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The Effect of Technological Innovation on the Financial Performance of Commercial Banks in Ethiopia

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By: -Zekariyas Yirgalem

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THE EFFECT OF TECHNOLOGICAL INNOVATION ON THE FINANCIAL PERFORMANCE OF COMMERCIAL BANKS IN ETHIOPIA

BY
ZEKARIYAS YIRGALEM

APPROVED BY BOARD OF EXAMINERS

Dean, Graduate Studies	**Signature**
Asmamaw Getie (Asst. Prof)	
Advisor	**Signature**
Giday G. (Ph.D)	
External Examiner	**Signature**
Simon Tareke (Asst. Professor)	
Internal Examiner	**Signature**

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Table of Contents

APPROVED BY BOARD OF EXAMINERS i

ACKNOWLEDGMENTS ii

List of table and figure vi

ACRONYMS vii

Abstract viii

Chapter One 1

Introduction 1

1.1 Background of the study 1

1.2 Statement of the problem 4

1.3 Objective of the study 6

1.3.1 General Objective of the study 6

1.3.2 Specific Objective of the study 6

1.4 Hypothesis of the study 6

1.5 Scope and limitation of the study 7

1.6 Significance of the study 8

1.7 Organization of the Study 8

Chapter Two 10

Literature Review 10

2.1 Related Literature Review 10

2.1 Theoretical Review 10

2.1 Innovation 10

2.1.1 Creativity vs Innovation 10

2.1.2 Importance of Innovation 11

2.1.3 Types of Innovation 12

Incremental Innovation 16

2.1.4. Theories of innovation 18

2.1.4.1 Schurnpeterian theory of creative destruction 19

2.1.4.2 Disruptive Innovation Theory 20

2.1.4.3 Diffusion of Innovation Theory 21

2.1.5 Types of Banking Innovation 23
2.1.6 Benefits and challenges of technological innovation in the banking sector 28
2.2 Financial Performance 28
2.2.1 Measurement of commercial bank's performance 29
2.5 Empirical studies 29
2.6 Summary and Research Gap 33
2.7 Conceptual framework 34
Chapter Three 35
3. Research Methodology and Design 35
3.1 Introduction 35
3.2 Research Methodology 35
3.3 Research Design 35
3.4 Source of Data 36
3.5 Population 36
3.6 Sampling Design and Techniques 37
3.8 Model specification and operational definition of variables 38
3.8.1 Model Specification 38
3.9 Operationalization of study variables 40
3.9.1 Dependent Variables 40
3.9.2 Independent Variables 40
CHAPTER FOUR 43
DATA PRESENTATION AND ANALYSIS 43
4.1 INTRODUCTION 43
4.2 Descriptive Analysis 43
4.3 Model Validity 46
4.3.1 Variance Inflation Factors 46
4.2.3 Normality Test 48
4.2.4. Heteroscedasticity Test 49
4.2.5 Autocorrelation Test 50
4.2.6 Hausman Test 50
4.3 Regression Analysis, interpretation and Discussion 51
4.3.1 Interpretation of R-squared and Adjusted R-squared 53
4.4 Results vs Hypothesis 57

CHAPTER FIVE 60
SUMMARY, CONCLUSION AND RECOMMENDATION 60
5.1 Summary of Major Findings 60
5.2 Conclusion 62
5.3 Recommendation 63
6. Reference 65
Appendix 75

List of table and figure

Figure 1 ***Diffusion of innovation model*** _____ *22*
Figure 2 ***Five stage in the decision innovation process*** _____ *22*
*Figure 3****: Conceptual Framework*** _____ *34*
*Figure 4****: Normality Test*** _____ *48*

Table 1Summary of Descriptive Statics _____ *45*
Table 2 Variance Inflation Factors _____ ***47***
Table 3: Heteroscedasticity Test: White _____ ***49***
Table 4: Autocorrelation Test: Breusch-Godfrey Serial Correlation LM Test _____ ***50***
Table 5: Hausman Test _____ ***51***
Table 6: Linear Regression Model _____ ***52***

ACRONYMS

ATMS-Automated teller machine

CRM-Customer Relationship Management

CLRM-Classic Linear Regression Model

DC-Debit Cards

E-Banking-Electronic Banking

EFTPOS-Electronic Funds Transfer at Point of Sales

FEM-Models of Fixed Effects

ICT-Information Communication Technology

OCC-Office of the Comptroller of the Currency

POS-Point of Sales

PC-Banking-Personal Computer Banking

ROA-Return on Assets

REM-Models of Random Effects

Abstract

Now a day technological innovation recognized as essential element of firm's competitive strategy and enhancement of its financial and operating performance. In fact, firms that employed innovation to enhance their operations or distinguish from rivals in goods and services performance relatively demonstrated better economic and financial status. The main objective of this study was to the technological innovation has any effect on financial performance of Ethiopian commercial banks. For this study, secondary data was collected from annual published report of the banks. Hence, EViews 8 software was employed to analyze the data. To see the association among technological innovation and financial performance, an econometric regression model applied over a decade (2014 – 2023 G.C.). Financial performance which is dependent variable is measured by Return on Asset (ROA). While independent variables identified as technological innovation measured by, ATMs, debit cards, internet banking, mobile baking POS terminals, Investment in computer software and bank size. Finally, this study explores how Ethiopian banks can leverage technology for profit. Mobile banking and POS terminals are clear winners, but debit cards, internet banking, and software require further optimization. For larger banks, balancing growth with efficient operations is key. By strategically adopting and refining technologies, Ethiopian banks can thrive in the digital age.

Keywords: Commercial Banks, Financial Performance, Technological Innovation,

Chapter One

Introduction

1.1 Background of the study

While the concept of innovation has existed throughout history, its interpretations and definitions have evolved considerably (Anderson, 2016). A common misconception equates innovation solely with technological advancements, often overlooking its broader scope. Innovation encompasses the introduction of any kind of novelty, including social, cultural, organizational, technological, scientific, and artistic aspects (Anderson, 2016). this broader understanding highlights the multifaceted nature of innovation and its presence across various domains.

According to Chesbrough (2003), the Oslo Manual (2018) defines innovation as the implementation of a new or significantly improved good or service, or a combination of both. This innovation must differ substantially from prior versions and be introduced to potential users. The authors emphasize the significance of innovation due to its applicability across all economic sectors (Chesbrough, 2003).

In an increasingly competitive landscape, businesses face pressure to distinguish themselves from the crowd. As market offerings become more alike, innovation emerges as a critical differentiator (Chuang & Hsu, 2010). By fostering the development and implementation of novel ideas, businesses can gain a competitive advantage. Innovation plays a pivotal role in transforming a company's market position, allowing it to stand out from competitors and capture a larger share of the market (Chuang & Hsu, 2010).

