The Effects of Digital Technology Usage on Profit Efficiency of Banking Sector in Ethiopia: Stochastic Frontier Analysis Approach

Tizita Gezahegn Ayele

A Thesis Submitted to the Department of Technology and Innovation Management, School of Humanities and Social Science

Presented in Partial Fulfillment of the Requirement for the Degree of Master of Science in Technology and Innovation Management

Office of Graduate Studies

Adama Science and Technology University

October 2023

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DECLARATION

I hereby declare that this Master Thesis entitled "**The Effects of Digital Technology Usage on Profit Efficiency of Banking Sector in Ethiopia: Stochastic Frontier Analysis Approach**" is my original work. That is, it has not been submitted for the award of any academic degree, diploma, or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

Tizita Gezahegn Ayele	_____	_____
Name of the Student	Signature	Date

RECOMMENDATION

I/we, the advisor(s) of this thesis, hereby certify that I/we have read the revised version of the thesis entitled "**The Effects of Digital Technology Usage on Profit Efficiency of Banking Sector in Ethiopia: Stochastic Frontier Analysis Approach**" prepared under my/our guidance by Tizita Gezahegn Ayele submitted in partial fulfillment of the requirements for the degree of Mater's of Science in Technology and Innovation Management. Therefore, I/we recommend the submission of a revised version of the thesis to the department following the applicable procedures.

Birku Reta Entele(PHD)____	_____	_____
Major Advisor	Signature	Date

_____	_____	_____
Co-Advisor	Signature	Date

APPROVAL PAGE

I/we, the advisors of the thesis entitled "**The Effects of Digital Technology Usage on Profit Efficiency of Banking Sector in Ethiopia: Stochastic Frontier Analysis Approach**" and developed by Tizita Gezahegn Ayele, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

Birku Reta Entele (PhD)	_____	_____
Major Advisor	Signature	Date
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Co-Advisor	Signature	Date

APPROVAL OF BOARD OF REVIEWERS

We, the undersigned, members of the Board of Examiners of the thesis by Tizita Gezahegn have read and evaluated the thesis entitled "**The Effects of Digital Technology Usage on Profit Efficiency of Banking Sector in Ethiopia: Stochastic Frontier Analysis Approach"** and examined the candidate during the open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in Technology and Innovation Management.

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Final approval and acceptance of the thesis are contingent upon the submission of its final copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and School Graduate Committee (SGC).

Department Head	Signature	Date
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Office of Postgraduate Studies, Dean	Signature	Date

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Table of Contents

LIST OF TABLES

LIST OF FIGURES AND ILLUSTRATIONS

LIST OF ACRONYMS AND ABBREVIATIONS

SFM - Stochastics Frontier Model

DEA - Data Envelopment Analysis

ICT - Information and Communication Technologies

ROA - Return on Asset

ROE - Return on Equity

ME - Managerial Efficiency

ATM - Automated Teller Machine

Mob - Mobile Banking

NBE - National Banks of Ethiopia

CBE - Commercial Bank of Ethiopia

AIB - Awash International Bank

DB - Dashen Bank

WB - Wegagen Bank

BOA - Bank of Abyssinia

UB - United Bank

AB - Abay Bank

ABSTRACT

In spite of the conspicuous use of the Digital technology as a delivery channel in banks´, there is a relative dearth of empirical studies related with the effects of digital technology usage on profit efficiency of banking sector in Ethiopia by using panel data and also had a limitation in terms of scope and methodological perspective´. Because of this fact, this paper fills the gap. Since, study is aimed to test the effects of Digital Technology Usage on profit efficiency of Banking Sector in Ethiopia over the period of 2016-2020 based on resource base view (RBV). To obtain information relevant to the study, five years of panel Quantitative secondary data collected from the selected commercial banks annual financial report and NBE's annual reports were used. In the study, all operational commercial banks in Ethiopia were taken as study population and purposive sampling method was used to select sample from the population. Accordingly, one government owned commercial bank and 6 private owned banks namely (Commercial bank of Ethiopia, Awash international bank, Dashen bank, bank of Abyssinia, United (Hibret) bank, Wegagen bank and Abay bank) were incorporated in the study. Descriptive statistics, pairwise correlations, and stochastic frontier analysis are employed to examine the effects of digital technology usage on profit efficiency of commercial banks in Ethiopia. Results of the Stochastic Frontier Approach indicated that the number of ATM machine has positive and significant impact on bank efficiency, measured in terms of return on asset as a proxy of profit and also mobile banking usage has negative effect on banks return on asset, return on equity and managerial efficiency of the selected commercial bank. The average efficiency level of profit efficiency proxy of ROA, ROE and ME of banking sector under the study period was 73.8, 99.93 and 87.55 present respectively, these suggesting that banks have potential to increase its profit by further improving its remaining inefficiency.

Keywords: *Banking Sector; Digital technology; efficiency; stochastic frontier model, Electronic banking, ROA, ROE, ME.*

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

With increased competition in all sectors around the world in this era of globalization, a strong banking industry is important in every country and can have a significant effect in supporting economic development through efficient financial services; as a result, many banks around the world are modifying their strategies to reach customers globally more easily and cheaply. As a result, banks are creating technology to assist them deliver banking products and services through the most cost-effective channels, one of which is the use of e-banking or online banking. These services have lower transaction costs than the typical technique. Booz and Hamilton (1997:4.)

Technology, client preferences, competitiveness, regulatory needs, changing demographics, and societal trends have all influenced the banking sector (Byers & Lederer, 2001). In the past ten years, there has been a significant change in banking operations and services. Technology advancements, global trade, competitiveness, and customer needs are some of the main factors that have accelerated the changes. In order to meet customer expectations and quickly react to the changing commercial landscape, banks are now competing with one another to offer new, innovative services that will give them a competitive edge (shind Lee, 2008). Evolutionary shifts have significantly influenced the corresponding strategies that banks have selected as a consequence.

In the banking sector, digital technology has become a revolutionary force that is reshaping how people access and manage their financial services (Malaquias & Silva, 2020; Ngalyuka, 2021). Mobile banking and ATMs have enormous potential to promote financial inclusion and improve the effectiveness of commercial banks in Ethiopia, a nation with a rapidly expanding economy and a sizable unbanked population (Beloke & AP, 2021). Mobile banking and ATMs have enormous potential to promote financial inclusion and improve the effectiveness of commercial banks in Ethiopia, a nation with a rapidly expanding economy and a sizable unbanked population (Beloke & AP, 2021). This manuscript delves into the digital technology of banking on the profit efficiency of commercial banks in Ethiopia, providing valuable insights for policymakers, banking institutions, and researchers (Gerlach & Lutz, 2021). Over the past few years, digital banking services have experienced a remarkable surge, reshaping the landscape of banking operations (Malaquias & Silva, 2020). The time when people had to

physically go to bank branches to make financial transactions is long gone. Customers may now conveniently and safely manage their funds using their mobile devices and ATMs thanks to digital banking (Malaquias & Silva, 2020; Ngalyuka, 2021). In Ethiopia, where traditional banking infrastructure is limited, mobile banking has emerged as a game changer, bridging the gap between underserved populations and essential financial services (Malaquias &Silva, 2020). This shift towards digital banking opens up new opportunities for commercial banks to enhance their operational efficiency and drive economic growth (Beloke & AP, 2021).

The current state of digital banking in Ethiopia reflects its increasing importance and relevance (Malaquias & Silva, 2020). As the Ethiopian economy continues to expand, there is a growing need to leverage technology to improve financial services (Malaquias & Silva, 2020). Digital banking has gained traction as a reliable and accessible means of conducting financial transactions, particularly among the unbanked population (Beloke & AP, 2021). Its convenience and user-friendly interface have made it an attractive option, empowering individuals to manage their accounts, transfer funds, pay bills, and even apply for loans with ease (Malaquias & Silva, 2020). This widespread adoption of mobile banking presents an exciting opportunity to explore its impact on the profit efficiency of commercial banks. Understanding the implications of mobile banking on the profit efficiency of commercial banks in Ethiopia is of utmost importance to optimize its potential (Beloke & AP, 2021). By enhancing operational(managerial) efficiency, digital banking can lead to cost savings, streamlined processes, and improved customer satisfaction (Gerlach & Lutz, 2021).

However, it is essential to address challenges such as ensuring robust cybersecurity measures, overcoming infrastructure limitations, and promoting digital literacy among customers (Ngalyuka, 2021). Through a comprehensive analysis of existing literature on digital banking adoption, usage behavior, determinants of banks' probability, and the role of financial technologies, this manuscript aims to shed light on the impact of digital banking on the operational efficiency of commercial banks in Ethiopia (Gerlach & Lutz, 2021; Malaquias & Silva, 2020; Ngalyuka, 2021; Beloke & AP, 2021).

1.2. Statement of the Problem

With the increasing growth of the electronic payment system, technology is now being used to conduct financial transactions via cell phones. M-banking is the next natural stage in the evolution of banking transactions, since it replaces bank branches and internet banking. Traditional branch-based retail banking has been the most common mode of completing financial transactions in Ethiopia over the years.

According to (Genene,2010) research, the challenges that will prevent the bank from obtaining efficiency and effectiveness in operations are recognized, and the bank industry is issuing cutting-edge technology in comparison to its competitors. However, neither the bank nor the researchers assess the benefits achieved or the problems experienced. Customer satisfaction, operational efficiency, and expansion are among the benefits acquiring to the bank. On the other hand, underutilization of capacity, poor design of technology, and skilled personnel turnover are the primary problems projected to face the bank.

Failures of technological systems at various times that disrupt basic banking operations and cause annoyance to the bank's efforts to provide timely service to its clients result in discontent and low technology dependence among the bank's staff, management, and customers. Society has a low level of technological awareness. Ethiopian Telecommunication Corporation charges exorbitant telecommunications and internet coast. Because local technology and software solution providers are underdeveloped, global software vendors charge exorbitant fees for financial technology in foreign currency (kalkidan, 2016). Despite the fact that numerous studies have been conducted, with the effects of digital banking on efficiency or performance of banking sector in developed countries , few studies were studied in African countries (Riquelme and Rios 2010), Brazil (Laukkanen, 2010), Taiwan (Luarn and Lin 2005), and China (Wang 2007).To the best of the researcher knowledge, there is a few research related directly to the effects of digital banking on efficiency of commercial banks(Ayana 2012), Garedachew 2010, kalkidan 2016).

Not only were the previous studies few in number in Ethiopia but they also had a limitation in terms of scope and methodological perspective. From scope perspective, the previous studies focused on cost and technical efficiency of the bank sector and none of them focused to measure the profit efficiency of the banks. However, analysing profit efficiency constitutes a more important source of information for management than the partial analysis of the cost efficiency. Second, as to the methodology employed, most of the previous studies employed the non-parametric approach of Data Envelopment Analysis (DEA) techniques. Unlike the DEA approach, this study used the parametric approach of Stochastic Frontier Analysis (SCF). the main objective of this research is to fill these empirical gaps by analyzing profit efficiency of commercial bank of Ethiopian using SCF approach and identifying the effects of digital banking usage in profit efficiency of banking sector.

Thirdly most of the study use traditional financial or accounting measures as a performance(Profit) measure, such as return on assets (ROA) or return on equity (ROE).but This study argues that it is more appropriate to measure enterprise performance using profit

efficiency than traditional financial or accounting measures, such as return on assets (ROA) or return on equity (ROE). Hence this research paper tried to fill research gap by assessing the effects of digital technology specifically ATM and mobile banking usage on profit efficiency of banking sectors in Ethiopian.

1.3. Objectives of the Study

1.3.1. General Objective

The general objective of this study is to identify the effects of digital technology usage on profit efficiency of banking sectors in Ethiopia.

1.3.2. Specific Objectives

- To estimate the overall efficiency of banking sector in Ethiopia
- To estimate the technical Inefficiency of banking sector in Ethiopia.
- Evaluate yearly trends of inefficiency of banks in Ethiopia.

1.4. Research Hypothesis

Based on the research objective and thorough analysis of theoretical and empirical literatures, the researcher has developed and tested the following hypothesis:

Hypothesis one: ATM has a positive and significant effect on ROE, ROA, and Managerial efficiency of banks.

Hypothesis tow: mobile banking has a positive and significant effect on ROE, ROA, and Managerial efficiency of banks.

1.5. Research Question

Based on the above statement of the problem the research question is stated as follows: -

- What is the efficiency level of banking sector in Ethiopia?
- What is the technical inefficiency level of banking sector in Ethiopia
- Which types of yearly trend the banks are shows?

1.6. Significance of the Study

The paper besides contributing to the existing knowledge of digital technology usage, it was assumed to have the following significances:

- The finding of the study provides valuable insights for the academic research, bank supervision, regulation, and management decisions by providing a tool to monitor and assess the effects of digital technology on managerial efficiency.
- It also fills the gap in the existing literature regarding the efficiency of commercial banks

- The study will be of great importance to future scholars and academicians as it will form basis for future research as well as providing literature for future studies on electronic banking.

1.7. Scope and Limitation of the Study

There are different types of efficiency measures that can be used to identify the Performance of commercial banks including cost efficiency, revenue efficiency, scale Efficiency, profit efficiency, technical efficiency, and allocative efficiency. However, this Study focuses on the profit efficiency and technical inefficiency and its effects on digital banking usage on profit (operation) efficiency. The study also does not include all commercial banks as a result of lack of data and shorter period of joining the banking industry.

1.8. Organization of the Paper

The thesis is organized into five distinct chapters in which the first chapter presents introduction to the study. The literature review part of the study is presented in chapter two which includes theories, empirical evidences and conceptual frame work. Chapter three presents the research design and methodology adopted to complete the study effectively and efficiently. Chapter four come with data presentation, analysis and interpretation. The final chapter winds up with conclusion and forwarding recommendation based on the result of the study.

CHAPTER TWO

LITERATURE REVIEW

This chapter reviews the existing research on the effects of digital banking usage on managerial efficiency of commercial banks of Ethiopia. In particular, the chapter examines theoretical reviews of various ideas on electronic banking, as well as empirical reviews of empirical studies done on the effects of electronic banking on bank efficiency.

