

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

**Determinants of Commercial Banks' Cost Efficiency in
Ethiopia: A Stochastic Frontier Analysis**

By

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Abstract

The study analyzes the determinants of Ethiopian commercial banks' cost efficiency using unbalanced sample of 12 commercial banks over the period 2000-2013 by employing a translog stochastic cost frontier approach. In order to examine bank specific factors which influence in (efficiency), a single stage maximum likelihood estimation procedure is applied to a stochastic cost frontier function. The findings show that bank specific factors of return on assets (ROA), return on equity (ROE) and intermediation ratio have a significant positive impact on cost efficiency of Ethiopian commercial banks. The result also shows that there is a positive insignificant relationship between bank size and cost efficiency. On the other hand, the capital adequacy ratio (CAR), with positive and significant coefficient, shows a positive relationship between this variable and total cost, which contributes to lower the banking efficiency. Thus, banks can improve their cost efficiency by way of improving their ROA, ROE, the method of advances. In addition they have to increase the share of capital by boosting banking investment operation.

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Acronyms

AIB - Awash International Bank S.C

BOA- Bank of Abyssinia S.C

CBB- Construction and Business Bank

CBE- Commercial Bank of Ethiopia

CBO- Cooperative Bank of Oromia

DB- Dashen Bank

DEA- Data Envelhopment Analysis

DFA- Distribution Free Approach

LIB- Lion International Bank S.C

MLE - Maximum Likelihood Estimates

NBE- National Bank of Ethiopia

NIB- Nib International Bank S.C

OIB- Oromia International bank S.C

UB- United Bank S.C

WB- Wegagen Bank S.C

ZB- Zemen Bank

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CHAPTER ONE: INTRODUCTION

1.1. Background of the Study

Commercial banks are the most important financial institutions and constitute the major financial system in the economy. They perform a variety of banking functions such as accepting deposits, advancing loans, financing foreign trade, agency functions, and miscellaneous services to customers. Besides performing the usual commercial banking functions, banks in developing countries play an important role in the economic development. The majorities of people in such countries are poor, unemployed, and engaged in traditional agriculture, there is acute shortage of capital, people lack initiative and enterprise, means of transport is underdeveloped, and industry is depressed. Thus, commercial banks can help in overcoming these obstacles and promoting economic development by granting loans to agriculture, trade, and industry, by helping in the formation of physical and human capital and by following the monetary policy of the country (Jhingan, 2004). Furthermore, a well organized, competitive, and comprehensive financial system is important for improving agricultural production, to expand micro and small enterprises, to reduce unemployment, to improve the growth and development of a nation (Wolday, 2012). Through mobilizing household and foreign savings, commercial banks can maintain economic growth by allocating them into productive sectors and spreading risk and providing liquidity. In addition, by identifying those entrepreneurs with the best chance of successfully initiating new goods and production process commercial banks improve the growth of technological innovation (Levine, 2004).

Banks play an invaluable role in transforming risk, size, and maturity of financial instruments. In doing so, they convert deposits into productive investment. Indeed, economies with a sophisticated financial system are more capable of evaluating assets whose real value is difficult to determine (Thankor, 1996). Accordingly, an efficient banking sector is essential for a vibrant economic performance.

According to Turati (2003) “banks are regarded as firms that emerge as a result of some sort of market imperfections, hence they bring about a certain degree of inefficiency with respect to perfectly competitive outcomes.” Thus, efficiency is an important issue both at macro and micro levels and in order to allocate and utilize resources effectively; banks should be sound and efficient (Hussein, 2003). The efficiency of commercial banks is usually measured in terms of minimization of inputs to produce a specific level of outputs or in terms of maximization of outputs given a specific level of inputs (Wang, 2008). Thus, measuring the determinants of commercial banks’ efficiency is important for owners as monitoring criteria of their business, it is also important for depositors to make decisions about their savings and it is crucial for government to assess a particular sector of the economy. Thus, this study examines the cost efficiency of commercial banks and factors affecting cost efficiency. Measuring the efficiency of banking institutions helps to evaluate the impact of various policy measures on the efficiency and performance of these institutions.

However, commercial banking is a difficult service industry in which to measure inputs, inputs prices, outputs, technical change, or productivity growth. First, there is disagreement over the services which are produced by banks and on the measurement of

these services. Because, banks produce services which are often priced implicitly below market interest rates on deposit balances, making the inputs and outputs variables included in the analysis inaccurate. In addition, banking is a highly regulated industry in which substantial inefficiencies have been shown to exist. As a result, technical improvements that increase the productivity of the most efficient firms may not be well reflected in the industry as a whole. Measurement of cost changes and productivity gains must take these factors into account, including the possibility of a period of significant disequilibrium as banks attempted to adjust to deposit deregulation (Berger and Humphrey, 1992).

1.2. Statement of the Problem

Commercial banks are the primary financial intermediaries in Ethiopia as they constitute a significant part of the financial sector. The report of National Bank of Ethiopia (2015) indicated that there are 3 public and 16 private commercial banks operating in the country making the total number of banks 19. Although the competition among banks in the market is increasing, commercial bank of Ethiopia still have a lion's share in the banking industry. The report of National Bank of Ethiopia (2014) shows that, the banking sector had a total asset of Birr 349.86 billion, mobilizing Birr 196.39 billion deposit and had an outstanding credit of Birr 116.71 billion of which public banks share is 73% of asset, 67% of deposit, and 54% of outstanding credit.

There are several studies which studied the determinants of the banking sector by using both parametric and non-parametric approaches in the world. Among these, Tecles and Tabak (2010) studied the determinants of bank efficiency in Brazil by using stochastic frontier analysis. Okuda et al. (2003) estimate the cost efficiency of the Malaysian

commercial banks. Jemric and Vujcic (2002) measure bank efficiency in Croatia for the period 1995-2000. Fries and Taci (2005) studied the efficiency of banks across 15 East European countries. Ayadi (2013) studied the cost efficiency of Tunisian commercial banks.

In the case of Ethiopia, Muluneh (2006) employed a stochastic frontier analysis to examine the cost efficiency of six private banks using quarterly data covering the year 1994-2001. Bewketu (2011) investigates the effects of ownership on performance and efficiency of 14 commercial banks. Eskindir (2013) employed the stochastic frontier approach to examine the cost efficiency of 10 commercial banks during the period 2007-2012 to determine whether ownership has an impact on the cost efficiency of banks and found that private commercial banks are more cost efficient than the state owned banks.

However, most of the above previous studies limited their investigation only for cost efficiency and neglect the causes of cost efficiency; they cover a short period of time and compare efficiency of banks based on their ownership. Thus, this study attempts find out the determinants of commercial banking efficiency and fill the gap in the existing literature by including new variables and by covering a longer time period.

1.3. Objective of the Study

The main objective of the paper is to identify the determinants of commercial banks cost efficiency.

The specific objectives are:

- ❖ To identify factors which are associated with cost efficiency in commercial banking;
- ❖ To examine the parameters of cost efficiency frontier;
- ❖ Based on the results to come up with policy recommendation.

1.4. Scope and Limitation of the Study

There are different types of efficiency measures that can be used to identify the performance of commercial banks including cost efficiency, revenue efficiency, scale efficiency, profit efficiency, technical efficiency, and allocative efficiency. However, this study focuses only on the cost efficiency and factors affecting it because of time and financial problem. The study also does not include all commercial banks as a result of lack of data and shorter period of joining the banking industry.

1.5. Significance of the Study

The study provides valuable insights for the academic research, bank supervision, regulation, and management decisions by providing a tool to monitor and assess banking efficiency. It also fills the gap in the existing literature regarding the efficiency of commercial banks. Moreover it used as a reference for those who want to do their thesis on the banking area.

1.6. Organization of the Paper

The remaining chapters organized as follows: Chapter two contain reviews of related literature on the concept of efficiency, and factors affecting banks efficiency by assessing

theoretical and empirical literatures. Chapter three contains methodology. Chapter four discusses estimation results. Chapter five includes conclusion and policy recommendation that is observed and implied from the outcome of descriptive as well as empirical analysis.

CHAPTER TWO: LITERATURE REVIEW

2.1. Theoretical Literature

2.1.1. Concept of Efficiency

Efficiency is a relative term which shows the ratio of achieved results to the means used. It is the ability of individuals or organizations effort to produce the desired result with minimum use of efforts and expenses. Therefore, in most of the situations, efficiency is a relative concept and must involve comparisons. It is the way of producing maximum value of output with a given value of inputs; or equivalently, by using minimum value of inputs to produce a given value of output (Bhat, 2001). According to Cooper (2004) a firm is said to be efficient on the basis of available evidence if and only if the performance of other firms do not show improvement in inputs or outputs without worsening some of its other inputs or outputs.

