiency scores. Besides, as this study only focuses on the input orientation approach alone and there shall be a view and findings that can address the output orientation as well. The inputs and outputs used is not the only indicator of efficiency, there are also multiple inputs and outputs which are indicators of efficiency, so in future other study may incorporate other additional outputs and inputs. Additionally, the study focuses only selected commercial banks; that are categorized in to four DMUs so the future and other study may deal with the individual private banks scoping all the private commercial banks of Ethiopia to see the strength, consistency and validity of the result and apply for comparative analysis among commercial bank of Ethiopia.

Lastly, while measuring the efficiency of Private commercial bank of Ethiopia various factors that is regional conflicts or, war, Pandemic disease like COVID 19, and others, Ethnic group and attitude, inflation, regulatory, economic system of the country, management behavior etc. which may affect the efficiency of the private commercial banks are not considered in this study, therefore future researcher may incorporate these variables.

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APPENDIX A

DEA Max Pro 7 Extract

— Project Info & Downloads

Project Name: Comparative Performance Analysis and Evaluation of Commercial banks. The case of Ethiopian Private banks using DEA approach. Period 2016 to 2020

Download Word (http://www.onlineoutput.com/dea-download-word/)

Download Excel (/dea/output/Excel?project_id=0_dea637799999483689427)

Print

— Model view

Number of Inputs: 2
Number of Outputs: 2
Number of DMUs: 4
Model : BasicRadial
Return to Scale: VRS
Orientation:In

— Outputs

Table 1: Efficiency

	Efficiency	
DMU1	1	Efficient
DMU2	0.998	Inefficient
DMU3	1	Efficient
DMU4	1	Efficient

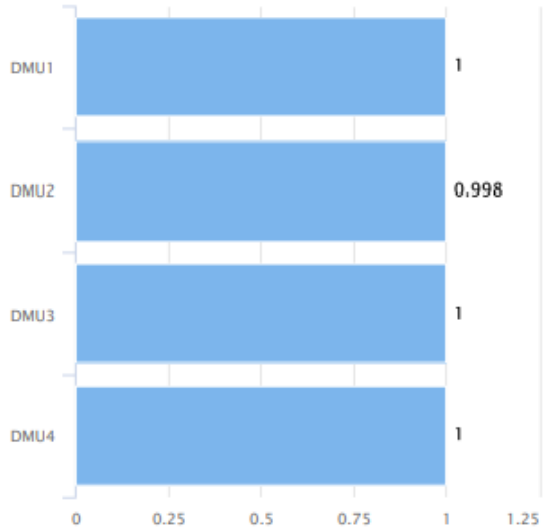


Fig 1: Efficiency graph

Table 2: Refrences

	Peer1	Peer2
DMU1	DMU1	-
DMU2	DMU1	DMU3
DMU3	DMU3	-
DMU4	DMU4	-

Table 3: Peer Frequencies

	Frequencies
DMU1	2
DMU3	2
DMU4	1

Table 4: Lambdas

	DMU1	DMU2	DMU3	DMU4
DMU1	1	0	0	0
DMU2	0.202	0	0.798	0
DMU3	0	0	1	0
DMU4	0	0	0	1

Table 5: Input weights

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0.001
DMU2	0	0
DMU3	0	0
DMU4	0	0.008

Table 6: Output weights

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0.004
DMU3	0	0.005
DMU4	0	0

Table 7: Input slacks

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0
DMU2	0	3.0
DMU3	0	0
DMU4	0	0

Table 8: Output slacks

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	78.496	0
DMU3	0	0
DMU4	0	0

Table 9: Inputs & Target inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	16050 → 16050	944 → 944
DMU2	7350 → 7333.326	481 → 476.109
DMU3	5133 → 5133	358 → 358
DMU4	1567 → 1567	125 → 125

Table 10: Outputs & Target outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	9850 → 9850	649 → 649
DMU2	4675 → 4753.496	340 → 340
DMU3	3467 → 3467	262 → 262
DMU4	1100 → 1100	125 → 125