2.1. Theoretical Literature Review

2.1.1. Theoretical Background of Firm's Performance

It is commonly known that the resource-based view (RBV) of the firm is one of the most accepted theories of strategic management to measure enterprise performance. The RBV basically predicts the relationship between the firm's resources and its performance. However, it has been criticized for its limited empirical support. This study argues that it is more appropriate to measure enterprise performance using profit efficiency than traditional financial or accounting measures, such as return on assets (ROA) or return on equity (ROE), among others (e.g., Bierly & Chakrabarati, 1996; De Carolis, 2003; Deephouse, 2000; Fernández, Iglesias- Antelo, López-López, Rodriguez-Rey & Fernández-Jardon, 2019; Hull & Rothenberg, 2008; Lin & Wu, 2014; Markides & Williamson, 1996; Wu, Yeniyurt, Kim & Cavusgil, 2006).

Profit efficiency refers to a firm's ability to manage its resources and produce outputs with greater economic value. This concept encompasses errors on the input side as well as on the output side. In addition, unlike the performance measures used by previous studies in the RBV related literature, profit efficiency is an indicator that assesses both the efficiency of a firm and the potential profit that this firm could earn if it were completely efficient. Consequently, profit efficiency is a better predictor for evaluating the overall performance of a firm than accounting and financial indicators . Financial and accounting indicators usually have different scores than profit efficiency and cannot be correlated due to intrinsic differences (Han, Kim, & Kim, 2012). For example, a firm with a high ROA may be inefficient when other economic and environmental dimensions are taken into account. Therefore, using profit efficiency as a performance measure can provide more empirical support to RBV research than has been achieved so far.

This theory highlights the importance of the resources and capabilities of the firm to achieving performance above the industry average. From an analytical perspective, the RBV assumes that

the competitive position of a firm depends on how specialized its assets and skills are and focuses its attention on the optimal use of these to create competitive advantage. For this, the RBV is based on two main assumptions (Barney,1991): (1) the firms in an industry are heterogeneous with respect to the resources they possess and (2) these resources are not perfectly mobile and, therefore, the heterogeneity will persist over time.

The utilization of resources is an important issue in the RBV (Majumdar, 1998; Miller & Ross, 2003), since as Winter (1995) argues, the mere possession of an exclusive resource does not guarantee that a firm achieves a competitive advantage. In this sense, Mahoney and Pandain (1992) argue that firms can achieve a greater profit not because they have superior resources but because their distinctive competences allow them to use those resources more efficiently. That is, a firm may have the skills to accumulate resources, but these resources would not be sufficient to achieve a competitive advantage; in addition, these resources must be used efficiently (Majumdar, 1998; Peteraf, 1993).

Thus, in the framework of the RBV, it is more appropriate to measure a firm's performance using profit efficiency than using traditional financial or accounting measures. The concept of profit efficiency refers to the firm's ability to reduce costs and to create greater economic value from its output. Peteraf and Barney (2003) emphasize the role of a firm's strategic resources in the creation of value. For these authors, the economic value of a good or service is the difference between its selling price and the economic cost of producing it. This definition of economic value is less associated with price or cost than with the commercial margin of a product. For a firm to generate a higher margin or greater value, it must not only combine and use its resources efficiently (cost efficiency) but also choose an efficient product-market combination (revenue efficiency).

The economic literature considers the two most important concepts of efficiency to be cost efficiency and profit efficiency, since they are based more on economic optimization in reaction to prices and competition in the market and less on the use of a certain technology (Berger and Mester, 1997). In other words, these two concepts of efficiency respond to two important economic objectives: the minimization of costs and the maximization of profits.

Cost efficiency is defined as the ratio between the minimum cost that can be achieved for a given volume of production and the current production cost. This concept tells us how much higher the costs of a firm are in relation to the costs of the most efficient firm that produces the same combination of outputs given the same prices for inputs, considering that the difference cannot be explained by a random error. For Leibenstein (1966), most of these inefficiencies

have their origin in management and/or organizational errors. Consequently, we can affirm that cost inefficiencies are due, first, to a bad choice of production plan (allocative inefficiency) and, second, to poor implementation of the production plan (technical inefficiency).

Therefore, considering profit efficiency as a measure of performance will allow us to know not only the differences in the use of resources among enterprises (cost efficiency) but also the differences in the response to the relative prices of the outputs (revenue efficiencies). In addition, profit efficiency, unlike other financial or accounting measures of performance, is an economic indicator that not only reveals how efficient a firm is but also indicates how much more profit that firm could achieve if it were completely efficient (Han, et al., 2012).

2.1.2. Innovation Diffusion Theory

The idea, way, practice, object and system that are perceived as new by individuals and institutions are called innovation. Wide gap has been existed in new type of innovation between what is known and what is actually used. Many innovations require a long period from the time when they become available to the time when they are widely adopted. Therefore, a common problem or many individuals and business organizations is how to speed up the rate of adoption and used in their day to day operation (Rogers, 2004).

Diffusion is the process of communicating innovation using channels over time among the members of a social system. It is a special type of communication in which the messages are concerned with a new idea. Diffusion has a special character that gives newness of the idea in the message content of communication. Diffusion is a kind of social change, refers a process by which alteration occurs in the structure and function of the social system. Hence, diffuse an innovation into a system is a challenge. The theory on the diffusion of new ideas and practices was investigated by various scholars and few of them are discussed below.

According to Dillon and Morris (1996), there are five factors that influence the diffusion of an innovation. The first is relative advantage, which refers to the extent in which technology offers improvement over the current available tools and channels. Second, compatibility is the consistency with social practices and norms among its users. The third one is complexity that refers to ease of use or learning and apply simply.

The fourth is trainability that refers the opportunity to test an innovation before applying and using it. And lastly observables, shows the extent to which the technology output and its gains are clear to see. These elements are not mutually exclusive and unable to predict either the extent or the rate of innovation diffusion.

Explicitly, the diffusion theory begins to describe the innovation-decision process within organizations or whether organizational type, size, or industry affects adoption. While there is an innovation decision described for individuals and within organizations. There is no description of

how the variables interact when innovations are diffused across organizations (Lundblad, 2003).

2.1.3. Recourse Base View Theory

The resource-based view (RBV) is a way of viewing the firm and consecutively of imminent strategy. The RBV was popularized by Hamel and Prahalad in their book Competing for the Future (1996). RBV considers the firm as a bundle of resources. These resources, and the way that they are combined, make firms different from one another and in turn allow a firm gain competitive advantage. This concept of RBV is quite different from the traditional Market Based View (MBV). According to MBV perspective, firms are considered as fairly homogenous and driving force for market competition is branding and positioning efforts of competing firms. Further, according to MBV, identifying alternative market as characterized by Michael Porter's five forces model is major strategic issue. MBV does not take into account whether firm is in position to exploit available market opportunity i.e., whether firms have enough resource and capabilities to compete in the marketplace.

2.1.4. Electronic Banking

E-banking is defined as the provision of retail and low-value banking goods and services through electronic channels by the Basel Committee on Banking Supervision (1998 and 2003). Deposit taking, lending, account management, financial advising, electronic bill payment, and the provision of other electronic payment products and services such as electronic money are examples of such products and services. "Electronic banking" or "e-banking" refers to both computer and telephone banking. It refers to banks' use of information and communication technology to provide services and manage client relationships more swiftly and efficiently (Charity-Commission, 2003). According to Burr (1996), it is an electronic connection between the bank and the customer used to prepare, manage, and control financial transactions.

The expression "e-banking" is technically and intricately hard to describe because it can be viewed differently depending on whom is accessing it. The adaptability of e-banking as a multichannel delivery method complicates its precise definition in the literature. Despite this, various attempts have been made to provide a concise and all-encompassing definition of e-banking (Furst et al, 2000; Basel Committee Report on Banking Supervision, 1998; Kricks, 2009; Auta 2010). Furst et al. (2000), for example, defined e-banking or internet banking as

the use of a remote delivery channel to perform banking services; Kricks (2009) defined e-banking as the automated delivery of new and traditional banking products and services directly to customers via electronic, interactive channels.

2.1.5. Overview of Banking System in Ethiopia

Modern banking in Ethiopia began in 1905, with the establishment of the Bank of Abyssinia. The Bank of Abyssinia was established under a fifty-year franchise arrangement with the National Bank of Egypt, which was held by the British at the time. To increase its presence in the country, the bank opened branches in Dire-Dawa, Gore, and Dessie. It also operated an agency in Gambella and a transit office in the port of Djibouti. The Bank of Abyssinia was succeeded by the Bank of Ethiopia after its formal liquidation on August 29, 1931 (National bank of Ethiopia, 2018). The nationalized banks were reorganized, resulting in the establishment of one commercial bank (Commercial Bank of Ethiopia), two specialized banks (the Agricultural and Industrial Bank (AIB), renamed the Development Bank of Ethiopia (DBE), and a Housing and Savings Bank (HSB), now known as the Construction and Business Bank (CBB), as well as one insurance company (the Ethiopian Insurance Corporation).

Following a change in government and a shift in economic policy, financial institutions were reorganized to operate within a market-oriented policy framework. Proclamation No. 83/1994, which permitted the construction of private banks, marked the beginning of a new era in the growth of Ethiopia's banking sector. Commercial banks, both public and private, are now open for business in accordance with Banking Proclamation No. 592/2008.According to the National Bank of Ethiopia's Fourth Quarter Report for 2008/09, the country had 13 banks operating in 2008/09, nine of which were private and the remaining three were state-owned. All of Ethiopia's banks have 636 branch offices spread across the country. In 2009, due to considerable branch development by private commercial banks, the banking system's total deposit liabilities increased to 78.1 billion. The percentage of private commercial banks increased to 38.2 from 35.2, representing annual deposit growth of 24% over the same period prior year.

Although the GOE permitted the establishment of private banks and insurance businesses in 1994, foreign ownership in this sector remains prohibited. Ethiopia currently has a central bank (The National Bank of Ethiopia), two government-owned banks, and sixteen commercial banks. The NBE enacted a regulation in September 2011 that increased the minimum paid up capital required to form a new bank from 75 million Birr ($3.4 million) to 500 million Birr ($22 million), effectively preventing newest banks from entering the market. Under the Growth

and Transformation Plan II (GTP II) period, NBE further increased the minimum paid up capital for banks to 2 Billion Birr ($90 million) and advised all the sixteen currently operating private banks to raise their paid-up capital to that level by 2020. Foreign banks are not permitted to provide financial services in Ethiopia, and foreign retail banks are barred from the market. Ethiopia currently allows some foreign banks to open liaison offices in Addis to facilitate loans to enterprises from their home countries. Banks from China, Germany, Kenya, Turkey, and South Africa have established liaison offices in Ethiopia.

The NBE governs the bank's minimum deposit rate, which is now 7%, while lending interest rates are free to float. In recent years, real deposit interest rates have been negative, owing primarily to inflation. In terms of assets, deposits, bank branches, and total banking employees, the state-owned Commercial Bank of Ethiopia (CBE) dominates the market. CBE amalgamated with another state-owned bank, the Construction and Business Bank, in 2016. The Development Bank of Ethiopia (DBE) is the other government-owned specialized bank. The state-owned DBE makes loans to investors in priority industries. DBE provides financing for short, medium, and long-term development initiatives, including industrial and agricultural enterprises. DBE also offers its customers various banking services such as checking and savings accounts. The NBE strives to promote monetary stability and a sound financial system by preserving credit and exchange circumstances conducive to the economy's balanced expansion. According to the National Bank of Ethiopia (2023) report, there are 29 active commercial banks in the country, including one state-owned bank and 28 private banks (NBE).

2.1.6. E-Banking History in Ethiopia

The evolution of e-banking in the world may be traced back to the early 1970s. For two reasons, banks began to consider e-banking as a means of replacing some of their traditional branch activities. For starters, branches were too expensive to establish and maintain due to the high overheads associated with them. Second, e-banking products/services such as ATMs and electronic cash transfers helped banks differentiate themselves. Banks' capacity to differentiate themselves on the basis of price is limited in a strongly competitive business. E-banking is clearly being adopted by banks and other financial organizations in both developed and developing countries. As technology advances, new types of electronic banking systems arise, each adding a new dimension to the user-bank interaction. ATMs, mobile and Internet (online) banking, electronic funds transfer, direct bill payments, and credit cards are among them (Gikandi and Bloor, 2010; Liaoa and Cheung, 2002).

In comparison to the rest of the world, Ethiopia's financial sector is one of the least developed. In Ethiopia, cash is still the most widely used medium of exchange, and electronic banking is not widely understood, let alone used for banking transactions. All Ethiopian banks are equipped to move with technology innovation, and they should clearly outline a timetable for their integration and technical advancement unlike other E-banking delivery routes, however, almost all banks have ATMs in handy places for their cardholders. Currently, debit service is only available for Visa and Master cards, and clients of respective banks can use their debit cards to withdraw cash and purchase products and services (Worku, 2010).

Despite this, Commercial Bank of Ethiopia launched ATM service for local consumers in 2001, with a fleet of eight ATMs in Addis Abeba. Furthermore, CBE has been a Visa member since November 14, 2005. However, due to a lack of adequate infrastructure, it was unable to realize the benefits of its membership. Despite being the first to introduce an ATM-based payment system and to obtain Visa membership, CBE trailed Dashen Bank, which fought hard to maintain its lead in electronic payment systems. Dashen Bank, an early adopter of e-banking in Ethiopia, has placed ATMs in handy locations for its own cardholders. The number of banks offering E-banking services increased gradually till it reached four in 2011. Surprisingly, three banks entered the market with a consortium in June 2012, increasing the number of E-banking service providers to seven. And, at the end of 2013, Berhan International Bank joined the group, bringing the total number of E-banking service providers to All commercial banks are now offering e-banking services to their consumers using the et-swith solution.

