

*Addis Ababa*  
*University*  
*(Since 1950)*



**ADDIS ABABA UNIVERSITY**

**SCHOOL OF COMMERCE**

**DEPARTMENT OF BUSINESS LEADERSHIP**

**EFFECT OF COMPETITION ON EFFICIENCY OF  
BANKING INDUSTRY IN ETHIOPIA**

**By**

**Wondwossen Arega**

**ID: GSE/7380/12**

**Advisor:**

**Dr. Seifu M**

**Addis Ababa**

**Ethiopia**

**June, 2022**

## **DECLARATION**

I, the undersigned, declare that this research is my original work, prepared under the guidance of Seifu M (PhD). All sources of materials used for this research have been duly acknowledged, the researcher further confirm that the research has not been submitted either in part or in full to any other higher learning institution for the purpose of earning any degree.

Wondwossen Arega

\_\_\_\_\_

**Addis Ababa University, Addis Ababa**

**June, 2022**

**Addis Ababa University**

**School of Commerce**

**APPROVED BY BOARD OF EXAMINERS**

---

**Advisor**

---

**Signature**

---

**External Examiner**

---

**Signature**

---

**Internal Examiner**

---

**Signature**

# **CERTIFICATE**

This thesis has been submitted to Addis Ababa University, School of Commerce for examination with our approval as university advisors.

---

---

**Advisor**

**Signature**

## **Acknowledgement**

I would like to express my deepest gratitude to my advisor Seifu M (PhD) for their unreserved follow up, invaluable comments and constructive guidance throughout conducting this research.

The researcher would also like to express deepest gratitude for my friends who has been providing different information on the preparation of this research.

# Table of Contents

List of Acronyms .....	i
List of Tables .....	ii
List of Figures .....	iii
Abstract .....	iv
CHAPTER ONE .....	1
INTRODUCTION .....	1
1.1 Background of the Study .....	1
1.2 Statement of the Problem .....	3
1.3 Research Questions .....	4
1.4 Objective of the Study .....	4
1.4.1 General Objective .....	4
1.4.2 Specific Objectives .....	4
1.5 Significance of the Study .....	5
1.6 Scope and Delimitation of the Study .....	5
1.7 Organization of the Study .....	5
CHAPTER TWO .....	7
LITERATURE REVIEW .....	7
2.1 Theoretical Review .....	7
2.1.1 Concepts and Definitions Efficiency .....	7
2.1.2 Banking Efficiency .....	10
2.1.3 Drivers of Banking Efficiency .....	12
2.1.4 Measures of Banking Efficiency .....	14
2.2 Theoretical Framework .....	17
2.2.1 Competition-Efficiency Hypothesis .....	17
2.2.2 Competition-Inefficiency Hypothesis .....	18
2.3 Empirical Review .....	19
CHAPTER THREE .....	29
RESEARCH METHODOLOGY .....	29
3.1. Research Design and Approach .....	29
3.2. Data Type and Sources .....	29

3.3. Sampling Design.....	30
3.4. Data Analysis.....	31
3.5 Variable Specification.....	31
3.5.1 Measuring Competition .....	31
3.5.2 Measuring Efficiency.....	32
3.6 Ethical Consideration.....	33
CHAPTER FOUR.....	34
RESULT AND DISCUSSION .....	34
4.1 Introduction.....	34
4.2 Competition in Commercial Banks in Ethiopia .....	34
4.3 Efficiency of Commercial Banks in Ethiopia .....	40
4.4 Effect of Competition on Efficiency.....	42
CHAPTER FIVE .....	45
CONCLUSION AND RECOMMENDATIONS .....	45
4.1 Summary of Major Findings.....	45
5.2 Conclusion .....	46
5.3 Recommendations.....	47
REFERENCES .....	49
Appendices.....	54
A1: Trans-log Cost Function: Fixed Effect Model .....	54
A2: Trans-log Cost Function Estimation: Random Effect Model .....	55
A3: Hausman Test: Trans-log Cost Function Estimation.....	56

## **List of Acronyms**

CBE	Commercial Bank of Ethiopia
CPI	Consumer Price Index
DEA	Data envelopment approach
GDP	Gross Domestic Product
HHI	Hirschman Index
NBE	National Bank of Ethiopia
SFA	Stochastic Frontier Approach

## **List of Tables**

Table 4. 1 HHI of Banking Industry in Ethiopia .....	35
Table 4. 2 Trans-log Cost Function Estimation .....	37
Table 4. 3 Summary: Competition.....	38
Table 4. 4 SFA Estimation.....	40
Table 4. 5 Cost Efficiency of Banks .....	41
Table 4. 6 Regression Result .....	43

## **List of Figures**

Figure 4. 1 Overall Market Share .....	35
Figure 4. 2 Trend of Competition .....	39

## Abstract

*This study was conducted with an objective of identifying effect of competition on efficiency of commercial banks in Ethiopia. Based on this aim this study has assessed competition in banking industry in Ethiopia, cost efficiency of the banks, and the effect of competition on the cost efficiency of the banks. The study has included 17 commercial banks in Ethiopia; 16 private banks and 1 public bank, Commercial Bank of Ethiopia (CBE). The study was conducted by using financial report of the banks from 2001 to 2020 and the data was collected from National Bank of Ethiopia (NBE). Since majority of the banks were established during the period under study, the study has used unbalanced panel data and the data analysis was conducted by using 250 observations. Competition in the banking industry was estimated by using Lerner Index and cost efficiency of the banks was estimated by using Stochastic Frontier Approach (SFA). Then the effect of competition on the cost efficiency was estimated by using Random Effect Model following Hausman procedure. Based on the data analysis, Lerner Index for the study period was 0.601 of banking industry in Ethiopia that suggests existence of monopolistic competition in the banking industry. On the other hand, the banks have cost efficiency closer to 1 suggesting that commercial banks in Ethiopia are efficiently handling their cost. The result of empirical estimations showed that there is there is negative and significant effect of competition on efficiency of commercial banks in Ethiopia. This indicated that banks with larger monopoly power have lower cost efficiency in banking industry in Ethiopia. This study implies that commercial banks in Ethiopia with large market power has lower cost efficiency.*

**Key Words:** Banking Industry in Ethiopia, Competition, Cost Efficiency, Monopoly, Lerner Index, SFA

# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of the Study

Effect of market structure on efficiency is suggested by both theoretical and empirical studies. Relatively, few theoretical literatures have linked competition and efficiency. Caves (1980) implied that competition is the enemy of sloth. According to Hicks (1935) monopoly power allows relaxing efforts that monopoly power allows managers to grab a share of the monopoly rents through discretionary expenses or a reduction of their effort.

In a view of industrial organisation theory, the level of concentration in a market will determine the competitiveness level among firms in the market. Basically, the 'structure-conduct-performance' paradigm views that markets which are dominated by few large firms (highly concentrated) are less competitive than markets which are low concentrated (Mason, 1939; Bain, 1951). The hypothesis contends that the higher the concentration, the lower the competition; increased market concentration is associated with higher prices and greater profits (Bain, 1951). Nevertheless, the 'efficient-structure' hypothesis infers that the degree of concentration is determined by the superior performance of the efficient banks. 'Efficient-structure' hypothesis postulates that firms with superior efficiency become more profitable, the firms will increase their market share; as a result, the competition declines. (Demsetz, 1973; Peltzman, 1977).

Leibenstein (1966) explains why inefficiencies inside firms exist, and why they are reduced by the degree of competition in product markets. According to Leibenstein (1966) inefficiencies would result from the existence of imperfections in the internal organization of firms: those imperfections have an impact on the level of information asymmetries between owners and managers. According to Leibenstein (1966), the main determinant of the reduction of inefficiencies is the increase of competitive pressures that competition provides incentives to managers to exert a higher effort; and a higher number of firms on the market improves the possibilities for owners to assess firm performance, relative to other firms.

Koskela and Stenbecka (2015) found that an increase in competition leads to a decline in lending rates which increased investments. The results also showed that under mean-shifting investment technologies, higher investments do not increase the bankruptcy risks of borrowers concluding that competition-fragility hypothesis is inconclusive. Matutes and Vives (2015) studied the effect of competition for deposits on the risk-taking behaviour of banks. They found that the uninsured market generates excessive deposit rates under perfect competition. Jimenez et al. (2017) investigated the competitiveness that greater banking competition was associated with an increase in non-performing loans, which means that competition brings about risk behaviour on the part of the banks. Berger et al. (2018) found that the risk exposure of banks was driven by higher market power. Increased market power increased loan portfolio risks, which support the competition-efficiency. Liu et al. (2020) studied the degree of competition in European countries during the period 2010 to 2018 and their study sought to establish the existence of the competition-efficiency relationship.

In Africa, a number of studies have also investigated the relationship between competition and efficiency using various competition and efficiency measurement techniques and finding mixed results. A study that employed DEA done in Ghana by Alhassan and Ohene-Asare (2016) found competition to improve cost efficiency; similar results were found for the Middle East North Africa (MENA) region by Apergis and Polemis (2016), concluding that increases in competition do not precede increases in cost efficiency.

Saka, Aboagye and Gemegah (2012), found that in Ghana competition improves technical efficiency. Their results were partly supported by Buchs and Mathisen (2005) who found that banks in Ghana behaved in a non-competitive manner and this may not be good for financial intermediation efficiency. Sarpong-Kumankoma, Abor and Aboagye (2017) also looked at competition and bank efficiency in sub-Saharan Africa. They found that increase in market power leads to greater bank cost efficiency, but the effect is weaker with higher levels of financial freedom.

This study intends to examine effect of competition on efficiency of commercial banks in Ethiopia.

## **1.2 Statement of the Problem**

Competition and efficiency are closely entwined in banking system; however, majority of past efficiency studies on banking industry have tended to neglect the nexus between competition and efficiency. Few attempts have been undertaken to investigate the relationship between bank competition and efficiency of banks. Empirical literature on the inter-linkages between competition and efficiency is inconclusive. Competition in promoting firm resilience from internal and external economic shocks through optimization and economies of scale, ultimately, leads to stability and efficiency in the industry. Competition positively affects efficiency that enables firms to utilize economies of scale. Competition encourages risk-taking behavior by financial institutions increasing financial inefficiency (Allen & Gale 2019).

It is highly believed that competition is highly important for development of financial sector. In Ethiopia, financial sector, particularly banking industry, is at low level of development. Currently, there are only 17 commercial banks, including the government bank, Commercial Bank of Ethiopia (CBE). Among these banks, 4(23.5%) are recently established, in last 10 years. Despite recent fast growth of the industry, more than 60% of the market is occupied by government owned single bank. However, it is indicated that CBE is not in competition with private banks in the country because it is policy bank and strategies of the bank do not affect competitiveness of the private banks. In contrary to this, the bank is providing all services of commercial banking similar to other private banks. This indicates there is partial competition from the bank with private banks. The private banks, in some cases follow the bank and in other cases they compete. Even when CBE is not considered, currently, half of the market is shared by only 25% of the private banks. On the other hand, the recently joined 25% banks possess only about 7% of the market. Therefore, the market structure within the banking industry enables the question that does the competition within the banking industry vary when the state-owned bank is considered and does the recently entered banks affected the banking market structure in Ethiopia?

Efficiency is among the main focuses of the management of commercial banks in Ethiopia; including both government and private banks. For the efficient production the banks focus on implementation of advanced technology in a banking industry and hiring experienced

employees from the industry. Currently, the most efficient bank costs 0.22 cents for 1 Birr income. On the other hand, the least efficient bank produces 1 birr with 0.68 cost. The market of these banks is 3.4% and 6.2% respectively. Commercial banks in Ethiopia focuses on efficient production to win competition in the market. But effectiveness of this strategy is not identified by the banks and other research firms in the country.

Different studies conducted to examine effect of competition on efficiency has not considered examination of effect of efficiency on competition. In addition, there are no studies on market leader in partial activities of competing and some activities without competition. Therefore, this study intends to identify competition and its effect on efficiency of banking industry in Ethiopia.

### **1.3 Research Questions**

This study is conducted to answer following research questions;

- What is the market structure of commercial banks in Ethiopia?
- How is efficiency of commercial banks in Ethiopia?
- What is the effect of competition on efficiency of commercial banks in Ethiopia?

### **1.4 Objective of the Study**

#### **1.4.1 General Objective**

General objective of this study is to examine effect of competition on efficiency of banking industry in Ethiopia.

#### **1.4.2 Specific Objectives**

Specific objectives of the study include;

- Identify competition in banking industry in Ethiopia;
- Assess efficiency of banking industry in Ethiopia;
- Effect of competition on efficiency of the banks; and

## **1.5 Significance of the Study**

This study is conducted with an aim of identifying effect of competition on efficiency of banking industry in Ethiopia. Findings of the study will have managerial and theoretical contribution in the area of the study. First, management of the commercial banks included in the study will be benefited from the study that the study provides information for the management about the competition and its effect on efficiency the banks. based on the competition practice of the banks, the management can affect management strategy.

Second, the study will have empirical and theoretical contribution for studies in the area of effect of competition on efficiency in banking industry. There are controversies literature between nonparametric approaches of DEA and parametric approaches of stochastic frontier approach (SFA) to measure efficiency. This study contributes for application of appropriate methodology for efficiency estimation. Therefore, this study will have theoretical and managerial contribution for finance management area at banking industry. Further, the study will source of literature for further empirical studies in the study area.

## **1.6 Scope and Delimitation of the Study**

For efficient management of the research activity, this study was scoped from different aspects; geographically, methodologically, and conceptually. Geographically, the study is scoped to commercial banks in Ethiopia. The time scope of the study includes 2001 to 2020. In addition, the study is methodologically scoped to quantitative approach that the study has not used secondary data and applies quantitative data analysis methods. Further, the study is conceptually is scoped to concepts related to competition and efficiency. Thus, the study assesses competition and efficiency of the banking industry, and relationship between competition and the efficiency.

## **1.7 Organization of the Study**

This paper is organized into five chapters; Introduction, Literature Review, Research Design and Methodology, Result and Discussion, and Conclusion and Recommendation. The first chapter highlights the introduction section, the second chapter will present the review of related literatures that includes theoretical review, empirical reviews and

conceptual framework. Chapter three will be about methodology of the study that includes research design, population and sampling, data type and method of collection, methods of data analysis. Chapter four will present results and discussion. Finally, chapter five will be presenting conclusion and recommendations based on the findings.

# **CHAPTER TWO**

## **LITERATURE REVIEW**

### **2.1 Theoretical Review**

#### **2.1.1 Concepts and Definitions Efficiency**

According to Farrell (1957), overall economic efficiency is composed of two components, i.e. technical efficiency and allocative efficiency. In other words, economic efficiency refers to the combination of technical and allocative efficiency (Coelli et al, 1998). Economic efficiency incorporates efficient selection of goods to be produced, efficient allocation of resources in the production of these goods, efficient choice of the methods of production and efficient allotment of the goods produced among the consumers. Economists argue that correct applications of the economic principles will bring about optimal efficiency in the allocation and utilization of all resources, their products and in competition with all other desires of the community.

The neoclassical assumes that producers in an economy always have an internal efficiency, that is, they are producing at their production frontier (allocative efficiency) with maximum output for given inputs (technical efficiency) and, therefore, are cost minimizers. The assumption of perfect internal organizational operations that assumes: no coordination failure, no prisoners dilemma and no market failure, can be considered to be dubious given the fact that performance indicators show inefficiency. This means, in reality however it remains apparent that two alike firms might not produce the same output. That means there will be a difference in cost and profit. This difference in output, cost and profit could be explained in terms of technical and allocative inefficiencies and same unforeseen exogenous shocks. Based on the ideas of Debreu (1951) and Farrell (1957), who built the standard framework of productive efficiency (production frontier), overall economic efficiency can be decomposed into scale efficiency, scope efficiency, pure technical efficiency and allocative efficiency.

## **Technical Efficiency**

Technical efficiency in a production unit refers to the achievement of the maximum potential output from given amounts of factor inputs taking into account physical production relationships (Farrell, 1957). Technical efficiency is most frequently associated with the role of management in the production process. For instance, Liebenstein (1966) has argued that firms may fail to produce on the outer boundary of their production surface due to the structure of preferences of managers and workers, giving rise to variations in the level of "X efficiency". It is also doing a task in the cheapest possible way that is producing a given level of output from the lowest possible combination of inputs or producing the maximum output given the level of inputs employed. It reflects the ability of firm or decision making unit to attain the maximum output from a given set of input. Thus, a technically efficient production could produce the same output with less of at least one input, or could use the same input to produce more output (Green, 1993). The level of technical efficiency of a particular firm is characterized by the relationship between observed production and some ideal or potential production. The measurement of firm's specific technical efficiency is based upon deviations of observed output from the best production of efficient frontier. If a firm's actual production point lies on the frontier, it is perfectly efficient. If it lies below the frontiers, then it is technically inefficient.

## **Allocative Efficiency**

Allocative efficiency, or as Farrell called it price efficiency, refers to the ability of a firm to choose the optimal combination of inputs given input prices (Farrell, 1957). If a firm realizes both technical and allocative efficiency, it is then cost efficient (overall efficient). Allocative efficiency measures the skills in achieving the best combination of inputs by taking into account their relative prices or produces the right mix of outputs given the set of prices (Kumhaker and Hevell, 2000). It reflects the capability of a firm to utilize input in optimal proportion, given their respective prices and the production technology. In other words, allocative efficiency refers to whether inputs for a given level of output and set of input prices are chosen to minimize the cost of production; assuming that the firm being examined is already fully technically efficient. It operates on the least cost expansion path,

i.e. the point where the marginal rate of technical substitution is equal to input price ratio. This is very important when one input can be substituted for another in the process of production.