APPENDIX B

BCC Model (VRS) Software extract per period

BCC_ Model VRS Raw Data Extract of 2016

Table1: Efficiency

	Efficiency	
DMU1	1	Efficient
DMU2	0.99773137	Inefficient
DMU3	1	Efficient
DMU4	1	Efficient

Table 2: References

	Peer1	Peer2
DMU1	DMU1	-
DMU2	DMU1	DMU3
DMU3	DMU3	-
DMU4	DMU4	-

Table 3: Peer Frequencies

	Frequencies
DMU1	2
DMU3	2
DMU4	1

Table 4: Lambdas

	DMU1	DMU2	DMU3	DMU4
DMU1	1	0	0	0
DMU2	0.202	0	0.798	0
DMU3	0	0	1	0
DMU4	0	0	0	1

Table 5: Input weights

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0.001
DMU2	0	0
DMU3	0	0
DMU4	0	0.008

Table 6: Output weights

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0.004
DMU3	0	0.005

DMU4	0	0

Table 7: Input slacks

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0
DMU2	0	3.8
DMU3	0	0
DMU4	0	0

Table 8: Output slacks

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	78.496	0
DMU3	0	0
DMU4	0	0

Table 9: Inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	16050	944
DMU2	7350	481
DMU3	5133	358
DMU4	1567	125

Table 10: Target inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	16050	944
DMU2	7333.326	476.109
DMU3	5133	358
DMU4	1567	125

Table 11: Outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	9850	649
DMU2	4675	340
DMU3	3467	262
DMU4	1100	125

Table 12: Target outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	9850	649
DMU2	4753.496	340
DMU3	3467	262
DMU4	1100	125

BCC_ Model VRS Raw
Data Extract of 2017

Table1: Efficiency

	Efficiency	
DMU1	1	Efficient
DMU2	0.918924	Inefficient
DMU3	1	Efficient
DMU4	1	Efficient

Table 2: References

	Peer1	Peer2
DMU1	DMU1	-
DMU2	DMU1	DMU3
DMU3	DMU3	-
DMU4	DMU4	-

Table 3: Peer Frequencies

	Frequencies
DMU1	2
DMU3	2
DMU4	1

Table 4: Lambdas

	DMU1	DMU2	DMU3	DMU4
DMU1	1	0	0	0
DMU2	0.171	0	0.829	0
DMU3	0	0	1	0
DMU4	0	0	0	1

Table 5: Input weights

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0
DMU2	0	0.001
DMU3	0	0
DMU4	0	0.005

Table 6: Output weights

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0.002
DMU3	0	0.003
DMU4	0	0

Table 7: Input slacks

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB

DMU1	0	0
DMU2	323.383	0
DMU3	0	0
DMU4	0	0

Table 8: Output slacks

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	62.636	0
DMU3	0	0
DMU4	0	0

Table 9: Inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	21433	1256
DMU2	10900	685
DMU3	7267	500
DMU4	2400	201

Table 10: Target inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	21433	1256
DMU2	9692.89	629.463
DMU3	7267	500
DMU4	2400	201

Table 11: Outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	14417	836
DMU2	6550	444
DMU3	5000	363
DMU4	1600	166

Table 12: Target outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	14417	836
DMU2	6612.636	444
DMU3	5000	363
DMU4	1600	166

BCC_ Model VRS Raw
Data Extract of 2018

Table1: Efficiency

	Efficiency	
DMU1	1	Efficient
DMU2	1	Efficient
DMU3	1	Efficient
DMU4	1	Efficient

Table 2: References

	Peer1
DMU1	DMU1
DMU2	DMU2
DMU3	DMU3
DMU4	DMU4

Table 3: Peer Frequencies

	Frequencies
DMU1	1
DMU2	1
DMU3	1
DMU4	1

Table 4: Lambdas

	DMU1	DMU2	DMU3	DMU4
DMU1	1	0	0	0
DMU2	0	1	0	0
DMU3	0	0	1	0
DMU4	0	0	0	1

Table 5: Input weights

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0
DMU2	0	0
DMU3	0	0
DMU4	0	0.004