According to Chen (2001) efficiency can be classified as scale efficiency, scope efficiency, technical efficiency, and allocative efficiency. A bank has the scale efficiency when it operates in the range of constant returns to scale. Scope efficiency occurs when a bank operates in different diversified locations. When a bank maximizes output from the given level of inputs technical efficiency occurs and when a bank chooses maximizing revenue, allocative efficiency occurs. Erkoç (2013) define efficiency as the ability of firms to produce output using a given level of inputs with minimum cost. This definition indicates that banks should allocate inputs and outputs properly with the aim of obtaining maximum result with minimum cost.

“Efficiency represents the degree of success in which producers achieve in allocating the available inputs and outputs they produce in order to achieve their goals” (Kumbhakar and Lovell, 2000). Hoyo et al. (2004) define efficiency as the relationship between what an organizations produces and what it could be feasibly produced under the assumption of full utilization of the available resources. Hughes and Mester (2001) define efficiency as the microeconomic concept which indicates the minimum inputs required to produce any given level of output. It is the measure of the difference between the desired performance and actual performance of firms. Generally, the above definitions relate the concept of efficiency as the relationship between inputs and outputs.

2.1.2. Cost Efficiency

A concept which can be used to measure financial institutions’ efficiency is a fundamental question to be addressed. With regards to banks, cost efficiency is the most commonly used concept in the literature of efficiency. The concept has the economic foundation for analyzing the efficiency of financial institutions because it is based on economic optimization in relation to market prices and competition, rather than being based solely on the use of technology (Berger and Mester, 2008).

The concept of cost efficiency is rooted in the neoclassical microeconomic theory, which focuses on resource allocation and utilization. It advocates non-wastage of resources by emphasizing cost reduction while producing the maximum possible level of output for a given technology and available inputs. Thus, a firm that is economically efficient may possess competitive advantage over other rival firms’ which produces less efficiently in the same industry. The main driving force behind cost efficiency is value creation.

Accordingly, in the process of transforming inputs into some output value, a change that increases value is an efficient change and one that decreases value is an inefficient change (Musonda, 2008).

Berger and Mester (2008) argue that while dealing with banking efficiency analyses, regulators, customers, managers, and stakeholders are concerned about the relative efficiency of banks. From the regulators perspective, inefficient banks are riskier and have a higher likelihood of failure. In addition, the efficiency of banks is directly linked to the productivity of the economy. Without a sound functioning of banking system, the economy cannot function well and efficiently. When banking system fails, the whole of a nation's payment system is in trouble. From the point of view of customers, only efficient banks can offer better services at reasonable prices. The stakeholders view is that only efficient banks can produce reasonable returns. The perspective of bank managers is that in a dynamic and competitive market environment, only efficient banks will survive and maintain their market share, and inefficient ones will exit from the market. The efficient banks are better able to compete because of their lower operational costs and can take away business from less efficient banks. In developing countries like Ethiopia, where propensity to consume is high and as a result savings of the people are low, banks play a significant role in attracting more deposits from the people and then distribute these saving as loans for various sectors of the economy (Rangarajan, 1997).

2.2. Empirical Literature

Over the past several years, a considerable research effort has been made to measure the efficiency of financial institutions, particularly commercial banks. The research has been

focused on estimating an efficient frontier and measuring the average differences between observed banks and banks on the frontier. Many studies found a significant difference in cost inefficiencies. However, there is no consensus on the sources of the differences in measured efficiency (Berger and Mester, 2008).

Berger and Mester (2008) find out the sources of efficiencies comes from the following three sources:(1) differences in the concept of efficiency used; (2) differences in measurement methods used to estimate efficiency within the context of these concepts; and (3) correlates of efficiency such as bank specific, macroeconomic, and regulatory characteristics which may explain some of the efficiency differences after controlling for efficiency concept and measurement method.

This section reviews the empirical literature on banking efficiency studies. Over the past several years, considerable research efforts have gone into measuring the efficiency of commercial banks by using both parametric and non-parametric frontier efficiency measurement techniques such as stochastic frontier analysis (SFA), data envelopment analysis (DEA), thick frontier analysis (TFA), etc.

Bhattacharyya et al. (1997) use stochastic frontier analysis to examine the efficiency patterns across ownership groups and through time for Turkish commercial banks. The findings of the study showed that foreign owned banks improved their efficiency over time whereas the opposite happens for the public sector banks. According to this study, the efficiency declines for foreign owned banks at the beginning of the period as a result of the adverse effect of capital adequacy requirement. However, the efficiency increases

at the end due to the increase in the number of branches and significant temporal effects. Jemric and Vujcic (2002) used DEA model and adopted the intermediation approach to measure bank efficiency in Croatia for the period 1995-2000. They use fixed assets, technology, number of employees (labor) and total deposits collected as inputs, and total loans extended and short term securities issued by official sectors were used as outputs. They found evidence that the relationship between bank size and efficiency is U-shaped.

Girardone et al. (2004) used SFA to estimate the efficiency scores and their determinants for Italian banks over the period 1993-1996. The result found that there is a positive relationship between efficiency and capital and a negative relationship of efficiency with non-performing loans. In addition, the study showed that there is no significant relationship between the size of banks and efficiency. Pasiouras (2008) used a DEA method to estimate efficiency scores of Greek commercial banks during the period 2000-2004. The result indicates that the inclusion of provisions on loans as input increases the efficiency score. In addition, banks which extended their activities abroad seem to be more technically efficient than those which are doing their business only at a national level.

Havrylchyk (2006) studied the cost efficiency of the polish domestic and foreign banking industry during the period 1997-2001 using DEA and an intermediation approach. The author includes labor, capital, and deposits as inputs while the outputs include loans and government bonds. In order to identify the determinants of efficiency the author used the second stage of tobit approach. The result shows that neither size nor capitalization is related to the efficiency but the ratio of total loans to total assets shows a significant

negative sign suggesting that banks that took more risks were less efficient. Pancurova and Lyocsa (2013) estimate the cost efficiency and their determinants for a sample of 11 central and Eastern European countries over the 2005-2008 periods by using data envelopment analysis. They found evidence that the size and financial capitalization of banks are positively associated with cost efficiency but the loans to asset ratio was negatively associated with cost efficiency.

Rouissi (2011) examine the cost and profit efficiency level of French commercial banks by classifying them as domestic and foreign by use of SFA over the period 2000 to 2007. The result indicates that foreign banks exhibit higher cost and profit efficiency than domestic banks. Garcia (2010) apply data envelopment analysis methodology to obtain efficiency estimates and a tobit regression model to determine the major factors that affect efficiency of Mexican banks over the period 2001 to 2009. He found the result that the Mexican banking sector experienced an average efficiency score of 85% and the major determinants of efficiency are loan intensity, GDP growth, and foreign ownership. On the other hand non-interest expenses, non performing loans and inflation rate reduce banking efficiency.

The study of Jackson and Fothi (1998) evaluates the technical efficiency of Turkish commercial banks using the non-parametric frontier methodology of data envelopment analysis (DEA) and investigate the determinants of efficiency by using the tobit model. They found that larger and profitable banks are more likely to operate at a higher level of technical efficiency. On the other hand capital adequacy ratio has a statistically

significant adverse impact on the efficiency of commercial banks, which may reflect the risk return tradeoff in the sector.

Tahir, Mazlina and Haron (2010) uses SFA to examine the cost efficiency levels of domestic and foreign commercial banks in Malaysia for the year 2000 to 2006 .The result indicates that domestic banks are found to be more cost efficient than foreign banks. On the other hand, Shen (2008) used stochastic frontier analysis to study the cost efficiency and their determinants for a sample of ten Asian countries during the period 2000 to 2006. The result shows that banking concentration may have a positive or negative impact on efficiency. Net interest margin and average capital ratio have a positive effect on efficiency.

The study of Rozzani and Rahman (2013) explores the area of bank efficiency and its determinants for conventional and Islamic banks in Malaysia with the usage of Stochastic Frontier Analysis. The study covers the period 2008-2011 for a sample of 19 conventional banks and 16 Islamic banks that operate in Malaysia. The result indicates that the levels of efficiency for both conventional and Islamic banks in Malaysia were highly similar. Further, it could be observed that efficiency would be better for conventional banks with the increment of bank size and also the decrement of both operational cost and credit risk, while the efficiency for Islamic banks would be better with only the decrement of operational cost.

Inui, Park, and Shin (2008) investigate the productivity of Japanese and South Korean banks using SFA. They also use the intermediation and value added approach in order to

identify inputs and outputs. In both approaches the study found that Japanese banks are efficient and productive than South Korean banks. Altunbas et al. (2000) estimate the technical efficiency of Japanese commercial banks over the period 1993-1996. They specified total loans, and total securities as outputs and three inputs (price of labor, price of total deposits, and price of physical capital). The study extended the existing literature to evaluate the impact of risk and asset quality on cost efficiency and shows that scale economies will tend to be overstated if these factors are not taken into account. Hao et al. (2001) examined the productive efficiency of 19 Korean private banks over the 1985-1995 periods. They employed the intermediation approach and estimated their costs using the stochastic frontier function. They specified total loans, securities, deposits, and fee income as outputs and personnel expenses, interest for borrowed funds and price of physical capital as inputs. Their results show that banks with higher rates of asset growth, fewer employees per million Won of assets, larger amounts of deposits and lower expense ratios were more efficient. They also found that the financial deregulation measures of 1991 had little or no significant effect on the level of bank efficiency.