### **Scale Efficiency**

Scale Efficiency often arises from the ability of large firms to allocate fixed costs such as advertising expenses or cost of technology across a greater volume of output. It also shows whether the decision-making units (e.g. banks) operate at the minimum of their long run average cost curve. It focuses on technical efficiency which is the ability of a bank to produce maximal output from a given set of inputs over a certain time period (Adongo et al., 2005). Scale economies are usually measured using data on all banks in the sample rather than just using the data on all of the banks. Scale Economies theoretically apply only to the production possibilities frontiers where firms are fully X-Efficient and minimize costs for every scale of output (Berger and Humphrey, 1994).

### **Scope Efficiency**

Scope efficiency may result from sharing information such as knowledge of customer's habits across products line. It refers to change in product mix related to cost. It occurs when it is more economical to produce two or more products jointly in a single production unit than to produce the products in separate specializing firms. Scope economies could emanate from two sources: i) spreading of fixed cost over an expanded product mixes and ii) cost complementarities in producing different products. Spreading fixed cost occurs, for example, when the fixed capital of a bank or its branches is more fully utilized by issuing many types of deposits to local residents than building separate offices to fulfill the separate demands for transactions accounts, saving accounts, consumer loans and business loans. Such economical spreading of costs occur to the extent that the production of different types of services requires much the same type of computer, accounting system and other fixed inputs of a branch and there is insufficient local demand to justify a full specialized branch for each of the services. In contrast, cost complementary between deposits and loans occur, for example, when the payment flow information developed in producing deposit

services is used to reduce the costs of acquiring credit information and monitoring loans to the same customer. However, there is problem in applying the translog cost/profit function or other multiplicative specification to evaluate scope economies.

X-Efficiency Leibenstin (1966) was the first to introduce the concept of X-inefficiency. He defined it as the loss at which a bank is operating (deviation from the optimum). X-inefficiency is an intra-firm inefficiency or the deviation from the production efficient frontier which depicts the maximum attainable output for a given level of input. This inefficiency can arise from management practice and the environment. X-inefficiency reflects the differences in managerial ability to control cost and/or maximize profits but not suboptimal economies of scale or scope. It has been linked to managerial quality. Empirical X-inefficiency is a measure of how banks utilize their inputs to produce a given level of output. Berger et. al., (1993) describe X-inefficiency as a variance from the efficient frontiers set by the best practice or benchmark firm. It incorporates two components, i.e. technical and allocative inefficiencies (Allen & Rai, 1996). According to Farrell (1957), technical inefficiency occurs due to sub optimal usage of input leading to waste, while allocative inefficiencies arise from inappropriate mix or composition of inputs using inefficient business process. Both inefficiencies are attributed to employee, management or environment factors. Despite the lack of harmony across all methods, it seems clear that x- efficiency differences are much more important than scale and scope efficiencies in banking. Most of the studies found out that average cost Xinefficiencies are on the order of 20% higher for virtually all size classes of banks as opposed to scale inefficiencies. Scope inefficiencies are difficult to measure but also appear to account for 5% or less of costs (Berger and Humphrey, 1994; Berger et. al., 1997). Duality concepts have the best economic foundation for analyzing the efficiency of banks for they are based on economic optimization in reaction to market price and competition. The following sections will discuss cost and profit x-efficiency based on the duality concept.

### **2.1.2 Banking Efficiency**

The concept of efficiency as a general performance indicator for all types of businesses was first formulated in the early works of Edgeworth (1881) and Pareto (1927) and

recorded its empirical implementation in the book of Shephard (1953). Efficiency in economics is interpreted as the maximum potential ratio between the output and the input of the product development process, which shows the optimal distribution of available resources that would allow achieving the maximum potential (Cvilikas & Jurkonyte-Dumbliauskiene 2016). According to Drucker (1963), efficiency can be defined as the ability of an organization to achieve its output from the minimum input level. In other words, Efficiency is defined as the measure of effectiveness that produces the minimum waste of time, effort, and skill.

The term efficiency is different from the term effectiveness, both are used to describe the performance of an entity but according to Jouadi & Zorgui (2014), efficiency summarizes the idea to produce with the best manner, which means that efficiency is focused on the use of minimum inputs to produce the best output, in other words, the optimized use of resources to generate the best products with the minimum costs. In management, we can consider efficiency as the study of the optimized use of internal factors of the firm. On the other hand, the effectiveness concept summarizes the yield of factors and the reach of goal, without considering the manner and the resources optimized use. Regarding the banking sector, Isrova (2010) stated that efficiency supports the fruitfulness of implemented macroeconomic policies, which generate the durable development, economic growth, and welfare for society, this is the same meaning that McKnley & Banaian (2000) stated as they define efficiency in terms of cost minimization and profit maximization.

The definition of bank's efficiency remains arguable among researchers. To determine what constitutes efficiency of banks, one should first decide on the nature of banking approaches. There are two main approaches that are widely used in the banking theory literature, namely, production and intermediation approaches where (Sealey & Lindley, 1977): first, The production approach assumes that financial institutions serve as producers of services for account holders; that is, they should perform transactions on deposit accounts and process documents such as loans; second, the intermediation approach is of the opinion that banks basically act as financial intermediaries whose primary role is to obtain funds from savers in exchange for their liabilities, and the banks, in turn, will provide loans to others for profit-making (Chu & Lim, 1998). The intermediation approach is also

known as asset approach, whereby the financial firms are assumed to act as an intermediary between the savers and borrowers. Banks are seen as purchasing labor, materials and deposit funds that produce outputs of loans and investments.

Berger & Humphrey (1997) argue that neither of these two approaches is perfect because they cannot fully capture the dual role of financial institutions as providers of transactions/document processing services and also being financial intermediaries. They point out that the production approach may be somewhat better for evaluating the efficiencies of bank branches, and the intermediation approach may be more appropriate for evaluating financial institutions as a whole. Diallo (2018) states that efficiency makes banks more resilient to shocks, thereby positively and significantly affecting growth. Bank efficiency relaxes credit constraints and increases the growth rate for financially-dependent industries during the crisis. Waheed & Younus (2010) provides quantitative support to the view that the financial sector's development is crucial to economic growth and the efficiency of the financial sector is potentially important to the long-term growth performance of the countries.

The literature shows different ways to classify Banking efficiency, Yudistira (2004) distinguishes between two main types of banking efficiency the first one is known under the name scale efficiency and was first introduced by Farrell (1957) which is the relationship between a bank's per unit average production cost and volume, the second type is the X-efficiency and was introduced by Leibenstien (1966) and it represents deviations from the cost-efficient frontier that depicts the lowest production cost for a given level of output, in a different way and it was also defined Kablan (2010) as the measure of how well management aligns technology, human resource management, and other resources to produce a given level of output.

### **2.1.3 Drivers of Banking Efficiency**

Harker & Zinos (2000) groups the drivers of bank efficiency into three main groups; the first one is the strategy, the second one is the execution of strategy and finally the environment, according to their research, these three groups represent the engine of

banking success. 1- Strategy: A bank faces many strategic choices concerning product mix, client mix, geographical location, distribution channels, and form of organization. These choices represent not only the way the Bank is providing its services to customers but also underlines the financial risk a bank is willing to face. A successful strategic decision regarding client mix hinges upon matching a targeted client segment with well-priced products. 2- Execution of Strategy: A strategy can be implemented through human resource management, use of technology, and process design, considering the X-efficiency definition stated in the previous part, X-efficiency can be used to assess the execution of the bank strategy. 3- Environment: Banks try to influence environmental factors through lobbying activities, marketing efforts, research, and development. These environmental factors are information technology, client tastes, and regulation (Kablan, 2010). Concerning the determinants of banking efficiency, the process of producing outputs from inputs can also be influenced by both regulatory-specific variables (e.g. bank type, ownership status and geographic region) and bank-specific variables (e.g. size, capital adequacy, asset quality, expenses and age) in explaining the variations in bank's efficiency estimates.

Alber (2011) considers the effects of banking expansion on profit efficiency of the Saudi banks. This has been conducted using a sample of 6 commercial banks (out of 11), and covering the period from 1998 to 2007. Profit efficiency has been measured using the ratio of actual profitability to the best one, which a similar bank can realize. Tests indicated that we could accept hypotheses regarding the effects of "availability of phone banking, "number of ATMs" and "number of branches" on profit efficiency of Saudi banks. Al-Farisi & Hendrawan (2012) examines the impact of capital structure on performance of conventional and Islamic banks, by using profit efficiency approach. They measure profit efficiency score for each bank in Indonesia during the period from 2002 to 2008 by using distribution free approach (DFA). Result indicate that banks' capital ratio have a negative effect on their profit efficiency. Sufian & Habibullah (2014) aims at exploring the impact of economic freedom on the efficiency of the Malaysian banking sector. Findings indicate that both greater freedom to start new businesses and restrictions on the activities of which banks could undertake tend to impede the efficiency of banks operating in the Malaysian

banking sector. Besides, Arrawatia, Misra & Dawar (2015) aims to investigate the relationship between competition and efficiency. Using bank-level data for Indian banks, relationship between competition and efficiency is examined by applying the Granger causality test for the period 1996 to 2011. Results show an increasing trend for competition for the period 1996 to 2004, and after that there is fall in competitive levels. Granger causality tests show that competition positively affects efficiency and vice-versa. Harimaya and Kondo (2016) examines whether branch expansions have realized efficiency gains by focusing on regional banks in Japan. The findings show that regional banks expanding their branch networks to certain levels exhibit lower cost inefficiencies.

#### **2.1.4 Measures of Banking Efficiency**

There are different approaches to measure efficiency, and different ways to classify the measures of efficiency. This could be illustrated as follows:

##### **Structural and Nonstructural Measures:**

Mester & Huges (2008) believes that the most common approaches to measuring banking efficiency are the structural approach and the nonstructural approach, according to this study, the nonstructural approach compares performance among banks using different financial ratios. The nonstructural approach also considers the relationship between performance and investment strategies and other factors such as characteristics of governance. It looks for evidence of agency problems in correlations of performance ratios and variables characterizing the quality of banks' governance. The structural approach – also known under the term "technical efficiency"- depends upon a theoretical model of the banking firm and a concept of optimization. The structural approach considers the bank as a financial intermediary that produces informational intensive financial services and diversifies risks and combines the theory of financial intermediation with the microeconomics of bank production. This helps guide the choice of outputs and inputs in the bank's production structure.

The structural approach brought a disagreement about what is exactly the banks' output, Berger & Humphrey (1992) state that the three common approaches of defining banks output are as follows:

1- The Asset Approach for defining Banks Output: The asset approach defines banks as financial intermediaries between liability holders and the receivers of bank funds. Thus, loans and other assets represent the bank output, while deposits and liabilities are the inputs of the banking process.

2- The user Cost Approach: The user cost approach uses the basis of net contribution to bank revenue to identify whether a financial product is input or output, which means that If the financial returns on an asset exceed the opportunity cost of funds or if the financial costs of a liability are less than the opportunity cost, then the instrument is considered to be a financial output. Otherwise, it is considered to be financial input. In other words, the user cost approach identifies whether an asset or liability category contributes to the financial output of a bank.

3- The Value-added Approach: The value-added approach considers that all liability and asset categories have some output characteristics. It doesn't distinguish inputs from outputs in a mutually exclusive way, and this is the difference between the value-added approach and the two previously stated approaches. A significant difference between the value-added approach and user cost approach is that the value-added approach uses operating cost data in an explicit way rather than determining these costs in an implicit way.

### **The Traditional, Parametric, and Non-Parametric Measures**

According to Wozniowska (2008), the measures of efficiency can be classified into three main groups, these groups are:

1- The Traditional Method: According to Tuskan & Stojanovic (2016), the traditional method of measuring efficiency refers to the using of ratio analysis from among several financial institutions and to calculate numerous accounting ratios, providing a measurement of the overall financial soundness of financial institutions and the operating

efficiency of its management which means that Financial statements are the main source of accounting information used in measuring the operating efficiency of a financial institution.

2- The Parametric Methods: The parametric methods- also known under “parametric programming”- is concerned in general with the production or expense function base. This is why it is used to estimate the characteristics of the function and measures economies of scale while assuming all decision-making units (DMUs) are operating efficiently. (Tuskan & Stojanovic, 2016), Burger & Humphrey (1997) classified the parametric methods into three different categories: The Stochastic Frontier Approach (SFA), The Thick Frontier Approach (TFA) and The Distribution-Free Approach (DFA).

3- The Non-Parametric Method: Charnes, Cooper & Rhodes (1978) considered the nonparametric methods – known under the non-parametric programming approach- as the methods that use decision-making Units' (DMUs) efficiency frontiers to construct measures of efficiency. This approach considers the degree to which total efficiency in the financial sector can be improved, and ranks the efficiency scores of DMUs. This efficiency measurement is derived from analyzing observations obtained from DMUs for defining productive units, which are characterized by common multiple outputs and commonly designated inputs.

### **The DEA Methodology**

Data envelopment approach (DEA) is the most common measure of efficiency, Charnes et al. (1978) defines DEA approach as a mathematical programming model applied to observations data that provide a new way of obtaining the empirical estimate of relations such as the production functions or efficient production possibility surface which are considered to be the cornerstone of modern economics. This approach provides an objectively determined numerical efficiency value using multiple inputs and outputs, and this is why Berger & Humphrey (1997) suggest that it is particularly valuable in assessing and informing government policy regarding financial institutions. Thus it was

recommended that DEA replaces the traditional method of measuring banking efficiency mentioned previously.

## **2.2 Theoretical Framework**

### **2.2.1 Competition-Efficiency Hypothesis**

The ‘competition-efficiency’ hypothesis states that increases in competition precipitate increases in profit efficiency. This is based on Efficient structure hypothesis proposed by Demsetz (1973) that considers an exogenous shock (e.g., deregulation under the Banking Directive) that forces banks to minimize costs, offer services at lower prices, and at the same time forces them to increase profits, e.g. through shifts in outputs. Efficient banks (i.e. those with superior management and production technologies, that translate into higher profits) will increase in size and market share at the expense of less efficient banks. This is likely to lead to higher market concentration (Vander Venet, 2002). In contrast, uncompetitive markets allow bank managers to enjoy a ‘quiet life’ whereby costs are not kept under control, leading to lower levels of efficiency (e.g., Pagano, 1993; Berger and Hannan, 1998). This hypothesis suggests competition causes efficiency of a bank.

The ‘prudent and efficient management’ hypothesis provides a rationale for the ‘competition-efficiency’ hypothesis. The theoretical underpinnings for the ‘competition-efficiency’ hypothesis can be found in a range of studies. In particular, Petersen and Rajan (1995) argue that in institutions exposed to more intensive competition, screening and monitoring procedures are more sophisticated, whereas banks in monopolistic markets spend less on monitoring. Similarly, Chen (2007) develops a theoretical model showing that competitive banks have better screening and monitoring procedures in place and are therefore less likely to suffer from nonperforming loans. This result is obtained since less risky borrowers have an incentive to obtain financing from a bank that can differentiate between good and bad credit risks, because good borrowers can reap benefits in the sense of better access to credit and higher credit lines.

Institutions that maintain efficient monitoring and screening procedures avoid additional costs that arise in inefficient institutions due to resource-intensive monitoring of delinquent

borrowers, analysis of workout arrangements, and seizing and disposing of collateral do not pose major problems in the more efficient banks.

### **2.2.2 Competition-Inefficiency Hypothesis**

The ‘Competition-Inefficiency’-Hypothesis is the alternative to the ‘competition-efficiency’ hypothesis. It suggests that competition leads to a decline in bank efficiency. Different reasons are provided for this hypothesis. First, higher competition is likely to be associated with less stable, shorter relationships between customers and banks (Boot and Schmeits, 2005) as customers’ propensity to switch to other providers increases in more competitive environments. This phenomenon will amplify information asymmetries that require additional resources for screening and monitoring borrowers. Second, since banks can expect a shorter duration of bank relationships in a competitive environment, they are likely to reduce relationship-building activities, which inhibits the reusability and value of information (Chan, Greenbaum, and Thakor, 1986). Taken together, these arguments suggest a reduction in the value of proprietary information held by banks, meaning that banks incur greater expenses in retaining old and attracting new customers through investments into ATMs, new information systems, and aggressive marketing efforts. Evanoff and Örs (2002), DeYoung, Hasan, and Kirchhoff (1998), and Kumbhakar et al. (2001) provide some empirical evidence for adverse effects of competition on bank efficiency. Thus, the alternative hypothesis implies that competition causes decreases in bank efficiency.

The ‘Poor and Inefficient Management’-Hypothesis is the alternative to the ‘Prudent and Efficient Management’-Hypothesis. This hypothesis states that competition adversely impacts bank efficiency, resulting in a negative effect on bank soundness. Consider a case where efficiency declines as outlined under the ‘competition-inefficiency’ hypothesis. Such institutions are preoccupied with retaining old and attracting new customers at any expense. Consequently, insufficient resources are allocated to underwriting standards, and screening and monitoring of borrowers (e.g., Dell’Ariccia and Marquez, 2005). Such banks are unlikely to employ sophisticated credit scoring models and might lack skills in appropriately assessing the value of collateral. This results in a high proportion of loans

with low or negative net present values, which ultimately affects bank soundness negatively. Thus, inadequate underwriting standards and insufficient resources devoted to increasing profits result in increased inefficiencies, which is likely to give rise to unsound bank operations. Berger and DeYoung (1997) offer evidence that poor management, reflected in banking inefficiencies, precedes higher levels of nonperforming loans. Similarly, DeYoung (1997) finds that asset quality and efficiency are related via management quality.