Building upon the established notion of innovation's multifaceted nature, this study concentrates on a specific category: technological innovation. As Bhargava, Jain, and Sharma (2018) posit, technological innovation entails the introduction of a new or significantly improved product or process. The defining characteristic lies in the substantial departure from pre-existing technological features. This focus on technological advancements allows for a more targeted investigation into how these innovations influence specific industries and practices.

While innovation can be a powerful driver of progress, it can also bring about temporary disruptions, as argued by Christensen, Baumann, and Eyre (2003). These disruptions may involve the obsolescence of outdated business models and job displacement in certain sectors. However, the long-term pursuit of improved methods fosters overall human learning and ultimately leads to prosperity. Furthermore, job losses due to innovation are often offset by the creation of new employment opportunities, allowing individuals to find new ways to contribute to society (Christensen, Baumann, & Eyre, 2003). This highlights the importance of adaptation and reskilling within the workforce to navigate the ever-evolving landscape driven by innovation.

The banking sector heavily leverages technological innovation to gain a competitive edge (Lee & Wah, 2015). This innovation allows banks to refine their service offerings and streamline operations, ultimately enhancing cost-efficiency. Technological advancements empower banks to reduce staffing needs and branch footprint, leading to lower overhead costs. Additionally, these innovations equip customers with the tools to conduct transactions conveniently and independently, anytime and anywhere. This self-service approach translates to reduced transaction costs for banks, creating a win-win scenario for both institutions and their customers (Lee & Wah, 2015).

Despite the global trend of technological advancements in banking, Ethiopia's banking sector exhibits a slower pace of innovation integration (World Bank, 2019). While commercial banks have introduced electronic banking systems, widespread adoption by customers remains a challenge (World Bank, 2019). This limited adoption suggests a need for further investigation into the factors hindering the integration of these innovative technologies within the Ethiopian banking landscape.

The Ethiopian banking sector has witnessed a significant surge in technological innovation over the past decade. Ethiopian banks have actively incorporated various technological advancements into their systems, including ATMs, debit cards, point-of-sale (POS) terminals, agency banking, internet banking, and mobile banking (Temam, 2018). This wave of innovation reflects a growing recognition of technology's potential to enhance financial inclusion, improve service delivery, and ultimately drive the sector's competitiveness.

Tadesse and Tilahun (2019) highlight the growing adoption of mobile banking and its contribution to improved customer satisfaction and reduced operational costs for banks. Similarly, Zeleke (2018) emphasizes the shift towards modern technologies in Ethiopian banks, highlighting their role in improving financial performance and overall efficiency. These studies paint a promising picture of a banking sector actively embracing technological advancements to serve its customers better.

In an increasingly digital world, a growing body of research, as highlighted by Brynjolfsson and McAfee (2014), underscores the significant impact of technological advancements on how businesses operate. This pervasive influence extends across various industries and functions, shaping how companies deliver value and achieve success. However, a critical gap exists in research on the financial effect of these advancements on Ethiopian businesses. This study aims to bridge this knowledge gap by specifically investigating the Ethiopian banking sector. The studies explore how technological innovations have influenced the financial performance of Ethiopian banks and analyze the extent of these changes in recent years. By delving into this under-researched area, this study can offer

valuable insights into the interplay between technological adoption and financial success within the Ethiopian banking landscape.

1.2 Statement of the problem

The effect of information and communication technologies (ICT) and e-commerce on bank performance remains a topic of debate within the financial sector (Ekinci, 2021). While the potential benefits of these technologies for boosting financial performance are undeniable, their implementation requires additional investments in knowledge, infrastructure, creativity, and organizational transformation. These investments, while crucial for success, also carry inherent costs and risks. Ultimately, the relationship between ICT, e-commerce strategies, and bank performance appears to be positive, but not without its complexities. These technologies are powerful tools, but not a guaranteed solution for financial success.

Due to technological advancements, Ethiopian commercial banks have seen notable shifts in their financial performance in recent years. In addition to increasing bank customer bases, mobile banking services have increased operational efficiency by lowering transaction costs and strengthening security measures (Kassie, 2019). Additionally, the use of digital payment methods has made transaction processing simpler and quicker, cutting down on the amount of time and labor needed for manual paperwork, and thereby increasing production levels overall (Abera, 2020). Without a doubt, these technological developments have completely transformed Ethiopia's banking industry, improving the financial performance of commercial banks.

One of the most influential economists of the first half of the 20th century, Joseph Alois Schumpeter, held that innovation is the driving force behind economic change and that profits are the ultimate goal of anyone who pursues it. He maintained that innovation is the creative application of an economic system's available productive means, which transforms the system from the inside out by dismantling the status quo and erecting a new one.

Engaging in innovative activities can be interpreted as a sign that a business is doing well in the marketplace, which helps draw in new clients. Since innovation fosters greater customer loyalty and satisfaction, it also aids in customer retention. This is because current

clients are probably going to continue using the company's goods and services regularly and will probably also persuade others to do the same, increasing the business's earnings and profitability. Narver and Slater (1990).

These days, one of the most significant instruments with the potential to influence the banking industry is technological innovation. It is predicted that technological advancements will destroy current banking service delivery models and replace them with new ones. Putting money into innovation has a substantial effect on banks' profitability and performance. This is because innovation has emerged as one of the major forces behind profitability in the twenty-first century and is becoming a more important determinant of banks' competitiveness and performance. (Abiad & Chaarani, 2018)

The way commercial banks operate has been profoundly altered by technology, which has revolutionized a number of areas including risk management, operational efficiency, and customer service. For example, the use of mobile applications and online banking platforms has increased client accessibility to and convenience with financial services (Birhane, 2018). Furthermore, by automating repetitive operations and identifying irregularities, the use of artificial intelligence-based algorithms and automated procedures has improved operational efficiency (Assefa, 2020).

In recent years, the banking industry in Ethiopia has experienced a notable surge in the integration of technological advancements like automated teller machines (ATMs), internet banking, and mobile banking. It is still unclear, nevertheless, how these technological advancements will affect Ethiopia's commercial banks' bottom lines. Thus, the purpose of this study is to look into how technological innovation effect Ethiopian commercial banks' financial performance.

Ten Ethiopian commercial banks one owned by the government and nine by private investors was the subject of this investigation. One metric to assess these banks' financial success was return on asset. The research was examined the data acquired from these establishments to determine the Effect of technological innovation on their financial outcomes.

1.3 Objective of the study

1.3.1 General Objective of the study

The main objective of this study is to examine The Effect of Technological Innovation on the Financial Performance of Commercial Banks in Ethiopia.

1.3.2 Specific Objective of the study

- To assess the effect of automated teller machines (ATMs) on commercial banks' financial performance.
- To examine the effect of debit cards on the financial performance of commercial banks.
- To determine the effect of online banking on the financial performance of commercial banks.
- To examine the effect of mobile banking on the financial performance of commercial banks.
- To evaluate the effect of point-of-sale (POS) terminals on commercial banks' financial results.
- To examine the effect of computer software investments on the financial performance of commercial banks.
- To determine the effect of bank's size on the financial performance of commercial banks.