According to Dawit (2016), ET Switch, a centralized switch system that plans to integrate all real-time and online payment systems in Ethiopia, which began by connecting all Automated Teller Machines (ATMs), has completed transactions valued at 1,175,089,410 birr since its launch in May 2016 despite a high transaction decline rate of 40% per month caused by connection failure and system breakage in its member banks. Aside from that, e-banking applications pose a security risk due to their reliance on essential ICT systems, which create vulnerabilities in financial institutions and organizations, potentially harming banking consumers. Banks must recognize and handle security problems in order to fully realize the promise of ICTs in delivering E-banking services. The prevention of cybercrime (the exploitation of ICTs by individuals to perpetrate fraud and other crimes against financial transactions) should be prioritized in the deployment of E-banking applications (ITU4D, 2006).

2.1.7. E-Banking System in Ethiopian Banking Industry and its opportunity

The evolution of e-banking in the world may be traced back to the early 1970s. For two reasons, banks began to consider e-banking as a means of replacing some of their traditional branch activities. For starters, branches were too expensive to establish and maintain due to the high overheads associated with them. Second, e-banking products/services such as ATMs and electronic cash transfers helped banks differentiate themselves. Banks' capacity to differentiate them on the basis of price is limited in a strongly competitive business. E-banking is clearly being adopted by banks and other financial organizations in both developed and developing countries. As technology advances, new types of electronic banking systems arise, each adding a new dimension to the user-bank interaction. ATMs, mobile and Internet (online) banking, electronic funds transfer, direct bill payments, and credit cards are among them (Gikandi and Bloor, 2010; Liaoa and Cheung, 2002).

In comparison to the rest of the world, Ethiopia's financial sector is one of the least developed. In Ethiopia, cash is still the most widely used medium of exchange, and electronic banking is not widely understood, let alone used for banking transactions. All Ethiopian banks are too late to keep up with technology growth, and they should explicitly outline a timetable for their integration and technical advancement. Unlike other E-banking delivery routes, however, almost all banks have ATMs in handy places for their cardholders. Currently, debit service is only available for Visa and Master cards, and clients of respective banks can use their debit cards to withdraw cash and purchase products and services (Worku, 2010).

Despite this, Commercial Bank of Ethiopia launched ATM service for local consumers in 2001, with a fleet of eight ATMs in Addis Abeba. Furthermore, CBE has been a Visa member since November 14, 2005. However, due to a lack of adequate infrastructure, it was unable to realize the benefits of its membership. Despite being the first to introduce an ATM-based payment system and to obtain Visa membership, CBE trailed Dashen Bank, which fought hard to maintain its lead in electronic payment systems. Dashen Bank, an early adopter of e-banking in Ethiopia, has placed ATMs in handy locations for its own cardholders.

The number of banks offering E-banking services increased gradually till it reached four in 2011. Surprisingly, three banks entered the market with a consortium in June 2012, increasing the number of E-banking service providers to seven. And, at the end of 2013, Berhan International Bank joined the group, bringing the total number of E-banking service providers to eight. All commercial banks are now offering e-banking services to their consumers using the et-switch solution.

According to Dawit (2016), ET Switch, a centralized switch system that plans to integrate all real-time and online payment systems in Ethiopia, which began by connecting all Automated Teller Machines (ATMs), has completed transactions valued at 1,175,089,410 birr since its launch in May 2016 despite a high transaction decline rate of 40% per month caused by connection failure and system breakage in its member banks.

Aside from that, e-banking applications represent a security risk due to their reliance on essential ICT systems, which create vulnerabilities in financial institutions and organizations, potentially harming banking consumers. Banks must recognize and handle security problems in order to fully realize the promise of ICTs in delivering E-banking services. The prevention of cybercrime (the exploitation of ICTs by individuals to perpetrate fraud and other crimes against financial transactions) should be prioritized in the deployment of E-banking applications (ITU4D, 2006).

2.1.8. Opportunity and Challenges Of E-Banking

E-banking tools and similar e-banking services provide many benefits, primarily to the bank, such as: customer acquisition through effective and time-saving services, building a good image of the bank, relieving or relieving the burden on employees, improving organizational efficiency by reducing costs and increasing the bank's income through various activities with electronic banking services, in order to benefit from the advantages mentioned above as a result of the introduction of electronic banking services,(Fetu, 2019)

(Daba, 2021) research on the potential operational efficiency benefits of electronic banking, He concluded that banks realized service benefits such as increased comfort and time savings, transactions can be made 7x24 without requiring physical interaction with the bank, quick and continuous access to information, better cash management, E-banking facilities speed up the cash cycle and increase the efficiency of business processes because a wide range of cash management instruments are available on internet sites, reduced inconveniences, speed, and funds Management banking activities incur difficulties because, Lack of banking services via the web or other electronic means, such as using mobile phone data and network security and privacy, as well as legislation to protect workers and secure the Internet, weak telecommunications, broken and slow Internet connections, and a lack of Internet awareness.

2.1.9. Benefits of Electronic Banking

Banks, like other organizations, are embracing information technology to boost corporate efficiency, improve service quality, and attract new consumers (Nath et al, 2001). According to Al-Sukkar and Hasan (2005), decreased costs are the most important criteria encouraging consumers to utilize online banking, followed by less paper effort and human error. As a result,

electronic channels can result in decreased transaction costs that are extremely competitive (Claessens and Kliengbiel, 2000). According to Kiang et al. (2000), disagreements between employees can be eliminated if there is a clear flow of processes. Conducting business outside of usual branch working hours has also been considered convenient for bankers. According to Jayewardene and Foley (2000), each ATM can do the same, largely routine, transactions as human tellers in branch offices, but at half the cost and with a four-to-one productivity gain. As a result, banks can provide consumers with quick, low-cost access to the bank 24 hours a day, seven days a week.

Increased accessibility and availability of more self-service distribution channels aids bank administration in decreasing the costly branch network and associated staff overheads (Birch and Young, 1997). A decrease in the proportion of clients visiting banks combined with an increase in alternative channels of distribution will reduce lineups in branches (Thornton and White, 2001). According to Thornton and White (2001), this results in increased consumer satisfaction. According to Jayewardene and Foley (2000), computerized banking enhances competition within the banking industry as well as from non-bank financial institutions. Electronic banking also gives customers the ability to quickly and easily compare prices across providers, which drives down costs and margins (Devlin, 1995).

According to Kerem (2003), banks respond differently to electronic banking, and those that regard electronic banking as a supplement and substitute for traditional channels gain better connection and involvement with clients. According to Nath et al. (2001), providing high-quality services can result in high-profit customers for the bank. According to Polatoglu and Ekin (2001), early adopters and heavy users of internet banking services are happier with the services than other consumer categories. According to Joseph and Stone (2003), the ability to provide services through technology is positively associated to satisfaction. Smith (2006) emphasizes the significance of human and technology-based delivery channels in increasing bank client satisfaction, preservation, and switching. Customers who use e-banking do not have to worry about managing large sums of money, submitting utility bills, or standing in long lines for services. According to Rahman (2009), by December 2006, 99 percent of private commercial bank (PCB) branches in Bangladesh were computerized. The average for all bank branches was 37% because only 4% and 16% of specialized banks (SBs) and state-owned commercial banks (SCBs) were computerized, respectively.

The gradual but often erratic development of electronic banking has been one of the most significant advancements in Zimbabwe's banking system (Dube et al, 2009). The expansion of internet access in Zimbabwe has aided the country's embrace of electronic banking. The Internet has altered the competitive landscape in the retail banking market. In Zimbabwe Electronic banking services were first seen in Zimbabwe in the early 1990s, when Standard Chartered Bank and CABS installed the first ATMs. Other electronic banking solutions have emerged in recent years, such as EFT systems, telephone banking, PC banking, and even internet banking (Njanike, 2010). The expansion of internet connectivity in Zimbabwe has significantly enhanced financial inclusion of formerly marginalized and excluded communities in the Zimbabwean economy. Technological advancements and competition in the banking business have increased retail and wholesale customers' access to a diverse variety of services**.** Electronic banking is seen as a valuable and powerful tool for driving development, supporting growth, fostering innovation, and increasing competitiveness (Kamel, 2005; Nath et al, 2001). Transitions from ATMs, phone banking, PC banking, and internet banking have demonstrated the growth of banking technology (Chang, 2003). Other studies suggest that banks have used electronic banking to gain a competitive edge, decrease expenses, and maintain a strategic position (Bradley and Stewart, 2003). Zimbabwe has also been a part of the global trend toward the use of modern technology, as seen by an increase in the use of electronic delivery channels such as ATMs and the internet.

Other advantages of electronic banking adoption in developed countries include the ability to attract new customers and expand the customer database, improve bank marketing and communication, and retain high-profit customers (Al-Sukkar and Hasan, 2005). Lack of user-friendly technology, customer demand, high initial set-up costs, redundancy of existing high-cost legacy systems, economic instability, regulatory controls, and a lack of suitable skills have been identified as some of the most significant issues impeding electronic banking adoption or diffusion (Bradley and Stewart, 2003, Kerem, 2003, and Chang, 2003). In Zimbabwe, the adverse sector-specific constraints impeding electronic banking adoption or diffusion were compounded by the economic downturn that began in 1997 and culminated in the 2008 economic catastrophe (Njanike, 2008; Kairiza, 2009).

2.10. Type of Electronic Banking

Electronic banking consists of the following: mobile banking, internet banking, telephone banking, electronic card, POS, and ATM. But the study focused only the technology mostly used by the customers those are: -

2.10.1. Automated Teller Machine (ATM)

An ATM is a device that provides a variety of services to users who are authorized by using a PIN-code. A cash ATM allows the user to make payments, withdraw money, and examine account information (Myllynen, 2009).

When compared to most branches, ATMs have lowered transaction expenses by about one-fourth. ATMs may perform a range of tasks, including cash withdrawal, cash deposits, and service requests, such as requesting a new check book. New technology has made it easier to deploy ATMs in shopping malls or busy commercial areas, lowering transaction and operation expenses for banks (Sambamuthy et al., 2010).

ATMs were among the first ICT technologies employed by banks and have remained among the most successful. The ATM is computerized telecommunications equipment that allows bank customers to access their financial accounts using self-service. A prototype was created in 1939, a contemporary ATM was patented in 1966, an ATM was implemented in London's Barclays Bank in 1967, and the United States began producing ATMs in 1968 (Bellis, 2010).

Alternate delivery channels like as ATMs, Telephone Interactive Voice Response systems, and internet banking is mature channels, according to (Koltveit et al. 2000), however advances in ICT allow for chances for enhancements even in these established technologies. Services such as SMS banking, text alerts, bill pay, automated clearinghouse, electronic payments, mobile banking, e-mail alerts and notifications, and internet banking are now prominent alternate delivery channel technologies. These are all relatively new ICT-enabled tactics that improve performance. According to Morsi (1996), banks are introducing ATM capabilities such as online loan applications, statement delivery, foreign currency dispensing, purchase of traveler's checks, and check cashing to entice clients.

2.10.2. Mobile Banking

Mobile banking entails using a mobile phone to settle financial transactions. It facilitates person-to-person transfers with monies available to the beneficiary immediately. Mobile payments make advantage of the card infrastructure to transport payment instructions as well as secure SMS messages to confirm receipt to the beneficiary. Mobile banking is intended for low-value transactions when speed of completion is critical. Account inquiry, funds transfer, phone recharge, password change, and bill payment are some of the services covered by this product, which are provided by a few institutions (Sathye, 1999).

2.2. Empirical Literature

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

focused on estimating an efficient frontier and measuring the average differences between observed banks and banks on the frontier. Many studies found a significant difference in cost inefficiencies. However, there is no consensus on the sources of the differences in measured efficiency (Berger and Mester, 2008).Berger and Mester (2008) find out the sources of efficiencies comes from the following three sources:(1) differences in the concept of efficiency used; (2) differences in measurement methods used to estimate efficiency within the context of these concepts; and (3) correlates of efficiency such as bank specific, macroeconomic, and regulatory characteristics which may explain some of the efficiency differences after controlling for efficiency concept and measurement method. This section reviews the empirical literature on banking efficiency studies. Over the past several years, considerable research efforts have gone into measuring the efficiency of commercial banks by using both parametric and non-parametric frontier efficiency measurement techniques such as stochastic frontier analysis (SFA), data envelopment analysis (DEA), thick frontier analysis (TFA), etc. Bhattacharyya et al. (1997) use stochastic frontier analysis to examine the efficiency patterns across ownership groups and through time for Turkish commercial banks. The findings of the study showed that foreign owned banks improved their efficiency over time whereas the opposite happens for the public sector banks. According to this study, the efficiency declines for foreign owned banks at the beginning of the period as a result of the adverse effect of capital adequacy requirement. However, the efficiency increases at the end due to the increase in the number of branches and significant temporal effects.

Jemric and Vujcic (2002) used DEA model and adopted the intermediation approach to measure bank efficiency in Croatia for the period 1995-2000. They use fixed assets, technology, number of employees (labor) and total deposits collected as inputs, and total loans extended and short term securities issued by official sectors were used as outputs. They found evidence that the relationship between bank size and efficiency is U-shaped. Girardone et al. (2004) used SFA to estimate the efficiency scores and their determinants for Italian banks over the period 1993-1996.The result found that there is a positive relationship between efficiency and capital and a negative relationship of efficiency with non-performing loans. In addition, the study showed that there is no significant relationship between the size of banks and efficiency. Pasiouras (2008) used a DEA method to estimate efficiency scores of Greek commercial banks during the period 2000-2004. The result indicates that the inclusion of provisions on loans as input increases the efficiency score. In addition, banks which extended their activities abroad seem to be more technically efficient than those which are doing their business only at a national

level.

Havrylchyk (2006) studied the cost efficiency of the polish domestic and foreign banking industry during the period 1997-2001 using DEA and an intermediation approach. The author includes labor, capital, and deposits as inputs while the outputs include loans and government bonds. In order to identify the determinants of efficiency the author used the second stage of approach. The result shows that neither size nor capitalization is related to the efficiency but the ratio of total loans to total assets shows a significant negative sign suggesting that banks that took more risks were less efficient. Pancurova and Lyocsa (2013) estimate the cost efficiency and their determinants for a sample of central and Eastern European countries over the 2005-2008 periods by using data envelopment analysis. They found evidence that the size and financial capitalization of banks are positively associated with cost efficiency but the loans to asset ratio was negatively associated with cost efficiency. Rouissi (2011) examine the cost and profit efficiency level of French commercial banks by classifying them as domestic and foreign by use of SFA over the period 2000 to 2007. The result indicates that foreign banks exhibit higher cost and profit efficiency than domestic banks. Garcia (2010) apply data envelopment analysis methodology to obtain efficiency estimates and a to bit regression model to determine the major factors that affect efficiency of Mexican banks over the period 2001 to 2009. He found the result that the Mexican banking sector experienced an average efficiency score of 85% and the major determinants of efficiency are loan intensity, GDP growth, and foreign ownership.On the other hand non-interest expenses, non-performing loans and inflation rate reduce banking efficiency.