### **2.3 Empirical Review**

Leibenstein (2016) explains why inefficiencies inside firms (the “X-inefficiencies”) exist, and why they are reduced by the degree of competition in product markets. X-inefficiencies would result from the existence of imperfections in the internal organization of firms: those imperfections have an impact on the level of information asymmetries between owners and managers. Indeed, the incompleteness of labor contracts makes the effort of managers at least partially discretionary. The discretionary share of the effort would not be the source of any problem if the owners would have means to control firm performance. But the production function is not known entirely. Therefore, owners can not check the level of effort exerted by managers. Leibenstein then considers that the main determinant of the reduction of inefficiencies is the increase of competitive pressures for two reasons. First, competition provides incentives to managers to exert a higher effort. As they are aware of the increase of competition, managers have to improve their performance unless their firm leaves the market. Thus, managers are motivated by their will to avoid the personal costs of bankruptcy. Second, a higher number of firms on the market improves the possibilities for owners to assess firm performance, relative to other firms. They acquire in this way a better knowledge about the production function of the firm. Owners are then able to make a better assessment of managerial performance and consequently to proceed to changes in management if necessary. Being informed about the comparative possibilities of competition, managers are inclined to exert a higher effort. Following Leibenstein’s works, a few studies have proposed a formalization of his ideas (Hart, 1983, Selten, 1986, Scharfstein, 1988). The X-efficiency theory from Leibenstein lies in fact within the scope of the “Structure – Conduct - Performance” (SCP) paradigm proposed by Bain (1951).

According to this paradigm, the market structure would influence firm behavior in terms of prices and quantities, and therefore firm profits.

This survey has until now only presented some theoretical references about the link between competition and efficiency, which are not necessarily specific to the banking industry. However, the banking markets have some specific characteristics in comparison to other markets. First, banking markets have a structure of imperfect competition, as observed in most studies on banking competition (e.g. De Bandt and Davis, 2000, Bikker and Haaf, 2002, Weill, 2004). In fact, theoretical literature in banking suggests that imperfect competition may result from the information asymmetries between the bank and the borrower in the credit activity. As a consequence, banks have to implement some mechanisms to solve the resulting problems such as adverse selection and moral hazard. One way out is the implementation by the bank of a customer relationship, meaning a long-term repeated relationship, to gain some information on the borrower. Banks can then reduce the problems related to information asymmetries. Nevertheless, an increase in banking competition may reduce the length of customer relationship. These specific characteristics of the banking industry may consequently modify the relationship between competition and efficiency in banking.

According to Diamond (1984), banks have a comparative advantage in the ex post monitoring of borrowers, in comparison to investors, because of the existence of scale economies resulting from their role of delegated monitor. As a consequence, competition may increase monitoring costs because of the existence of scale economies, and of potential reduction of the length of the customer relationship, further decreasing cost efficiency of banks. In other words, the specificities of the banking industry provide some additional arguments in favor of a negative relationship between competition and cost efficiency. This assumption will be called the 'banking specificities hypothesis' in the following. It can be argued that this assumption should be more validated in transition countries than in developed countries. Indeed, banks are supposed to suffer more from information asymmetries in transition countries, because of the uncertainties of accounting information, and of the relative lack of know-how of bank employees in the analysis of credit risk in connection with the short history of market economy.

There are a number of studies that have applied the Panzar-Rosse methodology in measuring the degree of competition in the banking sector. These include Gelos and Roldos (2002); Nathan and Neave (1989); Claessens and Laeven (2004); De Bandt and Davis (2000); and Aktan and Massood (2010). Bikker and Groeneveld (2000) used data from a sample of European countries between 1989 and 1996 and found that there was no competition during the study period. Haffani (2002) studied the structure of Tunisia's banking sector during the period 1980 to 1999 applying the Panzar-Rosse method. The results showed that the Tunisian banking sector operated under monopolistic conditions with increasing competition. Bikker and Haaf (2002) analysed 23 OECD countries over the period 1988 to 1998 and their results showed that the countries were operating in a market structure of monopolistic competition. They further found that competition seemed to be stronger for large banks and weaker for smaller banks.

Weill (2004) studied twelve European countries during the period 1994 to 1999 using the yearly Tobit-based estimates of the H-statistic. The results showed that the countries, e.g. Spain, were operating under a decreasing pattern of monopolistic competition. He further found that there was a negative relationship between competition and efficiency. Al-Muharrami et al. (2006) studied the Arab Gulf Cooperation Council's banking sector over the period 1993 to 2002. Using the pooled and the fixed effect method found that the H-statistics was 0.24 and 0.47 respectively. The results meant that the banking sector was operating in a monopolistic competition environment. Wong et al. (2006) studied the evolution of competition in the banking sector of Hong Kong during the period 1991 to 2005 using the Panzar-Rosse method. The results showed that competitive pressure was higher among larger banks and lower among smaller banks.

Roldos and Gelos (2004) studied the structure of the banking sector in a number of European and Latin American countries and found that there was significant bank consolidation which led to a decline in the number of banks. The reduction in the number of banks did not reflect an increase in consolidation of the banking sector as measured by the standard concentration ratios, thus competition did not increase. The decline in the competitive pressures was as a result of lowering barriers to entry through increased participation of foreign banks. Casu and Giradone (2006) found that the degree of

concentration and the level of competition were independent of each other. Ariss (2009) established that the market structure in the banking system in the MENA region exhibited a monopolistic competition structure despite the increase in concentration. Claessens and Laeven (2004) found that the banking sector, which allowed foreign banks to enter their market and that those that did not restrict entry and activities were more competitive. The results did not find any evidence supporting negative relationships between banking system concentration competition and. These results supported the contestability hypothesis as contestability was found to affect competition. Abdul-Majid and Sofian (2008) studied the level of competition and the structure of the Islamic banking industry in Malaysia and found that the Malaysian banking sector was neither a monopoly market or perfectly competitive. The results pointed that the Islamic banks in Malaysia operated under monopolistic competition.

Korsah, Nyarko and Tagoe (2001) measured the intensity of bank competition in the Ghanaian banking sector after the implementation of economic reforms. The results showed that there was an increase in competition in Ghana's banking system as a result of the economic reforms and the banking sector was oligopolistic in nature, which explained the profitability of the sector. Fu and Heffernan (2009) investigated the relationship between market structure and performance in the Chinese banking system after the reforms in the financial sector. They found that x-efficiency significantly decreased and the majority of the banks operated below the levels of efficiencies of effective scale.

Delis (2012) argued that financial reforms and the quality of institutions are major determinants that promote competitive conduct of banks. The argument implies that the competitiveness of the banking sector increases with financial sector reforms in countries with stronger institutions which bring about financial innovation. Moyo and Nandwa (2014) argued that reforms are supposed to increase the amount of competition leading to financial innovation and efficiency. This argument is supported by Hauner and Peiris (2005) argued that a high degree of competition and efficiency leads to financial stability, product innovation, and access by households and firms to financial services. Yildirim and Philippatos (2007) also supported this view and proved that an increase in competition can enhance the prospects for economic growth, by raising the availability of credit and

financial services to businesses and households. Moyo and Nandwa (2014) identified a negative side to increased competition; that it could be a source of systemic risk to the financial structure through contagion leading to macroeconomic instability and reduced investments and growth. Hauner and Peiris (2005) argued that the recent global financial crisis is a testimony to the effect of financial sector reforms that mostly originated from excessive risk taking behaviour by banks. Noland (1996) studied the liberalisation of the domestic financial markets and found that financial liberalisation led to the convergence of the borrowing rates between the formal and informal markets. The creation of this competitive environment led to the banks to adopt cost cutting measures, efficiently use resources, reduce labour costs and increase the quality of services such as faster clearing of payments, rapid loan application processing and extended banking hours for the benefit of their clients. Cooray (2003) compared the pre- and post-reform periods in Sri Lanka in terms of regulatory reforms. Cooray measured the number of financial instruments on the market, depth by the volume of deposits, and resilience by the ability to bounce back from a price change. In addition Cooray (2003) found that though the reforms were still being implemented there was improvement in the width and depth of the financial system.

There was also improvement in terms of competition. The operational and allocative efficiency was found to have increased while the financial sector became resilient. Bhetuwal (2005) examined the financial liberalisation in Nepal in terms of entry barriers, interest rate controls, credit controls, regulations and financial transactions, and privatisation of the financial sector each classified into fully repressed, partially repressed, largely liberalised and fully liberalised. The results revealed a two way causality, running from financial liberalisation leading to financial development and vice versa. Bhetuwal (2005) further found that the reforms did not have an effect on mobilisation of financial saving, interest rate and currency stabilisation. Poshakwale and Qian (2009) studied the effects of financial sector reforms on the competitiveness of the Egyptian financial sector competitiveness and production efficiency. Their findings indicated that there was significant improvement in the competitiveness and production efficiency after the reforms. However they did not find any long run relationship between increased efficiency and economic growth.

Koskela and Stenbecka (2000) found that an increase in competition leads to a decline in lending rates which increased investments. The results also showed that under mean-shifting investment technologies, higher investments do not increase the bankruptcy risks of borrowers concluding that competition-fragility hypothesis is inconclusive. Matutes and Vives (2000) studied the effect of competition for deposits on the risk-taking behaviour of banks. They found that the uninsured market generates excessive deposit rates under perfect competition. This means there is a high asset risk. Flat-rate deposit insurance schemes and perfectly competitive banks also yield excessive deposit rates even if there is no failure costs, and therefore high asset risk. The results favoured the competition fragility hypothesis. Jimenez et al. (2007) investigated the competitiveness of the Spanish banking system and concluded that greater banking competition was associated with an increase in non-performing loans, which means that competition brings about risk behaviour on the part of the banks. This supported the competition fragility hypothesis. Berger et al. (2008) found that the risk exposure of banks was driven by higher market power. Increased market power increased loan portfolio risks, which support the competition-stability. The results confirmed the existence of competition-stability and competition fragility hypothesis. Liu et al. (2010) studied the degree of competition in European countries during the period 2000 to 2008. Their study sought to establish the existence of the competition-stability relationship. The study employed the Lerner index as a measure of competition and the Z-index as a proxy of bank stability. A nonlinear relationship was established between competition and stability. A negative relationship was established between competition and net interest margins (proxy for profit) meaning that an increase in banking competition had the effect of decreasing the net interest margins and increasing bank stability. This supported the competition stability hypothesis. Chirwa (2003) studied the connection between market structure and profitability of commercial banks in Malawi. The level of competition was found to have increased as a result of an increase in the number of commercial banks and financial institutions in general. A long run relationship was established between concentration of the banking sector and the level of profitability. The study established that collusion hypothesis hold for the Malawian financial sector as commercial bank profitability was positively related with measures of concentration. Hakam, Fatine and Zakaria (2012) studied the determinants of competition in Morocco.

Macroeconomic aggregates were found to be the main determinants of competition in Morocco.

Competition and concentration had a positive relationship while profitability and economic growth were negatively correlated. This showed that sustained economic growth enabled banks to maintain a competitive edge through retaining their share of the markets sustaining high levels of concentration. The positive relationship between competition and interbank interest rates meant that monetary policies positively impacted on the level of competition.

Competition is not supposed to be a sudden process given that it can potentially cause bank insolvency which can affect financial stability (Bikker & Boss 2005). Banks that operate in non-competitive markets suffer from intermediate monitoring costs and are likely to generate risky loans setting the stage for subsequent problems in the system such as rising non-performing loans (Caminal & Matures 2002). Another perspective on banking sector competition is that a lack of competition leads to limited access to finance by the key productive sectors of the economy, which then limits established corporates from financing investment through the banking system. A banking system that lacks competition leads to financial exclusion since higher banking competition with access to a wide range of product offering at a lower price improves financial inclusion. Bikker (2010) contended that competition should be allowed to a certain extent, beyond which, it becomes counterproductive. Bikker (2010) further argued that competition to a certain level leads to reduced excess profits and banks become constrained in their efforts to build extra buffers to protect them from shocks.

Mlambo and Ncube (2011) studied the South African banking sector to ascertain its degree of competition and efficiency. Using the Panza and Rosse approach, they found that the South African banking sector was operating under monopolistic competition. They further found that the banking sector in South Africa was dominated by five banks which accounted for over 85 per cent of total banking assets. Using a unique and detailed bank-level data set for Zambia, Simpasa (2013) estimated the H-statistic for the Zambian banking sector. The study found the H-statistic to be positive and statistically different from zero and unit. Simpasa (2013) estimated the H-Statistic for Zambia at 0.46 implying that

Zambian banks earned their revenue under conditions of monopolistic competition. The study also found that all three input prices were positive and significant.

Zerayehu et. al (2013) assess the trend, nature, and extent of competition in the Ethiopian banking industry using qualitative, descriptive and econometric techniques. In Ethiopian context, the financial system is dominated by banking industry, and yet, it is amongst the major under-banked economy in the world. Banks performances are governed largely by macroeconomic performances than competitive parameters as high (low) performances coincided with good (bad) macroeconomic conditions. The Ethiopian banking industry can be characterized as highly profitable, concentrated and moderately competitive. In most cases, the dominant bank (Commercial Bank of Ethiopia) still seizes quasi-monopoly power. In terms of contestability, the Ethiopian banking industry can be characterized as incontestable as entry in the industry is difficult, due to legal, technological and economic factors. Competition in terms of price is relatively weak in the Ethiopian banking industry. The econometric study also confirms that there is monopolistic competition among banks in terms of prices. In a nut shell, banks in the Ethiopian case are competing in terms of service quality and efficiency (including use of technological advances), branch network expansions, advertising and prices, put in the order of their significance.

Alber (2015) aims at examining the effects of three main variables which are the bank size, the age and the ownership structure on efficiency of Egyptian banks using Data Envelopment Analysis (DEA) according to CCR method. The study sample consisted of 10 Banks operating in Egypt between 1984 and 2013. Wilcoxon Signed Rank test was used to do the analysis. Findings indicate that, efficiency scores differ significantly, according to the three variables (the age, the size, and the ownership) of the Egyptian banks. Moreover, small, old and private banks seem to be more efficient than big, young and public ones.

The study of Farrag & Lang (2015) analyzes the efficiency of Egyptian banks in the period 2000–2006 which faced major regulatory and structural changes. The sample of the study consists of 34 Commercial banks representing about 75% of the banking sector in Egypt. The results shows that the banks suffer significantly from internal X-inefficiency with an

average cost reduction potential of 12%. Egyptian commercial banks did not benefit from technological change; instead they faced a negative dynamics of the cost frontier. Further regression analysis conducted to explain the different efficiency levels of the banks revealed a positive impact of size, growth, and merger activities on efficiency, which implies bigger is better for Egyptian Banks.

Hassan & Jreisat (2016) offers a measure to test the efficiency of the Egyptian banks by determining the factors affecting the banking efficiency. Data Envelopment Analysis (DEA) was used in the first stage to calculate the efficiency level for banks, and to compare the efficiency level of large, medium and small banks and the efficiency the of foreign and domestic banks through a balanced panel which cover 14 banks operating in Egypt from 1997 to 2013. A detailed analysis per banking group reveals that medium banks are the most efficient ones, followed by foreign banks.

Novickyte & Drożdż (2018) examines the efficiency of the banks in Lithuania by employing the DEA method. The efficiency scores were calculated with a non-parametric frontier input-oriented DEA technique with the variable returns to scale (VRS) and the constant returns to scale (CRS) assumptions. The Lithuanian bank's efficiency analysis based on the VRS assumption shows that better results are demonstrated by the local banks. The technical efficiency analysis based on the CRS assumption shows that during the 2012–2016 period the larger Lithuanian banks applied a more appropriate business model than smaller (local) banks operating in Lithuania.

Abreu, kimura & Subreiero (2019) analyzes and presents the current mainstream research on banking efficiency by assessing recent articles from major finance journals. 87 papers were examined that were published between January 2011 and July 2017. These studies were classified according to study type, approach, objective, and method. This has been conducted through geographical coordinates in order to visualize the global connections among these articles.

## 2.4 Conceptual Framework

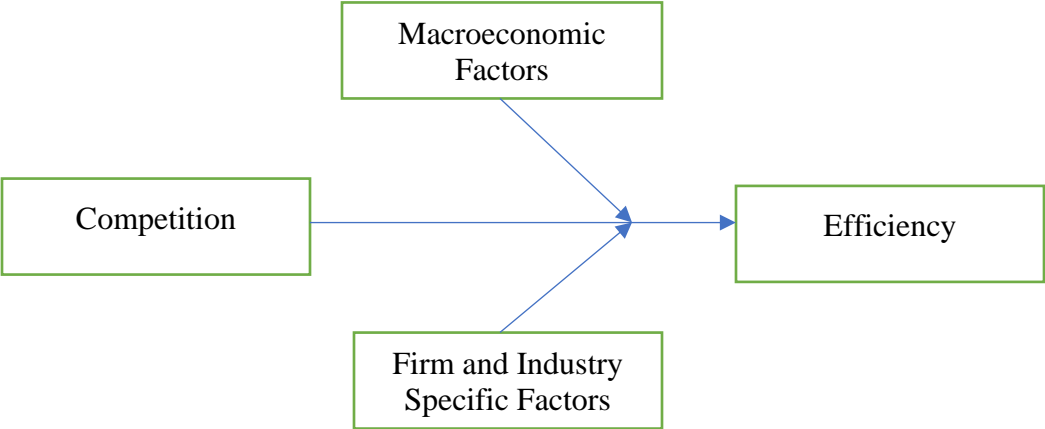


Figure 2. 1: Conceptual Framework

## **CHAPTER THREE**

### **RESEARCH METHODOLOGY**

#### **3.1. Research Design and Approach**

This study has followed quantitative research approach that the study was conducted by using quantitative data from secondary sources. Burns & Grove (2001) stated that research designing is intended to plan and implement the study in a way that enables to obtain intended results, thus, increasing the chances of obtaining information that could be associated with the real situation. As a method of analysis, this study has followed descriptive and explanatory research designs. Before running the explanatory analysis, the descriptive design was implemented intended to describe about bank specific and macroeconomic factors that are related to competition and efficiency.

The explanatory design was applied to examine the effect of competition on efficiency. Further, the explanatory analysis was conducted based on panel data analysis strategy that the dataset contains cross section of commercial banks in Ethiopia and yearly data about the banks in the dataset. Panel data has the advantage of giving more informative data as it consists of both the cross-sectional information, which captures individual variability, and the time series information, that captures dynamic adjustment. The study has used yearly data from yearly reports of commercial banks in Ethiopia for 20 years from 2001 to 2020. The study has included all commercial banks in Ethiopia. As the dataset contain all commercial banks in Ethiopia that have different establishment time, unbalanced panel data was used where majority of commercial banks in Ethiopia were formed within the study period.