1.4 Hypothesis of the study

The following theories are developed based on the goals of the study and the literature that will be covered in the upcoming chapter.

H1: Automated teller machines (ATMs) has a positive and significant effect on the financial performance of commercial banks in Ethiopia.

H2: Debit cards has a positive and significant effect on the financial performance of commercial banks in Ethiopia.

H3: Internet banking has a positive and significant effect on the financial performance of commercial banks in Ethiopia.

H4: Mobile banking has a positive and significant effect on the financial performance of commercial banks in Ethiopia.

H5: Point of sale (POS) terminals have a positive and significant effect on the financial performance of commercial banks in Ethiopia.

H6: Investments in computer software has a positive and significant effect on the financial performance of commercial banks in Ethiopia.

H7: Bank size has a positive and significant effect on the financial performance of commercial banks in Ethiopia.

1.5 Scope and limitation of the study

This study focused exclusively on commercial banks within Ethiopia. To choose the ten institutions included, researchers prioritized two key factors: ease of data access and the banks' utilization of technological advancements. The financial performance of each bank was then assessed using a metric known as return on asset, or ROA.

The Return on Assets (ROA) ratio is a popular metric used to assess bank profitability. It expresses the net income a bank generates relative to its total assets over a specific period. Since constructing accurate cash flow analyses can be challenging, ROA is widely employed for comparing bank profitability. [Boyte-White, C. (2022, May 5)].

Within the banking industry, technological advancements are often gauged by the presence and utilization of ATMs, debit cards, internet banking, mobile banking, and POS terminals. This focus ensures a comprehensive evaluation of a bank's technological capabilities. Furthermore, to account for potential discrepancies arising from bank size, researchers frequently incorporate it as a control variable. This practice helps to isolate the specific effects of technological innovation on the variable of interest, preventing larger banks from overshadowing the achievements of smaller institutions with robust technology adoption. [Riyadi, S., & Riyadi, S. (2018, March 11)].

This study relied on secondary data, specifically the publicly available annual reports of Ethiopian commercial banks, to gather information over a ten-year period. This approach offers a valuable gap into the relationship between technological innovation and financial

performance within the Ethiopian banking sector. However, a potential limitation lies in the lack of recent research on this topic within Ethiopia. This could restrict the ability to comprehensively compare the study's findings with other relevant research conducted in the country.

1.6 Significance of the study

Its goal is to determine how technological innovation effect Ethiopian commercial banks' financial performance. Econometric regression models were utilized in the study to examine secondary data from the banks' annual reports that are publicly available. The study's conclusions can help policymakers, investors, and other stakeholders gain a better understanding of how technological innovation effect Ethiopia's commercial banks' financial performance. The study also intends to investigate the connection between Ethiopian commercial banks' financial performance and technological innovation. The research can also shed light on the variables that affect the banking industry's adoption of technological advancements and how these advancements can be used to enhance financial inclusion and promote economic expansion.

Additionally, the study will be helpful to other researchers who want to investigate how technological innovation affects financial performance. The research will broaden and enhance the field's body of knowledge.

1.7 Organization of the Study

This study is designed to comprehensively explore the effect of technological innovation on the financial performance of Ethiopian banks. The research clarifies across five chapters. Chapter one sets the stage by providing essential background information on the Ethiopian banking sector and the research topic itself. It clearly defines the problem statement, outlining the specific questions this study aims to answer. Additionally, the chapter establishes the general and specific objectives that guide the research direction. To ensure transparency, the scope and limitations of the study are outlined, acknowledging its boundaries and potential constraints. The chapter concludes by emphasizing the significance of this research and its potential contribution to the field. Chapter two explores

into the theoretical foundations of the study. It explores relevant academic literature on both technological innovation and financial performance. This critical review establishes a strong theoretical framework for understanding the relationships under investigation. Chapter three then shifts the focus to the research methodology. It details the specific methods employed to gather and analyze data. This transparency allows readers to evaluate the research design and its rigor. Chapter four dives into the heart of the analysis. It presents the regression output, the statistical results obtained through the chosen methodology. This chapter meticulously interprets these findings, drawing meaningful conclusions about the connections between technological innovation and the financial performance of Ethiopian banks. Finally, Chapter five brings the research journey to a close. It summarizes the key findings gleaned from the analysis, highlighting the most significant insights. Building upon these findings, the chapter presents a clear and concise conclusion, reiterating the research objectives and their fulfillment. To ensure practical application, the chapter concludes by offering recommendations based on the research results. These recommendations can guide future research endeavors and inform strategic decision-making within the Ethiopian banking sector.

Chapter Two

Literature Review

2.1 Related Literature Review

The pertinent literature for this study is reviewed in this chapter. A review of the theories pertinent to the field of study is done. Furthermore, the chapter opens with an overview of the theories that shaped the conversation about technological innovation. It then focused on the empirical research examining the relationship between commercial banks' performance and technological innovation.

2.1 Theoretical Review

2.1 Innovation

Innovation is a process with several stages. Companies take this route in an effort to turn concepts into ground-breaking or enhanced goods, procedures, or services. In the end, this transformative power propels advancement, fortifies competitive advantage, and distinguishes them in the market. (Kelley, R., & Parker, R. D. (2015).

2.1.1 Creativity vs Innovation

While the terms "creativity" and "innovation" are often tossed around together, a closer look reveals a crucial distinction between them (IBM, 2020). Imagine creativity as the spark that ignites a fire, and innovation as the flame itself. Both are vital, but they play different roles.

According to Teresa Amabile (1999), a renowned psychologist who has extensively studied creativity, the key difference lies in focus. Creativity thrives on the unfettered generation of new ideas. These ideas can be anything from a catchy melody to a revolutionary product design. They can be tangible objects or intangible thoughts, but they all represent a novel approach.

Innovation, on the other hand, steps in after the initial spark. It's about taking those creative ideas and transforming them into reality within a specific context. It involves the dedicated effort required to make the idea feasible and impactful. Here, Amabile emphasizes the concept of "implementation" – how effectively an idea can be brought to life.

This distinction between focus extends to the measurement of these concepts. Creativity, by its very nature, is subjective. As TED Talks curator Chris Anderson (2010) highlights, judging the "goodness" of a creative idea can be a complex and personal process. Innovation, however, becomes measurable through its results. Did the new product launch successfully? Did the process improvement lead to increased efficiency? These concrete outcomes allow us to assess the effectiveness of an innovation.

In simpler terms, creativity is the birth of a new idea, while innovation is the successful journey of that idea from conception to implementation. Creativity is the wellspring of possibilities, while innovation transforms those possibilities into reality. One provides the fuel, the other the engine that drives progress.