Table 6: Output weights

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0.002
DMU3	0	0.003
DMU4	0	0

Table 7: Input slacks

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB

DMU1	0	0
DMU2	0	0
DMU3	0	0
DMU4	0	0

Table 8: Output slacks

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0
DMU3	0	0
DMU4	0	0

Table 9: Inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	28383	1639
DMU2	16875	852
DMU3	10133	699
DMU4	3333	244

Table 10: Target inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	28383	1639
DMU2	16875	852
DMU3	10133	699
DMU4	3333	244

Table 11: Outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	19183	825
DMU2	9275	607
DMU3	6600	412
DMU4	2300	224

Table 12: Target outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	19183	825
DMU2	9275	607
DMU3	6600	412
DMU4	2300	224

BCC_ Model VRS Raw
Data Extract of 2019

Table1: Efficiency

	Efficiency	
DMU1	1	Efficient
DMU2	0.934517	Inefficient
DMU3	1	Efficient
DMU4	1	Efficient

Table 2: References

	Peer1	Peer2
DMU1	DMU1	-
DMU2	DMU1	DMU4
DMU3	DMU3	-
DMU4	DMU4	-

Table 3: Peer Frequencies

	Frequencies
DMU1	2
DMU3	1
DMU4	2

Table 4: Lambdas

	DMU1	DMU2	DMU3	DMU4
DMU1	1	0	0	0
DMU2	0.457	0	0	0.543
DMU3	0	0	1	0
DMU4	0	0	0	1

Table 5: Input weights

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0
DMU2	0	0.001
DMU3	0	0
DMU4	0	0.003

Table 6: Output weights

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0
DMU3	0	0.002
DMU4	0	0

Table 7: Input slacks

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0

DMU2	1962.87	0
DMU3	0	0
DMU4	0	0

Table 8: Output slacks

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	9.571
DMU3	0	0
DMU4	0	0

Table 9: Inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	36083	2012
DMU2	22625	1163
DMU3	12300	921
DMU4	4933	307

Table 10: Target inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	36083	2012
DMU2	19180.57	1086.843
DMU3	12300	921
DMU4	4933	307

Table 11: Outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	26600	1230
DMU2	13975	712
DMU3	8533	651
DMU4	3333	293

Table 12: Target outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	26600	1230
DMU2	13975	721.571
DMU3	8533	651
DMU4	3333	293

BCC_ Model VRS Raw
Data Extract of 2020

Table1: Efficiency

	Efficiency	
DMU1	1	Efficient
DMU2	1	Efficient
DMU3	0.982471	Inefficient
DMU4	1	Efficient

Table 2: References

	Peer1	Peer2
DMU1	DMU1	-
DMU2	DMU2	-
DMU3	DMU1	DMU4
DMU4	DMU4	-

Table 3: Peer Frequencies

	Frequencies
DMU1	2
DMU2	1
DMU4	2

Table 4: Lambdas

	DMU1	DMU2	DMU3	DMU4
DMU1	1	0	0	0
DMU2	0	1	0	0
DMU3	0.232	0	0	0.768
DMU4	0	0	0	1

Table 5: Input weights

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0
DMU2	0	0.001
DMU3	0	0
DMU4	0	0.002

Table 6: Output weights

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0.001
DMU3	0	0
DMU4	0	0

Table 7: Input slacks

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0

DMU2	0	0
DMU3	0	169.356
DMU4	0	0

Table 8: Output slacks

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0
DMU3	0	83.71
DMU4	0	0

Table 9: Inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	45550	2414
DMU2	28400	1551
DMU3	15467	1065
DMU4	6033	413

Table 10: Target inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	45550	2414
DMU2	28400	1551
DMU3	15195.88	876.975
DMU4	6033	413

Table 11: Outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	35600	1507
DMU2	21150	1371
DMU3	11967	500
DMU4	4833	305

Table 12: Target outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	35600	1507
DMU2	21150	1371
DMU3	11967	583.71
DMU4	4833	305