Besides, this study has followed quantitative research approach that investigates quantitative properties and phenomena and relationships between the study variables by systematic and scientific way.

#### **3.2. Data Type and Sources**

This study has used secondary data for the objective of the study. It has included bank specific and macroeconomic factors. The macroeconomic factors that were included in the

study were inflation and GDP growth that were intended to examine the effect of economic stability and economic growth.

Data about bank specific variables was collected from secondary source such as financial statements and balance sheets of the banks from National Bank of Ethiopia (NBE) and websites of the banks. Data of macroeconomic factors were collected central statistical authority (CSA). All data used in study were quantitative data.

### 3.3. Sampling Design

This study has included all commercial banks operating in Ethiopia as a population of the study. To get larger data size to reach at generalizable conclusions, the study has tried to optimize the number of the banks to be included in the study and recentness of the time period. Based on this purpose, the study samples 17 commercial banks that are currently in operation. List of the banks currently in operation are presented in Table 3.1 below with respect to their establishment period.

*Table 3. 1: List of Commercial Banks in Ethiopia*

No.	Bank	Est.
1	Abay Bank S.C	2010
2	Addis international Bank S.C	2011
3	Awash International Bank S.C	1994
4	Bank of Abyssinia S.C	1996
5	Brehan Bank S.C	2009
6	Bunna International Bank S.C	2009
7	Commercial Bank of Ethiopia	1974
8	Cooperative Bank of Ethiopia S.C	2005
9	Dashen Bank S.C	1996
10	Dehub Global Bank S.C	2012
11	Enat Bank S.C	2013
12	Lion International Bank S.C	2006
13	Nib International Bank S.C	1999
14	Oromia Bank S.C	2008
15	United Bank S.C	1998
16	Wegagen Bank S.C	1997
17	Zemen Bank S.C	2009

Source: National Bank of Ethiopia (2022)

### **3.4. Data Analysis**

This study was conducted with an objective of identifying competition and its effect on efficiency of commercial banks in Ethiopia during the period of 2001 to 2020. To achieve this objective the study has used data about financial performance of the 17 commercial banks period from 2001 to 2020. The study dataset contains cross-sections and time variables. Thus, the study was analyzed by using panel data analysis strategy. The panel data has advantage over cross sectional and time series data by combining time series of cross section observations give more informative data, more variability, less co-linearity among variables, more degrees of freedom and more efficiency (Gujarati,2004).

The data was analyzed by using the descriptive statistics and multiple regressions. For the descriptive analysis, the study will use descriptive statistics such as the mean, standard deviation, maximum and minimum values were used.

Further, the regression analysis was conducted by using panel strategies. To this end, the study used Housman specification test to select appropriate model between fixed and the random effects models. Moreover, the diagnostic tests will be undertaken in order to check the validity of the model and fulfill the assumption of the Classical Linear Regression Model. The study has used STATA version 14 computer software to conduct the data analysis.

### **3.5 Variable Specification**

#### **3.5.1 Measuring Competition**

The Lerner index extent to market power which define as bank's price minus marginal cost divided by the bank's price. To calculate bank level data the Lerner index is used. The range is utilized  $0 < \text{Lerner} < 1$  for level of competition. At the point when the estimation of Lerner list is zero (0), it shows market power is lower but highly competitive. On the other hand, if the value of Lerner index is one (1), it indicates that market power will be more but less competitive.

Lerner index calculate as

$$Lerner_{it} = \frac{P_{TAit} - MC_{TAit}}{P_{TAit}}$$

Where,  $P_{TAit}$  represents the price of total assets  $MC_{TAit}$  indicates the marginal cost of total assets of the bank  $i$  at time  $t$ . Price indicates total operating income which calculates interest income plus non-interest income divided by total assets of banks  $i$  in time  $t$ .

$MC_{TAit}$  is computed from Cost function by using translog cost function. Translog cost function is provided as follows.

$$\begin{aligned} \ln C_{it} = & \beta_0 + \beta_1 \ln asset + \frac{\beta_2}{2} \ln asset^2 + \beta_3 \ln W_{1it} + \beta_4 \ln W_{2it} + \beta_5 \ln W_{3it} + \beta_6 W_{1it}^2 + \\ & \beta_7 W_{2it}^2 + \beta_8 W_{3it}^2 + \beta_9 \ln W_{1it} * \ln W_{2it} + \beta_{10} \ln W_{1it} * \ln W_{3it} + \beta_{11} \ln W_{2it} * \ln W_{3it} + \\ & \beta_{12} \ln asset_{it} * \ln W_{1it} + \beta_{13} \ln asset_{it} * \ln W_{2it} + \beta_{14} \ln asset_{it} * \ln W_{3it} + \varepsilon_{it} \quad (1) \end{aligned}$$

Where,  $\ln C$  is natural logarithm of total cost;  $\ln asset$  is natural logarithm of total asset;  $W1$  is input prices of labor (personal expenses to total assets);  $W2$  is Input prices of funds (interest expenses to total deposits); and  $W3$  is Input prices of fixed capital (other operating and administrative expenses to total assets).

From the trans-log cost function, marginal cost is computed as;

$$MC_{it} = \frac{C_{it}}{asset_{it}} (\beta_1 + \beta_2 \ln asset_{it} + \beta_3 \ln W_{1it} + \beta_4 \ln W_{2it} + \beta_5 \ln W_{3it}) \quad (2)$$

Where;  $MC_{it}$  is marginal cost of bank  $i$  at time  $t$ ;  $C_{it}$  is Total Cost of bank  $i$  at time  $t$

### 3.5.2 Measuring Efficiency

Cost efficiency examines how a bank work well under the level environment condition concern to ‘best-practice bank’ which producing the equivalent output. Cost efficiency measures for getting equal output, by reducing variance concern to benchmark bank with minimize cost. The cost efficiency level use generally from the cost function and it is

estimated by using Stochastic Frontier Approach (SFA) based on following functional form.

$$\begin{aligned} \ln C_{it} = & \beta_0 + \beta_1 \ln \text{asset} + \frac{\beta_2}{2} \ln \text{asset}^2 + \beta_3 \ln W_{1it} + \beta_4 \ln W_{2it} + \beta_5 \ln W_{3it} + \beta_6 W_{1it}^2 + \\ & \beta_7 W_{2it}^2 + \beta_8 W_{3it}^2 + \beta_9 \ln W_{1it} * \ln W_{2it} + \beta_{10} \ln W_{1it} * \ln W_{3it} + \beta_{11} \ln W_{2it} * \ln W_{3it} + \\ & \beta_{12} \ln \text{asset}_{it} * \ln W_{1it} + \beta_{13} \ln \text{asset}_{it} * \ln W_{2it} + \beta_{14} \ln \text{asset}_{it} * \ln W_{3it} + v_{it} + u_{it} \end{aligned} \quad (3)$$

Where  $v$  denotes the effect of statistical noise.  $\mu$  represents the non - negative random disturbance term which taking the effects of inefficiency.

Effect of competition on efficiency is estimated by using bank specific, industry specific and macroeconomic condition of the country. Bank specific factors are included by using competition, asset, liquidity risk and credit risk. The industry specific factors include type of ownership; and macroeconomic condition is indicated by economic growth and economic stability.

$$\begin{aligned} CE_{it} = & \beta_0 + \beta_1 \text{lerner}_{it} + \beta_2 \ln \text{asset}_{it} + \beta_3 \text{ownership}_{it} + \beta_4 \text{lr}_{it} + \beta_5 \text{cr}_{it} + \beta_6 \text{gdp}_t + \\ & \beta_7 \text{cpi}_t + \varepsilon_{it} \end{aligned} \quad (4)$$

As control variables, this study has used credit risk that computed as percentage of provision for doubtful loan computed as ratio of provision to doubtful loan over total loans;  $lr$  is liquidity risk computed as ratio of loan to total deposit;  $\ln \text{asset}$  indicates size of bank which is total assets is included as a proxy for size.  $\text{gdp}$  is natural logarithm of real GDP;  $\text{cpi}$  is natural logarithm of Consumer Price Index (CPI).

### 3.6 Ethical Consideration

. Every person involved in the study was entitled to the right of privacy and dignity of treatment, and no personal harm were caused to subjects in the research. Information obtained is held in strict confidentiality by the researcher. All assistance, collaboration of others and sources from which information was drawn were acknowledged.

## **CHAPTER FOUR**

### **RESULT AND DISCUSSION**

#### **4.1 Introduction**

This study is conducted with an objective of identifying relationship between competition and efficiency at commercial banks in Ethiopia. Based on this main objective, three specific objectives were developed; assessing competition in banking industry in Ethiopia, examine efficiency of commercial banks in Ethiopia, and identifying the effect of competition on efficiency of commercial banks in Ethiopia. To meet the objectives, the study has followed quantitative research approach and employed descriptive and explanatory research designs. Based on previous studies, this study has used balance sheet items and collected the data from NBE. The study has included all commercial banks in Ethiopia and the study period includes 2001 to 2020. Thus, the study has used unbalanced panel data and the data was analyzed by using panel data analysis methods. Before examining the effect of competition on efficiency of the banks, competition is estimated based on Lerner Index and HHI. In addition, the efficiency of the banks is predicted based on SFA method. While identifying the relationship between competition and efficiency, macroeconomic factors, such as inflation and economic growth were included to the estimation models.

This chapter presents result of data analysis, interpretation of results and discussion on the results. It has three main sections; the first section of the chapter presents competition in the banking industry in Ethiopia; the second section presents efficiency of the banks; and the third sections presents effect of competition on efficiency in banking industry in Ethiopia.

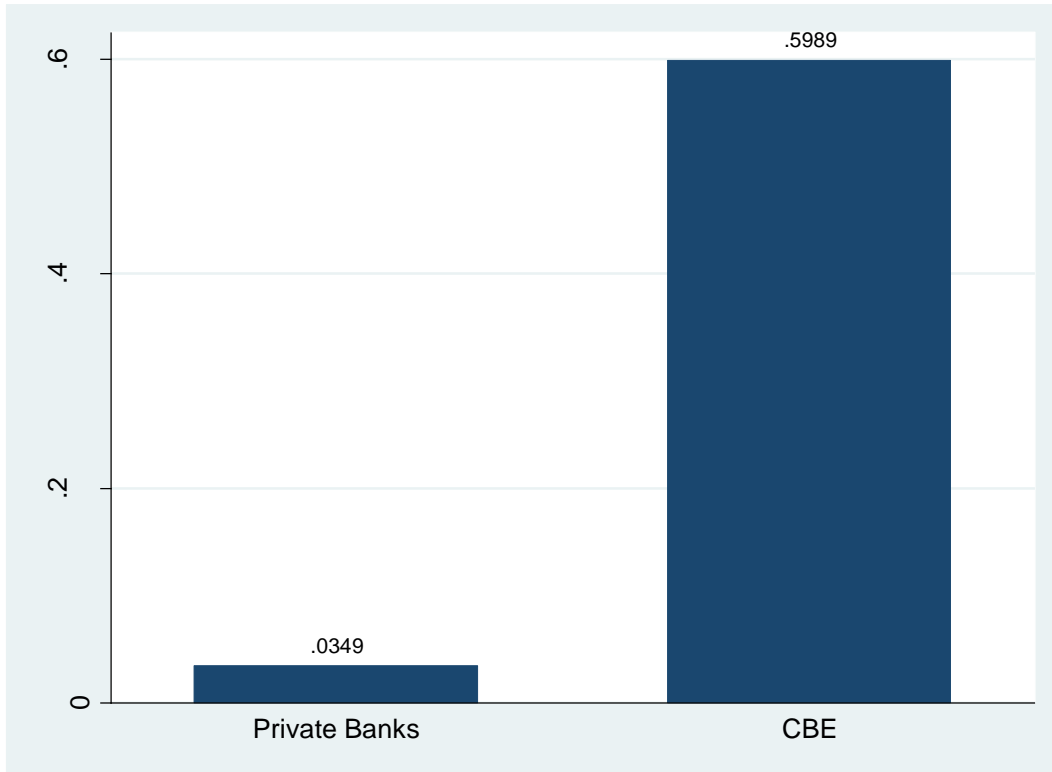
#### **4.2 Competition in Commercial Banks in Ethiopia**

This section of the study presents the competition in commercial banks in Ethiopia during study period (2001 – 20120). The competition status is assessed based on Lerner Index and HHI.

In the first section, this study presents the market structure based on revenue and HHI and the result is split for private banks and CBE during the study period. An average market

share of banks during the study period is presented by using market share and the market structure is analyzed by using HHI. The summary result is for market share during the study period is in Figure 4.1 below.

Figure 4. 1 Overall Market Share



Source: Author’s Computation, 2022

As depicted in Figure 4.1 above, in the two decades under the study, highest market share is possessed by CBE. The revenue share of CBE was 59.89% during the 2001 to 2020. On the other hand, an average revenue share of private banks during the study period was only 3.49%. This indicates the banking industry during periods from 2001 to 2020 was monopolized by CBE.

Summary of HHI is presented in Table 4.1 below for overall banking industry and separately for private banks and public bank i.e., CBE. In addition, the number of banks were presented as an additional indicator of market structure.

Table 4. 1 HHI of Banking Industry in Ethiopia

Year	Number of Banks	HHI		
		Overall	PV	CBE
2001	7	0.6040	0.0104	0.5936
2002	7	0.4964	0.0185	0.4778
2003	7	0.5642	0.0128	0.5514
2004	7	0.4431	0.0236	0.4195
2005	8	0.3887	0.0285	0.3603
2006	8	0.3710	0.0325	0.3385
2007	9	0.3499	0.0346	0.3153
2008	9	0.3424	0.0339	0.3085
2009	11	0.3694	0.0283	0.3411
2010	13	0.3105	0.0312	0.2793
2011	14	0.3432	0.0254	0.3178
2012	15	0.4205	0.0170	0.4035
2013	16	0.4049	0.0158	0.3891
2014	17	0.4003	0.0149	0.3854
2015	17	0.3943	0.0138	0.3805
2016	17	0.3787	0.0137	0.3649
2017	17	0.3258	0.0175	0.3084
2018	17	0.2670	0.0222	0.2448
2019	17	0.2860	0.0210	0.2650
2020	17	0.2597	0.0235	0.2362
<b>Overall</b>		<b>0.368</b>	<b>0.021</b>	<b>0.364</b>

Source: Author's Computation, 2022

As shown in Table 4.1 above, overall HHI of CBE is larger than HHI of the private banks with values of 0.364 and 0.021 respectively. This finding indicates that CBE is the market leader and the private banks are followers. In addition, the overall HHI during the study period was 0.368 that suggests there is weak competition in banking industry in Ethiopia. This further shows existence of monopolistic competition in banking industry in Ethiopia.

This study further assessed trend of competition during the study period by using detailed measures of competition. For this purpose, this study has used Lerner Index and HHI to analyze the market structure in detail. Lerner Index considers size of a bank and total cost used for business operation. As Lerner Index is computed by using price and marginal cost, first, marginal cost is computed from total cost function by following trans-log cost function. It is computed based on equation (1) and the result of empirical estimation is presented in Table 4.1.