2.1.2 Importance of Innovation

Innovation isn't just a buzzword; it's the lifeblood of economic growth. When businesses embrace innovation, they unlock a treasure chest of benefits, not just for themselves but for society as a whole (InnosuTra, 2007). Imagine innovation as a powerful engine, propelling us towards a better future.

One of the engine's key functions is cost reduction. While innovation often involves initial investment, it doesn't have to equate to skyrocketing expenses. As Robert Kaplan (2018) emphasizes, companies must keep a watchful eye on costs while innovating. One strategy is product simplification. This means stripping away unnecessary features that don't resonate with the target market. By focusing on what truly matters to customers, companies can streamline production and reduce costs.

Innovation also acts as a powerful job creator. While some fear that new technologies displace low-skilled workers, the reality is more nuanced. The OECD Jobs Strategy (n.d.) points out that innovation paves the way for entirely new industries. These industries, in

turn, demand new skill sets, creating a wave of job opportunities to replace those lost in declining sectors. Innovation fosters a dynamic job market, requiring continuous adaptation but ultimately leading to net job growth.

The engine also fuels market dominance. When a company pioneers a groundbreaking technology, it gains a crucial edge over competitors. Customers, eager to experience this innovation, flock to the company, leading to a rise in market share and brand loyalty (Kramer, 2019). Think of it as a magnet – a company with a truly innovative product attracts customers away from the competition.

Finally, the engine drives profitability and propels growth. Building strong customer relationships is paramount. By actively seeking feedback through surveys and other methods, companies can identify areas for product improvement. This translates to increased sales over time, boosting profitability. Furthermore, innovation fosters a culture of waste reduction, leading to tighter profit margins (bdc Website, n.d

Innovation is a powerful force, driving economic change, creating jobs, and propelling companies towards success. By harnessing its potential, businesses can not only secure their own future but also contribute to a more prosperous and dynamic world.

2.1.3 Types of Innovation

A number of frameworks have been put up to define the many categories of innovation. We'll talk about a few of them below.

2.1.3.1 Clayton Christiansen's Classification of Innovation

Disruptive innovation, sustainable innovation, and efficiency-based innovation are the three categories of innovation according to Harvard Business School professor Clayton Christensen (Strauss, 2018). The various traits of every kind of innovation will be covered in the sections that follow.

Disruptive innovation

Disruptive innovation is the story of the unexpected challenger, the upstart that rewrites the rules of an industry (Christensen, 1997). It's not about simply offering a better version of what already exists; it's about creating entirely new value propositions that redefine the market. Imagine a game of chess, where a seemingly insignificant pawn disrupts the established hierarchy of powerful pieces.

There are two main ways disruption unfolds. The first is "new-market disruption," where a product or service caters to a completely unaddressed need. This might involve making high-end products more affordable and accessible, opening doors for a whole new segment of customers. Think of the personal computer revolution, which transformed technology from a specialist tool into a household item.

The second type is "low-end disruption," where a simpler, often cheaper offering enters the market at the bottom. While it might not initially compete head-to-head with established players, it attracts new customers who were previously priced out or simply uninterested in the complexity of existing solutions. A classic example is the rise of budget airlines, offering no-frills travel at a fraction of the cost of traditional carriers. These new entrants, often smaller and nimbler, can quickly gain a foothold and eventually disrupt the entire industry (Christensen & Raynor, 2003).

The key takeaway? Disruptive innovation isn't about brute force; it's about finding innovative ways to create value for underserved segments or with simpler, more affordable solutions. It's a powerful tool, especially for smaller businesses, to challenge the established players and rewrite the rules of the game.

Sustaining innovation

While disruptive innovation throws a curveball at established markets, sustaining innovation plays a crucial role in long-term success (Tushman & O'Reilly, 1997). Imagine it as the steady hand that refines existing products and services, ensuring a company

remains competitive within its current playing field. Unlike its disruptive counterpart, it focuses on incremental improvements rather than revolutionary changes.

This focus on continuous improvement doesn't necessarily translate to job creation. Companies engaged in sustaining innovation are often vying for the same customer base, offering enhanced versions of existing products or services. Customers, having purchased the latest and greatest, are unlikely to continue buying older iterations. This doesn't eliminate value, but it does limit the potential for net job growth within the specific product or service line. However, to claim that sustaining innovation creates "little net worth" overlooks its broader impact. By consistently delivering improved offerings, companies strengthen customer loyalty and brand reputation. This translates to increased customer lifetime value, as satisfied customers are more likely to make repeat purchases and recommend the brand to others (Reichheld, 2006). Furthermore, sustaining innovation can lead to cost reductions through process optimization and economies of scale.

In conclusion, sustaining innovation isn't about flashy disruption. It's the lifeblood of established businesses, ensuring they stay relevant and competitive in a dynamic marketplace. While it might not create entirely new markets or jobs within a specific product line, it fosters customer loyalty, brand reputation, and cost efficiencies, all of which contribute significantly to a company's long-term net worth.

Efficiency based innovation

Innovation isn't just about creating new things; it's also about doing things better. Enter efficiency-based innovation, the art of "doing more with less" (Govindarajan & Wang, 2015). Imagine a company that streamlines its operations, squeezing out waste and maximizing output. This is the essence of efficiency-based innovation. The benefits are undeniable. By optimizing processes and eliminating inefficiencies, companies unlock a treasure trove of advantages. Free cash flow, the lifeblood of a business, increases as costs are reduced. Productivity soars as streamlined processes enable employees to achieve more in less time. This enhanced efficiency translates directly to increased competitiveness, allowing companies to undercut rivals on price or offer greater value. Profitability, the ultimate measure of success, naturally rises as costs shrink and market share expands.

However, there's a double-edged sword to consider: job cuts. Efficiency often means streamlining operations, which can sometimes lead to automation or workforce reductions. While new jobs may be created in areas like process design or technology implementation, the overall impact on existing jobs can be significant.

Despite this potential downside, efficiency-based innovation remains a crucial tool for businesses to thrive in a competitive landscape. By doing more with less, companies can unlock financial strength, boost productivity, and gain a competitive edge. The key lies in balancing the pursuit of efficiency with a commitment to responsible workforce management and reskilling initiatives.

2.1.3.2 Henderson and Clark's Classification of Innovation

Prior to Henderson & Clark's (1990) work, innovation was often categorized as either incremental or radical. They argued that this binary view was insufficient and potentially misleading. Their product-centric model proposes two key factors influencing innovation: components (individual elements) and architecture (how these components interact). Henderson & Clark (1990) asserted that both components and architecture can be innovated independently, but the most transformative advancements occur when they are addressed simultaneously. Building on this concept, they proposed a four-part innovation framework encompassing radical, incremental, architectural, and modular innovation (Henderson & Clark, 1990), this framework will be further explored in the following sections.