Appendix C

CCR Model (CRS) Software extract per period

CCR_ Model CRS Raw Data Extract of 2016

Table1: Efficiency

	Efficiency	
DMU1	1	Efficient
DMU2	0.977886	Inefficient
DMU3	1	Efficient
DMU4	1	Efficient

Table 2: References

	Peer1	Peer2	Peer3
DMU1	DMU1	-	-
DMU2	DMU1	DMU3	DMU4
DMU3	DMU3	-	-
DMU4	DMU4	-	-

Table 3: Peer Frequencies

	Frequencies
DMU1	2
DMU3	2
DMU4	2

Table 4: Lambdas

	DMU1	DMU2	DMU3	DMU4
DMU1	1	0	0	0
DMU2	0.186	0	0.787	0.106
DMU3	0	0	1	0
DMU4	0	0	0	1

Table 5: Input weights

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0.001
DMU2	0	0.001
DMU3	0	0.001
DMU4	0	0.008

Table 6: Output weights

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0
DMU3	0	0

DMU4	0	0.008

Table 7: Input slacks

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0
DMU2	0	0
DMU3	0	0
DMU4	0	0

Table 8: Output slacks

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0
DMU3	0	0
DMU4	0	0

Table 9: Inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	16050	944
DMU2	7350	481
DMU3	5133	358
DMU4	1567	125

Table 10: Target inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	16050	944
DMU2	7187.462	470.363
DMU3	5133	358
DMU4	1567	125

Table 11: Outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	9850	649
DMU2	4675	340
DMU3	3467	262
DMU4	1100	125

Table 12: Target outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	9850	649
DMU2	4675	340
DMU3	3467	262
DMU4	1100	125

CCR_ Model CRS Raw
Data Extract of 2017

Table1: Efficiency

	Efficiency	
DMU1	1	Efficient
DMU2	0.91188	Inefficient
DMU3	1	Efficient
DMU4	1	Efficient

Table 2: References

	Peer1	Peer2
DMU1	DMU1	-
DMU2	DMU1	DMU4
DMU3	DMU3	-
DMU4	DMU4	-

Table 3: Peer Frequencies

	Frequencies
DMU1	2
DMU3	1
DMU4	2

Table 4: Lambdas

	DMU1	DMU2	DMU3	DMU4
DMU1	1	0	0	0
DMU2	0.357	0	0	0.877
DMU3	0	0	1	0
DMU4	0	0	0	1

Table 5: Input weights

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0
DMU2	0	0.001
DMU3	0	0
DMU4	0	0.005

Table 6: Output weights

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0.001
DMU3	0	0
DMU4	0	0.006

Table 7: Input slacks

	Total Deposit in 000`	Non-Interest Expense in 000`

	ETB	ETB
DMU1	0	0
DMU2	183.221	0
DMU3	0	0
DMU4	0	0

Table 8: Output slacks

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0
DMU3	0	0
DMU4	0	0

Table 9: Inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	21433	1256
DMU2	10900	685
DMU3	7267	500
DMU4	2400	201

Table 10: Target inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	21433	1256
DMU2	9756.27	624.638
DMU3	7267	500
DMU4	2400	201

Table 11: Outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	14417	836
DMU2	6550	444
DMU3	5000	363
DMU4	1600	166

Table 12: Target outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	14417	836
DMU2	6550	444
DMU3	5000	363
DMU4	1600	166

CCR_ Model CRS Raw
Data Extract of 2018

Table1: Efficiency

	Efficiency	
DMU1	1	Efficient
DMU2	1	Efficient
DMU3	0.949212	Inefficient
DMU4	1	Efficient

Table 2: References

	Peer1	Peer2
DMU1	DMU1	-
DMU2	DMU1	DMU2
DMU3	DMU1	DMU4
DMU4	DMU4	-

Table 3: Peer Frequencies

	Frequencies
DMU1	3
DMU2	1
DMU4	2

Table 4: Lambdas

	DMU1	DMU2	DMU3	DMU4
DMU1	1	0	0	0
DMU2	0	1	0	0
DMU3	0.093	0	0	2.097
DMU4	0	0	0	1

Table 5: Input weights

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0
DMU2	0	0.001
DMU3	0	0
DMU4	0	0.004