Table 4. 2 Trans-log Cost Function Estimation

<code>corr(u_i, Xb) = 0.3075</code>	<code>F(14, 217) = 110001.34</code> <code>Prob &gt; F = 0.0000</code>																																																																																																
<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; width: 15%;">Inc</th> <th style="text-align: left; width: 15%;">Coef.</th> <th style="text-align: left; width: 15%;">Std. Err.</th> <th style="text-align: left; width: 10%;">t</th> <th style="text-align: left; width: 10%;">P&gt; t </th> <th style="text-align: left; width: 15%;">[95% Conf. Interval]</th> </tr> </thead> <tbody> <tr><td><code>lnasset</code></td><td><code>.7194834</code></td><td><code>.0506403</code></td><td><code>14.21</code></td><td><code>0.000</code></td><td><code>.6196736 .8192933</code></td></tr> <tr><td><code>lnasset2</code></td><td><code>.0969435</code></td><td><code>.0063632</code></td><td><code>15.24</code></td><td><code>0.000</code></td><td><code>.0844019 .109485</code></td></tr> <tr><td><code>lnl</code></td><td><code>.3885311</code></td><td><code>.0879862</code></td><td><code>4.42</code></td><td><code>0.000</code></td><td><code>.2151141 .5619482</code></td></tr> <tr><td><code>lnf</code></td><td><code>.1809902</code></td><td><code>.0542571</code></td><td><code>3.34</code></td><td><code>0.001</code></td><td><code>.0740518 .2879287</code></td></tr> <tr><td><code>lnfc</code></td><td><code>.3615393</code></td><td><code>.0524641</code></td><td><code>6.89</code></td><td><code>0.000</code></td><td><code>.258135 .4649437</code></td></tr> <tr><td><code>lnapl</code></td><td><code>.0669669</code></td><td><code>.0108212</code></td><td><code>6.19</code></td><td><code>0.000</code></td><td><code>.0456389 .088295</code></td></tr> <tr><td><code>lnapf</code></td><td><code>.1532355</code></td><td><code>.0101428</code></td><td><code>15.11</code></td><td><code>0.000</code></td><td><code>.1332444 .1732266</code></td></tr> <tr><td><code>lnapfc</code></td><td><code>-.1964213</code></td><td><code>.0133964</code></td><td><code>-14.66</code></td><td><code>0.000</code></td><td><code>-.2228249 -.1700177</code></td></tr> <tr><td><code>lnl2</code></td><td><code>.066259</code></td><td><code>.0094909</code></td><td><code>6.98</code></td><td><code>0.000</code></td><td><code>.047553 .0849651</code></td></tr> <tr><td><code>lnf2</code></td><td><code>.0859818</code></td><td><code>.0047972</code></td><td><code>17.92</code></td><td><code>0.000</code></td><td><code>.0765268 .0954368</code></td></tr> <tr><td><code>lnfc2</code></td><td><code>.0954154</code></td><td><code>.0077003</code></td><td><code>12.39</code></td><td><code>0.000</code></td><td><code>.0802384 .1105923</code></td></tr> <tr><td><code>lnlf</code></td><td><code>-.0465311</code></td><td><code>.011909</code></td><td><code>-3.91</code></td><td><code>0.000</code></td><td><code>-.0700033 -.0230589</code></td></tr> <tr><td><code>lnlfc</code></td><td><code>-.0668552</code></td><td><code>.0119868</code></td><td><code>-5.58</code></td><td><code>0.000</code></td><td><code>-.0904807 -.0432297</code></td></tr> <tr><td><code>lnffc</code></td><td><code>-.1456835</code></td><td><code>.011714</code></td><td><code>-12.44</code></td><td><code>0.000</code></td><td><code>-.1687713 -.1225958</code></td></tr> <tr><td><code>_cons</code></td><td><code>.5878832</code></td><td><code>.2785333</code></td><td><code>2.11</code></td><td><code>0.036</code></td><td><code>.0389062 1.13686</code></td></tr> </tbody> </table>		Inc	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	<code>lnasset</code>	<code>.7194834</code>	<code>.0506403</code>	<code>14.21</code>	<code>0.000</code>	<code>.6196736 .8192933</code>	<code>lnasset2</code>	<code>.0969435</code>	<code>.0063632</code>	<code>15.24</code>	<code>0.000</code>	<code>.0844019 .109485</code>	<code>lnl</code>	<code>.3885311</code>	<code>.0879862</code>	<code>4.42</code>	<code>0.000</code>	<code>.2151141 .5619482</code>	<code>lnf</code>	<code>.1809902</code>	<code>.0542571</code>	<code>3.34</code>	<code>0.001</code>	<code>.0740518 .2879287</code>	<code>lnfc</code>	<code>.3615393</code>	<code>.0524641</code>	<code>6.89</code>	<code>0.000</code>	<code>.258135 .4649437</code>	<code>lnapl</code>	<code>.0669669</code>	<code>.0108212</code>	<code>6.19</code>	<code>0.000</code>	<code>.0456389 .088295</code>	<code>lnapf</code>	<code>.1532355</code>	<code>.0101428</code>	<code>15.11</code>	<code>0.000</code>	<code>.1332444 .1732266</code>	<code>lnapfc</code>	<code>-.1964213</code>	<code>.0133964</code>	<code>-14.66</code>	<code>0.000</code>	<code>-.2228249 -.1700177</code>	<code>lnl2</code>	<code>.066259</code>	<code>.0094909</code>	<code>6.98</code>	<code>0.000</code>	<code>.047553 .0849651</code>	<code>lnf2</code>	<code>.0859818</code>	<code>.0047972</code>	<code>17.92</code>	<code>0.000</code>	<code>.0765268 .0954368</code>	<code>lnfc2</code>	<code>.0954154</code>	<code>.0077003</code>	<code>12.39</code>	<code>0.000</code>	<code>.0802384 .1105923</code>	<code>lnlf</code>	<code>-.0465311</code>	<code>.011909</code>	<code>-3.91</code>	<code>0.000</code>	<code>-.0700033 -.0230589</code>	<code>lnlfc</code>	<code>-.0668552</code>	<code>.0119868</code>	<code>-5.58</code>	<code>0.000</code>	<code>-.0904807 -.0432297</code>	<code>lnffc</code>	<code>-.1456835</code>	<code>.011714</code>	<code>-12.44</code>	<code>0.000</code>	<code>-.1687713 -.1225958</code>	<code>_cons</code>	<code>.5878832</code>	<code>.2785333</code>	<code>2.11</code>	<code>0.036</code>	<code>.0389062 1.13686</code>
Inc	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]																																																																																												
<code>lnasset</code>	<code>.7194834</code>	<code>.0506403</code>	<code>14.21</code>	<code>0.000</code>	<code>.6196736 .8192933</code>																																																																																												
<code>lnasset2</code>	<code>.0969435</code>	<code>.0063632</code>	<code>15.24</code>	<code>0.000</code>	<code>.0844019 .109485</code>																																																																																												
<code>lnl</code>	<code>.3885311</code>	<code>.0879862</code>	<code>4.42</code>	<code>0.000</code>	<code>.2151141 .5619482</code>																																																																																												
<code>lnf</code>	<code>.1809902</code>	<code>.0542571</code>	<code>3.34</code>	<code>0.001</code>	<code>.0740518 .2879287</code>																																																																																												
<code>lnfc</code>	<code>.3615393</code>	<code>.0524641</code>	<code>6.89</code>	<code>0.000</code>	<code>.258135 .4649437</code>																																																																																												
<code>lnapl</code>	<code>.0669669</code>	<code>.0108212</code>	<code>6.19</code>	<code>0.000</code>	<code>.0456389 .088295</code>																																																																																												
<code>lnapf</code>	<code>.1532355</code>	<code>.0101428</code>	<code>15.11</code>	<code>0.000</code>	<code>.1332444 .1732266</code>																																																																																												
<code>lnapfc</code>	<code>-.1964213</code>	<code>.0133964</code>	<code>-14.66</code>	<code>0.000</code>	<code>-.2228249 -.1700177</code>																																																																																												
<code>lnl2</code>	<code>.066259</code>	<code>.0094909</code>	<code>6.98</code>	<code>0.000</code>	<code>.047553 .0849651</code>																																																																																												
<code>lnf2</code>	<code>.0859818</code>	<code>.0047972</code>	<code>17.92</code>	<code>0.000</code>	<code>.0765268 .0954368</code>																																																																																												
<code>lnfc2</code>	<code>.0954154</code>	<code>.0077003</code>	<code>12.39</code>	<code>0.000</code>	<code>.0802384 .1105923</code>																																																																																												
<code>lnlf</code>	<code>-.0465311</code>	<code>.011909</code>	<code>-3.91</code>	<code>0.000</code>	<code>-.0700033 -.0230589</code>																																																																																												
<code>lnlfc</code>	<code>-.0668552</code>	<code>.0119868</code>	<code>-5.58</code>	<code>0.000</code>	<code>-.0904807 -.0432297</code>																																																																																												
<code>lnffc</code>	<code>-.1456835</code>	<code>.011714</code>	<code>-12.44</code>	<code>0.000</code>	<code>-.1687713 -.1225958</code>																																																																																												
<code>_cons</code>	<code>.5878832</code>	<code>.2785333</code>	<code>2.11</code>	<code>0.036</code>	<code>.0389062 1.13686</code>																																																																																												
<code>sigma_u</code>	<code>.02511969</code>																																																																																																
<code>sigma_e</code>	<code>.01873128</code>																																																																																																
<code>rho</code>	<code>.64265694 (fraction of variance due to u_i)</code>																																																																																																
<code>F test that all u_i=0: F(16, 217) = 10.28</code>	<code>Prob &gt; F = 0.0000</code>																																																																																																

Another indicator of competition in the banking industry is Lerner Index that considers price and marginal cost while analyzing competition in a market. Lerner index is computed at the firm level where the marginal cost is computed from cost function and price is computed by using revenue and asset of a bank. It indicates variation of price from marginal

cost. The summary of Lerner Index for overall banking industry and separately for the private banks and CBE; and it is presented in Table 4.3 below.

*Table 4.3 Summary: Competition*

Year	Number of Banks	Lerner		
		Overall	PV	CBE
2001	7	0.785	0.8806	0.2150
2002	7	0.841	0.8766	0.6238
2003	7	0.872	0.8763	0.8432
2004	7	0.891	0.9125	0.7612
2005	8	0.891	0.8904	0.8987
2006	8	0.781	0.7634	0.9047
2007	9	0.757	0.7442	0.8552
2008	9	0.737	0.7240	0.8393
2009	11	0.762	0.7495	0.8900
2010	13	0.801	0.7999	0.8131
2011	14	0.823	0.8269	0.7749
2012	15	0.794	0.7960	0.7660
2013	16	0.728	0.7299	0.7012
2014	17	0.660	0.6655	0.5722
2015	17	0.521	0.5208	0.5247
2016	17	0.398	0.4047	0.3015
2017	17	0.291	0.2926	0.2719
2018	17	0.213	0.2214	0.0790
2019	17	0.254	0.2681	0.0358
2020	17	0.338	0.3430	0.2507
<b>Overall</b>		<b>0.601</b>	<b>0.596</b>	<b>0.601</b>

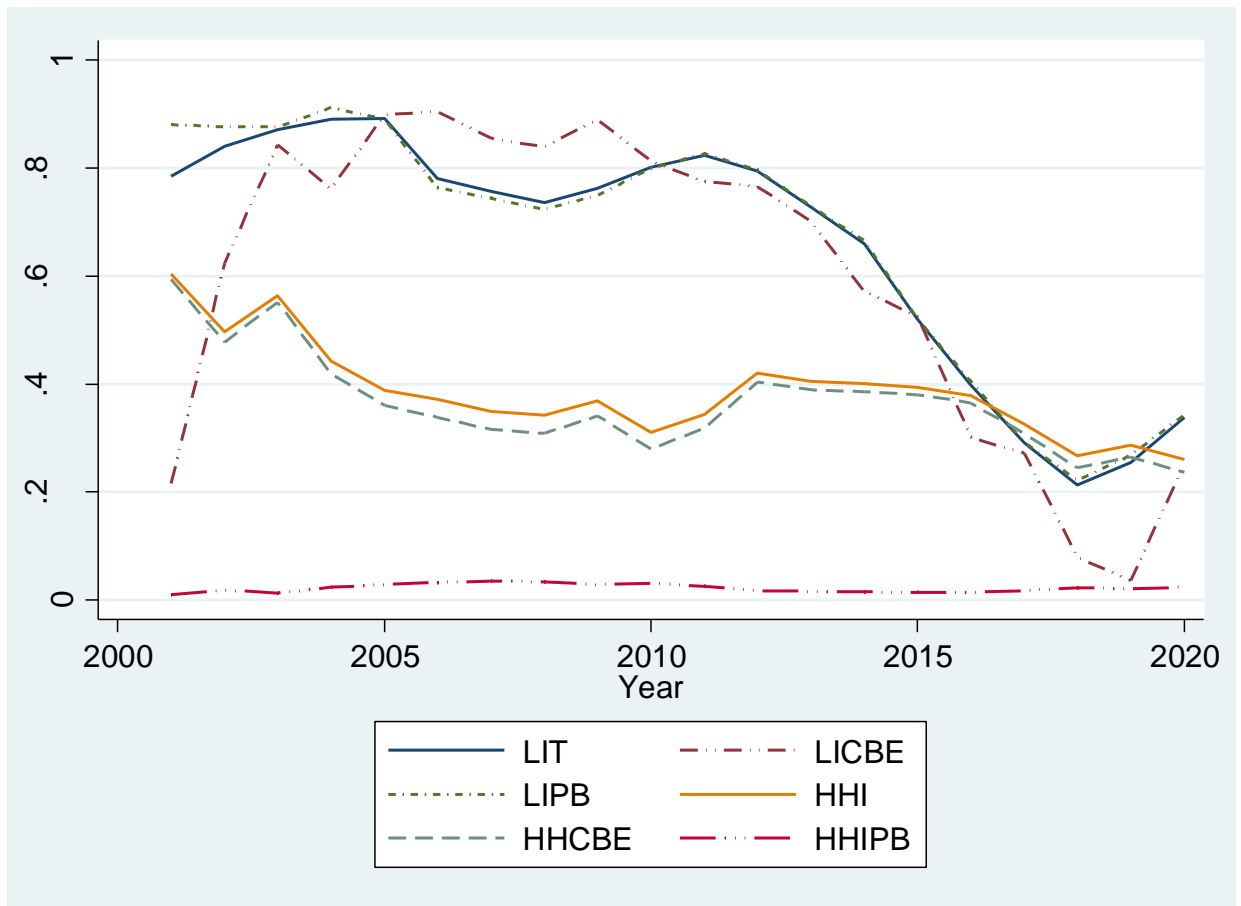
Source: Author's Computation, 2022

As depicted in Table 4.3, the overall Lerner Index during the study period was 0.601 that indicates during period from 2001 to 2020, on average, price of commercial banks in Ethiopia for their price is higher by 0.6 Birr than marginal cost. This indicates there is weak

competition among commercial banks in Ethiopia. In perfectly competitive market, firms set price equals marginal cost and at market where monopoly exists price is higher than marginal cost. The Lerner index of the market is similar to Lerner index of the public bank, CBE. On the other hand, the Lerner index of private banks is below the market average during the study period. But there is no significant variation from market average between CBE and private banks.

The trend of competitive condition during the study period is presented in Figure 4.2 below.

Figure 4. 2 Trend of Competition



Source: Author’s Computation, 2022

As shown in Figure 4.2 above, market power of commercial banks in Ethiopia is declining in banking industry in Ethiopia that suggests the banks are losing the monopoly power and the marketing is becoming competitive. This is further indicated that CBE is losing its

market power and its market share is decreasing. On the other hand, the market power of private banks is increasing with very slow rate. Thus, the competition in banking industry in Ethiopia is becoming competitive in regards to market share.

Similar to finding through HHI, competition of commercial banks in Ethiopia is becoming competitive that on overall Lerner Index is declining for the industry analysis. In particular, Lerner Index of private banks is declining similar to industry level Lerner Index. In contrast to private banks, Lerner Index of CBE is highly changing during the study period. currently, the Lerner Index of CBE is at lowest level that suggests there is small variation between price and marginal cost in CBE. This further indicates that CBE is providing its service with very competitive price.

### 4.3 Efficiency of Commercial Banks in Ethiopia

The second objective of this study to examine efficiency of commercial banks in Ethiopia. Based on this objective, efficiency of the banks is estimated by using SFA model of cost function. The result of SFA model is summarized in Table 4.4 below.

Table 4. 4 SFA Estimation

Inc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnasset	.5815343	.0094745	61.38	0.000	.5629646	.6001039
lnl	.2394175	.0122225	19.59	0.000	.215462	.2633731
lnf	.2631369	.0086521	30.41	0.000	.246179	.2800948
lnfc	.4250893	.0108683	39.11	0.000	.4037877	.4463908
_cons	.6740993	.0538702	12.51	0.000	.5685157	.7796829
/mu	.091588	.0507622	1.80	0.071	-.007904	.1910801
/eta	-.2006508	.0460364	-4.36	0.000	-.2908806	-.1104211
/lnsigma2	-4.813602	.5383738	-8.94	0.000	-5.868795	-3.758408
/ilgtgamma	.926006	.7607846	1.22	0.224	-.5651044	2.417116
sigma2	.0081186	.0043708			.0028263	.0233208
gamma	.7162643	.1546141			.3623672	.9181232
sigma_u2	.005815	.0043727			-.0027553	.0143853
sigma_v2	.0023035	.0002147			.0018827	.0027244

Source: Author's Computation, 2022

As shown in Table 4.4 above, asset is significant at significance level of 1% and the effect is positive that the coefficient is positive. This indicates the as production of the bank

increases the total cost is increasing. Specifically, 1% increase of asset of the banks results on 0.58% increase of cost. Thus, marginal cost of the banks is increasing during study period for increase of production. In addition, cost of labor, funds and capital is positively and significantly linked with total cost where 1% increase of cost of labor, funds and capital resulted in increase of cost by 0.24%, 0.26%, and 0.43% respectively.

The cost efficiency is estimated from the trans-log cost function and the estimated efficiency is summarized in Table 4.5 below.

*Table 4. 5 Cost Efficiency of Banks*

<b>Over</b>	<b>Industry</b>	<b>PB</b>	<b>CBE</b>
2001	0.9971	0.9969	0.9981
2002	0.9964	0.9962	0.9976
2003	0.9957	0.9954	0.9971
2004	0.9947	0.9944	0.9965
2005	0.9941	0.9938	0.9957
2006	0.9927	0.9925	0.9947
2007	0.9915	0.9912	0.9936
2008	0.9896	0.9893	0.9921
2009	0.9867	0.9864	0.9904
2010	0.9849	0.9846	0.9883
2011	0.9821	0.9818	0.9857
2012	0.9791	0.9789	0.9825
2013	0.9757	0.9755	0.9787
2014	0.9682	0.9678	0.9740
2015	0.9622	0.9618	0.9683
2016	0.9540	0.9535	0.9614
2017	0.9428	0.9422	0.9530
2018	0.9306	0.9299	0.9429
2019	0.9160	0.9151	0.9306
2020	0.8986	0.8975	0.9158
<b>Overall</b>	<b>.9642</b>	<b>.9631</b>	<b>.9769</b>

Source: Author's Computation, 2022

As shown in Table 4.5 above, commercial banks in Ethiopia are cost efficient that very small amount of inefficiency is observed. Further, the values of observed cost efficiency are closer to 1 that implies the inputs used; human power, deposit and other operating inputs

are efficiently utilized in the business process of revenue generation from interest and non-interest sources. Specifically, the overall mean computed for the banking industry is 0.9642 that suggests the banks are utilizing 96.42% of inputs efficiently. Comparatively, CBE is more efficient than private banks with mean of 0.9769 and 0.9631 respectively. In both groups of banks, private banks and CBE, lowest efficiency is observed in recent periods, lowest in 2020. This indicates that the efficiency of the banks is decreasing. Specifically, efficiency score for the industry was 0.8986; and it is 0.8975 and 0.9158 for private banks and CBE respectively.

As shown is presented in previous sections, 4.2 and 4.3, the market structure of banking industry in Ethiopia is becoming competitive and the cost efficiency is declining during the study period. But it is not clear that competition is whether resulting on efficiency or not. The effect of competition on efficiency of the banking industry is presented in following section.

#### **4.4 Effect of Competition on Efficiency**

This study is mainly conducted to examine the effect of competition on efficiency of commercial banks in Ethiopia. In line with this objective, competition and efficiency of the banks empirically estimated and presented in previous sections. The competition was examined by using Lerner Index based on revenue and cost. In addition, the efficiency was computed by using SFA model. This section of the study presents the result of empirical estimation about effect of the competition on efficiency of the banks.