Radical Innovation

Radical innovation often captures the public imagination when discussing innovation in general (Verganti, 2009). This is because it disrupts existing industries or even creates entirely new ones, often through the introduction of revolutionary technologies (Lee et al., 2016). Due to the inherent disruption of established business models, radical innovation presents the most significant execution challenges (Christensen, 1997). As Barczak (cited in Carleton, 2019) highlights, the potential rewards of radical innovation are high, but so are the associated risks. The very nature of radical innovation, being so different from

existing solutions, can make it difficult for target audiences to accept (Dew & Thomas, 2008).

Incremental Innovation

Incremental innovation stands in stark contrast to its radical counterpart. It focuses on introducing minor, cost-effective improvements to existing products or services (Abernathy & Utterback, 1978). This allows companies to subtly differentiate their offerings in the marketplace, providing a slight edge over competitors. The inherent advantage of incremental innovation lies in its lower risk profile. Consumers are generally more receptive to minor changes compared to entirely new concepts introduced through radical innovation (Duncan, 1975). While the potential returns of incremental innovation may be lower, so too are the associated risks and capital requirements (Carleton, 2019). This makes it a more predictable and manageable approach, particularly for established companies seeking to maintain a competitive edge.

Architectural Innovation

Architectural innovation takes a distinct approach compared to both radical and incremental innovation. It focuses on reshaping how existing components interact within a product, without necessarily introducing entirely new technologies (Henderson & Clark, 1990). This focus on reconfiguration can sometimes make it challenging to definitively identify architectural innovation, as it may initially be accommodated within existing frameworks (Magnusson, 2002). In essence, architectural innovation maintains the core components of a product while fundamentally altering the way they work together (Kylliäinen, 2019). This focus on internal architecture can unlock significant performance improvements or create entirely new functionalities within a familiar product form.

Modular Innovation

Modular innovation, sometimes referred to as component innovation, takes the opposite approach to architectural innovation (Henderson & Clark, 1990). Here, the focus shifts to introducing entirely new technologies that fundamentally change the core design concepts of individual components within a product (Yang et al., 2015). Interestingly, the established connections or linkages between these components often remain relatively unchanged during this process (Magnusson, 2002). This creates a scenario where a product's core functionality might be preserved, but its underlying components are revolutionized with new technologies. This approach allows for faster integration of advancements and potentially opens doors for future architectural innovations that leverage the newly introduced modular components.

2.1.3.4 Business Model Innovation and Marketing Innovation

Building on the concept of innovation types, Kylliäinen (2020) introduces another valuable perspective in her blog exploring key innovation management models and theories. This perspective focuses on the source of innovation, categorizing it into three distinct areas: business model innovation, technology innovation, and marketing innovation (Kylliäinen, 2020). Each category highlights the origin of the innovative idea, allowing for a more nuanced understanding of how different types of innovation can drive progress.

Business Model Innovation

According to Chesbrough (2003), business model innovation refers to the process of modifying or redefining a company's core structure and its components to create novel value propositions, capture new market opportunities, and ultimately gain a competitive edge. This type of innovation often involves a fundamental shift in how a company delivers value to its customers. This value creation can take various forms, such as developing new revenue streams or establishing innovative distribution channels. Business model innovation empowers companies to adapt and thrive in a dynamic business landscape characterized by evolving customer demands (Landry, 2020).

Technology innovation

The concept of technological innovation, as defined by Jeong et al. (2020), is not simply the implementation of new technology. It's a strategic journey undertaken by organizations that recognize the critical role technology plays in driving market competitiveness. This journey involves a shift in mindset, actively seeking ways to leverage technology as a source of innovation. By harnessing the potential of technology, organizations can develop novel products, services, and processes that propel them ahead of the competition (Jeong et al., 2020).

Marketing Innovation

Marketing innovation plays a critical role in bridging the gap between a company's offerings and its target audience (Verhoef et al., 2009). Even the most groundbreaking business model or meticulously crafted product can falter without effective communication and outreach. Marketing innovation thrives on identifying new channels and markets to promote products, ensuring they reach the right customers (Kylliäinen, 2019). Furthermore, it goes beyond simply raising awareness. It's about creating unique value propositions that resonate with customers and differentiate a company from its competitors. This can involve novel communication strategies, targeted customer experiences, or even the creation of entirely new customer segments (Hunt & Morgan, 2019). By fostering marketing innovation, companies can ensure their products and services find the right audience and deliver value that competitors struggle to match.

2.1.4. Theories of innovation

The many theories and models that can be used to explain how technological innovation affects commercial banks' financial performance are examined in this section. Numerous theories were proposed, such as the Schurnpeterian Theory of Creative Destruction, the Disruptive Innovation Theory, and the Diffusion of Innovation Theory.

2.1.4.1 Schurnpeterian theory of creative destruction

According to some scholars, Schurnpeter (1928, 1939) saw innovations as constant gales of creative destruction that were necessary forces propelling growth rates in a capitalist system. Over his lifetime, his ideas changed to the point where his early beliefs—that innovation depended primarily on exceptional people willing to take on exceptional risks as "an act of will"—were distinguished from his later beliefs—which acknowledged the role of large corporations in organizing and supporting innovation. This led to his emphasis on the role of oligopolies in innovation, which was later mistakenly perceived as the primary contribution of his work (Freeman, 1994).

Schumpeter (1928) drew attention to the disruptive and discontinuous character of technological change in capitalism, which inevitably brings with it both long-term growth and short-term instability. Rather than being a determinist of technology, he understood the importance of social and organizational factors in his cyclical process of industrial change. According to Schumpeter, the opportunity for new profits was created by the innovations of entrepreneurs, who could be independent inventors or R&D engineers in large corporations. Consequently, a wave of investment would be initiated by groups of imitators drawn by the enormous profits, which would reduce the profit margin for the innovation. However, an innovation, or series of innovations, Schumpeter conceptualized as Kondratiev cycles, would emerge before the economy could equilibrate, restarting the business cycle.

Despite all of his knowledge about the function of innovation, Schumpeter was unable to adequately describe where innovation comes from. Though he did not address its source, he was able to highlight its significance and its function in timing economic cycles. It's interesting to note that this made it possible for proponents of Keynesian economics to claim that investment levels drove innovation. It wasn't until the 1960s that economists started looking for the origins of innovation once more. Researchers who were able to show how little neo-classical economics could explain, such as Abramovitz (1956) and Solow (1957), brought attention to the significance of innovation. Solow's analysis of US economic data from 1909 to 1949 revealed that just 12.5% of the growth in per capita

output was attributable to increases that could be linked to a rise in capital usage. Solow ascribed the unexpectedly high 87.5 percent residual to technical change.

Romer (1986, 1994), echoing Solow's observation, persisted in urging innovation theorists to incorporate the innovation process into their models. To achieve this, the innovation research that arose from Schurnpeter's foundation has focused on the generation of innovation and its subsequent spread among businesses, sectors, and geographical areas.