The study of Jackson and Fothi (1998) evaluates the technical efficiency of Turkish commercial banks using the non-parametric frontier methodology of data envelopment analysis (DEA) and investigate the determinants of efficiency by using the model. They found that larger and profitable banks are more likely to operate at a higher level of technical efficiency. On the other hand, capital adequacy ratio has a statistically significant adverse impact on the efficiency of commercial banks, which may reflect the risk return tradeoff in the sector. Tahir, Mazlina and Haron (2010) uses SFA to examine the cost efficiency levels of domestic and foreign commercial banks in Malaysia for the year 2000 to 2006 .The result indicates that domestic banks are found to be more cost efficient than foreign banks. On the other hand, Shen (2008) used stochastic frontier analysis to study the cost efficiency and their determinants for a sample of ten Asian countries during the period 2000 to 2006. The result shows that banking concentration may have a positive or negative impact on efficiency. Net interest margin and average capital ratio have a positive effect on efficiency. The study of Rozzani and Rahman

(2013) explores the area of bank efficiency and its determinants for conventional and Islamic banks in Malaysia with the usage of Stochastic Frontier Analysis.The study covers the period 2008-2011 for a sample of 19 conventional banks and 16 Islamic banks that operate in Malaysia.

The result indicates that the levels of efficiency for both conventional and Islamic banks in Malaysia were highly similar. Further, it could be observed that efficiency would be better for conventional banks with the increment of bank size and also the decrement of both operational cost and credit risk, while the efficiency for Islamic banks would be better with only the decrement of operational cost. Inui, Park, and Shin (2008) investigate the productivity of Japanese and South Korean banks using SFA. They also use the intermediation and value added approach in order to identify inputs and outputs. In both approaches the study found that Japanese banks are efficient and productive than South Korean banks. Altunbas et al. (2000) estimate the technical efficiency of Japanese commercial banks over the period 1993-1996. They specified total loans, and total securities as outputs and three inputs (price of labor, price of total deposits, and price of physical capital).The study extended the existing literature to evaluates the impact of risk and asset quality on cost efficiency and shows that scale economies will tend to be overstated if these factors are not taken into account. Hao et al. (2001) examined the productive efficiency of 19 Korean private banks over the 1985- 1995 periods.

They employed the intermediation approach and estimated their costs using the stochastic frontier function. They specified total loans, securities, deposits, and fee income as outputs and personnel expenses, interest for borrowed funds and price of physical capital as inputs. Their results show that banks with higher rates of asset growth, fewer employees per million Won of assets,larger amounts of deposits and lower expense ratios were more efficient. They also found that the financial deregulation measures of 1991 had little or no significant effect on the level of bank efficiency. Sufian (2009) used DEA method to estimate the efficiency of the Malaysian banking sector during the Asian banking crisis in 1997 and found a significant and negative relationship between bank deposits and levels of efficiency which implies that banks which have large amount of deposits tends to be less efficient. In addition banks which have higher ratios of loan to assets have higher efficiency scores. This positive relationship can be explained by the efficient market hypothesis that the most efficient banks can achieve lower production costs enabling them to offer reasonable credit and gain market share from large inefficient banks. Manlagnit and Chelo (2011) examined the cost efficiency of Philippine commercial banks using the SFA method to determine the efficiency scores found

that risk and asset quality negatively affect the efficiency of banks. This substantial increase in cost inefficiency could be attributed to the adverse effects of the Asian crisis of 1997, the cost of banking reform and regulatory changes that have been adopted to stabilize and strengthen the sector. Tecles and Tabak (2010) studied the determinants of bank efficiency in Brazil by using SFA during the period 2000-2007 and found that large banks are the most cost efficient.

In addition there is a positive relationship between the degree of capitalization and bank efficiency. Regarding African studies, Kablan (2010) uses SFA to assess the determinants of banking system efficiency and financial development in Sub Saharan Africa over the period 2007 to 2009. Sub Saharan African banks found to be generally cost efficient, however non-performing loans undermine efficiency. The result shows that in order to improve efficiency there should be an improvement in the regulatory and credit environment. In addition, the political and economic environments have a negative impact on the financial development in SSA. Raphael (2013) employs DEA to estimate the relative efficiency of 58 selected commercial banks operating in the East African community from 2008 to 2011. The result shows that most commercial banks in East Africa are operating under decreasing returns to scale. Therefore, inefficient utilization of input resources could be one of the reasons for the inefficiency of commercial banks in East Africa. Cube (2009) employs SFA to determine the cost and profit efficiency of South African banks during the period 2000 to 2005. The result of the study shows that South African banks have significantly improved their cost efficiency over the period of the study. About and Natali (2015) studied the cost efficiency of Tunisian banking system using SFA during the period 1997 to 2012. The result shows that banks which have a high population density, high ratio of intermediation, high return on assets and equities ratio found to be more efficient.

However, cost efficiency of Tunisian banks negatively affected by a high capital assets ratio, a greater concentration, and a wide density of deposits request as well as per capita income. Aydin (2013) studied the cost efficiency of Tunisian commercial banks by using DEA for the period 1996-2010. The result suggested that market share in terms of deposit negatively affect cost efficiency of the sector and engagement in risky activities especially in the field of credit and a high bank capitalization positively influences the cost efficiency of commercial banks. In addition, state owned banks are more efficient than their private counterparts. Kiyota (2009) provides a comparative analysis of cost and profit efficiency of commercial banks operating in 29 Sub Saharan African countries during the period 2000 to 2007. The study uses SFA in the

first step and to bit model for the second step analysis and provides cross country evidence on the impact of environmental factors on efficiency. The result shows that medium and larger banks are the most cost efficient than others. Hussein (2003) provides analysis of the characteristics of cost efficiency of Islamic banks in Sudan between 1990 and 2000.

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

Therefore, Sudanese banks should implement serious policy instruments for the development of human capital in order to reduce cost inefficiency. On the other hand, Kirkpatrick et al. (2007) will examine the efficiency of Anglophone African banks after the period of banking crisis (1992-1999). They use the stochastic cost frontier function, then as a second step they explained these cost efficiencies found by bank specific factors and relevant macroeconomic variables. They found that cost inefficiency is increased by the presence of nonperforming loan ratios and financial liberalization. In Ethiopia, Malone (2006) employed the SFA to examine the determinants of cost efficiency for six private banks by using quarterly data over the period 1994-2001. The result shows that size of banks is negatively related with efficiency while capital is found to be positively affecting efficiency of banks. The study does not include public banks and restricted the study only to private banks. Iskandar (2013) uses the stochastic frontier analysis to investigate the cost efficiency of commercial banks based on their ownership during the period 2007-2012. The result shows private commercial banks are more cost efficient than state owned bank.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Research Design

The Explanatory research design is used in this study. Because the nature of the relationship between one dependent variable and one or more independent variables is explained in an explanatory study. The goal of this research is to examine the relationship between digital technology and the efficiency of selected government-owned and private commercial banks in Ethiopia. As a result, the researcher employed an explanatory research design.

3.2. Data Type and Source

The study uses secondary Quantitative data type collected from annual financial report of the selected commercial banks and NBE's annual reports.

3.3. Population and Sampling

The population of the study is all commercial banks found in Ethiopia that are registered with the National Bank of Ethiopia (NBE). Sampled on the top seven senior commercial banks in Ethiopia that are registered with the National Bank of Ethiopia (NBE) based on year of establishment and the availability of data.

Table 1:list of top seven senior public and private banks in Ethiopia

No	Name of the Bank	Year of establishment
1	Commercial Bank of Ethiopia (CBE)	1963
2	Awash international bank (AIB)	1994
3	Dashen bank (DB)	1995
4	Bank of Abyssinia (BOA)	1996
5	Wegagen Bank (WB)	1997
6	United Bank	1998
7	Abay Bank	2010

Source: Own computation

3.4. Sample Design and Size

According to the National Bank of Ethiopia (2023) report, there are 29 active commercial banks in the country, including one state-owned bank and 28 private banks. Based on the year of establishment and the availability of data, the study purposefully picked 7 commercial banks from this group Namely (commercial Bank of Ethiopia (CBE), Awash International Bank (AIB), Dashen Bank (DB), Bank of Abyssinia (BOA), Wegagen bank (WB) United Bank (UB) and Abay Bank (AB)). The sampling design was adopted for this research is purposive sampling because purposive sampling procedure decreases the generalizability of findings and this study might not be generalizable to all areas of financial institutions. In other words, units

are selected ‘on purpose’ in purposive sampling Also called judgmental sampling, this sampling method relies on the researcher’s judgment when identifying and selecting the individuals, cases, or events that can provide the best information to achieve the study’s objective .

3.5. Data Collection Method

The secondary data for this study would obtain from the sampled banks documents and National Bank of Ethiopia annual report.

3.6. Data Analysis

To meet the study's objectives, five years of panel data from seven commercial banks (from 2016 to 2020) are employed. Descriptive statistics, correlation and stochastics frontier Analyses (SFM) are used to analyze the acquired panel data. To analyze data trends, descriptive statistics, mean and standard deviation, maximum and minimum values are utilized. STATA was utilized in this investigation.

3.7. Data and Model Specification

3.7.1. Data and Variables

The method used to measure the efficiency of the capital market in the banking sector was the parametric approach of Stochastic Frontier Analysis. The analysis unit in this study was commercial banks in the Ethiopian capital market between 2016 to 2020. Employing panel data in empirical research is necessary if we want to analyses the impact of resources on sustained competitive advantage, since it seems evident that the use of longitudinal data allows us to more adequately capture the concept of sustainability than cross-sectional analysis (Armstrong & Shimizu, 2007). The financial data, price of factors of production, values of raw/intermediate material inputs, number of financial technologies adopted and digital banking users and others were extracted from the data set obtained from each year annual report of National bank of Ethiopia.

The selection of the variables was made according to the literature and available information. Regarding the profit efficiency frontier function, we specify three outputs, (Return on asset, return on equity and operating efficiency) to be considered one by one, and five inputs (resources necessary to obtain the profit of the banks).

These inputs include the number of full-time equivalent employees, total spending on funds, prices depreciation and digital banking technologies. The prices of the inputs cannot be identified directly; therefore, it must be approached from the available information. Lastly, the

dependent variable of the profit frontier function is the return on asset, return on equity and managerial efficiency (separately one by one). All of these variables are described as below.

3.7.2. Empirical Methods (Stochastic Frontier Methodology)

The frontier method has been the most often used methodology for estimating efficiency. According to this methodology, a firm is labelled efficient if it operates in the efficient frontier of the industry. There have been numerous studies on this issues that use the frontier method (Chen et al., 2015; Demas & Montes-Sancho, 2010; Knott, Posen & Wu, 2009; Majumdar, 1998; Majumdar & Marcus, 2001;). Among these methods, data envelopment analysis (DEA) and the stochastic frontier approach (SFA) are the most used. The DEA was introduced by Charnels, Cooper and Rhodes (1978) and uses linear programming techniques to estimate efficiency. However, the DEA is a nonparametric method that ignores prices and, therefore, can only measure technical efficiency. A second drawback of this method is that it considers the entire distance between a firm and the efficient frontier as inefficiency, not taking into account the possible existence of random errors.

The SFA is a methodology that uses econometric methods to estimate efficiency; it was introduced simultaneously by Aligner, Lovell and Schmidt (1977) and Meuse and Van den Broeck (1977). Unlike DEA, SFA is a parametric technique that is better suited to the concept of profit efficiency discussed above. In the SFA, it is said that a firm is inefficient in profit if its profit is less than the best-practice profit after eliminating the random error. That is, the performance of a specific firm is evaluated with respect to the efficient frontier, and any deviation from this efficient frontier is due to random errors and inefficiency. In the SFA, this deviation is represented by a compound error term.

The possibility of having panel data allows more reliable estimates of efficiency to be obtained, since it provides a level of efficiency for each firm throughout the study period. Normally, panel data models assume that efficiency is invariant over time. However, Battese and Coelli (1995) propose a model that relaxes this assumption and suggest that the determinants of inefficiency can be expressed as a linear function of a set of explanatory variables that reflect the inherent characteristics of a firm. Therefore, this paper has followed the dominant functional specification in literature based on the works by Bettese and Coelli (1992, 1995), in which it is formalized technical inefficiency in the production function of stochastic frontier for panel data. Thus, consider the following production function of a given state i:

$$y_{it} = \exp(x_{it}\beta + v_{it} - u_{it}) = \exp(x_{it}\beta + v_{it})\exp(-u_{it}) \qquad \text{or}$$

$$\ln y_{it} = x_{it}\beta_{it} + v_{it} - u_{it} \qquad (1)$$

$i = 1, ..., N \qquad firms, \ t = 1, ...T, years$

Where y_{it} is the vector representing produced quantities by the unit of production i,i in period t; x_{it} is the vector of inputs used by the unit of production in period t; β is the vector of coefficients to be used that define the production technology. The term u_{it} is vectors representing inefficiencies found that reduce profit, and v_{it} represents random error. To facilitate the estimation of inefficiency, it is assumed that random error and inefficiency, v and u, respectively, are separable from the remainder of the profit function. Furthermore, it is assumed that random errors vit are normally distributed, independent and identically distributed as N (0, σv^2) and independent of u_{it} .The second term concerns the part relating to technical inefficiency, constituting a deviation in relation to the production frontier (which can be inferred by negative sign and by restriction $u \geq 0, \quad u \geq 0$). They are assumed nonnegative random variables with normal truncated distribution.