As shown in Table 4.3, the effect of competition is negative ( $\beta = -0.013$ ) and statistically significant at 0.05 ( $p=0.03$ ). This indicates that competition and efficiency are negatively related that implies commercial banks in Ethiopia that have higher monopoly power have lower efficiency and vis-versa holding other factors constant. Specifically, on average, 1% increase of market power of a bank results 0.013% decrease of cost efficiency. This implies that, when other factors are constant, competition improves efficiency of commercial banks in Ethiopia. In contrast, commercial banks in Ethiopia that have higher market power have lower cost efficiency than banks that have lower market power.

Table 4. 6 Regression Result

CE	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
lerner	-0.013	0.006	-2.06	0.039	-0.025	-0.001	**
lnasset	0.008	0.002	3.48	0.001	0.003	0.012	***
ownership	-0.027	0.020	-1.33	0.185	-0.067	0.013	
lnlr	0.009	0.018	0.52	0.602	-0.025	0.044	
lncr	-0.038	0.112	-0.34	0.731	-0.258	0.181	
gdp	0.730	0.300	2.44	0.015	0.143	1.318	**
cpi	-0.481	0.167	-2.88	0.004	-0.809	-0.154	***
Constant	-1.162	0.986	-1.18	0.238	-3.094	0.770	
Mean dependent var		0.964	SD dependent var		0.038		
Overall r-squared		0.513	Number of obs		248.000		
Chi-square		1168.250	Prob > chi2		0.000		
R-squared within		0.869	R-squared between		0.057		

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

Source: Author's Computation, 2022

While identifying the effect of competition on efficiency of the banks, this study has controlled the effect of size of a bank as large banks have high monopoly power than smaller banks and they became cost efficient because of economies of scale. As expected, the effect of size of a bank is positive and significant on efficiency of a bank. The coefficient ( $\beta = 0.008$ ) of size is positive and significant ( $p < 0.01$ ), this indicates that, on average, 1% increase in asset of a bank at a given period results 0.008% rise in cost efficiency of a bank.

The second variable included to the empirical model is 'type of ownership' (private banks or CBE). The effect of this variable is not statistically significant. Whether the bank is public or private, cost efficiency does not significantly vary. Relatively, efficiency of public banks, CBE, is lower than cost efficiency of private banks.

Further, liquidity risk and credit risk, are not statistically significant where coefficient of liquidity risk is positive and credit risk is negative.

Finally, this study has included macro-economic condition while examining the effect of competition on cost efficiency. The macro-economic condition is indicated by national income and economic stability. The effect of national income is positive and significant ( $p < 0.05$ ) that indicates economic growth improves efficiency of commercial banks in Ethiopia. The estimation result shown that 1% rise of economic growth result on 0.73% rise on efficiency of commercial banks in Ethiopia, holding other factors constant.

Economic stability is indicated by using CPI, where higher value of CPI indicates economic instability and lower value of CPI indicates economic stability. The coefficient of CPI on efficiency is negative and significant ( $p < 0.01$ ) that indicates economic instability causes cost inefficiency of commercial banks in Ethiopia.

## **CHAPTER FIVE**

### **CONCLUSION AND RECOMMENDATIONS**

#### **4.1 Summary of Major Findings**

This study was conducted to identify effect of competition on efficiency of commercial banks in Ethiopia. In addition to examining the effect of competition on efficiency of the banking industry, the study has explored market structure of the industry and cost efficiency of banks. The study used yearly financial reports of the banks from 2001 to 2020 and the data was analyzed by following panel data analysis methods. The study has adopted descriptive and explanatory research designs. Based on the panel models, market structure of the banks was estimated by using Lerner Index and HHI; and efficiency of the banks was estimated by using SFA model. Under the empirical estimation of effect of competition on efficiency, the study has included bank specific, industry specific and macroeconomic factors to the empirical model. Based on the research design adopted the study has reached on following major findings.

The banking industry in Ethiopia is expanding and at the beginning periods of the study, there were only 7 commercial banks and currently the industry includes 17 banks; 16 private banks and 1 public bank. At the end of first five years of study period, in 2005, there were only 8 banks i.e., only one bank was added to the banking industry. However, at ended of the second five years, in 2010, the number of banks operating in banking industry in Ethiopia had grown by 5 additional banks and the banking industry comprised 13 commercial banks i.e., on average, 1 additional bank is established each year. Currently, the banking industry comprises 17 commercial banks, suggesting that competitiveness of the banking industry is increasing as the number of banks is increasing. On the other hand, another indicator of competition, market concentration, HHI was 0.6061 in 2001 and at end of 10 years, in 2010 HHI of the banking industry became 0.3105. In this period, HHI for private banks was 0.0104 and 0.5936 for largest bank, CBE. Currently, HHI of the became 0.2597 for the banking industry. However, HHI for 16 private banks is 0.0235 and 0.2362 for the largest bank. The third, preferred approach to measure competition, method is Lerner Index; in 2001 the index was 0.785 for the industry; and 0.881 for the private banks and 0.215 for the largest bank in the industry. At the end of study period, Lerner

Index was 0.338 for the industry; and 0.251 for the largest bank, CBE, and 0.343 for other 16 banks.

This study has selected cost efficiency while identifying efficiency of the banks and it was estimated based on SFA approach. An average cost efficiency during study period was 0.9642 for the banking industry in Ethiopia; ranging from 0.79 for least efficient bank to 0.999 for most efficient bank. Cost efficiency of the industry was 0.997 at beginning period of the study and it is 0.8986 for the ending period. Comparatively, on average, the largest bank in the industry had cost efficiency of score of 0.976 and other banks had cost efficiency score of 0.963. During the beginning of the study, cost efficiency was 0.998 for largest bank and 0.996 for other 16 banks. At the end of the study period, cost efficiency score was 0.9158 for largest bank and 0.8975 for other banks.

After examining competition and efficiency of banking industry in Ethiopia, this study has identified effect of the competition on efficiency of the banks. Based on the econometric procedure, effect of competition on efficiency was empirically estimated by using random effect model. Based on the empirical estimation, coefficient of competition indicator, Lerner Index was -0.013 and it is statistically significant at 0.05 significance level. Among the bank specific control variables, bank size,  $\lnasset$  ( $\beta = 0.008$ ) is significant at 0.01 ( $p = 0.001$ ). However, liquidity risk and credit risk were not significant. In addition, the industry specific control variable, type of ownership is not statistically significant. On the other hand, macroeconomic factors, economic growth ( $\beta = 0.73$ ) and economic instability ( $\beta = -0.481$ ) were significant at 5% and 1% significance levels respectively.

## **5.2 Conclusion**

Based on the major findings, following conclusions are drawn.

Market structure of the banking industry in Ethiopia is changing from time to time during 2001 to 2020. The number of firms in the industry were increasing causing competition in the industry. Market power of banks in the industry is decreasing and the industry became competitive. Although there is some monopoly power of largest bank, CBE, in the industry, competition in the industry is increased and market share of the banks is decreasing from

2001 to 2020. Furthermore, despite existence of some monopoly in regards to market power, the price margin of the banks became small and the banks are providing their services with competitive price. This study suggests banking industry in Ethiopia is following monopolistic competition.

Commercial banks in banking industry in Ethiopia were operating in cost efficient way. The banks have very small proportion of cost inefficiency. Thus, commercial banks in Ethiopia are technically efficient that they are efficiently utilizing employees, deposit from customers, and converting other expenses to generate interest and non-interest income.

The cost efficiency of commercial banks in banking industry in Ethiopia is significantly affected by competition in the banking industry. In this regard, banks that provide their services with smaller price were more cost effective than banks that provide the banking service with larger price. Thus, this study reveals that monopoly causes cost inefficiency and competition causes cost efficiency in banking industry in Ethiopia.

In addition, this study reveals that cost efficiency is positively affected by size of a bank that larger banks are more cost efficient than smaller banks because of economies of scale. Furthermore, cost efficiency of the banking industry is negatively affected economic instability and positively affected by economic growth.

### **5.3 Recommendations**

Based on the conclusion drawn, this study provides following suggests to management of commercial banks in banking industry in Ethiopia.

- As there is monopoly power in banking industry in Ethiopia, small banks are recommended to increase their market share by providing competitive services. In addition, they have to invest idle deposits to increase their interest revenue.
- The larger banks are recommended to efficiently manage their additional asset as by expansion of size of a bank, they are losing their efficiency.

- Furthermore, banks with an objective of improving cost efficiency are recommended to focus on cost management instead of price rise for the service provided.
- Finally, management of the banks are recommended to manage their cost efficiency by considering external macroeconomic environment. Thus, they must consider economic growth and instability for cost efficiency.

## REFERENCES

- Allen, F., & Gale, D. (2004). Competition and financial stability. *Journal of money, credit and banking*, 453-480.
- Ajisafe., R. A. and Ankinlo., A. E. (2014). Competition and Efficiency of Commercial Banks: An Empirical Evidence from Nigeria. *American Journal of Economics*, 4(1):18-22
- Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The review of economic studies*, 58(2), 277-297.
- Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management science*, 30(9), 1078-1092.
- Barr, R, Seiford, LM and Siems, T (1994), “Forecasting Bank Failure; Non-parametric Frontier Estimation Approach”, *Recherches Economiques de Louvain*, vol. 60,no. 4, pp. 417-29.
- Biekpe, N. (2011). The competitiveness of commercial banks in Ghana. *African Development Review*, 23(1), 75-87.
- Bikker, J. A., Shaffer, S., & Spierdijk, L. (2012). Assessing competition with the Panzar-Rosse model: The role of scale, costs, and equilibrium. *Review of Economics and Statistics*, 94(4), 1025-1044.
- Boyd, J. H., & De Nicolo, G. (2005). The theory of bank risk taking and competition revisited. *The Journal of finance*, 60(3), 1329-1343.
- Brownbridge, M., (1998), March. The causes of financial distress in local banks in Africa and implications for prudential policy. *United Nations Conference on Trade and Development*.

Casu, B., & Girardone, C. (2006). Bank competition, concentration and efficiency in the single European market. *The Manchester School*, 74(4), 441-468.

Charnes, A., Cooper, W.W., and Rhodes, E. (1978, "Measuring the efficiency of decision-making units", *European Journal of Operational Research*, Vol. 2 No. 6, pp. 429-44.

Chen, C. (2009). Bank efficiency in Sub-Saharan African middle income countries (No. 9-14). *International Monetary Fund*.

Claessens, S. (2009). Competition in the financial sector: overview of competition policies. *The World Bank Research Observer*, 24(1), 83-118.

Cooper, W. W., Seiford, L. M. and Kaoru, T., (2000), *Data Envelopment Analysis; A comprehensive Text with Models, Application, References and DEA-Solver Software*, Kluwer Academic Publishers, Boston.

Cooper, W. W., Seiford, L. M., Tone, K., & Zhu, J. (2007). Some models and measures for evaluating performances with DEA: past accomplishments and future prospects. *Journal of Productivity Analysis*, 28(3), 151-163.

Farrell M J (1957), 'The measurement of Productive Efficiency', *Journal of the Royal Statistical Society*, Vol 120, No. 3, 253-90.

Fosu, S. (2013). Banking competition in Africa: Subregional comparative studies. *Emerging Markets Review*, 15, 233-254.

Gutiérrez de Rozas, L. (2007). Testing for competition in the Spanish banking industry: The Panzar-Rosse approach revisited. *Banco de España Research Paper No. WP-0726*.

Hao, J., Hunter, W.C. and Yang, W. (2001), "Deregulation and efficiency: the case of private Korean banks", *Journal of Economics and Business*, Vol.53 Nos 2/3, pp. 237-54.

Hausman, J. A. (1978). Specification tests in econometrics. *Econometrica: Journal of the econometric society*, 1251-1271.

Horvatova E (2018), Technical Efficiency of Banks in Central and Eastern Europe, *International Journal of Financial Studies*, 6, 66.

Kamau, A. W. (2009). Efficiency in the banking sector: An empirical investigation of commercial banks in Kenya. Unpublished Doctoral Thesis.

Kamau, A. W. (2011). Intermediation efficiency and productivity of the banking sector in Kenya. *Interdisciplinary Journal of Research in Business*, 1(9), 12-26.

Kiemo, S. M., Olweny, T. O., Muturi, W. M., & Mwangi, L. W. (2019). Bank-Specific Determinants of Commercial Banks Financial Stability in Kenya. *Journal of Applied Finance and Banking*, 9(1), 119-145.

Kithinji, A & Waweru. N.M. (2007) Merger Restructuring and Financial Performance of Commercial banks in Kenya. *Economic, Management and Financial Markets Journal*, 2 (4), 9-39

Kiyota, H. (2009, November). Confronting the global financial crisis: bank efficiency, profitability and banking system in Africa. In *Fourth African Economic Conference*.

Kumar, M., Charles, V., & Mishra, C. S. (2016). Evaluating the performance of Indian banking sector using DEA during post-reform and global financial crisis. *Journal of Business Economics and Management*, 17(1), 156-172.

Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of econometrics*, 108(1), 1-24.

Lerner, A. P. (1934). "The Concept of Monopoly and the Measurement of Monopoly Power". *The Review of Economic Studies*. 1 (3): 157–175.

Maudos, J. (2017). Income structure, profitability and risk in the European banking sector: The impact of the crisis. *Research in International Business and Finance*, 39, 85-101.

Mlambo, K., & Ncube, M. (2011). Competition and efficiency in the banking sector in South Africa. *African Development Review*, 23(1), 4-15.

Moyo B (2018)“ An analysis of competition, efficiency and soundness in the South African banking sector” *South African Journal of Economic and Management Sciences* ISSN: (Online) 2222-3436, (Print) 1015-8812.

Moyo, J., Nandwa, B., Council, D. E., Oduor, J., & Simpasa, A. (2014). Financial sector reforms, competition and banking system stability in Sub-Saharan Africa. *New perspectives*.

Mwega, F. (2011). The competitiveness and efficiency of the financial services sector in Africa: A case study of Kenya. *African Development Review*, 23(1), 44-59.

Nguyen, T.P.T and Nghiem, S. H. (2018). The effects of competition on Efficiency: The Vietnamese Banking Industry Experience. *The Singapore Economic Review*, 63(1), 1-30

Novickyte L and Drozd J (2018), Measuring the Efficiency in the Lithuanian Banking Sector: The DEA Application, *International Journal of Financial Studies*, 6, 37.

Ombongi, P. N., & Long, W. (2018). Assessing Nature of Competition in Kenya’s Banking Sector. *International Journal of Research in Business Studies and Management*, 5(2), 11-19.

Osborne.M, Fuertes.A.M, & Milne.A, (2015) “Capital, profitability and financial stability in banking: Evidence from US banks” *American Economic Review*.

Ouenniche J and Carrales S (2018), Assessing efficiency profiles of UK commercial banks: a DEA analysis with regression-based feedback

Panzar, J. C., & Rosse, J. N. (1987). Testing for" monopoly" equilibrium. *The journal of industrial economics*, 443-456.

Paradi, J. C, Sherman D. H, Tam F. K 2018 Data Envelopment Analysis in the Financial Services Industry: A Guide for Practitioners and Analysts working in Operations Research Using DEA. Cham: Springer International Publishing AG, ISBN 978-3-319-69723-9.

Robin, I., Salim, R., & Bloch, H. (2018). Cost efficiency in Bangladesh banking: does financial reform matter?. *Applied Economics*, 50(8), 891-904.

Sanderson A and Bara A, (2017), Decomposition of the Technical Efficiency: Pure Technical and Scale Efficiency of the financial system; *Economic Research Southern Africa*.

Sanya S and M. Gaertner. 2012. Competition in the EAC banking system. *IMF Working Paper No. 12/32*.

Schaeck, K. and Cihak, M (2014). Competition, Efficiency, and Stability in Banking. *Financial Management*, 43(1), 215-241

Titko J and Jureviciene. D (2014) DEA Application at Cross-Country Benchmarking: Latvia Vs. Lithuanian Banking Sector, *Proceedings of Social and Behavioral Sciences* 110 (2014), pg. 1124-1135

Tusha, A., & Hashorva, A. (2015). Lerner Index and Boone indicator to Albanian banking sector. *International Journal of Scientific and Engineering Research*, 6(10), 467-471.

Uddin, S. S., & Suzuki, Y. (2011). Financial reform, ownership and performance in banking industry: the case of Bangladesh. *International Journal of Business and Management*, 6(7), 28.

Yildirim C (2002). "Evolution of Banking Efficiency within an Unstable Macroeconomic Environment: the Case of Turkish Commercial Banks." *Appl Econ* 34(18): 2289-2301.