Since new technology replaces older technology, which is superior because it is more valuable to adopters, the Schurnpeterian Theory is still relevant today.

2.1.4.2 Disruptive Innovation Theory

Among the most significant theories of innovation from the past ten years is undoubtedly disruptive innovation. Its central ideas spread so quickly that, a year after the theory was published in 1998, people were still using the term without citing Harvard professor Clayton Christensen or his book The Innovator's Dilemma (Harvard Business School Press). The 1997 bestseller The Innovator's Dilemma is credited with coining the phrase disruptive innovation as we know it today. Harvard Business School professor Clayton Christensen examined in the book because, in contrast to earlier models (such as the Henderson-Clark model), some radical innovations strengthened an industry's position for an incumbent. In particular, he conducted a thorough analysis of the disk drive industry since it was the most complex, dynamic, and technologically discontinuous sector of our economy. Just keep in mind that from 50 kilobytes in 1967 to 1, 7 megabytes in 1973, 12 megabytes in 1981, and 1100 megabytes in 1995, the amount of memory that could fit into a square inch of disk grew by 35% annually.

Disruptive theory is pertinent because it clarifies the kinds of technologies that banks use. Because banking technology replaces traditional banking, it is disruptive.

2.1.4.3 Diffusion of Innovation Theory

In information systems research, Rogers' (1995) Diffusion of Innovation (DOI) theory is a widely used model that explains why users adopt new technologies. "The process by which an innovation is communicated through certain channels among the members of a social society over time" is how Rogers (1995) defines diffusion. According to Rogers (1995), an innovation is a concept or item that is thought to be novel.

DOI states that an innovation's relative advantage, complexity, compatibility, trial ability, and observability all have an impact on its rate of diffusion. Relational advantage is "the extent to which an innovation is perceived as being superior to its predecessor's. Similar to the perceived ease of use construct in TAM, complexity is defined as "the extent to which an innovation is perceived by the potential adopter as being relatively difficult to use and comprehend." "The degree to which an innovation is seen to be compatible with existing values, beliefs, experiences, and needs of adopters" is what compatibility refers to. The "degree to which an idea can be experimented with on a limited basis" is known as trial ability. Lastly, according to Rogers (1995), observability is the "degree to which the results of an innovation are visible."

The diffusion theory explains why banks adopt technological innovations, making it relevant. Relevant advantage is one of the factors driving banks' adoption of technological innovations. This indicates that banks with a greater financial advantage than those without it are those that implement technological innovations.

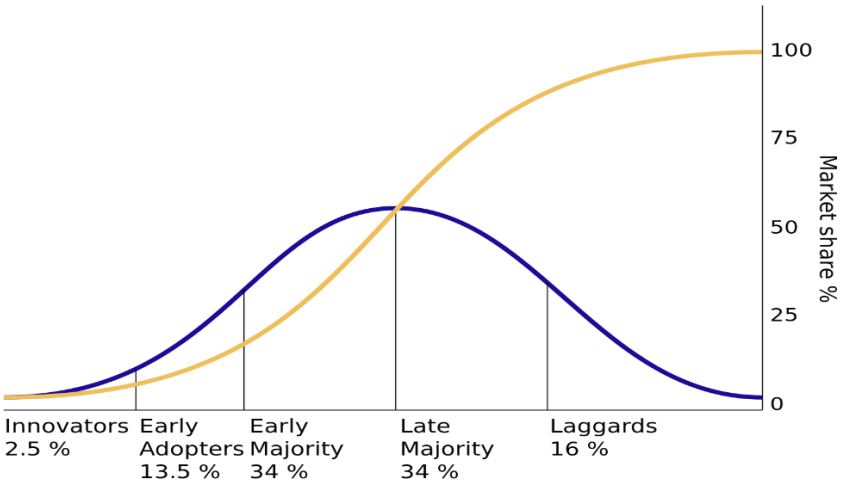


Figure 1 **Diffusion of innovation model**

Source: Rogers (1995)

The spread of innovations in Rogers' view. As new technology (blue) is adopted by successive consumer groups, its market share (yellow) will eventually approach saturation. There are segments of adopters on the blue curve.

A five-step decision-making process leads to diffusion. It takes place over time through several channels of communication between people who belong to similar social systems. In 1943, Ryan and Gross were the first to recognize adoption as a process. This theory is based on Rogers' five stages (steps), which are awareness, interest, evaluation, trial, and adoption.

Figure 2 Five stage in the decision innovation process
Source: Wikimedia Commons

An innovation may be rejected by a person at any point before, during, or after the adoption process. Asking questions like, "How do technically inefficient innovations diffuse?" and "What impedes technically efficient innovations from catching on?" Abrahamson critically examined this process. Abrahamson offers recommendations on how organizational scientists can assess the diffusion of innovations more comprehensively. Rogers renames the five stages as knowledge, persuasion, decision, implementation, and confirmation in later editions of Diffusion of Innovation. However, throughout the editions, the descriptions of the categories have stayed the same.

Five stages of the adoption process

Stage	Definition
Knowledge / Awareness	The individual is first exposed to an innovation, but lacks information about the innovation. During this stage the individual has not yet been inspired to find out more information about the innovation.
Persuasion	The individual is interested in the innovation and actively seeks related information/details.
Decision	The individual takes the concept of the change and weighs the advantages/disadvantages of using the innovation and decides whether to adopt or reject the innovation. Due to the individualistic nature of this stage, Rogers notes that it is the most difficult stage on which to acquire empirical evidence.[12]
Implementation	The individual employs the innovation to a varying degree depending on the situation. During this stage the individual also determines the usefulness of the innovation and may search for further information about it.
Confirmation / Continuation	The individual finalizes their decision to continue using the innovation. This stage is both intrapersonal (may cause cognitive dissonance) and interpersonal, confirmation the group has made the right decision. This stage allows the adopter to seek reassurance that the decision and implementation are beneficial. Adopters typically experience cognitive dissonance without this final confirmation. Dissonance could be heightened by negative information about the innovation, and if dissonance is not relieved, the innovation may be discounted to restore balance. Change agents help adopters in this stage feel comfortable with their decision.

2.1.5 Types of Banking Innovation

Fisher (1998) states that there are three distinct categories in which technology is used in the banking industry today: customer-assisted (a bank employee using customer-assisted technology as a resource to complete a transaction, such as call center customer service officers using a Customer Relationship Management (CRM) System to understand a customer's profile and provide instant responses to customers' queries on the banking transactions and up-to-date billings (Gutek & Welsh, 1999); and customer transparent. Customer-independent technology involves a customer conducting and completing a

transaction with a bank entirely independent of any human contact with the institution, such as ATMs, phone banking, and Internet banking.