Sufian (2009) used DEA method to estimate the efficiency of the Malaysian banking sector during the Asian banking crisis in 1997 and found a significant and negative relationship between bank deposits and levels of efficiency which implies that banks which have large amount of deposits tends to be less efficient. In addition banks which have higher ratios of loan to assets have higher efficiency scores. This positive relationship can be explained by the efficient market hypothesis that the most efficient

banks can achieve lower production costs enabling them to offer reasonable credit and gain market share from large inefficient banks.

Manlagnit and Chelo (2011) examined the cost efficiency of Philippine commercial banks using the SFA method to determine the efficiency scores found that risk and asset quality negatively affect the efficiency of banks. This substantial increase in cost inefficiency could be attributed to the adverse effects of the Asian crisis of 1997, the cost of banking reform and regulatory changes that have been adopted to stabilize and strengthen the sector. Tecles and Tabak (2010) studied the determinants of bank efficiency in Brazil by using SFA during the period 2000-2007 and found that large banks are the most cost efficient. In addition there is a positive relationship between the degree of capitalization and bank efficiency.

Regarding African studies, Kablan (2010) uses SFA to assess the determinants of banking system efficiency and financial development in Sub Saharan Africa over the period 2007 to 2009. Sub Saharan African banks found to be generally cost efficient, however non-performing loans undermine efficiency. The result shows that in order to improve efficiency there should be an improvement in the regulatory and credit environment. In addition the political and economic environments have a negative impact on the financial development in SSA. Raphael (2013) employs DEA to estimate the relative efficiency of 58 selected commercial banks operating in the East African community from 2008 to 2011. The result shows that most commercial banks in East Africa are operating under decreasing returns to scale. Therefore, inefficient utilization of

input resources could be one of the reasons for the inefficiency of commercial banks in East Africa.

Ncube (2009) employs SFA to determine the cost and profit efficiency of South African banks during the period 2000 to 2005. The result of the study shows that South African banks have significantly improved their cost efficiency over the period of the study. Abaoub and Nouali (2015) studied the cost efficiency of Tunisian banking system using SFA during the period 1997 to 2012. The result shows that banks which have a high population density, high ratio of intermediation, high return on assets and equities ratio found to be more efficient. However, cost efficiency of Tunisian banks negatively affected by a high capital assets ratio, a greater concentration, and a wide density of deposits request as well as per capita income. Ayadi (2013) studied the cost efficiency of Tunisian commercial banks by using DEA for the period 1996-2010. The result suggested that market share in terms of deposit negatively affect cost efficiency of the sector and engagement in risky activities especially in the field of credit and a high bank capitalization positively influences the cost efficiency of commercial banks. In addition, state owned banks are more efficient than their private counterparts.

Kiyota (2009) provides a comparative analysis of cost and profit efficiency of commercial banks operating in 29 Sub Saharan African countries during the period 2000 to 2007. The study uses SFA in the first step and tobit model for the second step analysis and provides cross country evidence on the impact of environmental factors on efficiency. The result shows that medium and larger banks are the most cost efficient than others. Hussein (2003) provides analysis of the characteristics of cost efficiency of

Islamic banks in Sudan between 1990 and 2000. Using the stochastic approach, the author estimates the cost frontier for a sample of 17 commercial banks. The results show large variations in the efficiency of Sudanese Islamic banks. In addition, the analysis extended in order to examine the determinants of bank efficiency and found that smaller banks are more efficient than their larger counterparts. He found a positive relationship between the ratio of capital adequacy and cost efficiency. Therefore Sudanese banks should implement serious policy instruments for the development of human capital in order to reduce cost inefficiency.

On the other hand, Kirkpatrick et al. (2007) will examine the efficiency of Anglophone African banks after the period of banking crisis (1992-1999). They use the stochastic cost frontier function, then as a second step they explained these cost efficiencies found by bank specific factors and relevant macroeconomic variables. They found that cost inefficiency is increased by the presence of nonperforming loan ratios and financial liberalization.

In Ethiopia, Muluneh (2006) employed the SFA to examine the determinants of cost efficiency for six private banks by using quarterly data over the period 1994-2001. The result shows that size of banks is negatively related with efficiency while capital is found to be positively affecting efficiency of banks. The study does not include public banks and restricted the study only to private banks. Eskindir (2013) uses the stochastic frontier analysis to investigate the cost efficiency of commercial banks based on their ownership during the period 2007-2012. The result shows private commercial banks are more cost efficient than state owned bank.

CHAPTER THREE: METHODOLOGY

This chapter discusses the major issues in the banking efficiency measurement analysis. The first issue is the selection and specification of inputs, inputs prices, and outputs variables. The second issue is on the choice of appropriate measurement techniques for cost efficiency analysis. Concerning the first issue, there are different approaches which are used by different researchers. However, the intermediation and production approaches are the most widely used in the literature to model the efficiency of banking firms. On the second issue, efficiency results can differ due to measurement techniques, and there is no general agreement on the preferred estimation methodology of banking efficiency analysis.

3.1. Specification of Inputs and Outputs

Before modeling the cost frontier function for the banking firms it is important to specify and identify input, input price, and output variables in the banking efficiency analysis. However, there is no general agreement in the literature on the identification of inputs and outputs since banks provide services rather than readily identifiable physical products which are produced in the other sectors of the economy like agriculture. In spite of the difficulties researchers find out different ways of identifying inputs and output variables (Berger and Mester, 2008).

Among many researchers Shen (2008) identified the following four approaches which are used for the identification and selection of input and output variables. These are the intermediation approach, production approach; value added approach, and dual approach.

The intermediation approach recognizes the banks unique characteristics as financial intermediaries which collect deposits and transfer it in the form of loans and other earning assets. According to the intermediation approach, banks produce intermediation services through the collection of deposits and other liabilities and their function in interest earning assets, such as loans, securities and other investments. In this approach, banks incur both operating and interest expenses as costs in order to produce revenue generating services (loans and other investments) as outputs (Hughes and Mester, 2008).

On the other hand, the production approach takes a different view to define the bank activity as the production of services. In this approach, physical quantities of labor and capital are used as inputs to produce physical quantities or number of processed loan and deposit accounts. Thus, the outputs represents the services provided to customers and are measured by the number of accounts serviced or transactions processed. However, in case of non availability of detailed transaction flow data, they are replaced by the data on the value of deposits and loan accounts as a measure for the services provided. Thus deposits and loans are counted as outputs. The inputs include labor, capital and their respective costs. However, this approach does not include interest expenses in the total costs, which constitutes a major portion of total costs in commercial banks Shen (2008). The value added approach identifies any balance sheet item (asset or liability) as output if it absorbs a relevant share of capital and labor, otherwise it is considered as input or non relevant output. In this case deposits and loans are considered as an output because they constitute a considerable share of capital and labor.

Since none of the above approaches take into account the dual roles of banks as providing transaction services and being financial intermediaries that transfer funds from savers to investors, Shen (2008) used another approach called the dual approach. This approach attempts to capture the dual roles of banks as providing transaction services and financial intermediaries' by taking into account the role of deposits as both input and output variables. According to this approach deposits have the input characteristics since they are used by banks as the raw materials for making loans and have the output characteristics because they are related with a significant amount of liquidity and payment services provided to depositors. This approach is justified by the fact that the banks role is that by using labor and capital to collect deposits, and transfer these deposits into loans. Thus this approach takes banks deposits as both input and output.

Generally, there is no common agreement among researchers on the identification of inputs and outputs vectors in banking efficiency studies. Therefore this issue is an ongoing debate. Out of the above measures, the intermediation approach has been commonly used in the conventional banking cost efficiency literature (Shanmuganand Das, 2004). In addition, Elyasiani and Mehdiian (1990) gave the following advantages of using the intermediation approach over others. First, by taking into account deposits as inputs, the intermediation approach allows accounting for interest expenses as input price which constitute the major portion of total costs in the banking industry. Second, it properly identifies deposits as inputs, and it has also an edge over other definitions for data quality considerations.