Table 6: Output weights

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0.001
DMU3	0	0
DMU4	0	0.004

Table 7: Input slacks

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB

DMU1	0	0
DMU2	0	0
DMU3	0	0
DMU4	0	0

Table 8: Output slacks

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0
DMU3	0	134.18
DMU4	0	0

Table 9: Inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	28383	1639
DMU2	16875	852
DMU3	10133	699
DMU4	3333	244

Table 10: Target inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	28383	1639
DMU2	16875	852
DMU3	9618.368	663.499
DMU4	3333	244

Table 11: Outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	19183	825
DMU2	9275	607
DMU3	6600	412
DMU4	2300	224

Table 12: Target outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	19183	825
DMU2	9275	607
DMU3	6600	546.18
DMU4	2300	224

CCR_ Model CRS Raw
Data Extract of 2019

Table1: Efficiency

	Efficiency	
DMU1	1	Efficient
DMU2	0.931264	Inefficient
DMU3	1	Efficient
DMU4	1	Efficient

Table 2: References

	Peer1	Peer2
DMU1	DMU1	-
DMU2	DMU1	DMU4
DMU3	DMU3	-
DMU4	DMU4	-

Table 3: Peer Frequencies

	Frequencies
DMU1	2
DMU3	1
DMU4	2

Table 4: Lambdas

	DMU1	DMU2	DMU3	DMU4
DMU1	1	0	0	0
DMU2	0.466	0	0	0.474
DMU3	0	0	1	0
DMU4	0	0	0	1

Table 5: Input weights

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0
DMU2	0	0.001
DMU3	0	0
DMU4	0	0.003

Table 6: Output weights

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0
DMU3	0	0
DMU4	0	0.003

Table 7: Input slacks

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0
DMU2	1917.653	0
DMU3	0	0
DMU4	0	0

Table 8: Output slacks

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0
DMU3	0	0
DMU4	0	0

Table 9: Inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	36083	2012
DMU2	22625	1163
DMU3	12300	921
DMU4	4933	307

Table 10: Target inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	36083	2012
DMU2	19152.2	1083.06
DMU3	12300	921
DMU4	4933	307

Table 11: Outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	26600	1230
DMU2	13975	712
DMU3	8533	651
DMU4	3333	293

Table 12: Target outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	26600	1230
DMU2	13975	712
DMU3	8533	651
DMU4	3333	293

CCR_ Model CRS Raw
Data Extract of 2020

Table1: Efficiency

	Efficiency	
DMU1	1	Efficient
DMU2	1	Efficient
DMU3	0.965819	Inefficient
DMU4	1	Efficient

Table 2: References

	Peer1
DMU1	DMU1
DMU2	DMU2
DMU3	DMU4
DMU4	DMU4

Table 3: Peer Frequencies

	Frequencies
DMU1	1
DMU2	1
DMU4	2

Table 4: Lambdas

	DMU1	DMU2	DMU3	DMU4
DMU1	1	0	0	0
DMU2	0	1	0	0
DMU3	0	0	0	2.476
DMU4	0	0	0	1

Table 5: Input weights

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	0	0
DMU2	0	0
DMU3	0	0
DMU4	0	0.001

Table 6: Output weights

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0.001
DMU3	0	0
DMU4	0	0.003

Table 7: Input slacks

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB

DMU1	0	0
DMU2	0	0
DMU3	0	5.967
DMU4	0	0

Table 8: Output slacks

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	0	0
DMU2	0	0
DMU3	0	255.211
DMU4	0	0

Table 9: Inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	45550	2414
DMU2	28400	1551
DMU3	15467	1065
DMU4	6033	413

Table 10: Target inputs

	Total Deposit in 000` ETB	Non-Interest Expense in 000` ETB
DMU1	45550	2414
DMU2	28400	1551
DMU3	14938.32	1022.63
DMU4	6033	413