The traditional frontier models consider that all the firms in an industry share the same technology; that is to say, there is no heterogeneity between them and, therefore, it is assumed that the efficient frontier is common for all firms. However, a basic assumption of the RBV is the heterogeneity of resources between firms (Barney, 1991; Peteraf, 1993). If firms are heterogeneous from the point of view of resources, in the sense that some firms have resources that generate more value than others (Peteraf, 1993), then the assumption that all firms face the same efficiency frontier is incorrect. That is, each firm will have its own efficiency frontier and, therefore, inefficiency will be given by the deviation of each firm from its frontier of possibilities. Tsionas (2002) proposes a new model where it is possible to relax the assumption that all firms in an industry are homogeneous and face the same efficient frontier. This model is called the random stochastic frontier model and can be expressed as

$$\ln y_{it} = x_{it}\beta_i + v_{it} - u_{it} \qquad (2)$$

where βi is the vector of random parameters to be estimated. That is, it is assumed that the coefficients of the explanatory variables vary between firms, and therefore, each one has its own optimal possibilities frontier. This approach takes into account the differences in the allocation of resources between firms. The parameters βi are considered to follow a multivariate normal distribution such that $\beta_i \sim N(\bar{\beta}, \Omega)$, where $\bar{\beta}$ is a vector of parameter means and Ω is a positive definite covariance matrix. If Ω=0, the model considered will be that specified in equation (1), that is, a fixed stochastic frontier model.

According to the above, the specification of the stochastic profit frontier trans log with random coefficients for the case of one output and five inputs and imposing the restrictions of homogeneity and symmetry for banking sector can be expressed as;

$$\ln ROA_{it} = \alpha + \beta_{1,i} \ln x_{1,it} + \beta_{2,i} \ln x_{2,it} + \beta_{3,i} \ln x_{3,it} + \beta_{4,i} \ln x_{4,it} + \beta_{5,i} \ln x_{5,it}$$
$$+ \frac{1}{2}[\beta_{6,i} (\ln x_{1,it})^2] + \beta_{7,i} \ln x_{1,it} \ln x_{2,it} + \frac{1}{2}[\beta_{8,i} (\ln x_{2,it})^2] +$$
$$\beta_{9,i} \ln x_{1,it} \ln x_{3,it} + \beta_{10,i} \ln x_{1,it} \ln x_{4,it} + \beta_{11,i} \ln x_{1,it} \ln x_{5,it} + \frac{1}{2}[\beta_{12,i} (\ln x_{3,it})^2] +$$
$$\beta_{13,i} \ln x_{2,it} \ln x_{3,it} + \beta_{14,i} \ln x_{2,it} \ln x_{4,it} + \beta_{15,i} \ln x_{2,it} \ln x_{5,it} + \frac{1}{2}[\beta_{16,i} (\ln x_{4,it})^2] +$$
$$\beta_{17,i} \ln x_{3,it} \ln x_{4,it} + \beta_{18,i} \ln x_{3,it} \ln x_{5,it} + \frac{1}{2}[\beta_{19,i} (\ln x_{5,it})^2] + \beta_{20,i} \ln x_{4,it} \ln x_{5,it} + v_{it} - u_{it}$$

- The other variables have the same interpretation as in equation (1).

Table 2:variables used in the estimation of profit efficiency

variables	Variable name	Definition
output		
ROA	Return on Asset	measures as a ratio of (net income to average total asset) x100
ROE	Return on Equity	measures as a ratio of (net income to equity) x100
ME	Managerial (operational)Efficiency	measures as a ratio of operating expenses to operating income
INPUT		
X1	Price of Funds	total interest expenses / total funds
X2	Price of Labor	estimated as total cost of salaries, including social security costs, divided by the number of equivalent full-time employees
X3	Price of physical capital	estimated as the depreciation of fixed assets divided by the fixed assets
X4	installed ATM machines	proxy for digital banking _estimated as total number of ATM installed by each bank over time and currently operating
X5	number of mobile banking users	proxy for digital banking estimated as total number of respective bank customers using Mobile banking services

CHAPTER FOUR

DATA ANALYSIS AND INTERPRETATIONS

This chapter provides a brief presentation and discussion of the data analysis outcomes. The study used panel date of five years (from 2016 to 2020) and in seven carefully chosen commercial banks. These figures were obtained from the Ethiopian Central Bank and audited financial statements of selected commercial banks. STATA version 16 was used to analyses and interprets the data. Descriptive statistics were discussed, followed by correlation and stochastics frontier analysis.

4.1. Descriptive Statistics

The banking sector plays an important role in the Ethiopian economy. The sustainability of the Ethiopian banking sector will depend on the ability of every banking institution to maintain their competitiveness. Banking competitiveness is reflected in the level of efficiency of the banking system itself.

Figure 1and 2 shows the overall yearly trends of ROA, ROE, ME, number of ATM and number of mobile banking user of seven (7) commercial banks from the years 2016 to 2020.the figure shows that ROA, ROE and ME of CBE shows decreasing trend this implies that CBE increase its resource to make the trend vis verse. within the study year Dashen bank shows increasing trends of ROA unlike to ROA, Dashen bank ROE and ME shows fluctuation. Following to Dashen bank Awash international bank shows increasing trends on its ROE but the rest of five banks shows fluctuations on its ROA, ROE and ME .in terms of its NATM and NMOB user the figure shows that the three banks (commercial bank of Ethiopia (CBE) Wegagen bank (WB)and Abay bank (AB)) shows increasing trends on its NATM and NMOB users. bank of Abyssinia and united banks shows increasing trend on its NATM but it has no stable trend on its number of mobile banking user, un like to the five banks Awash international bank and Dashen bank has no constant increment or decrement on its both NATM and NMOB.

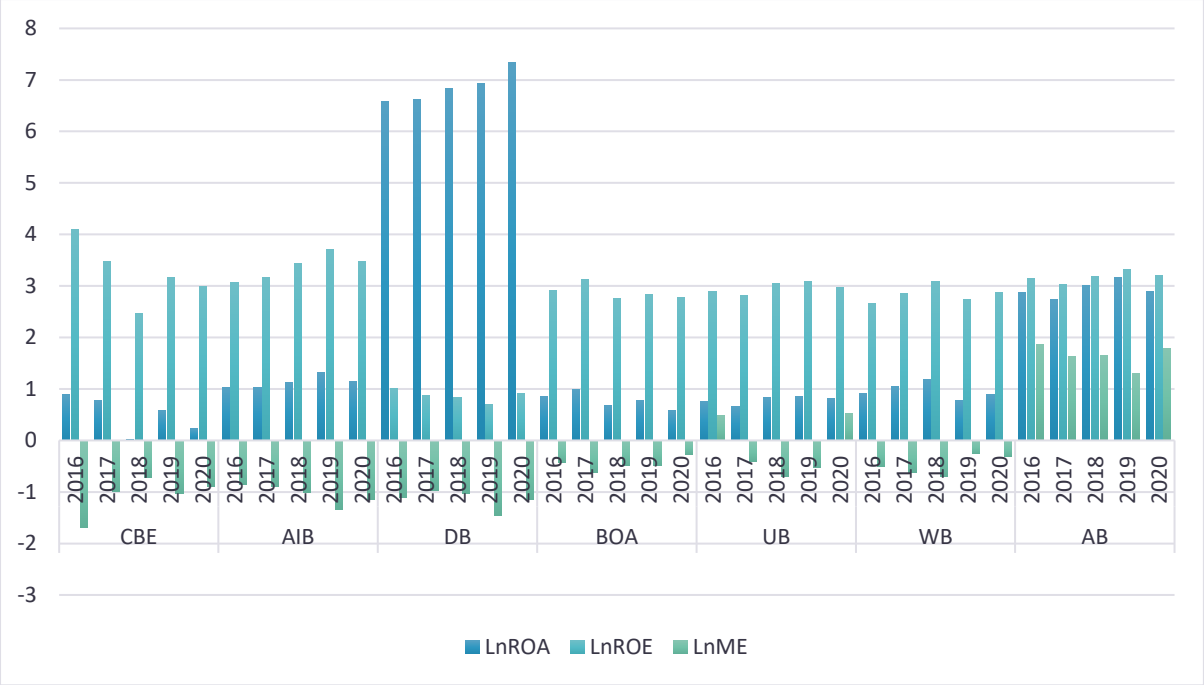

Figure 1:Yearly Trends of ROA, ROE, ME of CBE, AIB, DB, BOA, UB, WB and AB.

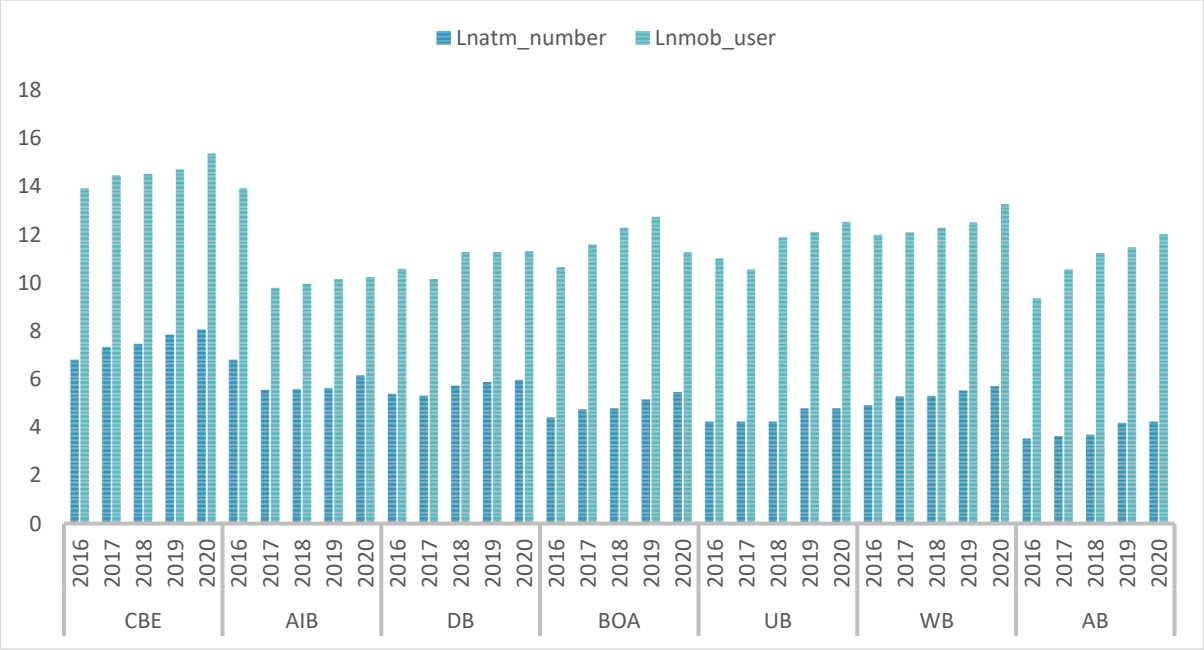

Figure 2:Yearly Trends of NATM, and NMOB of CBE, AIB, DB, BOA, UB, WB and AB.

4.2. Results and Discussions

Table 3and figure 3 below provides an overview of the descriptive statistics for the explained and explanatory variables for seven (7) commercial banks from 2016 to 2020 with 35 observations. For the dependent variables ROA, ROE, and ME with five independent variables, namely the cost of funds, the cost of labor, the cost of physical capital, the number of ATMs,

and the number of mobile banking users, these comprise the mean, minimum, maximum, standard deviation, and the number of observations.

Table 3:Descriptive Statics of Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
LnROA	35	1.993746	2.163122	.0087099	7.337658
LnROE	35	2.761933	.8451954	.6934887	4.100945
LnME	35	1.227750	.9547425	0.69839	1.86463
pofund	35	.2602857	.0844876	.12	.49
polabor	35	.1025714	.2194156	0	.95
pophycapital	35	8.284857	27.37894	0	134.21
Lnatm_number	35	5.373733	1.155864	3.526361	8.040125
Lnmob_user	35	11.85028	1.520246	9.355652	15.36307

Source: Own computation

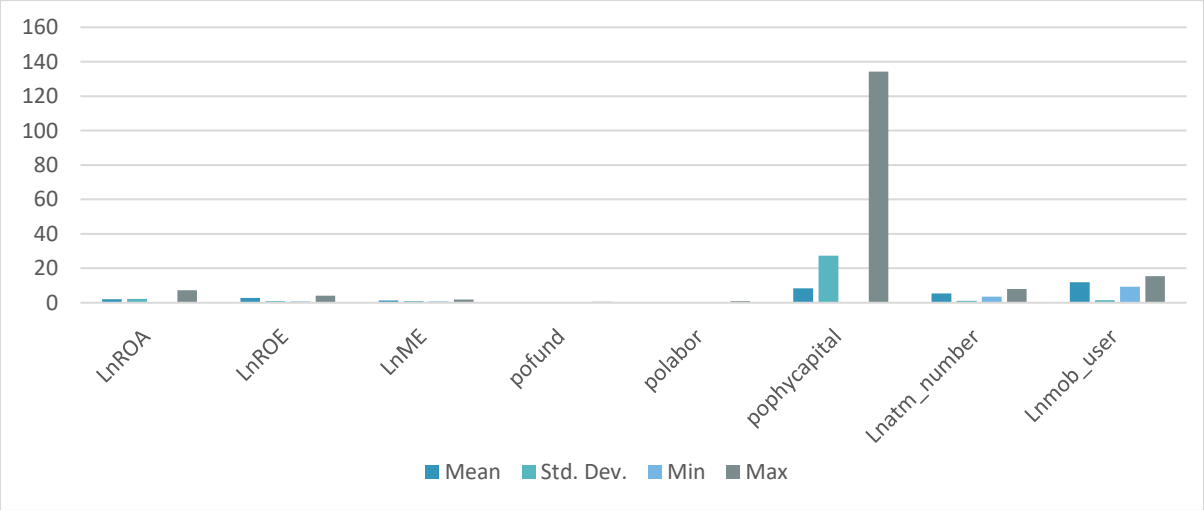

Figure 3:: Descriptive Statics of Variables

The above table and figures show that during 2016 to 2020 the average profit level for sampled commercial banks. The average return on asset is 1.99 percent, return on equity is 2.76 percent and managerial efficiency is 1.23 percent, showing the profit vary across banks and over time. This reveals that the introduction and application of e-banking channels or products in last five years contributed over ally for the improvement of commercial banks managerial efficiency.