Thus, concerning the definition of inputs, outputs and their respective price specification, this study adopts the intermediation approach. According to this approach, the bank's total cost (C) is approximated by the sum of personnel expenses (which includes wages and salaries), interest expenses, and other operating expenses derived from the banks annually consolidated income statement and NBE. The three inputs used are labor, capital, and deposits with the corresponding prices defined as below. The first is price of labor (W_1) which is measured by the ratio of personnel expenses to number of employees. The second variable is price of capital (W_2) which is measured by the ratio of other operating expenses to fixed assets. The third one is the price of deposits (W_3) which is calculated by the ratio of interest expenses to total deposits. The outputs are specified as total loans (Y_1) which includes short term loans, medium term loans, long term loans, and other loans, excludes the loan loss reserves; other earning assets (Y_2) such as short and long term investments, deposits with national bank and other banks, non interest income which comes from net fee and commission and other operating income (Abaoub and Nouali, 2015; Vennet, 2000).

Table 3.1: Variables used in the estimation of cost function

| Variable | Variable Name | Definition |
|----------------------------|------------------------|---|
| C | Total Costs | Personnel Expenses + Interest Expenses + Operating expenses |
| Outputs | | |
| Y ₁ | Loan Advances | Loan distributed to different entities |
| Y ₂ | Other Earning Assets | Investment and Other assets |
| Inputs Prices | | |
| W ₁ | Price of Labor | Personnel Expenses/Number of Employees |
| W ₂ | Price of Capital | Operating Expenses/Fixed Assets |
| W ₃ | Price of Deposits | Interest Expenses/Total Deposits |
| Determinants of Efficiency | | |
| LnTA | Bank Size | Natural logarithm of total assets |
| CAR | Capital adequacy ratio | Capital/ total assets |
| IR | Intermediation ratio | Total loans/total deposits |
| ROA | Return on assets | Gross profit/ total assets |
| ROE | Return on equity | Gross profit / equity |

Source: National Bank of Ethiopia

3.2. Choice of Estimation Methodology

There are different measurement methodologies which generate from different concepts of efficiency. Thus, it is important to choose the appropriate measurement method in relation to the availability of data. The method chosen should be related to economic optimization in relation to market prices and competition rather than on the use of technology.

In the literature of banking efficiency studies, there are two commonly used measurement methods. The first one is the accounting approach of efficiency measurement, which measures efficiency of banks by using accounting methods of comparing financial ratios related to costs. In this approach cost efficiency in the banking industry is measured by using a cost to income ratio (Isik and Hassan, 2000). Although this method is widely used to measure efficiency, it has certain limitations. According to Yeh (1996) it is difficult to establish a suitable standard which gives meaningful results. Secondly, efficiency is calculated by using only a subset of data which is available to a firm. The problem with this measure is that a bank may perform well when using one measure but poorly when using another measure. The method also does not take into account differences in exogenous price of inputs and outputs faced by different financial firms (for example, because of differences in market share and or differences in location). In addition, even though the traditional methods of estimation techniques consider a random error, they estimate an average function and not a border function. Thus, they are incapable of decomposing the gap between the estimated function and the observations in terms of inefficiencies and random error (Orea and Kumbhakar, 2006). Therefore, there is a need

for a more flexible way of analyzing the differences in efficiency across banks financial position. This would be a method which incorporates the majority of bank's inputs and outputs available within the firm and frontier efficiency methodologies attempts to do this.

Frontier efficiency methodologies summarize bank performance in a single statistics that controls for a difference among banks in a multi-dimensional framework which has its roots in economic theory. The development of frontier efficiency methodologies makes conventional methods of the accounting approach less important. They measure firm efficiency relative to the best practice frontiers consisting of other firms in the industry. These methods dominate the traditional techniques in terms of giving more meaningful and reliable results of firm performance (Hughes and Mester, 2008).

Generally, Fare et al. (1994) puts forward the following advantages of frontier efficiency methods over the traditional conventional ratio analysis. They are useful for testing economic hypothesis. For example, both agency theory and transaction cost economies make prediction about the likely success of firms with different characteristics such as organizational form, distribution systems, economies of scale and scope, corporate governance and vertical integration in attaining objectives of cost minimization or profit maximization under various economic conditions. The second important use of frontier methodologies is to give direction to regulators and policy makers about the appropriate response to problems and developments in an industry in particular and the economy in general. They are also useful to compare cross country economic performance. For example, Fare et al. (1994) compare the productivity of banking in industrialized nations.

Another application of frontier methodologies is to inform the management about the effects of policies, strategies, and technologies adopted by firms. Although firms employ a variety of benchmarking techniques, frontier efficiency methodologies can provide more meaningful information than conventional ratio analysis, which often makes the results with lots of statistics which are difficult to summarize easily in terms of one or a few performance measures. Furthermore, they can also be used to compare the performance of departments, divisions, or branches within the firm. Thus due to these features of frontier efficiency methodologies, the conventional ratio analysis is becoming obsolete (Berger and Mester, 1997).

Frontier techniques involves various models for choosing an appropriate measurement techniques for a sample of banks and also determine how closely individual banks put relative to this standard. The best practices usually in the form of an efficient frontier which is estimated using econometric or mathematical programming techniques. The most common frontier efficiency estimation techniques are data envelopment analysis (DEA), the free disposable hull (FDH), the stochastic frontier approach (SFA), the thick frontier approach (TFA) and the distribution free approach (DFA). The first two of these are nonparametric techniques, and the latter three are parametric methods (Maudos et al., 2002).

The distribution free approach (DFA) assumes a functional form for the cost frontier, but separates the inefficiency term from random error in a different way with that of the stochastic frontier approach. It assumes that inefficiencies are stable over time and random errors are assumed to be zero over time and thus requires little assumptions about

the distributional form for the inefficiency term and random error. Then the estimation of the inefficiency of each bank is measured as the difference between its average residual from the estimated cost function and that of the bank on the cost efficiency frontier. On the other hand, the thick frontier approach (TFA) does not make any distributional assumption for the random error, but assumes that inefficiencies vary between the highest and lowest quartile firms. In this approach a relatively large subset of firms are used to define the frontier (Berger and Mester, 1997).

On the other hand, the non-parametric approaches when compared with the parametric approaches put significantly less formulation in the specification of the frontier. The non-parametric methods generally do not take into account prices and can, therefore, account only for technical inefficiency in using too many inputs or producing too few outputs. They cannot compare firms which tend to specialize in different inputs or outputs, because there is no way to compare one input or output with another without including relative prices. Thus, the nonparametric techniques typically focus on technological optimization rather than economic optimization, and do not correspond well with the cost efficiency concepts. Another drawback of the non-parametric techniques is that they usually do not allow for random error in the data, assuming away measurement error and luck as factors affecting outcomes. As a result, they separate inefficiency differences from random error by assuming that random error is zero (Bauer, 2008).

Among the non-parametric frontier efficiency methods data envelopment analysis (DEA) is the most commonly used method. It imposes no formation on the cost function, so that the frontier is determined by the data in the sample and does not allow for random error.

In other words, it assumes that there is no measurement error, no inaccuracies associated with accounting data and no luck or chance that may temporarily affects a bank better measurement performance (Berger and Humphrey, 1997). If any of these errors are present in the dataset, then that may be reflected as a component of the measured inefficiency.

Although both parametric and non parametric techniques have been used for measuring efficiency in the banking industry, so far there is no preferred efficiency frontier technique has been emerged. Because both parametric and non-parametric frontier approaches have their own advantages and disadvantages, which makes the choice of appropriate efficiency measurement methods in a particular application difficult (Cummins, 1998; Hussels, 2006).

Generally, the parametric approaches have the advantage of using strong assumptions concerning the form of the efficient frontier and therefore involve a certain economic behavior. In addition, it allows for tests of economic hypothesis concerning the goodness of fit of the model. However, the requirements in the specification of a particular frontier function such as Cobb-Douglas or translog taken as a disadvantage, which may be restrictive in most cases. On the other hand, the non-parametric approaches do not require the specification of a particular functional form for the frontier. In addition, the methods do not take into account a random error and therefore runs the possibility of mistaking measurement error and inefficiency. It is also impossible to estimate parameters for the model, and hence impossible to test hypothesis concerning the performance of the model. In addition, the methods ignore prices and therefore typically focus on technological

rather than economic optimization (Berger and Mester, 1997). Therefore, they are not appropriate for comparing firms specializing in a multiproduct industry.

Despite the differences in the preferred efficiency methodology, an emerging view suggests that it is not necessary to have a consensus as to one single best frontier approach for measuring bank efficiency (Iqbal and Molyneux, 2005). Instead, there should be a set of consistency conditions to be met for the efficiency measures derived from various approaches. If efficiency estimates are consistent across different methodologies then these measures will be convincing, and therefore, valid or believable estimates (Bauer et al., 1998). According to Bauer et al. (1998), a method is considered as consistent if (i) its distribution is comparable to other commonly used methods, (ii) produces approximately the same ranking of institutions when compared with other measurement techniques, (iii) predominantly identifies the same best and worst banks, (iv) efficiency scores should be consistent with 'competitive market conditions, (v) measured efficiencies should be consistent with the existing measures of performance, and (vi) mostly produces the same relative ranking of banks over time. In sum, the results of efficiency estimates obtained from different approaches should be consistent by generating related efficiency levels and rankings concerning the identification of efficient and inefficient banks. In light of the above stated consistency conditions, methodological cross checking is highly recommended for a banking efficiency analysis.