Table 11: Outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	35600	1507
DMU2	21150	1371
DMU3	11967	500
DMU4	4833	305

Table 12: Target outputs

	Total Loan in 000` ETB	Non-Interest Income in 000` ETB
DMU1	35600	1507
DMU2	21150	1371
DMU3	11967	755.211
DMU4	4833	305

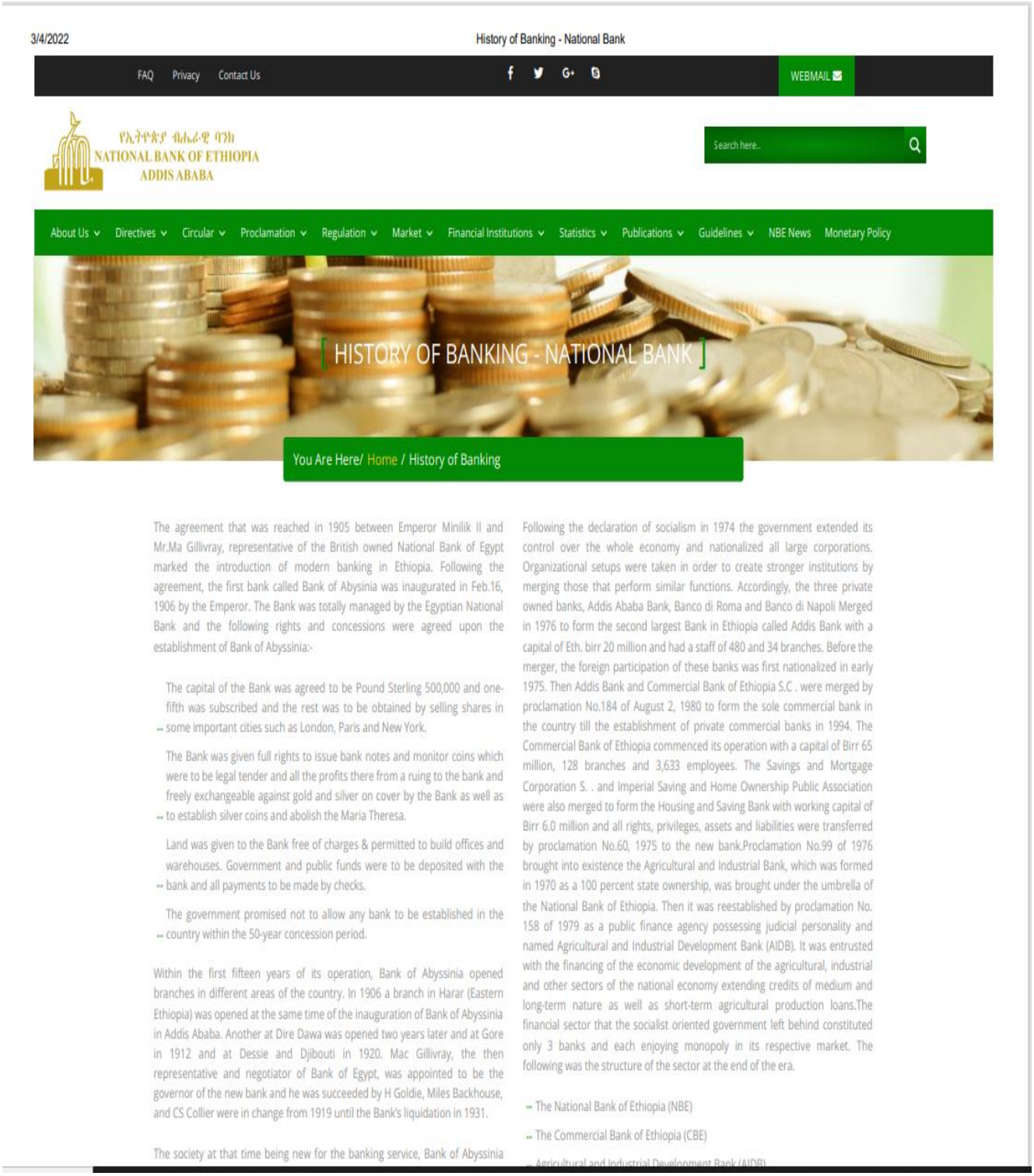
Appendixes D

Raw Data of Variables per Bank per DMU

DMUs	Name of Banks per DMU	Period: 20216				Period: 2017				Period: 20218				Period: 20219				Period: 2020			
		Inputs in 000` ETB		Outputs in 000`ETB		Inputs in 000` ETB		Outputs in 000`ETB		Inputs in 000` ETB		Outputs in 000`ETB		Inputs in 000` ETB		Outputs in 000`ETB		Inputs in 000` ETB		Outputs in 000`ETB	
		Total Deposit	Non-Interest Expense	Total Loan	Non-Interest Income	Total Deposit	Non-Interest Expense	Total Loan	Non-Interest Income	Total Deposit	Non-Interest Expense	Total Loan	Non-Interest Income	Total Deposit	Non-Interest Expense	Total Loan	Non-Interest Income	Total Deposit	Non-Interest Expense	Total Loan	Non-Interest Income
DMU1: Private Banks Older than 18-25 years in the industry	Awash Bank	22800	1389	15200	901	30500	1642	22200	1176	43400	2146	31000	1206	59600	3232	46900	2079	74300	3296	57400	2336
	Dashen Bank	22700	1163	12500	1212	27800	1707	17700	1344	36000	2201	23100	1186	44700	2636	32300	1277	53400	3022	42300	1462
	Abyissina Bank	13600	805	8000	536	20700	1220	13900	789	25800	1635	17800	553	32100	1973	23400	784	47500	2780	37600	1170
	Wegagen Bank	11800	818	7500	509	15600	1109	10200	798	20500	1458	14800	972	23500	1658	16100	2098	30100	1968	23700	2966
	Hibret Bank	13000	814	8400	448	17600	1002	11800	462	23000	1302	14900	623	29000	1443	21600	661	34700	1871	26700	462