However, there is little difference in profitability among the banks as witnessed by the values of the standard deviation 2.16,0.84 and 0.95 respectively. The standard deviation reveals how much dispersion exists from the average value. A low SD indicates that the data points are very close to the average value. While high SD reveals the data, point is spread out over a large range of values (Brooks, 2019).

4.3. Correlations

The correlation coefficient measures the strength and direction of the linear relationship between two variables. In this case, there are six variables: (1) return on asset (2) price of Funds (3) *Price of labor* (4) *Price of physical capital* (5) installed ATM machines and (6) number of mobile banking users. The diagonal elements in the table represent the correlations of each variable with itself, which are always equal to 1. The off-diagonal cell displays the correlation between dependent and independent variable. However, it is important to note that the correlation coefficient is close to zero, indicating that there is no significant linear relationship between dependent and independent variable. It is worth noting that correlation coefficients range from − 1 to + 1. A value of -1 represents a perfect negative correlation, + 1 represents a perfect positive correlation, and 0 indicates no linear correlation.

Table 4:Correlation Analysis of Variables (Proxy by ROA, ROE, ME)

	LnROA	Lnpofund	Lnpola~r	Lnpoph~l	Lnatm_~r	Lnmob_~r
LnROA	1.0000					
Lnpofund	-0.1586	1.0000				
Lnpolabor	0.9041	-0.0273	1.0000			
Lnpophycap~l	0.4659	-0.0649	0.6229	1.0000		
Lnatm_number	-0.1206	0.5117	-0.0113	-0.2635	1.0000	
Lnmob_user	-0.3902	0.3914	-0.3581	-0.3829	0.6862	1.0000
	LnROE	Lnpofund	Lnpola~r	Lnpoph~l	Lnatm_~r	Lnmob_~r
LnROE	1.0000					
Lnpofund	0.0600	1.0000				
Lnpolabor	-0.9339	-0.0273	1.0000			
Lnpophycap~l	-0.6108	-0.0649	0.6229	1.0000		
Lnatm_number	-0.0373	0.5117	-0.0113	-0.2635	1.0000	
Lnmob_user	0.1983	0.3914	-0.3581	-0.3829	0.6862	1.0000
	LnME	Lnpofund	Lnpola~r	Lnpoph~l	Lnatm_~r	Lnmob_~r
LnME	1.0000					
Lnpofund	-0.4591	1.0000				
Lnpolabor	-0.2659	-0.0273	1.0000			
Lnpophycap~l	-0.0619	-0.0649	0.6229	1.0000		
Lnatm_number	-0.6852	0.5117	-0.0113	-0.2635	1.0000	
Lnmob_user	-0.2306	0.3914	-0.3581	-0.38291.	0.6862	1.0000

Source: Own computation

The above table 4 presents the pairwise correlations of dependent and independent variables of the study proxy of ROA, ROE and ME. The correlation matrices show that that price of fund, number of ATM, and number of mobile banking user have negative relation when correlated with ROA. price of fund, number of ATM, and number of mobile banking user are correlated at -0.16, -0.12, and -0.39 respectively. This implies that when the values of these independent variables increase the value of dependent variable, that is ROA, decreases or there is an inverse correlation between these variables. On the other hand, price of labor, and price of physical capital, have positive relation when correlated with ROA. price of labor, and price of physical capital, are correlated at 0.90 41and 0.46 with ROA respectively implying that an increase in values of these explanatory variables result in an increase of dependent variable (ROA);and also The correlation matrices show that price of labor, price of physical capital and number of ATM have negative relation when correlated with ROE. price of labor, price of physical capital and number of ATM are correlated at -0.93, -0.61, and -0.034 respectively.

This implies that when the values of these independent variables increase the value of dependent variable, that is ROE, decreases or there is an inverse correlation between these variables. On the other hand, price of fund and number of mobile banking users have positive relation when correlated with ROE. price of labor and number of mobile banking users, are correlated at 0.0600 and 0.1983 with ROE respectively implying that an increase in values of these explanatory variables result in an increase of dependent variable (ROE).un like with ROA and ROE The correlation matrices show that price of fund, price of labor, price of physical capital, number of ATM and number of mobile banking user have negative relation when correlated with ME. Price of fund, price of labor, price of physical capital, number of ATM and are correlated at -0.4591, -0.2659, -0.6852, -0.2306. This implies that when the values of these independent variables increase the value of dependent variable, that is ME, decreases or there is an inverse correlation between these variables.

4.4. Stochastic Frontier Model Analysis

4.4.1. Profit Efficiency of Banks Using SFM (Proxy By ROA, ROE, ME)

The efficiency results are presented in Table 7, which displays the estimates from Time-varying decay model (truncated-normal). This model was used to assess the profit efficiency of the commercial banks in relation to the digital technology and the constant term. The digital technology usage is indicated in this study by a number of ATM machines installed and mobile banking users.

Table 5:Profit Efficiency of Bank Using SFA (Proxy Of ROA)

Variables	Model 1: Profit Efficiency of banks using SFM (proxy by ROA)				
	Parameters	**Coefficients**	**SE**	**P>|z|**	**sig**
Constant	***β*** 0	8.30	15.39	0.00	***
price of Funds	***β*** 1	-8.07	5.34	0.13	@
Price of labor	***β*** 2	-24.06	3.55	0.00	***
Price of physical capital	***β* 3**	4.985	1.88	0.00	***
Installed ATM	***β*** 4	9.267	2.61	0.00	***
Number of mobile banking users	***β* 5**	-3.57	2.79	0.20	@
Price of funds* price of Funds	***β*** 1 ***β*** 1	2.69	2.04	0.18	@
Price of labor* Price of labor	***β 2 β*** *2*	-1.49	0.924	0.10	@
Price of physical capital* Price of physical capital	***β*** 3 ***β*** 3	-0.17	0.07	0.00	***
Installed ATM machines* Installed ATM machines	***β*** 4 ***β*** 4	0.67	0.26	0.01	**
Number of mobile banking users* Number of mobile banking users	***β*** 5 ***β*** 5	-0.12	0.198	0.53	*
price of Funds* price of labor	***β*** 1 ***β*** 2	-3.02	1.06	0.00	**
price of Funds* Price of physical capital.	***β*** 1 ***β*** 3	0.23	0.44	0.59	@
price of Funds * Installed ATM machines	***β*** 1 ***β*** 4	-0.60	0.47	0.19	@
price of Funds* Number of mobile banking users	***β*** 1 ***β*** 5	0.19	0.28	0.48	@
Price of labor* Price of physical capital	***β*** 2 ***β*** 3	1.05	0.19	0.00	***
Price of labor* Installed ATM machines	***β*** 2 ***β*** 4	5.04	0.77	0.00	***
Price of labor* Number of mobile banking users	***β*** 2 ***β*** 5	-1.03	0.46	0.02	**
Price of physical capital* Installed ATM machines	***β*** 3 ***β*** 4	-0.84	0.21	0.00	***
Price of physical capital* Number of mobile banking users	***β*** 3 ***β*** 5	0.29	0.10	0.00	***
Installed ATM machines* Number of mobile banking users	***β*** 4 ***β*** 5	0.34	0.16	0.03	**
σ2		3.75	3.21		
γ		0.05	.012		
Log-likelihood		3.44			

*, **, *** Significance level at 10 %, 5 %, 1%consecutively @ means insignificant, S.E = Standard Error. *** p < 0.01, ** p < 0.05, *p<0.10.

Model 1 shows that Number of ATM machine has positive and significant impact on bank efficiency but mobile banking has negative and insignificant impact on banks efficiency measured in terms of return on asset by the estimated coefficients of 9.26 and -3.57 respectively.

Table 6:Profit Efficiency of Bank Using SFA (Proxy Of ROE)

Variables	Model 2: Profit Efficiency of banks using SFM (proxy by ROA)				
	Parameters	**coefficients**	**SE**	**P>|z|**	**sig**
Constant	$\beta 0$	6.81	10.97	0.53	@
price of Funds	$\beta 1$	-2.23	3.76	0.55	@
Price of labor	$\beta 2$	-4.68	2.74	0.08	*
Price of physical capital	$\beta 3$	1.04	1.52	0.49	@
Installed ATM	$\beta 4$	5.21	2.007	0.00	***
Number of mobile banking users	$\beta 5$	-4.76	2.002	0.07	**
Price of funds* price of Funds	$\beta 1 \beta 1$	-0.365	1.38	0.79	@
Price of labor* Price of labor	$\beta 2 \beta 2$	-0.720	0.56	0.19	@
Price of physical capital* Price of physical capital	$\beta 3 \beta 3$	-0.05	0.05	0.35	@
Installed ATM machines* Installed ATM machines	$\beta 4 \beta 4$	-0.17	0.20	0.40	@
Number of mobile banking users* Number of mobile banking users	$\beta 5 \beta 5$	0.19	0.14	0.18	@
price of Funds* price of labor	$\beta 1 \beta 2$	-1.53	0.65	0.01	**
price of Funds* Price of physical capital.	$\beta 1 \beta 3$	0.25	0.30	0.42	@
price of Funds * Installed ATM machines	$\beta 1 \beta 4$	0.18	0.29	0.53	@
price of Funds* Number of mobile banking users	$\beta 1 \beta 5$	-0.35	0.223	0.11	@
Price of labor* Price of physical capital	$\beta 2 \beta 3$	0.19	0.14	0.17	@
Price of labor* Installed ATM machines	$\beta 2 \beta 4$	1.21	0.56	0.03	**
Price of labor* Number of mobile banking users	$\beta 2 \beta 5$	-0.60	0.36	0.09	*
Price of physical capital* Installed ATM machines	$\beta 3 \beta 4$	-0.26	0.16	0.10	@
Price of physical capital* Number of mobile banking users	$\beta 3 \beta 5$	0.11	0.07	0.10	@
Installed ATM machines* Number of mobile banking users	$\beta 4 \beta 5$	-0.01	0.11	0.942	@
$\sigma 2$		0.04	0.009		
γ		0.02	0.00067		
Log-likelihood		8.05			

*, **, *** Significance level at 10 %, 5 %, 1%consecutively @ means insignificant, S.E = Standard Error. *** $p < 0.01$, ** $p < 0.05$, *$p<0.10$.

Model 2 shows that Number of ATM machine has positive and significant impact on bank efficiency but mobile banking has negative and significant impact on banks efficiency measured in terms of return on equity by the estimated coefficients of 5.21 and -4.76. respectively**.**

Table 7::Profit Efficiency of Bank Using SFA (Proxy Of ME)

Variables	**Model 3**: Profit Efficiency of banks using SFM (proxy by ME)				
	Parameters	**coefficients**	**SE**	**P>|z|**	**sig**
Constant	β 0	40.26	9.37	0.00	***
price of Funds	β 1	-5.83	2.93	0.04	**
Price of labor	β 2	-6.12	3.11	0.04	**
Price of physical capital	**β 3**	3.43	1.33	0.01	**
Installed ATM	β 4	10.39	2.08	0.00	***
Number of mobile banking users	**β 5**	-13.39	1.79	0.12	***
Price of funds* price of Funds	β 1 β 1	0.006	.		
Price of labor* Price of labor	*β 2 β 2*	-4.66	0.59	0.00	***
Price of physical capital* Price of physical capital	β 3 β 3	-0.03	0.04	0.52	@
Installed ATM machines* Installed ATM machines	β 4 β 4	0.71	0.19	0.00	***
Number of mobile banking users* Number of mobile banking users	β 5 β 5	0.62	0.13	0.00	***
price of Funds* price of labor	β 1 β 2	0.74	0.64	0.25	@
price of Funds* Price of physical capital.	β 1 β 3	-0.67	0.25	0.00	***
price of Funds * Installed ATM machines	β 1 β 4	0.84	0.31	0.00	***
price of Funds* Number of mobile banking users	β 1 β 5	0.10	0.24	0.68	@
Price of labor* Price of physical capital	β 2 β 3	0.76	0.16	0.00	***
Price of labor* Installed ATM machines	β 2 β 4	2.91	0.73	0.00	***
Price of labor* Number of mobile banking users	β 2 β 5	-1.95	0.39	0.00	***
Price of physical capital* Installed ATM machines	β 3 β 4	-0.09	0.15	0.55	@
Price of physical capital* Number of mobile banking users	β 3 β 5	-0.09	0.07	0.16	@
Installed ATM machines* Number of mobile banking users	β 4 β 5	-0.23	0.13	0.08	*
σ2		0.034			
γ		3.33			
Log-likelihood		57.69			

*, **, *** Significance level at 10 %, 5 %, 1%consecutively @ means insignificant, S.E = Standard Error. *** $p < 0.01$, ** $p < 0.05$, *$p<0.10$.

Model 3 shows that Number of ATM machine has positive and significant impact on bank efficiency but mobile banking has negative and significant impact on banks efficiency measured in terms of managerial efficiency by the estimated coefficients of 10,39 and -13.39. respectively.

4.4.2. Sum Efficiency

Table 8:Sum Efficiency (Proxy Of ROA, ROE And ME)

Variable	Obs	Mean	Std. Dev.	Min	Max
Efficiency (ROA|)	35	.7380517	0	.7380517	.7380517
Efficiency (ROE)	35	0.9993091	.0000311	.9992486	.9993474
Efficiency (ME|)	35	0.8755458	0	.8755458	.8755458

Profit efficiency is an indicator that assesses both the efficiency of a banks and the potential profit that this firm could earn if it were completely efficient. Consequently, profit efficiency is a better predictor for evaluating the overall performance of a firm than accounting and financial indicators. Thus, the model shows that the profit efficiency of banks considered in This implies these banks have potential to increase its profit by further improving its remaining inefficiency study's sample is on average 73.8 percent. nearly accounted to 26.2 percent. and also, the estimated efficiency

results show that the average profit efficiency of banks using ROE and ME as a proxy for profit is 99.9 and 87.55 percent respectively. The reason way the result of efficiency differentiate in terms of ROA, ROE and managerial efficiency as a proxy of profit is RBV basically predicts the relationship between the firm's resources and its performance. This study argues that it is more appropriate to measure enterprise performance using profit efficiency than traditional financial or accounting measures, such as return on assets (ROA) or return on equity (ROE).