3.2.1. Specification of the Stochastic Cost Frontier Model

Against the above background, there is no loss of generality in using either methodology to analyze efficiency in banking. The choice of the approach adopted is a matter of

convenience and is largely influenced by the data used in the analysis and ease of application. Consequently, this study chooses to use the stochastic frontier approach.

According to (Battese and Coelli, 1995) stochastic frontier approach estimates a border function by taking into account the distributional assumptions for both components of random error and inefficiencies. According to the theoretical foundations of efficiency, the border of efficiency represents all the most efficient points; the distance of every observation relative to this border represents its degree of inefficiency. However, the empirical observations can deviate from the border for two reasons: on one hand, the existence of measurement error in any observed variable and the presence of exogenous shocks which can be favorable or unfavorable) on the other hand. The random component follows a normal symmetric distribution, whereas the inefficiency term follows an asymmetric distribution, defined positively for a cost function.

The stochastic frontier approach assumes that bank inefficiency components have a truncated normal distribution which is independently and identically distributed across different banks, an assumption which is violated in the second step of the estimation procedure. This procedure permits cost efficiencies and their determinants to be estimated using a one-step maximum likelihood estimates (MLE) procedure (Fries and Taci, 2004). They put forward the following reasons for choosing cost efficiency of banks as an indication of efficiency measure. First, greater relative cost efficiency may be associated with structural and institutional reforms and with the more efficient provision of public services by the state, such as the rule of law. Second, efficiency gains reduce the resources associated with operation of payment systems and with intermediation of

savings into investments. For example, like productivity gains in other economic sectors, greater cost efficiency in banking contributes directly to overall economic development. Third, cost efficiency may be associated with other dimensions of bank performance which contribute to overall development, such as the making of more productive loans, but which cannot be directly measured with available bank level data. This association may exist if factors that contribute to greater cost efficiency also promote improvement in other aspects of banking performance.

According to (Berger and Mester; Shen and Jones, 2008) cost efficiency provides a measure of how close a bank's actual cost is to what a best practice institution's cost would be for producing the same output bundles under the same conditions. The measure is derived from a cost function in which total cost depends on the prices of inputs (W), the output quantities (Y), bank specific variables (Z) and an error term (ϵ). Thus the general form for the stochastic cost frontier function specified as follows:

$$C_{it} = f(W_{it}, Y_{it}, Z_{it}; \beta) + \epsilon_{it} \dots \dots \dots (1)$$

Where C measures total cost, W is a vector of input prices, Y is a vector of output quantities, Z is bank efficiency determinants, β 's are parameters to be estimated, ϵ_{it} is treated as a composite error term which is given by $\epsilon_{it} = \mu_{it} + v_{it}$, v_{it} represent the random error term which follows a normal symmetric distribution around the border, $N(0, \sigma_v^2)$ incorporates measurement error and luck that may results in high or low costs for banks. The other component, μ_{it} , captures the inefficiency term which follows a truncated normal asymmetric distribution or a half-normal distribution. Furthermore, μ_{it} and v_{it} are

independently and identically distributed. The inefficiency component, (μ_{it}) is assumed to be a function of a set of bank specific variables (Z_{it}) that may affect performance, a vector of coefficients to be estimated (δ) and random error (W_{it}).

$$\mu_{it} = Z_{it} \delta + W_{it} \dots \dots \dots (2)$$

Where, the random variable W_{it} has a half normal distribution with zero mean and variance μ^2 . To simplify the measurement of efficiency, a functional form has to be chosen given the multiplicity of bank functions. Thus to estimate the cost frontier function, the translogarithmic functional form is seems to be best adapted compared to other functional forms because it takes into account the various complementarities between explanatory variables and it does not impose any restriction on the functional form. Moreover, panel data is used because observing banks at several points in time allows for possibly better estimates. For instance, assumptions relating to the stochastic frontier analysis can be relaxed, allowing for more flexibility in the handling of the model. Consequently, according to Kumbhakar and Lovell (2000) the estimation of banks relative efficiency using panel data is obtained by estimating a translog cost function of the general form as follows:

$$\ln C_{it} = \ln C_{it}(Y_{it}, W_{it}, Z_{it}; \delta) + \mu_{it} \dots \dots \dots (3)$$

Where $\mu_{it} = v_{it} + \mu_{it}$ for every bank $i = 1, \dots, N$; C_{it} is total cost of bank i , Y_{it} is outputs' vector of bank i , W_{it} is inputs' vector of bank i , Z_{it} is bank specific variables, δ is vectors of parameters to be estimated, μ_{it} is the measure of inefficiency of bank i and is

determined by a set of bank specific variables. Staikouras and Schmiedel (2007) estimate the specific cost efficiency frontier using the specification of translog as follows:

$$\ln C_{it} = \alpha_0 + \sum_j \alpha_j \ln W_{jit} + \sum_k \beta_k \ln Y_{kit} + 0.5 \sum_h \sum_j \alpha_{hj} \ln W_{hit} \ln W_{jit} + 0.5 \sum_k \sum_l \alpha_{kl} \ln Y_{kit} \ln Y_{lit} + \sum_h \sum_k \delta_{hk} \ln W_{hit} \ln Y_{kit} + \sum_m \gamma_m \ln Z_{mit} + v_{it} + \mu_{it} \dots \dots \dots (4)$$

Where $i = (1, \dots, 12)$ refers to number of banks, $t =$ years of study (2000-2013), h and $j = (1, \dots, 3)$ are parameters of input prices, k and $l = (1, 2)$ are outputs, m refers to number of bank specific variables; α , β , and γ are parameters to be estimated. To decrease the number of parameters and consequently, to win in terms of degrees of freedom, the following limitations must be imposed:

$$\alpha_{hj} = \alpha_{jh} \text{ and } \alpha_{kl} = \alpha_{lk} \dots \dots \dots \text{ (Symmetry constraints)}$$

Furthermore, any function of cost must be homogeneous of degree 1 in input prices. So, a proportional increase in input prices increases the total cost in the same proportion without affecting the factors request. The linear homogeneity conditions were imposed during the estimation by normalizing the cost and inputs prices by the input price of capital. This condition of homogeneity is translated by the following limitations:

$$\sum_j \alpha_j = 1; \sum_j \alpha_{hj} = 0; \sum_j \delta_{hk} = 0 \dots \dots \dots \text{ (Homogeneity constraints)}$$

These constraints of symmetry and homogeneity reduce significantly the number of parameters to be estimated.

3.3. Determinants of Efficiency

Different factors may explain efficiency levels in a financial industry. Some of the factors may be inherent in the internal organizational structure of the bank, including managerial expertise, experience of workers and skill levels. Internal sources of (in) efficiency typically include carelessness, human mistakes, disruption of production technology or insufficient capacity to respond to changing incentives. Other factors may be external to the firm. These factors may include luck, regulatory constraints, macroeconomic shocks, real business cycles, labor disputes, and structure of the market in which the firm is operating. Taken together, these factors may account for a substantial amount of variability and differences across firms performance levels. Internal factors are firm specific and therefore within the control of the firm, external factors are outside the control of the firm (Musoda, 2008).

Therefore, the inclusion of efficiency correlates in the stochastic frontier analysis is an important issue in the efficiency estimation. These variables are supposed to affect the distribution of inefficiency, which are usually neither the inputs nor the outputs of the production process. However, they affect the productivity performance of firms and these variables have been incorporated in a variety of ways: i) they may shift the frontier function and/or the inefficiency distribution; ii) they may scale the frontier function and/or the inefficiency distribution; iii) they may shift and scale the frontier function and/or the inefficiency distribution (Belotti, Gillardi and Atella, 2012).

According to Pancurova and Lyocsa (2013), there are many variables which affect the efficiency of commercial banks. Thus to examine the determinants of bank efficiency

this study chooses the following explanatory variables. This includes size of the bank which is measured by the natural logarithm of total assets (lnTA), return on assets (ROA) which is measured by the ratio of gross profit to total assets to measure bank profitability, return on equity (ROE) which is measured by the ratio of profit to equity, capital adequacy ratio (CAR) which is the ratio of capital to total assets to measure capitalization and intermediation ratio (IR) which indicates the bank's ability to convert deposits into loans and measured as the ratio of deposits to loans. These variables are explained as follows.

a) Bank Size (lnTA): in order to account for the size of each bank and its possible effects on efficiency, this study uses the natural logarithm of total assets as a proxy variable. According to the theory of conventional economic efficiency, it was argued that size promotes efficiency by reducing possible costs of gathering and processing information (Bashir, 1999; Said, 2012). Large banks are capable of mobilizing more funds in generating high returns for its depositors and equity holders due to its diversification, which is achieved from having more resources. By these resources, larger banks are able to finance large numbers of profitable investment opportunities and acquire better access to investment activities. Based on the conventional economics efficiency theory and findings of previous researchers (such as Rozzani and Rahman, 2013) it is hypothesized that larger banks would acquire better efficiency, since these banks would have more resources to be allocated for better services to its customers). This brings the formulation of the hypothesis that there is a significant positive relationship between the size of banks and efficiency.