ATMs

The original purpose of ATMs was to serve as cash dispensing machines. But thanks to technological developments, ATMs can now perform a variety of functions, including bill payment, money transfers between accounts, and deposits. For a competitive edge, banks typically use this electronic banking gadget in addition to all others. Customers can use the time they save by not having to wait in line at bank branches to engage in other worthwhile activities. ATMs also save customers time when it comes to service delivery. With an average of roughly 6,400 transactions per month versus 4,300 for human tellers, ATMs are a more cost-effective method of producing higher productivity than human tellers over a longer period (Rose, 1999).

Additionally, the banks continue to be productive even after banking hours because the ATMs keep running when human tellers stop.

H1: Automated teller machines (ATMs) has a positive and significant effect on the financial performance of commercial banks in Ethiopia.

Debit card

ATM cards were the original form of debit cards. It is a plastic credit card that is connected to the bank account of the cardholder. The amount of money available in the cardholder's bank account is evaluated when the card is used. Banks established a network so that their clients could use their cards at any ATM owned by any bank in the network, thereby increasing customer convenience. Debit cards are the name given to these ATM cards over time (Parker et al, 2011).

H2: Debit cards has a positive and significant effect on the financial performance of commercial banks in Ethiopia.

Telephone banking

Financial institutions that offer telephone banking, which enables clients to conduct transactions over the phone, are referred to as phone banks (Cronin, 1997). The automated phone answering system used for telephone banking typically has voice recognition or keypad response (Jane Blake, 2000). Although this feature isn't always available, to ensure security, the customer must first authenticate using a verbal or numeric password or by answering security questions from a live agent in a call center or branch.

Leow (1999) asserts that telebanking offers many advantages to both consumers and banks. Customers benefit from greater convenience, greater accessibility, and significant time savings. Conversely, though, from the banks' financial standpoint, providing telephone-based services comes at a significantly lower cost than providing branch-based services. It is nearly as productive as ATMs, with the exception that it does not produce the same amount of cash disbursement as ATMs do.

As a delivery channel that offers retail banking services around-the-clock, even after business hours, it generates ongoing productivity for the bank. As an alternative to visiting a bank branch or ATM, it provides retail banking services to clients at their homes or places of business. Customers benefit from time savings and increased convenience, which boosts productivity.

Personal computer banking

"PC-Banking is a service which allows the bank's customers to access information about their accounts via a proprietary network, usually with the help of proprietary software installed on their personal computer". The customer can carry out a variety of retail banking tasks once they have access. The use of personal computers has increased as a result of growing awareness of the value of computer literacy. This undoubtedly contributes to the expansion of PC banking, which essentially opens a branch in the house or place of business and provides round-the-clock, seven-day service. It also offers the advantages of ATMs and telephone banking (Abor, 2005).

Internet banking

To give customers access to their bank accounts via a website and to enable them to enact certain transactions on their account, given compliance with stringent security checks," is how Essinger (1999) defined the concept of Internet banking. According to the Office of the Comptroller of the Currency (OCC) of the Federal Reserve Board of Chicago Online Money Transfers handbook (2001), "The provision of traditional (banking) services over the Internet" is the definition of Internet banking. By definition, internet banking gives users more flexibility and convenience in addition to nearly total control over their finances. Both transactional (offering retail banking services) and informational (educating clients about the bank's offerings, etc.) services are provided.

H3: Internet banking has a positive and significant effect on the financial performance of commercial banks in Ethiopia.

Mobile banking

The provision of banking services via mobile devices, such as phones or tablets, is known as mobile banking. It is an advancement and substitute for online banking. Mobile users can use their phones for banking purposes, including bill payments, money transfers, and balance checks. Typically, mobile banking requires the use of an application, which is software. An internet connection is not necessary to use mobile banking; all you need is a mobile connection (Sadiku et al, 2017).

H4: Mobile banking has a positive and significant effect on the financial performance of commercial banks in Ethiopia.

POS Terminals

Retail establishments use hardware called point of sale (POS) terminals to process credit and debit card payments. To determine whether there are enough funds available to transfer to the merchant, the point of sale terminal scans the magnetic strips on debit and credit cards. The transfer is then made (Halton, 2021).

H5: Point of sale (POS) terminals have a positive and significant effect on the financial performance of commercial banks in Ethiopia.

Branch networking

To create and share consolidated customer information and records, branch networking refers to the computerization and interconnection of geographically dispersed standalone bank branches into a single, unified system known as an enterprise network (EN) or wide area network (WAN) (Abor, 2005). The elimination of time and distance constraints allows for a faster rate of interbranch transactions. As a result, productivity increases over time. Additionally, because multiple networked branches serve the clientele as a single system, there is a simulated division of labor among bank branches, which boosts productivity across the board. Moreover, it gives customers more time for productive activities by reducing the distance they must travel to bank branches.

Electronic funds transfer at point of sale (EFTPOS)

An online system known as an Electronic Funds Transfer at the Point of Sale enables consumers to instantly transfer money from their bank accounts to merchant accounts while making purchases (at purchase points).

The process of electronic fund transfers (Chorafas, 1988).EFTPOS makes banking more productive by facilitating customers' shopping payment requirements rather than performing secretarial work when managing checks and cash withdrawals for purchases. Additionally, the system keeps running after banking hours, which means that the bank continues to be productive even after banking hours. Additionally, consumers can use the time and energy they would have spent traveling to bank branches or ATMs to withdraw cash for other useful purposes. Research on the topic is becoming more and more necessary as the significance of innovation in developing nations rises.

2.1.6 Benefits and challenges of technological innovation in the banking sector

Technology advancements have significantly impacted Ethiopian commercial banks' financial results. According to Haile et al. (2018), the nation's banking sector has seen a radical transformation with the advent of internet and mobile banking. Customers now have more convenience, and banks' operating expenses have decreased as a result. Furthermore, information technology integration has improved efficiency in areas like risk management and loan processing, claim Molla and Azene (2012). As a result, Ethiopia's commercial banks are performing better financially as a result of these technical developments.

Adoption of technology advancements has greatly improved operational efficiency in the banking sector. According to a study by Tunlaw, Mosaku, and Olamitunji (2018), integrating online banking services with automated teller machines (ATMs) has enhanced customer satisfaction by cutting down on the amount of time clients spend in line. Additionally, the use of digital payment systems has sped up transaction processing, allowing banks to process more transactions in less time (Tunlaw et al., 2018). Because fewer physical branches and manual transaction processing are now required, these innovations have allowed banks to save money.

2.2 Financial Performance

Financial performance, according to Naz et al. (2016), is the degree to which a company's financial stability is assessed over time. It is a financial strategy used to manage current and non-current assets, revenues, expenses, and financing to increase sales and profitability for a company's shareholders. The goal of measuring financial performance is to give stakeholders all the information they need to make informed decisions. Comparing the company's performance to that of its competitors in the industry is another use for it. One can gauge a company's financial performance using a variety of ratios. These ratios' findings show the profitability, liquidity, and leverage of the business (Ntuite, 2015).