4.5. Average 5 Years' Technical Inefficiency of Banks in Comparison

Table 9:Average Five Years' Inefficiency of Banks in Comparison

BANKS	INEFFICIENCY USING ROA	INEFFICIENCY USING ROE	INEFFICIENCY USING ME
AB	5.7048742	0.0283348	3.2833596
AIB	5.7048741	0.0280739	3.1248836
BOA	5.7048742	0.0284787	3.0548836
CBE	3.1813241	0.0126803	1.7828904
DB	3.1813242	0.014368	1.9413664
UB	5.7048742	0.0290065	3.2833596
WB	5.7048742	0.0315981	3.2833596

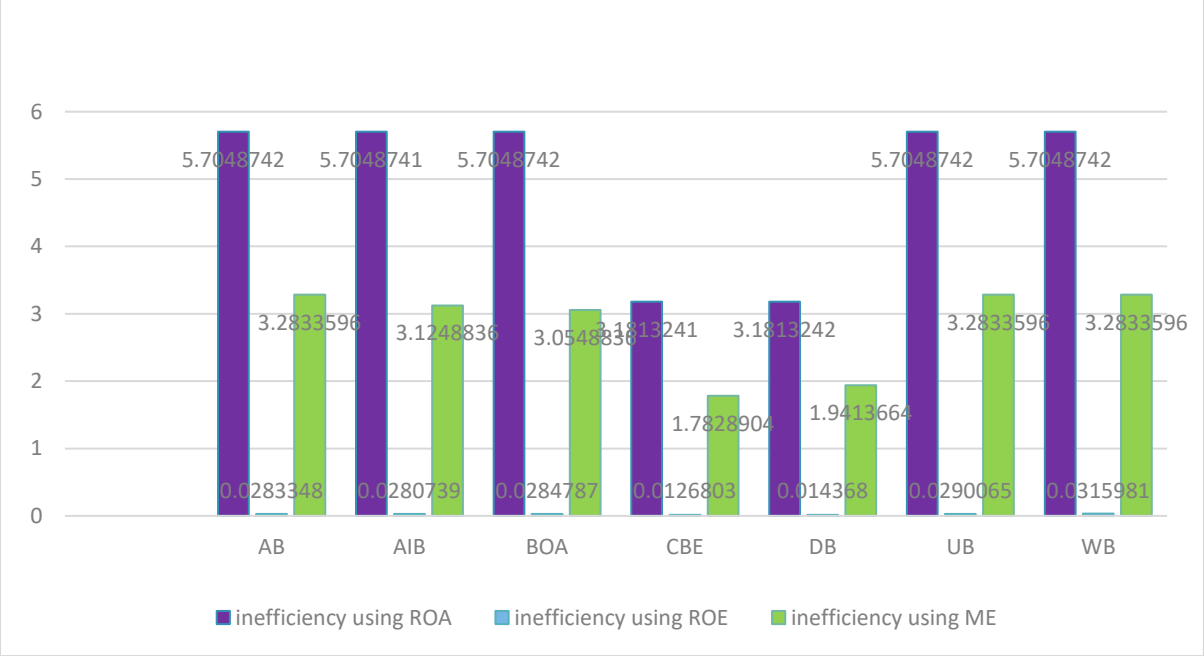

Figure 4:Average Five-Year Inefficiency of Banks

Where;

IUROA_ predicted inefficiency using ROA as a proxy for profit

IUROE-is predicted inefficiency using ROE as a proxy for profit

IUME -is predicted inefficiency using ME (Management efficiency i.e. operating expenses to operating income ratio) as a proxy for profit.

Bank wise technical inefficiency of 7 commercial banks of Ethiopia showed a clearer perception about the performance and profit efficiency individual bank and portrayed in Table 9 and figure 4. The most efficient banks during the study period were found to commercial bank of Ethiopia (CBE) with 3.18,0.013 and 1.78 of inefficiency using ROA as a proxy for profit, inefficiency using ROE as a proxy for profit and inefficiency using ME (Management efficiency i.e. operating expenses to operating income ratio) as a proxy for profit respectively. This implies that when the values of technical inefficiency decrease the value of efficiency increase, or there is an inverse relation between the variables. the result shows that commercial banks of Ethiopia (CBE) is the most efficient banks during the study period. next to CBE, Dahen bank is efficient banks than other private commercial banks that are including in the study with 3.18,0.014 and 1.94 of inefficiency using ROA as a proxy for profit, inefficiency using ROE as a proxy for profit and inefficiency using ME (Management efficiency i.e. operating expenses to operating income ratio) as a proxy for profit respectively.

The reason way commercial banks of Ethiopia become the leader bank when comparing to other private commercial banks not because of its high ROA, ROE. The RBV basically predicts the relationship between the firm's resources and its performance. However, it has been criticized for its limited empirical support. This study argues that it is more appropriate to measure enterprise performance using profit efficiency than traditional financial or accounting measures, such as return on assets (ROA) or return on equity (ROE). Profit efficiency refers to a firm's ability to manage its resources and produce outputs with greater economic value. This concept encompasses errors on the input side as well as on the output side.

4.6. Banks Wise Level of Sum Technical Inefficiency Over Time

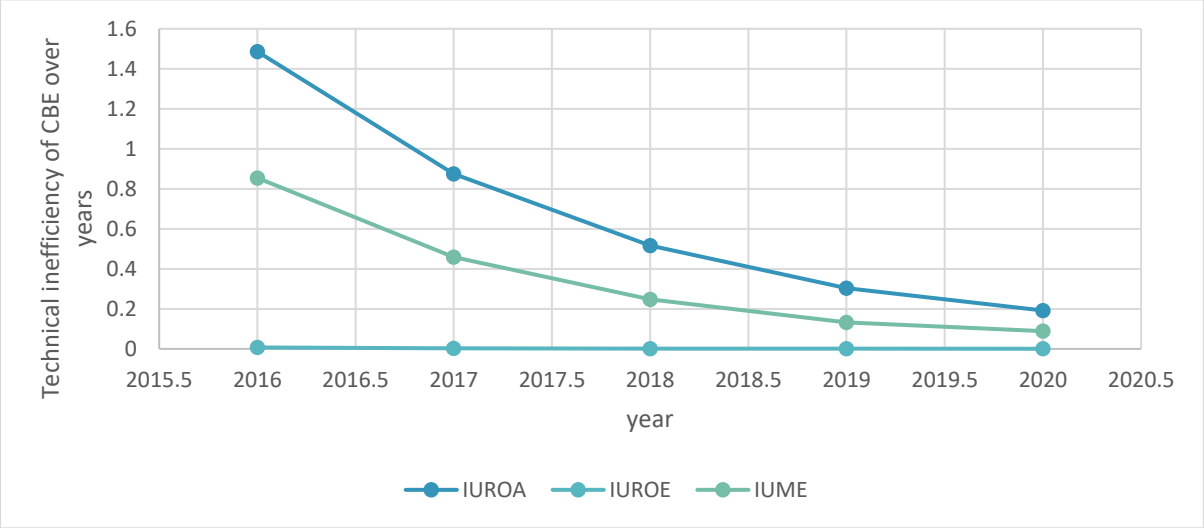

Figure 5:Yearly Inefficiency Trends of Commercial Banks of Ethiopia (CBE)

Fig 5. shows yearly technical inefficiency of commercial banks of Ethiopia (CBE). the above figure observed that the highest inefficiency was in 2016. within inefficiency level score of 1.48,0.006 and 0.85, using ROA, ROE and ME as a proxy for profit the inefficiency respectively. generally, the graph shows year to year decreasing trends of inefficiency using ROA as a proxy for profit, inefficiency using ROE as a proxy for profit and inefficiency using ME as a proxy for profit.

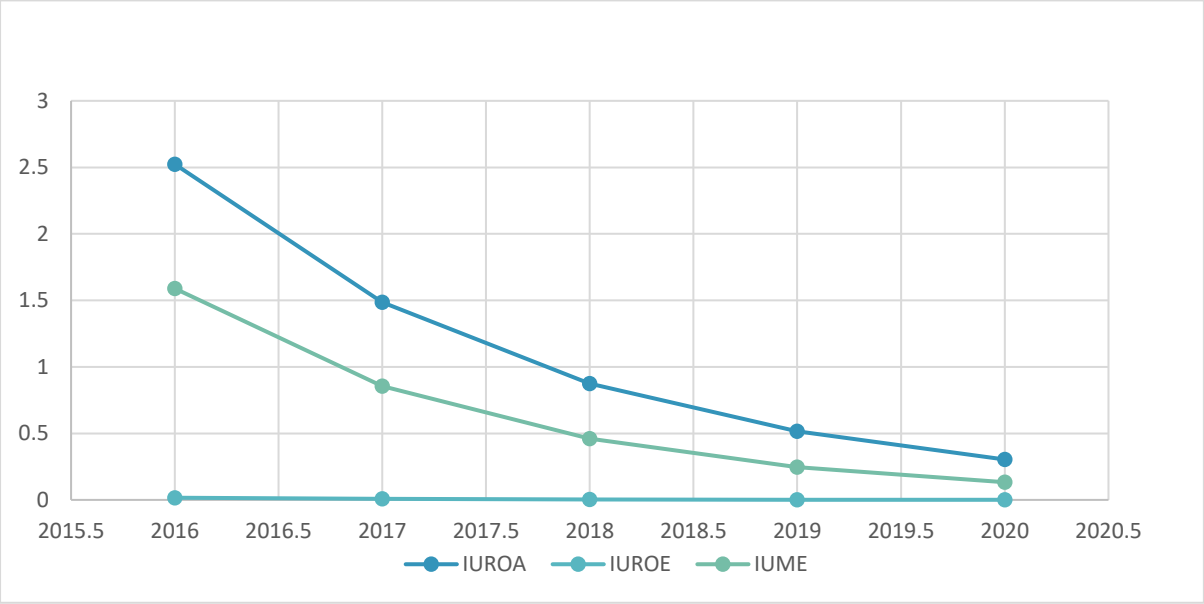

Figure 6:Yearly Inefficiency Trends of Awash International Bank (AIB)

Fig 6. shows yearly technical inefficiency of Awash international bank (AIB). the above figure observed that the highest inefficiency was in 2016. within inefficiency score of 2.52, 0.016 and 1.58, level using ROA, ROE and ME as a proxy for profit the inefficiency respectively.

generally, the graph shows year to year decreasing trends of inefficiency using ROA as a proxy for profit, inefficiency using ROE as a proxy for profit and inefficiency using ME as a proxy for profit.

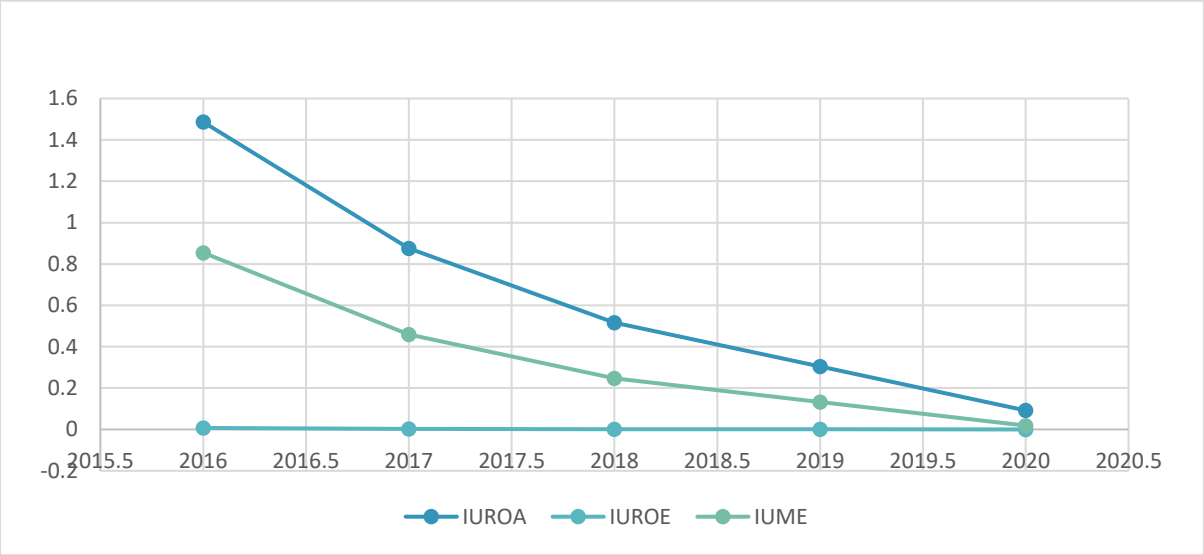

Figure 7:Yearly Inefficiency Trends of Dashen Bank (DB)

Fig 7. shows yearly technical inefficiency of Dashen bank (DB). the above figure observed that the highest inefficiency was in 2016. within inefficiency level score of 1.48,0.007 and 0.85, using ROA, ROE and ME as a proxy for profit the inefficiency respectively. generally, the graph shows the year to year decreasing trends of inefficiency using ROA as a proxy for profit, inefficiency using ROE as a proxy for profit and inefficiency using ME as a proxy for profit.