	Nib Bank	12400	674	7500	290	16400	855	10700	447	21600	1089	13500	412	27600	1128	19300	481	33300	1545	25900	647
DMU1: Average		16050	944	9850	649	21433	1256	14417	836	28383	1639	19183	825	36083	2012	26600	1230	45550	2414	35600	1507
Banks Older than 15 -17 years in the industry	Zemen Bank	5400	227	3300	336	7300	349	4000	503	10200	391	5000	424	11600	477	7600	568	14400	498	11200	539
	COOP bank	8400	626	5900	255	14200	1045	9700	409	25800	1340	14700	658	36100	1882	21400	900	45500	2620	34200	1581
	Oromia int. Bank	9300	650	5200	400	13400	836	7000	583	19900	1026	10000	963	26500	1523	15300	832	27600	1995	20100	1491
	Lion Bank	6300	422	4300	368	8700	510	5500	279	11600	652	7400	383	16300	768	11600	546	26100	1091	19100	1874
DMU2: Average		7350	481	4675	340	10900	685	6550	444	16875	852	9275	607	22625	1163	13975	712	28400	1551	21150	1371
Bank 12-14 years in the industry	Berhan Bank	5300	373	3700	326	7600	531	5400	477	10900	807	7100	435	14900	1099	10000	670	16500	1339	12700	800
	Bunna Bank	5300	363	3600	244	7400	508	5300	293	9900	677	6800	359	10500	891	8100	550	13900	974	11600	112
	Abay Bank	4800	337	3100	216	6800	461	4300	319	9600	612	5900	443	11500	773	7500	733	16000	881	11600	588
DMU3: Average		5133	358	3467	262	7267	500	5000	363	10133	699	6600	412	12300	921	8533	651	15467	1065	11967	500
DMU4: Newly Joined less than 12 years	Enat Bank	2400	131	1600	132	3600	239	2400	183	5000	258	3300	262	7400	308	5000	240	8300	440	6500	273
	Addis Bank	1500	142	1100	145	2200	208	1600	178	2900	251	2000	202	3900	310	2600	265	4600	318	3500	303
	Debub Global Bank	800	102	600	97	1400	156	800	136	2100	224	1600	207	3500	303	2400	374	5200	482	4500	340
DMU4: Average		1567	125	1100	125	2400	201	1600	166	3333	244	2300	224	4933	307	3333	293	6033	413	4833	305