Moreover, Scale economies and economies of scope provide another perspective for analyzing firm size. Economies of scale occur when more units of a good or service can be produced on a larger scale, yet with less input costs. Therefore, economies of scale are associated with size of the firm, implying that larger firms enjoy economies of scale due to larger production technology. In contrast, economies of scope relate to a reduction in costs resulting from joint production. Thus, a firm which decreases its average costs because of changes in production of different products (related or unrelated) is said to be enjoying economies of scope. Economies of scope also provide firms with means to generate operational efficiencies, especially when these are driven by diversification. In the case of banking, for instance, it may be economical for a bank to diversify into different areas of financial services such as investment banking, commercial banking, leasing, and life insurance rather than pursue traditional commercial banking alone. Such a strategy may be driven by synergies of knowledge of commercial banking and investment banking of particular corporate customers. For larger banks, diversification may be an important business strategy aimed at reducing portfolio risk and hence gain efficiency.

Although scale economies may be important, bigger may not necessarily be better in the sense that when firms expand in size, the chain of command also becomes complex. Therefore decisions taken at the top may take longer and information distorted by the time it reaches the bottom ladder of the firm. When this happens, the firm may not be realizing cost reductions as predicted by the theory. Accordingly, diseconomies of scale may set in. Thus, smaller firms may be more efficient than larger firms in this regard. A

similar interpretation may be offered for economies of scope. While economies of scope often provide an incentive to expand product lines, the creation of new products may be less efficient than expected, resulting in diseconomies of scope. This is because the introduction of new product brands may require additional managerial expertise or personnel, higher raw material costs, a reduction in competitive focus, and the need for additional facilities, which collectively could result in an increase of a firm's per unit costs. Therefore, economies of scope may not be obvious. For the banking example above, managers may find it challenging to manage insurance business while also trying to provide commercial banking services to a wide range of customers. For this reason the predicted synergies may actually lead to huge cost increases (Musoda, 2008). Therefore, the effect of bank size in efficiency is ambiguous (it may be positive or negative).

b) Capital Adequacy Ratio (CAR): is measured as the ratio of bank's capital over total assets. It indicates the coverage of banks assets by owners' funds which is used to measure bank's financial strength and stability. The effect of this on efficiency is however unclear. On one hand, expansion in bank capital may be efficiency enhancing since capital serves as an alternative source of funding. On the other hand strengthening bank capital may not always translate into higher efficiency performance and could end in wasteful investment in some cases. To this end, the effect of bank regulatory capital on efficiency may be ambiguous. Nonetheless, the general consensus is that tighter regulations could suppress banking efficiency performance (Turati, 2003).

c) Intermediation Ratio (IR): indicates the ability of banks to convert deposits into loans. It reflects the differences among the banking firms in terms of the extent to which

they convert deposits into loans. The flow of deposits into the banking sector determines the amount of loans granted. Furthermore, banks which rely more on deposits to finance assets face a higher funding risk than those that hold a relatively higher proportion of equity capital. This variable is measured as the proportion of total deposits to gross loans and is expected to yield a positive sign implying that greater dependence on interest bearing deposits relative to total loans leads to increasing bank expenses and results in cost inefficiency. This may be associated with bank holdings of government securities and crowding out effect of private borrowing by the public sector or inadequate institutions to support lending to the private sector such as the absence of effective secured transaction and bankruptcy laws (Musoda, 2008).

d) Return on Equity (ROE): It is the ratio of profit to equity capital and provides a useful measure of the profitability of equity investment in banking. One can expect more efficient banks to earn higher profits, which should lead to a positive relationship between ROE and efficiency.

e) Return on Asset (ROA): indicates the profit earned per birr of assets. It reflects the management's ability to utilize the banks financial and real investment resources to generate profit. It depends on the banks policy decisions as well as on uncontrollable factors relating to the economy and government regulations.

3.4. Sample and Data

This study uses unbalanced panel data of 12 commercial banks in Ethiopia for the period 2000-2013. (See Appendix A for the name of commercial banks which are included in

the study). The sources of data is obtained from the annual report of National Bank of Ethiopia (NBE) and the published balance sheet and income statements as reported in annual reports for each respective banks. The report of National Bank of Ethiopia (2013) indicates that there are 3 public and 16 private commercial banks operating in the country making a total of 19 commercial banks in the country. Among these, 2 public and 10 private commercial banks (a total of 12 commercial banks) are included in the study period 2000-2013. Because the data on the development bank of Ethiopia is not fully reported and other private banks are too young to have organized data on the required variables for the study period.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Descriptive Statistics

As mentioned in chapter three, three input prices, two output variables, and five efficiency correlated variables are used to determine the efficiency level of commercial banks included in the study. The identification and selection of inputs and outputs variables is based on the intermediation approach which is briefly explained in chapter three. Accordingly the input price measurement lies on the following three variables. The first is price of labor (W_1) which is calculated by the ratio of personnel expenses to number of employees. The second variable is price of capital (W_2) which is measured by the ratio of other operating expenses to fixed assets. The third one is the price of deposits (W_3) which is calculated by the ratio of interest expenses to total deposits. Expenditures on these inputs consist of the majority of all banking costs. The outputs (Y), are specified as total loans (Y_1) which includes short term loans, medium term loans, long term loans, and other loans, excludes the loan loss reserves; other earning assets (Y_2) such as short and long term investments, deposits with national bank and other banks, non interest income which comes from net fee and commission and other operating income.

Thus table 4.1 summarizes averages, standard deviations, as well as the minimum and maximum values of basic and bank specific variables of commercial banks held within the sample. These descriptive values of the inputs, outputs, the dependent variables, and the environmental variables show differences and variations between the various banks.

Table 4.1: Descriptive statistics of the variables used in the estimation of cost efficiency

| Variable Name | Mean | Std. Dev | Min | Max |
|-----------------------------------|----------|----------|---------|----------|
| Total Cost (in million Birr) | 481.1844 | 643.9877 | 7.72 | 5163 |
| Input Prices | | | | |
| Price of labor (W_1) | 0.0760 | 0.0565 | 0.0157 | 0.2592 |
| Price of capital (W_2) | 2.3417 | 3.0756 | 0.3568 | 27.5 |
| Price of deposit (W_3) | 0.1094 | 0.6781 | 0.0010 | 7.9889 |
| Outputs(in millions' Birr) | | | | |
| Loans(Y_1) | 4079.959 | 8940.923 | 130.67 | 71545 |
| Deposits(Y_2) | 10797.51 | 43316.93 | 75.446 | 465191.1 |
| Determinants of Efficiency | | | | |
| LnTA | 8.004 | 1.3851 | 5.6276 | 12.1915 |
| CAR | 0.1373 | 0.1031 | 0.0374 | 1.1721 |
| IR | 1.2930 | 5.4712 | 0.0120 | 64.4987 |
| ROA | 0.0494 | 0.0386 | -0.0358 | 0.2260 |
| ROE | 0.4287 | 0.3714 | -0.6116 | 2.6832 |

Source: own computation based on National Bank of Ethiopia (NBE) annually data

4.2. Estimation Results of the Stochastic Cost Frontier Analysis

The empirical results of the cost frontier estimations were performed by maximum likelihood function incorporated into Stata 12.1. Alternative specifications and

assumptions about the distribution of the one-sided error term were also tried. Specifically, a more restrictive half-normal distribution of the inefficiency effects and a specification assuming heteroscedasticity (Bottasso and Sembenelli, 2004; Hadri, 1999) were estimated but results were unreliable due to model instability arising from non convergence even at a higher number of iterations. Accordingly, results of these estimations are not reported. On the other hand, convergence of the single stage frontier estimation and cost inefficiency model assuming a truncated normal distribution is achieved only after a small number of iterations. Consequently, the reported results are based on the chosen specification taking into account the assumptions made about the inefficiency error component. In this vein, a more general unrestrictive truncated normal distribution is assumed. The advantage of the truncated normal distribution is that it allows for a simultaneous estimation of the stochastic frontier function and analysis of the determinants of the inefficiency effects under very general conditions (Fujii, 2001).