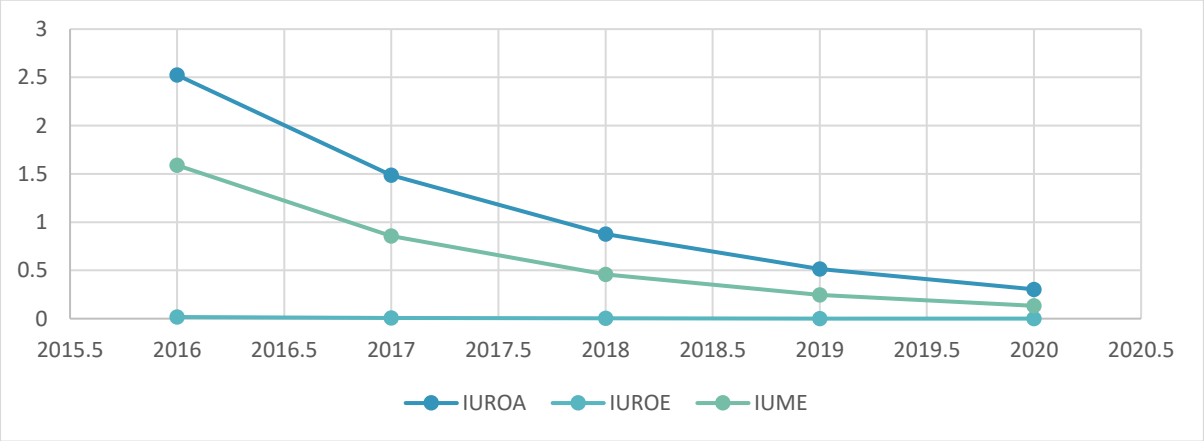

Figure 8:Yearly Inefficiency Trends of Bank of Abyssinia (BOA)

Fig 8. shows yearly technical inefficiency of bank of Abyssinia (BOA). the above figure observed that the highest inefficiency was in 2016. within inefficiency level score of respectively. generally, the 2.52,0.016 and 1.58, using ROA, ROE and ME as a proxy for profit the inefficiency graph show the decreasing trends of inefficiency using ROA as a proxy for

profit, inefficiency using ROE as a proxy for profit and inefficiency using ME as a proxy for profit.

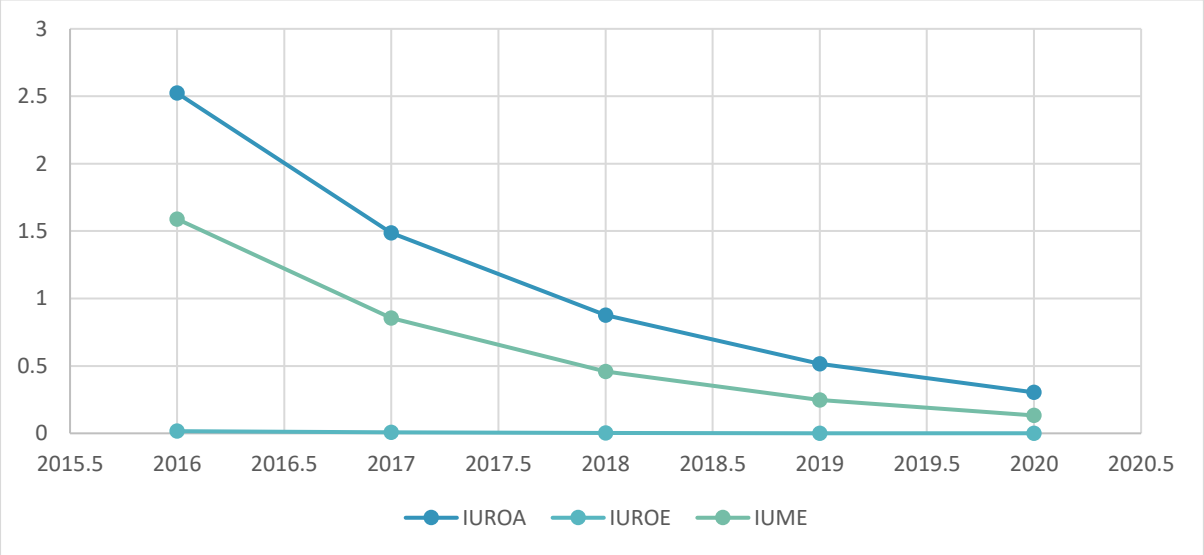

Figure 9:Yearly Inefficiencies Trends of United Bank (UB)

Fig 9. shows yearly technical inefficiency of United bank (UB)bank. The above figure observed that the highest inefficiency was in 2016.with in technical inefficiency level score of 2.52,0.016 and 1.58, using ROA, ROE and ME as a proxy for profit the inefficiency respectively. generally, the graph shows the decreasing trends of inefficiency using ROA as a proxy for profit, inefficiency using ROE as a proxy for profit and inefficiency using ME as a proxy for profit.

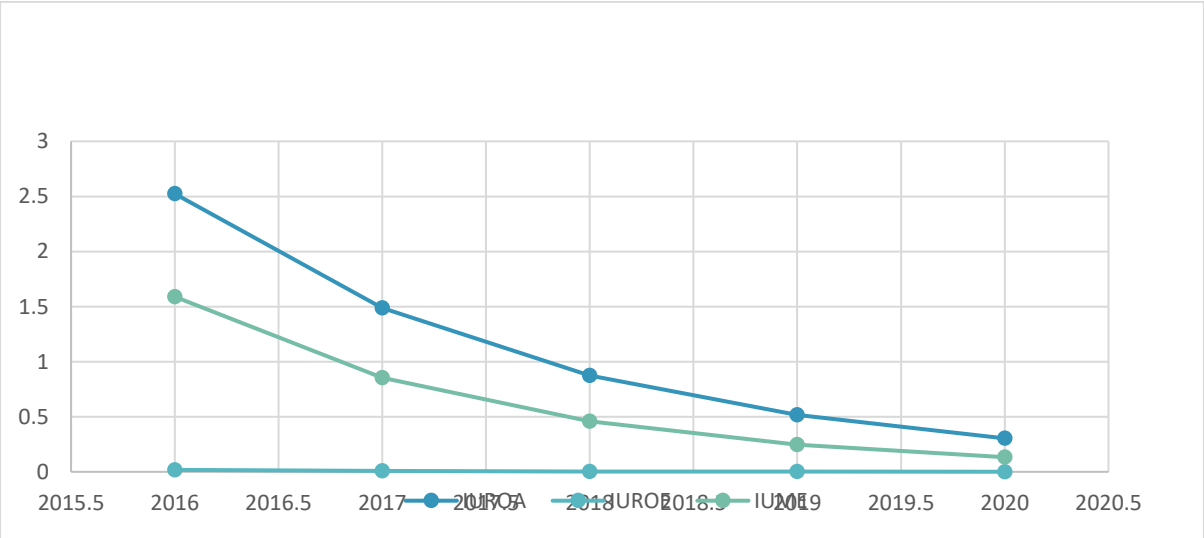

Figure 10:Yearly Inefficiency Trends of Wegagen Bank (WB)

Fig 10. shows yearly technical inefficiency of Wegagen bank (WB). The above figure observed that the highest inefficiency was in 2016.with in inefficiency level score of 2.52,0.017 and 1.58, using ROA, ROE and ME as a proxy for profit the inefficiency respectively. generally, the

graph shows the decreasing trends of inefficiency using ROA as a proxy for profit, inefficiency using ROE as a proxy for profit and inefficiency using ME as a proxy for profit.

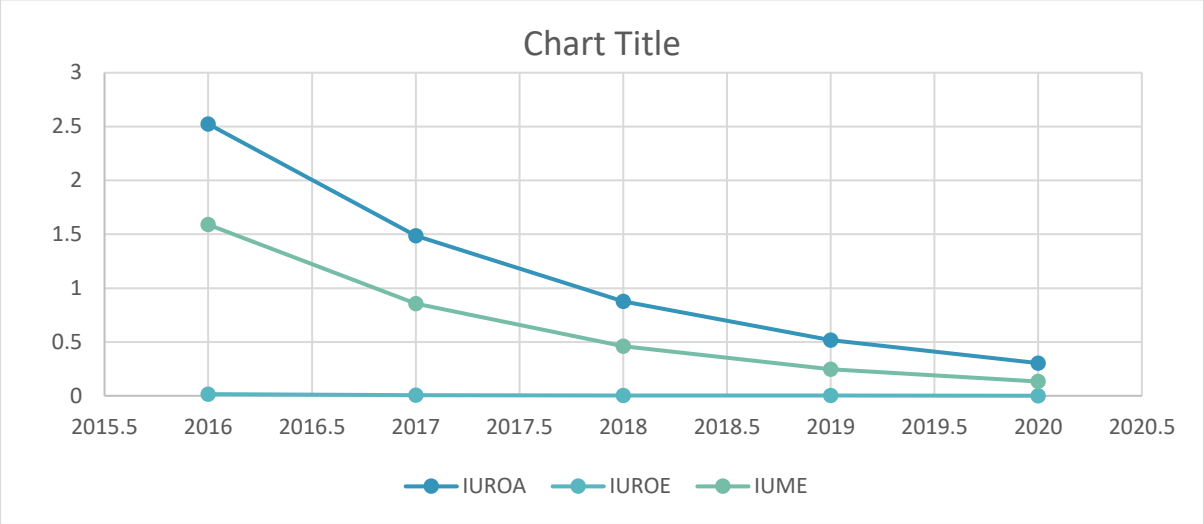

Figure 11:Yearly Inefficiencies Trends of Abay Bank

Fig 11. shows yearly technical inefficiency of Abay bank (AB). the above figure observed that the highest inefficiency was in 2016. within inefficiency level score of 2.52,0.015 and1.59, using ROA, ROE and ME as a proxy for profit the inefficiency respectively. generally, the graph shows the decreasing trends of inefficiency using ROA as a proxy for profit, inefficiency using ROE as a proxy for profit and inefficiency using ME as a proxy for profit.

- The above figures results showed that highest inefficiency was in recorded 2016. structural capital helps develop the company's organizational activities effectively and efficiently to facilitate the growth of efficiency. Human capital is a very important factor for organizations efficiency and relational capital is a component of intellectual capital that has the most dominant influence on financial sustainability.

4.7. Hypothesis Testing ROA, ROE and ME as a Proxy of Profit

Hypothesis 1*:* Number of ATM machine has a positive effect on ROE, ROA and Managerial efficiency of banks.

As observed from the above table, The p-value is less than 0.05; therefore number of ATM has a positive and significant effect on ROE, ROA and Managerial efficiency of banks; this seems that if the number of ATM increases the also increase ROE, ROA and Managerial efficiency of banks. This reveals that Banks get more return in the form of charge fee and other benefits related to deposit by customers. The bank customers can easily access their account at any time irrespective of banking hours for withdraw or transfer of money. ATM is a modern

as well as convenient electronic channel that seems to be on street corner, retail store, university, hotels and attached to every bank building.

The result informs that ATM has able to generate income for banks and there is aggressive ATM network expansion by Ethiopian commercial banks. ATM machines are now located at non- traditional locations like petrol stations, supermarkets, universities, colleges and in rural areas. This indicates how banks attach to ATM machines in reaching and maintaining customers. Banks should maintain or visit the existed machines and expand services through active machines more and more to improve their return.

Hypothesis 2: Mobile banking has a positive effect on profitability of commercial banks in Ethiopia (ROA).

The finding in the above table shows that the p-value is greater than 0.05; therefore, there is a negative but significant relationship between number of mobile banking user, ROA, ROE, and Managerial efficiency of banks and. An increase in number of mobile banking is not attractive to banks and leads to a decrease in ROA, ROE, and ME. The finding informs that commercial banks may not possess the competitive advantage to venture in to mobile baking. This is due to the fact that it creates user centric utility/ advantage than financial service providers.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

The basic intent of this chapter is to present the overall overviews of the research by summing up the main findings of the analysis part and give future research directions. Accordingly, the chapter starts with its discussion by briefly sum up the overviews of the study and its main findings. In section two based on the study finding the researcher highlight some recommendations for the target populations the study pivoting on.

5.1. CONCLUSION

This study explored the effects of digital banking usage on the profit (managerial) efficiency of commercial banks was analyzed through constructing stochastics frontier model. Using purposive sampling technique seven commercial banks operated in Ethiopia was selected for the period covering from 2016 to 2020. Secondary data was obtained from central bank of Ethiopia and annual audited financial statements of each commercial bank.

- Results of the Stochastic Frontier Approach indicated that the number of ATM machine has positive and significant impact on bank efficiency measured in terms of return on asset and also mobile banking usage has negative effect on banks return on asset, return on equity and managerial efficiency.
- The average efficiency level of profit efficiency proxy of ROA, ROE and ME of banking sector under the study period was 0.73, 0.99 and 0.87 respectively, suggesting that banks have potential to increase its profit by further improving its remaining inefficiency.in other word by improving its input; like labor, capital, fund and technologies.
- Commercial banks of Ethiopia are the most efficient banks followed by Dashen bank, bank of Abyssinia, awash international bank, Wegagen bank, united bank and awash bank with within technical inefficiency using ROA, ROE and ME as a proxy for profit the inefficiency score of 1.48,0.007 and 0.85 respectively.

5.2. POLICY RECOMMENDATION

E-banking is an important current issue and also it has a great impact on the whole system and affects the banks return. E-banking system is a new financial evolution in Ethiopia. These recommendations are able to support banking sector in Ethiopia and others. The leading bank in terms of profitability was mostly use it resource accurately. Based on the finding and conclusion of the study, the researcher forwards the following recommendation. It is essential

for banks and policymakers to adopt a comprehensive approach when striving to improve efficiency.

- The practical implications of this study suggest that commercial banks in Ethiopia should continue investing in ATM., recognizing their potential to enhance operational efficiency and customer satisfaction.
- Commercial banks should also ensure active and proper maintenance of ATM outlets to ensure quality service delivery to their clients. ATM channels would be installed strategically to make accessible for many customers and to boost the income from it.
- Additionally, fostering a supportive regulatory environment and promoting digital literacy among the population are crucial steps towards facilitating the widespread adoption and utilization of mobile banking, ultimately leading to improved operational efficiency.

5.3. AREAS FOR FURTHER STUDY

- Future research should delve deeper into the specific mechanisms through which digital banking induces return on asset, return on equity and operational efficiency in the Ethiopian banking sector.
- Exploring non-linear relationships, identifying potential moderating factors, and considering contextual induces can provide a more nuanced understanding of the relationship between digital banking usage and operational efficiency.
- Study can add recent innovations that does not include in these studies on the impact of Ethiopian banking profit efficiency.

In summary, this study highlights the number of ATM machine has positive and significant impact on bank efficiency measured in terms of return on asset return on equity and managerial efficiency .and also mobile banking usage has negative effect on banks return on asset, return on equity and managerial efficiency.

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