Appendixes E

History of Banking in Ethiopia



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HISTORY OF BANKING - NATIONAL BANK

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The agreement that was reached in 1905 between Emperor Minilik II and Mr.Ma Gillivray, representative of the British owned National Bank of Egypt marked the introduction of modern banking in Ethiopia. Following the agreement, the first bank called Bank of Abysinia was inaugurated in Feb.16, 1906 by the Emperor. The Bank was totally managed by the Egyptian National Bank and the following rights and concessions were agreed upon the establishment of Bank of Abyssinia:-

- The capital of the Bank was agreed to be Pound Sterling 500,000 and one-fifth was subscribed and the rest was to be obtained by selling shares in some important cities such as London, Paris and New York.
- The Bank was given full rights to issue bank notes and monitor coins which were to be legal tender and all the profits there from a ruing to the bank and freely exchangeable against gold and silver on cover by the Bank as well as to establish silver coins and abolish the Maria Theresa.
- Land was given to the Bank free of charges & permitted to build offices and warehouses. Government and public funds were to be deposited with the bank and all payments to be made by checks.
- The government promised not to allow any bank to be established in the country within the 50-year concession period.

Within the first fifteen years of its operation, Bank of Abyssinia opened branches in different areas of the country. In 1906 a branch in Harar (Eastern Ethiopia) was opened at the same time of the inauguration of Bank of Abyssinia in Addis Ababa. Another at Dire Dawa was opened two years later and at Gore in 1912 and at Dessie and Djibouti in 1920. Mac Gillivray, the then representative and negotiator of Bank of Egypt, was appointed to be the governor of the new bank and he was succeeded by H Goldie, Miles Backhouse, and CS Collier were in change from 1919 until the Bank's liquidation in 1931.

The society at that time being new for the banking service, Bank of Abyssinia

Following the declaration of socialism in 1974 the government extended its control over the whole economy and nationalized all large corporations. Organizational setups were taken in order to create stronger institutions by merging those that perform similar functions. Accordingly, the three private owned banks, Addis Ababa Bank, Banco di Roma and Banco di Napoli Merged in 1976 to form the second largest Bank in Ethiopia called Addis Bank with a capital of Eth. birr 20 million and had a staff of 480 and 34 branches. Before the merger, the foreign participation of these banks was first nationalized in early 1975. Then Addis Bank and Commercial Bank of Ethiopia S.C . were merged by proclamation No.184 of August 2, 1980 to form the sole commercial bank in the country till the establishment of private commercial banks in 1994. The Commercial Bank of Ethiopia commenced its operation with a capital of Birr 65 million, 128 branches and 3,633 employees. The Savings and Mortgage Corporation S. . and Imperial Saving and Home Ownership Public Association were also merged to form the Housing and Saving Bank with working capital of Birr 6.0 million and all rights, privileges, assets and liabilities were transferred by proclamation No.60, 1975 to the new bank.Proclamation No.99 of 1976 brought into existence the Agricultural and Industrial Bank, which was formed in 1970 as a 100 percent state ownership, was brought under the umbrella of the National Bank of Ethiopia. Then it was reestablished by proclamation No. 158 of 1979 as a public finance agency possessing judicial personality and named Agricultural and Industrial Development Bank (AIDB). It was entrusted with the financing of the economic development of the agricultural, industrial and other sectors of the national economy extending credits of medium and long-term nature as well as short-term agricultural production loans.The financial sector that the socialist oriented government left behind constituted only 3 banks and each enjoying monopoly in its respective market. The following was the structure of the sector at the end of the era.

- The National Bank of Ethiopia (NBE)
- The Commercial Bank of Ethiopia (CBE)
- Agricultural and Industrial Development Bank (AIDB)