The subsequent discussion reports the results obtained from the translog stochastic cost frontier function and the accompanying inefficiency model. The estimation result of the translog function is based on the conditional mean model approach of SFA method, using Stata 12.1 statistics software. The conditional mean model approach allows the single step estimation of maximum likelihood estimates (MLE) of the parameters of the stochastic cost frontier function and the inefficiency model. All summary statistics and regression reports in this paper were generated using the same software Stata 12.1. The linear homogeneity conditions were imposed during the estimation by normalizing the

cost and inputs prices by the input price of capital. The empirical results of the stochastic cost frontier model obtained by MLE are presented in Table 4.2 as follows.

Table 4.2: Empirical results of the stochastic cost frontier model

| Variables | Parameter | Coefficient | Std. Error |
|-----------------------------------|-----------|-------------|------------|
| Constant | 0 | 1.8421*** | 0.3077 |
| lnw ₁ | 1 | 0.0793 | 0.0600 |
| lnw ₃ | 2 | 0.7207*** | 0.0527 |
| lnY ₁ | 1 | -0.6037** | 0.2535 |
| lnY ₂ | 2 | 1.3173*** | 0.2159 |
| lnw ₁ lnw ₁ | 11 | -0.0272** | 0.0112 |
| lnw ₁ lnw ₃ | 12 | 0.0639** | 0.0322 |
| lnw ₁ lnY ₁ | 11 | 0.0884** | 0.0236 |
| lnw ₁ lnY ₂ | 12 | -0.0956** | 0.0346 |
| lnw ₃ lnw ₃ | 22 | -0.0729** | 0.0509 |
| lnw ₃ lnY ₁ | 21 | -0.3095*** | 0.0734 |
| lnw ₃ lnY ₂ | 22 | 0.2567*** | 0.0625 |
| lnY ₁ lnY ₁ | 11 | 0.3159*** | 0.0649 |
| lnY ₁ lnY ₂ | 12 | -0.6184*** | 0.1367 |
| lnY ₂ lnY ₂ | 22 | 0.3033*** | 1.2465 |

Source: own computation based on National Bank of Ethiopia (NBE) annually data

Log likelihood function=56.0235 and the notations ***, **, * shows level of significance at 1%, 5% and 10% respectively.

The result shows that the price of deposits is significant with positive sign. This sign is expected since the increase in interest payment raises the costs of banks and consequently their levels of inefficiency. However, the price of labor indicates a positive insignificant sign which indicates the low payment level of wages and salaries paid for the employees. The coefficients of outputs (loans and other earning assets) are significant with negative sign for first and positive for the second. The negative sign of loans indicates that the collected funds from customers and lend afterward, serve to decrease the costs of financial intermediation and consequently increases the efficiency level of banks. The parameters β_{11} , β_{12} and β_{22} which represent the impact of the joint production of two outputs on total costs, are statistically significant. On the other hand, the β_{12} parameter which represents the interaction between price of labor and price of deposits is significant and positive sign of independence between labor and deposits in the costs of the banking industry and negatively affect the efficiency of banks. Finally, the parameters β_{11} , β_{12} , β_{21} , and β_{22} representing the effects of inputs on banking products, are statistically significant and partially positive. For example the coefficient β_{21} has a negative sign which indicates that the activity of lending is much assisted by the use of deposits than by banks staff.

4.3. Determinants of Banking Efficiency

The estimation results of determinants of bank efficiency are based on the conditional mean model approach of SFA method, using Stata 12.1 statistics software. The conditional mean model approach allows the single step estimation of maximum likelihood estimates (MLE) of the parameters of the stochastic cost frontier function and

the inefficiency variables. The empirical results of determinants of bank efficiency obtained by MLE are presented in Table 4.3 as follows.

Table 4.3: Empirical results of determinants of bank efficiency

| Determinants of Efficiency | Parameter | Coefficient | Std.rror |
|----------------------------|-----------|-------------|----------|
| lnTA | 1 | -2.3139 | 3.6554 |
| CAR | 2 | 2.3022* | 7.4462 |
| IR | 3 | -0.7067* | 0.3887 |
| ROA | 4 | -12.0405* | 55.3420 |
| ROE | 5 | -12.12622* | 21.4128 |
| Constant | 0 | 11.2701 | 15.6862 |
| lnsigma ² | | 0.9619 | 1.6694 |
| Llgtgamma | | 7.5875*** | 1.6581 |
| sigma ² | | 2.6169 | 4.3688 |
| Gamma() | | 0.9994 | 0.0008 |
| sigma_u ² | | 2.6156 | 4.3687 |
| sigma_v ² | | 0.0013 | 0.0006 |

Source: own computation based on National Bank of Ethiopia (NBE) annually data. The notations ***, **, * shows level of significance at 1%, 5% and 10% respectively.

The inefficiency variables are quite supposed to have an effect on the total cost since all the coefficients of these variables are significant except size of the bank. The result leads to predict an important effect of these variables on the costs of banks and consequently on their levels of efficiency. Both variables of profitability (ROA and ROE) indicators have a negative and significant coefficient affect negatively the total cost of banks and thus positively the banking efficiency. In fact, the more the bank tries to improve its economic and financial performance, the more it will be able to lower its costs and consequently improve efficiency. The result is in conformity with the studies of (Dietsch and Vivas, 2000; and Kauko, 2009). Bank size (lnTA) does not significantly affect cost efficiency which is in conformity with the view that large branch network results in higher costs and higher cost inefficiency. The capital adequacy ratio (CAR), with positive and significant coefficient, shows a positive relationship between this variable and total cost, which contributes to lower the banking efficiency. Indeed a high level of capital reduces the risk of insolvency and, after all, the cost of borrowed capital. However, the Ethiopian banks show weak capital average ratio and therefore lacking levels of own capital with regard to total assets, which increases the risk of insolvency, the cost of borrowed capital, total cost and consequently affects banking efficiency negatively.

The intermediation ratio (IR), with a coefficient of negative and significant sign, acts negatively on the total cost, thus positively on the cost efficiency. In fact, the more the ratio of intermediation is high, the lower are the banking costs, and the higher will be the efficiency of banks. Banking systems with a higher intermediation ratio (ratio of total loans to total deposits) have significantly lower costs. This may reflect the developments

in the legal and regulatory framework which support both the financial intermediation process and lower costs to banks. These may include the development of effective secured transactions laws and bankruptcy procedures which are necessary to support lending to customers (Pancurova and Lyocsa, 2013).

According to these results, it is important to mention the crucial role of bank specific variables as determining factors of the Ethiopian banks cost efficiency. Moreover, the estimate of gamma (γ) for cost inefficiency is 0.9995 which is close to one, indicates that the inefficiency determinants are likely to be highly significant in the analysis of the value of cost function. In other words, the γ parameter associated with variances in the stochastic cost frontier is estimated to be close to 1 indicating that the inefficiency term dominates the random error term in the overall error variance. Thus, deviations from the frontier are largely driven by bank specific inefficiency effect.

4.4 Analysis of Average Bank Level Efficiency Scores

Table 4.4 below presents a ranking of average bank specific cost efficiency scores estimated from the translog frontier cost function. The efficiency estimates show that for the banking sector as a whole, banks operated below the frontier, with mean cost efficiency of 0.925. The implication is that Ethiopian commercial banks could improve their performance by saving up to 7.5% in their costs per year if they were all utilizing the best practice technology over the sample period.

Table 4.4: Mean cost efficiency of banks

| Bank | Mean Efficiency | Std. deviation | Rank |
|------|-----------------|----------------|------|
| CBE | 0.911 | 0.019 | 10 |
| CBB | 0.830 | 0.017 | 12 |
| AIB | 0.925 | 0.012 | 9 |
| DB | 0.907 | 0.012 | 11 |
| BOA | 0.956 | 0.007 | 2 |
| WB | 0.949 | 0.009 | 5 |
| UB | 0.940 | 0.012 | 7 |
| NIB | 0.930 | 0.011 | 8 |
| CBO | 0.950 | 0.008 | 4 |
| LIB | 0.955 | 0.006 | 3 |
| OIB | 0.948 | 0.008 | 6 |
| ZB | 0.970 | 0.003 | 1 |

Source: Author's estimates

Individually, the estimated cost efficiency indicators show that relative to the common frontier, the most efficient bank (ZB) has a score of 0.97, that is, approximately 4.5% more efficient than the average bank in the sample. This shows that ZB could cut its costs by 3% to move to the best practice frontier. Put differently, the level of inefficiency for ZB is approximately 3%. This is due to the size of the bank which has only one branch and makes it easy to control costs. Conversely, the least performing bank (CBB) with an efficiency score of 0.83 shows input wastage of up to 17%. This maybe because of the bank's specialization in the construction sector which makes the banks operation limited relative to other banks. Other banks are generally in good position although none was operating optimally. The overall result emerging from these efficiency indicators is that, although Ethiopian banks are inefficient on average, for most of them the scores are

skewed closer to the frontier. This is shown by the trend in the cost efficiency estimates depicted by figure 1 and table 4.5 below. Figure 1 illustrates efficiency scores for the annually observations; table 4.5 reports annual efficiency score for each banks. Figure 1, shows, for most commercial banks there is a sustained upward trend in cost efficiency, depicting some reduction in inefficiency over the sample period.