## Appendices

### A1: Trans-log Cost Function: Fixed Effect Model

```

R-sq:
  within = 0.9999
  between = 0.9993
  overall = 0.9997

Obs per group:
  min = 7
  avg = 14.6
  max = 20

corr(u_i, Xb) = 0.3075

F(14, 217) = 110001.34
Prob > F = 0.0000
  
```

inc	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
lnasset	.7194834	.0506403	14.21	0.000	.6196736	.8192933
lnasset2	.0969435	.0063632	15.24	0.000	.0844019	.109485
lnl	.3885311	.0879862	4.42	0.000	.2151141	.5619482
lnf	.1809902	.0542571	3.34	0.001	.0740518	.2879287
lnfc	.3615393	.0524641	6.89	0.000	.258135	.4649437
lnapl	.0669669	.0108212	6.19	0.000	.0456389	.088295
lnapf	.1532355	.0101428	15.11	0.000	.1332444	.1732266
lnapfc	-.1964213	.0133964	-14.66	0.000	-.2228249	-.1700177
lnl2	.066259	.0094909	6.98	0.000	.047553	.0849651
lnf2	.0859818	.0047972	17.92	0.000	.0765268	.0954368
lnfc2	.0954154	.0077003	12.39	0.000	.0802384	.1105923
lnlf	-.0465311	.011909	-3.91	0.000	-.0700033	-.0230589
lnlfc	-.0668552	.0119868	-5.58	0.000	-.0904807	-.0432297
lnffc	-.1456835	.011714	-12.44	0.000	-.1687713	-.1225958
_cons	.5878832	.2785333	2.11	0.036	.0389062	1.13686
sigma_u	.02511969					
sigma_e	.01873128					
rho	.64265694	(fraction of variance due to u_i)				

F test that all u\_i=0: F(16, 217) = 10.28      Prob > F = 0.0000

## A2: Trans-log Cost Function Estimation: Random Effect Model

```

Random-effects GLS regression              Number of obs   =       248
Group variable: bank                      Number of groups =       17

R-sq:                                     Obs per group:
    within = 0.9999                        min =           7
    between = 0.9995                       avg =          14.6
    overall = 0.9998                       max =          20

corr(u_i, X) = 0 (assumed)                Wald chi2(14)   =    1.39e+06
                                           Prob > chi2     =     0.0000
    
```

lnc	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnasset	.7580102	.0502955	15.07	0.000	.6594328	.8565875
lnasset2	.0999253	.0065176	15.33	0.000	.087151	.1126995
lnl	.3650948	.0800917	4.56	0.000	.208118	.5220717
lnf	.1700632	.0562428	3.02	0.002	.0598293	.2802972
lnfc	.3104592	.0549451	5.65	0.000	.2027688	.4181497
lnapl	.0806456	.0111967	7.20	0.000	.0587006	.1025907
lnapf	.1497683	.0106476	14.07	0.000	.1288994	.1706371
lnapfc	-.2033565	.0139523	-14.58	0.000	-.2307025	-.1760106
lnl2	.0752831	.0090748	8.30	0.000	.0574968	.0930695
lnf2	.0875689	.0050309	17.41	0.000	.0777086	.0974293
lnfc2	.1004308	.0080145	12.53	0.000	.0847226	.116139
lnlf	-.0562607	.0124225	-4.53	0.000	-.0806084	-.031913
lnlfc	-.0801934	.0122111	-6.57	0.000	-.1041267	-.0562602
lnffc	-.1457166	.0123944	-11.76	0.000	-.1700091	-.121424
_cons	.3918288	.2301773	1.70	0.089	-.0593103	.842968
sigma_u	.00955617					
sigma_e	.01873128					
rho	.20652246	(fraction of variance due to u_i)				

### A3: Hausman Test: Trans-log Cost Function Estimation

	Coefficients		(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
	(b) fe	(B) re		
lnasset	.7194834	.7580102	-.0385267	.0058995
lnasset2	.0969435	.0999253	-.0029818	.
lnl	.3885311	.3650948	.0234363	.0364266
lnf	.1809902	.1700632	.010927	.
lnfc	.3615393	.3104592	.0510801	.
lnapl	.0669669	.0806456	-.0136787	.
lnapf	.1532355	.1497683	.0034672	.
lnapfc	-.1964213	-.2033565	.0069352	.
lnl2	.066259	.0752831	-.0090241	.0027792
lnf2	.0859818	.0875689	-.0015872	.
lnfc2	.0954154	.1004308	-.0050154	.
lnlf	-.0465311	-.0562607	.0097296	.
lnlfc	-.0668552	-.0801934	.0133382	.
lnffc	-.1456835	-.1457166	.000033	.

b = consistent under Ho and Ha; obtained from xtreg  
 B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(14) = (b-B)'[(V\_b-V\_B)^(-1)](b-B)  
 = 45.14  
 Prob>chi2 = 0.0000  
 (V\_b-V\_B is not positive definite)

#### A4: Dataset

bank	year	loan	asset	deposit	Interest Income	Interest Expense	Non-Interest Income	revenue	salary	Provision for Doubtful Loan	General Expense	Non-Interest Expense	Net Income
AB	2011	158	456.88	263.38	4.9	1.1	7.44	11.24	3.65	1.6	9.78	15.04	-2.66
AB	2012	452.15	1237.9	778.91	42.67	15.63	54.08	81.13	15.73	5.21	28.8	49.74	24.16
AB	2013	853.85	1951.1	1475.93	88.34	28.66	81.98	141.67	33.49	5.56	51.33	90.38	38.46
AB	2014	1493.08	3196.78	2518.22	163.46	63.69	130.43	230.21	65.52	7.48	81.52	154.53	57.6
AB	2015	2340.67	4582.18	3623.81	285.04	107.83	213.2	390.41	99.51	11.09	111.81	222.4	125.45
AB	2016	3118.64	6186.77	4832.58	418.85	148.71	215.69	485.83	129.07	18.28	146.01	293.36	147.01
AB	2017	4308.82	8692.4	6832.36	549.14	218.86	298.7	628.98	192.89	0	187.3	380.19	174.15
AB	2018	6002.71	12325.1	9466.09	873.3	358	436.12	951.42	259.9	62.54	210.43	532.87	316.99
AB	2019	7711.49	15106.3	11598.4	1103.99	468.71	717.3	1352.58	348.97	52.13	268.47	669.57	501.6
AB	2020	11753.8	20203.7	16098.9	1507.16	567.46	522.26	1461.97	451.9	27.95	341.82	821.67	501.2
AIB	2001	561	907	751	57	30	19	46	10	5	13	28	11
AIB	2002	637	1112	930	61	29	20	52	13	5	15	33	12
AIB	2003	800	1401	1164	58	26	43	75	14	24	19	57	14
AIB	2004	946	1770	1493	68	30	56	94	16	19	24	59	26
AIB	2005	1290	2226	1940	94	34	55	115	22	9	29	60	38
AIB	2006	1872	2954	2567	137	48	91	180	30	0	39	69	78
AIB	2007	2512	3830	3112	214.5	62	128.5	281	38	0	39	77	143
AIB	2008	2737.88	4820.22	3869.53	251	106	172	317	48	0	65	113	142.8
AIB	2009	2713	6422.55	4962.41	276.42	120.04	201	357.38	67.11	29.01	58.81	154.93	142.97
AIB	2010	3145.69	7944.78	6105.94	303.33	154.92	383.38	531.78	93.61	17.9	69.44	180.95	247.56
AIB	2011	3986.46	10115.8	7743.78	394.71	209.47	532.84	718.08	121.15	5.21	86.65	213.01	360.63
AIB	2012	5504.61	11936.7	9204.36	668.69	284.94	442.04	825.79	150.26	11.25	133.69	295.2	394.42

AIB	2013	7710	16079.5	12545.2	890.19	362.66	529.51	1057.04	248.93	55.92	169.17	474.03	438.61
AIB	2014	9176.36	20028.8	15039.7	1089.1	475.57	832.07	1445.6	341.4	31.59	244.07	617.05	618
AIB	2015	12482	23869.6	18520.4	1461.49	638.84	839.49	1662.13	466.85	8.61	325.45	800.91	645.34
AIB	2016	15450.8	29609.6	22832	1922.54	781.76	901.42	2042.21	615.3	18.66	422.26	1056.23	743.77
AIB	2017	22576.3	41974.9	30590.9	2587.58	914.18	1176.18	2849.57	848.1	94.03	557	1499.13	1003.37
AIB	2018	31304.2	55268.1	43451.4	4201.57	1479.15	1203.12	3925.54	1234.43	10.13	719.9	1964.46	1492.43
AIB	2019	47262.1	74635.4	59616.1	5977.05	2107.72	2079.14	5948.47	1632.6	93.3	878.06	2603.96	2439.72
AIB	2020	57274.3	89288	70577.9	7872.83	2655.68	2336.25	7553.4	2218.05	587.58	1148.13	3953.75	2597.99
AdIB	2012	154.49	424.67	211.4	12.14	4.96	23.48	30.66	4.67	1.57	15.13	21.37	7.31
AdIB	2013	328.01	916.17	561.27	32.27	13.74	52.63	71.16	10.14	1.71	22.24	34.1	27.21
AdIB	2014	511.04	1262.72	792.41	60.52	25.46	85.22	120.28	17.68	2.31	40.19	60.18	44.66
AdIB	2015	771.56	1714.98	1109.6	95.68	41.58	111.72	165.82	31.27	3.61	53.03	87.91	58.21
AdIB	2016	1063.15	2462.19	1562.54	149.77	63.18	142	228.59	47.42	4.15	67.2	118.77	82.41
AdIB	2017	1581.26	3414.62	2271.7	199.77	88.2	177.55	289.12	77.53	6.32	87.14	170.99	92.25
AdIB	2018	2056.93	4215.97	2970.38	288.77	135.27	198.14	351.64	96.47	8.17	99.42	204.06	112.9
AdIB	2019	2677.41	5514.85	3946.56	407.78	208.09	261.1	460.79	124.5	12.13	119	255.63	159.25
AdIB	2020	3481.74	6490.44	4635.69	515.89	256.53	313.16	572.53	158.51	1.1	138.68	298.29	213.12
BOA	2001	687	896	651	72	27	17	62	6	10	11	27	19
BOA	2002	669	1142	909	65	34	15	46	7	20	11	38	-2
BOA	2003	809	1333	1076	62	27	19	54	8	24	14	46	6
BOA	2004	962	1585	1275	97	29	26	94	10	11	19	40	38
BOA	2005	1234	2057	1627	105	33	47	119	13	0	24	37	61
BOA	2006	1963	2834	2177	165	41	55	179	30	4	23	57	85
BOA	2007	2305	3396	2721	202	60	65	207	35	47	30	112	67
BOA	2008	2817.15	4269.94	3477.77	252.42	93.4	95.02	254.04	45.26	142.77	44.1	232.13	14.58
BOA	2009	2708.96	5476.62	4494.19	275.89	112.07	128.92	292.74	65.91	22.95	58.39	147.25	100.46
BOA	2010	3153.24	6279.54	5138.85	261.88	127.31	207.07	341.63	79.29	0	66.01	145.3	140.58

BOA	2011	3315.69	7277.96	6075.26	372.08	163.72	245.98	454.34	90.81	19	86.16	195.96	180.93
BOA	2012	3897.41	8239.51	6771.46	497.49	208.45	225.59	514.63	106.29	23.63	96.13	226.05	216.32
BOA	2013	4702.07	10160.1	8496.15	583.51	258.23	281.02	606.3	134.28	0.45	120.1	254.83	264.76
BOA	2014	5153.46	11276.4	9096.48	734.2	316.11	278.69	696.78	173.16	0.18	171.96	345.3	270.71
BOA	2015	5995.56	13667.5	11118.2	853.5	370.86	353.63	836.28	238.88	0	223.44	462.31	291.74
BOA	2016	8121.37	16828.1	13635	1097.72	452.63	535.47	1180.56	389.13	19.43	304.45	713.01	360.57
BOA	2017	14105.4	25324.8	20700.8	1601.08	599.43	791.22	1792.88	614.99	48.86	392.68	1056.53	570.31
BOA	2018	17991	31983	25794.5	2721.26	1056.11	552.71	2217.86	862.55	118.36	471.24	1452.15	562.8
BOA	2019	23735	39294.4	32146.4	3504.37	1507.62	784.36	2781.11	984.2	148.47	624.42	1757.09	777
BOA	2020	37247.9	56890.5	47627.6	4848.9	1810.28	833.15	3861.77	1827.56	138.82	824.25	2790.63	853.65
BrB	2010	153.19	379.52	238.01	5.85	1.84	2.42	6.44	4.03	1.53	6.88	12.44	-4.2
BrB	2011	331.82	913.8	694.26	34.1	17.69	33.13	49.54	8.45	2.18	12.87	23.5	21.22
BrB	2012	499.55	1285.03	931.73	57.82	28.24	51.5	81.09	14.05	2.14	18.37	34.57	33.62
BrB	2013	978.9	2197.31	1593.13	87.07	39.2	55.29	103.16	22.57	0.37	27.25	50.19	37.08
BrB	2014	1184.7	2813.46	2011.8	167.76	60.59	86.37	193.54	44.71	14.56	56.89	116.16	45.01
BrB	2015	1901.83	4171.94	3067.9	210.35	73.06	162.38	299.68	74.76	7	80.22	161.97	103.7
BrB	2016	3757.39	7196.3	5296.52	460.42	134.49	325.83	651.76	158.89	29.39	110.61	298.9	265.79
BrB	2017	5331.11	10488.9	7592.4	687.94	227.46	476.83	937.3	283	21.13	161.76	465.89	329.99
BrB	2018	7191.45	14068	10861.7	1112.79	417.35	434.97	1130.41	438.75	25.18	255.55	719.48	327.85
BrB	2019	10215.8	19172.6	14964.3	1535.81	605.04	662.91	1593.68	622.86	66.82	323.94	1013.62	457.93
BrB	2020	12717	21355.3	16608.7	2064.34	817.8	784.56	2031.11	780.87	35.8	506.96	1323.62	553.19
BulB	2010	192.26	480.11	240.26	8.43	1.9	11.5	18.03	4.57	1.93	11.48	17.98	0.04
BulB	2011	366.26	781	491.32	34.07	13.09	39.43	60.41	11.14	2.22	20.24	33.6	19.47
BulB	2012	651.94	1365.03	903.31	63.16	23.37	46.94	86.73	14.17	3.13	30.3	47.61	27.84
BulB	2013	949.43	2128.45	1547.61	120.92	39.69	50.7	131.93	24.2	3.72	36.64	64.55	46.22
BulB	2014	1359.69	3011.94	2151.59	180.56	55.4	115.58	240.74	50.66	5.38	77.09	133.12	79.96
BulB	2015	2445.97	4499.69	3501.04	308.28	89.92	173.81	392.17	86.53	11.64	112.1	210.28	134.51

BulB	2016	3694.82	6820.96	5384.6	491.08	174.24	243.8	560.64	130.04	35.37	144.38	309.78	187.46
BulB	2017	5290.25	9820.01	7479.58	631.48	253.73	293.34	671.09	189.68	26.18	189.96	405.82	201.38
BulB	2018	6942.32	13021.2	9947.37	1032.55	389.4	359.86	1003.02	286.3	42.72	246.77	575.79	315.26
BulB	2019	8281.21	14494.8	10586.7	1281.95	439.8	550.44	1392.59	400.9	50.85	315.82	767.56	461.37
BulB	2020	11567.1	18867.1	13650.8	1670.7	541.84	502.94	1631.79	532.05	72.67	444.46	1049.18	440.87
CBE	2001	10658	21489	17471	987	428	354	913	113	488	99	700	19
CBE	2002	9751	22146	18530	586	395	418	609	129	627	360	1116	-471
CBE	2003	8553	24200	19762	670	251	628	1047	133	80	118	331	545
CBE	2004	8325	27975	22531	680	268	588	1000	162	212	139	513	334
CBE	2005	9556	33169	25367	646	291	740	1095	175	0	131	306	572
CBE	2006	9296	35849	28286	853	330	971	1494	187	0	187	374	802
CBE	2007	9759	43456	32873	1036	351	1217	1902	218	0	514	732	864
CBE	2008	17338.5	50416.1	37633.3	1541	534	1431	2438	285	0	285	570	1361
CBE	2009	20906.1	59411.4	43489.4	2357.84	614.09	1489.89	3233.64	325.08	0	192.88	517.96	1920.71
CBE	2010	24017	74186.9	54646.2	2742.82	744.13	1751.39	3750.08	431.17	4.31	506.85	942.32	1968.33
CBE	2011	35981.2	114265	84798.5	4081.54	1117.21	2912.68	5877.01	561.57	0	1077.85	1639.42	2862.98
CBE	2012	62314.4	158804	116584	6703.45	1676.4	4870.4	9897.45	873.48	0	1092.38	1965.86	5434.14
CBE	2013	69726.2	195443	154438	9539.17	2379.73	4188.29	11347.7	1333.71	500.54	952.09	2786.34	5866.09
CBE	2014	89277	244128	194052	11996.6	3437.78	5800	14358.8	2578.19	537.76	1293.98	4409.92	6889.58
CBE	2015	110963	305075	242497	16769.4	4884.32	6443.33	18328.4	3337.34	541.48	1746.13	5624.96	8770.1
CBE	2016	143046	383644	289044	21442.9	6421.3	5980.54	21002.1	4616.73	1999.55	2225.14	8841.42	8329.24
CBE	2017	157126	490068	365102	25977.1	9205.66	6272.09	23043.6	4636.87	1206.45	4686.49	10529.8	9574.21
CBE	2018	179488	573894	451858	37328.5	14750.3	1635	24213.2	7778.59	1547.64	4880.89	14207.1	5366.35
CBE	2019	215079	712882	540941	45675.3	20056.8	8626.06	34244.5	9672.64	3267.97	5604.35	18545	11487
CBE	2020	255215	819279	593041	53769.8	24680.1	11469.5	40559.2	16747.6	939.73	7915.2	25602.5	9533.67
CBO	2005	3	129	15	0.29	0.04	0.02	0.27	0.65	0	0.72	1.37	-1.1
CBO	2006	127	224	98	5	0.4	0.21	4.81	3	1	5	9	-4.19