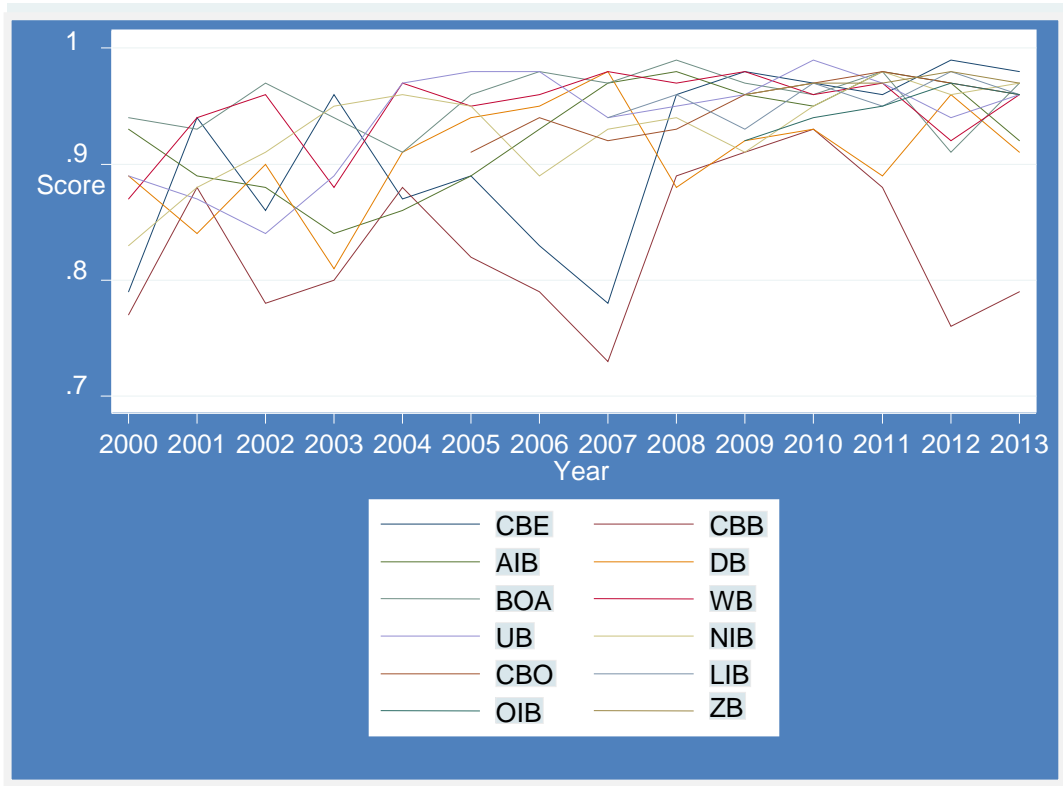
Table 4.5: Cost Efficiency Scores of Commercial Banks

| Bank | Year(2000-2013) | | | | | | | | | | | | | |
|------|-----------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 |
| CBE | 0.79 | 0.94 | 0.86 | 0.96 | 0.87 | 0.89 | 0.83 | 0.78 | 0.96 | 0.98 | 0.97 | 0.96 | 0.98 | 0.98 |
| CBB | 0.77 | 0.88 | 0.78 | 0.8 | 0.88 | 0.82 | 0.79 | 0.73 | 0.89 | 0.91 | 0.93 | 0.88 | 0.76 | 0.79 |
| AIB | 0.93 | 0.89 | 0.88 | 0.84 | 0.86 | 0.89 | 0.93 | 0.97 | 0.98 | 0.96 | 0.95 | 0.98 | 0.97 | 0.92 |
| DB | 0.89 | 0.84 | 0.9 | 0.81 | 0.91 | 0.94 | 0.95 | 0.98 | 0.88 | 0.92 | 0.93 | 0.89 | 0.96 | 0.91 |
| BOA | 0.94 | 0.93 | 0.97 | 0.94 | 0.91 | 0.96 | 0.98 | 0.97 | 0.99 | 0.97 | 0.96 | 0.98 | 0.91 | 0.97 |
| WB | 0.87 | 0.94 | 0.96 | 0.88 | 0.97 | 0.95 | 0.96 | 0.98 | 0.97 | 0.98 | 0.96 | 0.97 | 0.92 | 0.96 |
| UB | 0.89 | 0.87 | 0.84 | 0.89 | 0.97 | 0.98 | 0.98 | 0.94 | 0.95 | 0.96 | 0.99 | 0.97 | 0.94 | 0.96 |
| NIB | 0.83 | 0.88 | 0.91 | 0.95 | 0.96 | 0.95 | 0.89 | 0.93 | 0.94 | 0.91 | 0.95 | 0.98 | 0.96 | 0.97 |
| CBO | - | - | - | - | - | 0.91 | 0.94 | 0.92 | 0.93 | 0.96 | 0.97 | 0.98 | 0.97 | 0.96 |
| LIB | - | - | - | - | - | - | - | 0.94 | 0.96 | 0.93 | 0.97 | 0.95 | 0.98 | 0.96 |
| OIB | - | - | - | - | - | - | - | - | - | 0.92 | 0.94 | 0.95 | 0.97 | 0.96 |
| ZB | - | - | - | - | - | - | - | - | - | 0.96 | 0.97 | 0.97 | 0.98 | 0.97 |

Source: Estimation Result

Based on sample estimates between 2000 and 2013, the mean efficiency index rose by 7.9% from 0.864 in 2000 to 0.943 in 2013. The lowest level of cost efficiency (0.73) occurred in the year 2007 by CBB and the highest cost efficiency (0.99) occurred in the year 2008 and 2010 by BOA and UB respectively.

Figure 1: Efficiency Scores of Commercial Banks



Source: Estimation Result Using Stata 12.1

CHAPTER FIVE: CONCLUSION AND POLICY IMPLICATION

Doubts about the efficiency of commercial banks reflected in wide interest spreads continue to be a point of public policy debate. This study explores the area of bank efficiency, where it is important for banks to have better efficiency in terms of the usage of its cost in providing better services. This study has evaluated the cost efficiency of Ethiopian banks using the stochastic frontier approach by incorporating bank specific factors in the analysis. The intermediation approach is adopted to identify and define the inputs and outputs variables which are used in the analysis. The results show that Ethiopian banks are on average inefficient in the order of 7.5 %, indicating that mismanagement of resources remains a problem to better cost performance. However, over the years, there has been some improvement in the relative cost efficiency of banks, with new small banks displaying spectacular growth in performance. This could be caused by the aspiration of large banks to provide services with better quality for their customers, leading these banks to incur higher costs. Hence, the plan of bank expansion through the setting of new branches should be reconsidered as the cost of setting up new branches would lead to an over utilization of capital.

With respect to the determinants being examined, it could be seen that there was a significantly positive relationship between the variables returns on assets (ROA), returns on equities (ROE), intermediation (IR) and bank efficiency while there was no significant relationship found between bank size and bank efficiency. On the other hand, capital adequacy ratio (CAR) has a negative impact on efficiency. Based on the results, the importance of efficiency correlates was shown in the study which shows that banks tends

to be more efficient in an economy characterized by high returns on assets (ROA) and returns on equities (ROE) as well as a high ratio of intermediation (IR). These factors suggest that there should be a stronger policy response to overcome the impediments which continue to affect banks' cost performance. The result of this analysis leads to important implication for management of the bank, policy makers, and bank regulators in Ethiopia. Thus, banks can improve their cost efficiency by way of improving the method of loans and advances, by increasing the share of capital relative to assets and by boosting banking investment operation; the less efficient banks can improve their resource utilization. Moreover, Ethiopian authorities have committed to the privatization, modernization, and opening of the banking system to the foreign banks within as part of liberalization programs in order to have competitive, efficient and developed financial and banking systems.

Future research can be extended by including more variables such as macroeconomic variables (for example, inflation rate) and also by including other new banks which are not included in this study with factors influencing the efficiency of Ethiopian commercial banks. In addition, the methodology of stochastic frontier analysis could be compared with other parametric and non-parametric measures of efficiency such as Data Envelopment Analysis. Other than these, as the SFA model built in the study did not show complete variation of efficiency being explained by the selected determinants, there could be other significant variables such as institutional and regulatory factors which contribute to the changes of performance and efficiency in financial institutions.

Therefore, researchers of future studies could also consider other factors that may affect the changes in cost efficiency of banks.

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Declaration

I, the undersigned, declare that this thesis is my own original work and has not been presented for a degree in any other university, and that all sources of materials used for the thesis have been duly acknowledged.

The examiners' comments have been duly incorporated.

Declared by

Name: _____

Signature: _____

Date: _____

Confirmed by:

Name: _____

Signature: _____

Date: _____