CBO	2007	239	424	277	15	2	5.4	18.4	6	1	9	16	2.4
CBO	2008	322.28	678.2	489.9	32.06	5.35	11.44	38.14	9.37	1.34	12.4	23.12	11.76
CBO	2009	595.99	1022.88	788.68	44.98	12.06	11.4	44.33	15.45	4.15	21.1	40.7	2.36
CBO	2010	721.77	1768.32	1371.81	74.92	27.32	53.58	101.18	24.66	10.21	30.17	65.04	25.1
CBO	2011	801.9	2500.59	1980.41	94.94	43.05	97.36	149.25	32.89	-2.2	50.3	80.99	47.27
CBO	2012	1383.51	3670.73	2797.54	172.05	59.24	131.94	244.74	42.34	3.91	58.71	104.97	102.02
CBO	2013	2116.06	6537.47	4465.04	239.67	68.65	300.89	471.9	86.82	31.97	86.87	205.65	188.91
CBO	2014	3712.48	7350.37	5450.1	422.29	100.96	459.63	780.96	119.78	36.15	150.06	305.99	343.16
CBO	2015	6738.33	11462.1	7367.89	701.73	137.49	524.39	1088.63	161.61	228.43	217.6	607.64	312.44
CBO	2016	6177.32	10687.3	8488.32	823.67	228.89	254.67	849.45	189.28	334.56	288.67	812.5	39.03
CBO	2017	10001.5	17724.2	14276.8	1116.61	336.24	408.72	1189.09	415.33	93.66	440.51	949.5	207.82
CBO	2018	15066	29888	25807.6	1850.03	620.37	657.99	1887.65	700.43	42.1	559.5	1302.04	439.21
CBO	2019	22159.2	41790.8	36168.3	2813.36	1035.11	900.06	2678.31	959.02	28.94	923.32	1911.28	657.78
CBO	2020	30179.4	52488.5	45510.9	4159.73	1544.85	1582.01	4196.89	1089.33	153.46	1531.49	2774.28	1182.62
DB	2001	714	1100	886	70	31	37	76	11	0	29	40	21
DB	2002	872	1486	1191	77	36	38	79	14	4	22	40	24
DB	2003	1267	1991	1621	82	30	52	104	19	23	25	67	27
DB	2004	1690	2677	2178	117	41	75	151	23	16	34	73	56
DB	2005	2232	3420	2833	162	52	72	182	29	12	44	85	71
DB	2006	3164	4546	3692	242	67	125	300	41	14	60	115	133
DB	2007	3988	6041	4861	320	93	165	392	53	8	73	134	187
DB	2008	4382	7828.59	6151.52	420.07	162.15	249.75	507.68	73.24	18.25	83.62	175.11	239.06
DB	2009	4451.51	9732.58	7925.21	434.78	199.45	320.79	556.12	97.48	2.17	103.98	203.63	249.88
DB	2010	5048.84	12353.4	10144.5	482.66	248.19	481.67	716.14	115.36	11.36	131.17	257.89	324.04
DB	2011	6217.54	14659.8	11841.2	603.68	325.27	678.51	956.91	144.71	17.06	165.26	327.04	450.66
DB	2012	8123.81	17520	14065.6	897.73	410.23	827.63	1315.13	189.96	19.45	212.45	421.86	652.02
DB	2013	8862.32	19747.2	15851.3	1020.76	489.88	796.05	1326.94	255.39	17.77	240.82	513.98	606.79

DB	2014	9607.82	21962.2	17681.3	1140.82	573.16	1004.17	1571.84	313.54	0	300.71	614.25	712.48
DB	2015	11527	24763.9	19814.1	1414.22	667.29	1101.05	1847.98	501.12	13.33	369.72	884.17	729.13
DB	2016	12695.1	28576.4	22758.5	1521.64	740.82	1211.64	1992.46	569.04	29.1	443.71	1041.85	727.05
DB	2017	18082.9	34624.6	27782.5	2070.38	921.26	1344.72	2493.84	788.48	131.66	593.93	1514.08	756.11
DB	2018	23285.6	45425.4	35986.8	3243.9	1432.8	1186.69	2997.8	1094.81	13.2	746.38	1854.39	928.95
DB	2019	32576.4	56218.4	44721.5	4301.33	1927.71	1053.56	3427.19	1394.4	0.93	752.82	2148.15	1016.79
DB	2020	42160.9	68261.3	53493.9	5824	2458.86	1381.58	4746.72	1886.34	7.01	1063.26	2956.61	1537.11
DGB	2013	100.33	380.56	158.37	7.05	1.17	7.82	13.7	10.01	1.46	16.53	27.99	-14.28
DGB	2014	270.4	874.82	500.23	37.17	11.6	40.23	65.8	20.01	3.49	23.82	47.31	18.46
DGB	2015	338.9	1143.59	819.34	47.22	20.55	62.53	89.2	31.86	0.24	34.51	66.61	17.18
DGB	2016	599.31	1291.95	871.76	84.24	25.26	102.78	161.77	42.63	6.04	45.15	93.81	51.69
DGB	2017	794.27	2062.9	1431.53	105.32	40.28	127.71	192.76	60.19	5.48	59.37	125.04	50.85
DGB	2018	1580.84	3260.69	2153.32	213.47	80.28	206.97	340.17	84.5	10.41	103.3	198.2	106.63
DGB	2019	2451.67	5487.51	3523.44	321.67	144.1	373.6	551.17	125.69	18.19	123.34	267.22	210.71
DGB	2020	4521.05	7812.58	5289.29	521.74	247.4	581.57	855.91	225.16	-4.79	392.66	613.03	199.05
EB	2014	506.74	1417.34	929.44	41.85	15.87	77.77	103.74	13.05	5.12	55.89	74.06	25.98
EB	2015	1133.61	2209.44	1565.22	125.75	63.3	71.8	134.26	27	6.71	36.52	70.22	52.66
EB	2016	1624.89	3248.18	2389.27	183.28	103.6	131.84	211.52	44.8	6.69	57.31	108.81	79.21
EB	2017	2465.99	4848.28	3681.05	298.58	200.68	200.94	298.85	70.85	15.71	83.68	170.24	94.31
EB	2018	3334.59	6482.37	4976.41	489.61	312.14	261.65	439.12	118.2	5.13	99.27	222.59	158.88
EB	2019	5132.92	9201.55	7118.28	742.83	483.38	239.83	499.28	146.32	6.76	114.73	267.81	201.63
EB	2020	6502.76	11166	8346.32	1047.14	656.12	280.94	671.95	188.06	37.26	207.08	432.47	208.5
HB	2001	134	214	129	13	4	9	18	3	1	6	10	5
HB	2002	163	314	189	17	6	7	18	4	1	6	11	4
HB	2003	290	469	287	19	6	12	25	4	5	9	18	5
HB	2004	384	674	532	27	11	19	35	7	9	9	25	7
HB	2005	593	1073	865	46	17	45	74	10	7	14	31	31

HB	2006	1004	1599	1220	71	29	55	97	14	6	17	37	44
HB	2007	1410	2182.5	1541	122	40	70	152	23	13	29	65	64
HB	2008	1859.66	3249.96	2443.35	171.13	62.83	108.52	216.82	34.35	13.58	43.06	90.99	91.04
HB	2009	2152.23	4651.7	3615.75	210.08	87.66	134.87	257.28	54.68	16.7	52.36	123.73	93.59
HB	2010	2613.61	5896.23	4724.85	251.01	104.29	259.64	406.36	67.74	28.87	62.08	158.69	174.45
HB	2011	3276.96	7725.62	6065.82	338.88	144.84	291.68	485.71	83.26	6.73	73.18	163.17	231.83
HB	2012	4085.38	8786.86	6757.51	518.65	198.66	312.93	632.93	117.9	5.67	102.86	226.43	297.86
HB	2013	4710.76	9985.99	8063.47	601.59	247.31	304.53	658.81	151.47	0	133.18	284.65	281.96
HB	2014	5069.62	11876.4	9402.46	716.23	278.33	325.33	763.23	198.93	1.45	201.83	402.2	278.17
HB	2015	6860.08	14360.9	11804.4	948.09	385.85	385.85	948.08		10.83	579.01	589.84	281.32
HB	2016	8534.36	17269.9	13037.6	1226.18	526.01	447.64	1147.81		27.11	692.15	719.26	339.02
HB	2017	11996.3	21902.9	16505.2	1549.03	634.78	461.76	1376.01	524.77	37.4	325.14	887.31	381.72
HB	2018	15065.8	28030.9	23079.1	2264.37	1026.8	604.48	1842.05	678.87	105.68	354.08	1138.62	573.63
HB	2019	21723.4	35736.1	29079.8	3148.31	1472	553.96	2230.26	848.68	90.85	479.92	1419.45	752.31
HB	2020	27471.6	42998.5	34771.6	4229.12	1836.13	650.77	3043.76	1001.01	76.95	1230.42	2308.38	893.54
LIB	2007	75	266	122	3	0.4	1.2	3.8	3	0.8	5	8.8	-5
LIB	2008	182.47	574.13	375.23	19.91	6.45	9.24	22.7	9.96	1.37	12.2	23.53	-0.83
LIB	2009	470.14	952.46	703.6	32.7	11.35	16.31	37.66	14.82	2.79	16.3	33.91	2.62
LIB	2010	583.99	1363.61	1017.58	56.38	19.79	54.66	91.25	18.05	4.57	18.58	41.19	39.96
LIB	2011	676.33	1808.11	1297.37	75.77	27.14	65.25	113.88	23	0.32	28.76	52.08	43.75
LIB	2012	970.66	2463.03	1736.66	115.71	40.13	103.9	179.48	37.1	5.41	32.27	74.77	75.41
LIB	2013	1318.06	2942.43	2105.86	168.96	55.79	128.08	241.25	46.84	2.06	41.65	90.54	111.41
LIB	2014	1562.03	3613.33	2686.98	209.11	73.95	132.93	268.08	71.33	3.75	65.81	140.9	96.58
LIB	2015	2878.32	5859.36	4457.39	326.86	106.6	312.08	532.34	122.88	30.38	153.68	306.94	150.58
LIB	2016	4389.7	8119.23	6333.56	527.2	169.61	367.6	725.19	200.23	38.57	202.11	440.91	196.16
LIB	2017	5598.27	10975.9	8774.85	763.61	240.71	279.07	801.96	251.3	26.28	173.47	451.04	268.46
LIB	2018	7561.25	14319.6	11639.6	1172.71	423.83	334.33	1083.22	347.85	50.4	204.63	602.88	390.77

LIB	2019	11852.6	20391.6	16396.7	1672.55	610	545.54	1608.1	485.57	142.42	284.58	912.57	539.04
LIB	2020	19557.9	31782.6	26131.7	2676.64	990.01	433.7	2120.33	670.65	246.64	422.4	1339.7	643.11
NIB	2001	210	336	208	19	5	13	27	3	1	5	9	12
NIB	2002	324	534	345	29	10	16	35	4	3	6	13	13
NIB	2003	550	885	588	37	11	29	55	6	20	10	36	13
NIB	2004	786	1247	832	56	15	37	78	8	8	13	29	35
NIB	2005	1133	1732	1223	83	24	52	111	11	18	16	45	46
NIB	2006	1475	2027	1452	107	33	54	128	17	9	21	47	58
NIB	2007	1817	2607	1879	147	42	61	166	25	5	30	60	76
NIB	2008	2113.81	3650.11	2469.93	210	62.22	106.58	254.36	35.55	19.04	41.01	95.59	113.04
NIB	2009	2220.29	4806.5	3296.39	253.59	75.11	172.42	350.9	53.47	23.39	54.67	131.53	153.66
NIB	2010	2546.14	5970.51	4127.19	266.28	89.71	290.22	466.79	77.12	33.2	71.23	181.56	200.89
NIB	2011	2766.52	7111.52	5157.4	332.86	119.42	323.79	537.23	96.64	15.34	81.18	193.16	246.43
NIB	2012	3708.9	8275.7	5838.13	433.65	151.91	325.78	607.52	115.77	1.41	100.86	218.04	286.23
NIB	2013	4542.99	9144.54	6655.21	570.52	184.95	280.67	666.24	140.07	0	134.49	274.56	299.37
NIB	2014	5523.5	10747.3	7923.29	570.52	184.95	280.67	666.24	141.07	0	134.49	275.56	297.37
NIB	2015	6999.19	13256.1	9774.11	888.08	300.49	320.68	908.26	235.98	0	231.48	467.46	337.07
NIB	2016	7647.14	15830.4	12423	1141.05	392.31	289.98	1038.72	290.76	0	256.1	546.86	389.79
NIB	2017	10888.4	21019.7	16416.4	1500.42	530.76	448.19	1417.84	387.23	41.95	306.5	735.69	443.4
NIB	2018	13704	26688.9	21619.2	2072.79	875.71	404.56	1601.64	554.13	47.61	344.71	946.45	514.85
NIB	2019	19440.3	33717.4	27663.7	2858.49	1215.38	476.92	2120.03	702.93	65.57	423.1	1191.59	720.75
NIB	2020	25788.5	42463.8	33651.1	3901.74	1715.15	640.06	2826.65	952.12	31.07	539.61	1522.8	1043.63
OIB	2009	113	321	184	1	0.2	1.6	2.4	1.9	0	3.6	5.5	-3.1
OIB	2010	368.99	1118.57	820.93	30.38	15.23	49.88	65.03	20.05	3.09	20.39	43.52	19.23
OIB	2011	661.74	1961.94	1526.32	62.08	32.57	91.06	120.57	30.08	2.82	30.98	63.88	44.46
OIB	2012	1019.6	2787.39	2117.3	122.43	55.4	106.9	173.93	50.33	6.13	52.31	108.77	49.52
OIB	2013	1621.23	3911.23	3050.44	195.84	63.72	137.62	269.74	81.41	10.52	86.23	178.16	66.93

OIB	2014	2565.27	6151.66	5004	326.6	101.4	218.85	444.05	124.89	9.96	103.74	238.59	153.87
OIB	2015	4767.18	9534.84	8005.99	517.11	156.64	329.97	690.44	213.76	31.61	151.12	396.49	221.78
OIB	2016	5258.34	11281.9	9348.1	763.35	236.75	273.65	800.24	313.68	31.99	232.88	578.55	155.18
OIB	2017	7175.54	16292.9	13414.1	910.75	328.75	583.32	1165.32	421.38	59.27	305.97	786.62	288.38
OIB	2018	11681.8	23796.7	19927	1642.39	543.6	826.01	1924.81	622.67	29.72	334.37	986.77	727.71
OIB	2019	17486.8	31779.3	26589.1	2399.46	836.81	831.84	2394.49	798.7	155.8	438.63	1393.13	745.87
OIB	2020	17394.2	33831.5	27730.9	3153.57	1246.89	681.46	2588.14	968.24	4.11	550.71	1523.06	860.55
WB	2001	344	583	449	38	17	22	43	9	8	12	29	6
WB	2002	406	646	515	42	20	20	42	10	5	15	30	6
WB	2003	571	889	704	42	17	25	50	11	8	16	35	11
WB	2004	738	1140	876	66	18	44	92	14	14	19	47	32
WB	2005	1002	1616	1288	80	22	70	128	20	19	26	65	48
WB	2006	1593	2259	1778	120	35	100	185	31	29	31	91	71
WB	2007	2155	3480	2723.5	185	55	135	265	44	32	36	112	112
WB	2008	2346.78	4124.89	2966.33	238.24	89.68	192	340.56	55.01	52.47	43.1	150.57	138.84
WB	2009	2112.38	5118.31	3728.38	233.54	83.46	238.7	388.78	74.34	2.9	55.41	132.65	180.63
WB	2010	2473.87	5741.93	3922.8	247.25	75.74	318.09	489.6	90.85	8.53	72.7	172.07	223.34
WB	2011	2910.05	8061.05	5957.48	314.85	100.19	500.08	714.73	120.49	40.36	95.75	256.6	323.28
WB	2012	3565.67	8347.15	5758.18	441.66	139.88	408.49	710.27	144.39	0.04	107.6	252.03	336.25
WB	2013	4690.14	10393.8	7550.66	585.45	172.38	365.7	778.77	183.82	3.37	138.66	325.84	343.32
WB	2014	4604.42	11528.8	8385.11	659.99	230.46	408.78	838.3	243.4	-6.77	187.88	424.51	318.44
WB	2015	6169.49	13711.4	9870.94	853.62	291.19	472.63	1035.07	323.71	27.55	231.24	582.5	352.45
WB	2016	7630.32	16189.8	11078.5	1024.15	342.56	508.86	1190.46	379.5	43.79	288.67	711.96	375.62
WB	2017	10377.2	20949.2	14018.2	1345.23	466.84	798.23	1676.62	543.91	42.64	381.93	968.48	532.16
WB	2018	15047.6	27390.9	20506.1	2115.77	752.12	971.91	2335.56	677.15	88.78	519.54	1285.47	793.56
WB	2019	16451.3	29770	23545.3	2518.99	1027.05	690.12	2182.06	794.17	83.21	569.54	1446.92	620.96
WB	2020	23714.1	38159.6	30094.1	3245.3	1234.36	1171.8	3182.74	1099.05	216.25	790.18	2105.48	831.73

ZB	2009	186.76	462.59	277.85	4.59	2.91	13.42	15.1	5.49	1.97	16.78	24.24	-6.4
ZB	2010	377.92	1055.62	688.02	31.24	22.82	102.76	111.19	9.4	4.02	28.63	42.05	50.99
ZB	2011	633.74	1613.42	1162.56	60.64	41.06	157.03	176.61	15.58	5.49	34.4	55.47	84.71
ZB	2012	994.56	2394.24	1792.88	102.83	66.12	163.78	200.49	23.09	6.64	47.45	77.18	86.37
ZB	2013	1252.93	3248.47	2505.53	150.11	100.52	254.94	304.53	35.5	98.6	46.62	180.71	94.15
ZB	2014	1303.68	3924.77	3030.87	205.43	114.45	249.82	340.8	49.06	4.6	66.65	120.31	183.88
ZB	2015	2156.69	4874.34	3823.26	262.57	136.71	239.41	365.27	73.77	0	90.99	164.76	153.28
ZB	2016	3253.85	7373.83	5486.92	367.06	206.73	336.29	496.62	95.95	23.62	107	226.57	202.77
ZB	2017	3970.61	9669.25	7323.28	463.19	294.66	503.02	671.55	135.42	39.62	140.23	315.27	249.39
ZB	2018	5048.87	12489.2	10241.3	712.41	441.73	423.31	693.99	171.56	27.65	152.46	351.67	271.02
ZB	2019	7609.53	14689	11625.2	1015.05	531.24	567.92	1051.73	205.64	-0.44	210.67	415.87	483.77
ZB	2020	9747.4	18495.7	14417.3	1462.03	593.38	683.35	1552	298.3	5.62	249.73	553.66	739.12