2.2.1 Measurement of commercial bank's performance

Ntuite's (2015) study indicates that the most widely used metric to assess a bank's performance is profitability. A commercial bank's primary objective is profit, notwithstanding its possible social and economic objectives. The profitability of commercial banks can be assessed using a ratio.

Return on asset

Corporate Finance Institute (n.d) defines Return on Asset (ROA) as one type of return-on-investment metric that measures the profitability of a company to its total assets. It indicates how well a company is performing by comparing the capital it has invested and the profit it has generated from the capital. A higher return indicates productive and efficient management in utilizing economic resources. ROA can be calculated using the following formula:

Return on Asset (ROA) = (Net Income / Total Assets) * 100

2.5 Empirical studies

Numerous investigations have been carried out to investigate the impact of technological advancements on the financial outcomes of banks across various nations. We'll talk about these studies and the ones done in Ethiopia below.

Hani El-Chaarani and Zouhour El-Abiad's research paper, "The Impact of Technological Innovation on Bank Performance," was published in the Journal of Internet Banking and Commerce, Vol. 23 (3), in 2018. Over eight years (2010–2017), the study looks at how technological innovation factors affect Lebanese banks' performance. Return on equity (ROE) and return on assets (ROA) were used in the study as stand-ins for performance level. The investment in computer software, automated teller machines, mobile banking,

and Internet banking are examples of technological innovation factors. According to the study, Lebanese banks' performance is positively impacted by their investments in technological innovation, specifically in automated teller machines (ATMs) and Internet banking. Nevertheless, the findings also show that the performance of Lebanese banks is not significantly impacted by investments in computer software and mobile banking.

Evangeline W. Wachira, "The Effect of Technological Innovation on the Financial Performance of Commercial Banks in Kenya," November 2013, University of Nairobi1. The purpose of the study was to ascertain how technological innovation affected Kenyan commercial banks' performance. The study focused on all of Kenya's commercial banks and used a descriptive cross-sectional design. The Central Bank of Kenya provided secondary data in the form of annual financial reports. The study discovered that Kenyan commercial banks' financial performance had improved as a result of technology advancements. This was accomplished by higher bank sales, higher profits, and a higher return on equity. The study's findings showed that the independent variables' combined influence on profitability was favorable. In their study's conclusion, the researchers found that technological innovation plays a significant role in a bank's performance.

The impact of financial innovation on the performance of commercial banks in Kenya is examined in John M. Kihoro's research paper, "Financial Innovation and the Performance of Commercial Banks in Kenya." The research findings were released in May 2018 in the International Journal of Economics, Commerce and Management, Vol. VI, Issue 5. The results of the study indicated that the performance of Kenya's commercial banks was positively and statistically significantly impacted by agency, mobile, online, and ATM banking. Return on equity (ROE) and return on assets (ROA) were used in the study as stand-ins for performance level.

Gathee (2018) carried out a comparable study. The study's goal was to investigate how technological advancements have affected Kenyan commercial banks' operational management. In addition to being a study, this one used a descriptive survey research design. Operational management was the study's dependent variable, and the independent variables were innovations in mobile, processes, and electronic funds. The study's findings showed that operational management and process and mobile innovation were significantly

correlated, but there was no statistically significant correlation between operational management and electronic funds innovation. The study's conclusion said that banks should invest in mobile and process innovation because they lower operating costs.

An unidentified author's article titled "Effects of Banking Innovation on the Financial Performance of Commercial Banks in Somalia" was published in the IJARKE Journals, an online journal of academics and research. The impact of banking innovations on the financial performance of commercial banks in Mogadishu, Somalia, was the main focus of the study. A descriptive research design was employed in the study, and secondary data was obtained from the banks' published annual reports. For seven years (2014 – 2020), an econometric regression model was employed to ascertain the association between banking innovation and financial performance. According to the study, bank innovations have an impact on commercial banks' profits, revenue, return on assets, and client deposits in Somalia. Additionally, the results showed that the impact will be statistically significant. Nevertheless, additional information about the particular banking innovations that were examined was not included in the paper.

Electronic banking, MICR, Smart Cards, Telephone Banking, Automated Teller Machines, and other ICT products are used in many developing and developed countries. Electronic data interchange, electronic funds transfers, electronic office banking, and Horne (Agboola, 2002). Yasuharu (2003) claims that the use of communication networking and information technology has revolutionized how banks and other financial institutions operate. Some believe that the financial services industry will undergo significant structural changes as a result of the Internet revolution, while others believe that existing trends will continue. Self-service facilities, or automated customer service machines, are made possible by information and communication technology and allow potential customers to complete their account opening paperwork online. Customers can receive instructions on when and how to receive their checkbooks, credit and debit CDs, and account numbers validated, along with assistance (Agboola, 2004).

Chaarani & Abiad (2018) carried out a second study in Lebanon to look at the effect of technological innovation on the country's banks' performance. The technological components included investments in computer software, internet banking, mobile banking,

and ATMs. ROA and ROE were used as performance metrics. The study employed multiple regression analysis along with descriptive statistics, sampling 17 of the nation's 48 banks. The study's conclusions showed that investing in ATMs and online banking has a beneficial effect. On the other hand, the performance of banks in Lebanon was not significantly impacted by mobile banking or software investments.

To ascertain the impact of technological advancements on the financial performance of commercial banks in Zambia, Haabazoka (2018) carried out an investigation. To explain the relationship between the variables and monthly data from all 19 banks in Zambia over four years, the study used a descriptive research design. To ascertain how technological innovation affected bank performance, which was gauged by income, the study concentrated on three areas of innovation: automated teller machines (ATMs), mobile banking, and internet banking. The Bank of Zambia and several audited financial statements of distinct commercial banks provided secondary data. The study's findings showed that, in contrast to Internet banking, which had a weak correlation with commercial banks' financial performance in Zambia, mobile banking and automated teller machines (ATMs) had a positive and significant impact.

To ascertain the impact of electronic banking on Ethiopia's commercial banks' financial performance, Damtew (2016) conducted research there. Profit before tax and return on assets were used as financial performance indicators in the study, which also used Automated Teller Machines, Debit Cards, and Point of Sale (POS) terminals in ten Ethiopian commercial banks as independent variables. The study's conclusions showed that while automated teller machines (ATMs) and point of sale (POS) have a positive effect on commercial banks' return on assets (ROA), they harm their profitability. Nonetheless, Ethiopian commercial banks' profitability and return on assets (ROA) are positively impacted by debit cards.

Temam (2018) conducted a study akin to this one to investigate the impact of financial innovations on Ethiopian commercial banks' financial performance. The study sampled nine Ethiopian commercial banks that were specifically chosen using secondary data. The variables that were identified as independent and controlled were the number of mobile banking users, automated teller machine terminals, new savings accounts, point-of-sale

terminals, debit cardholders, and managerial efficiency. The dependent variable used to gauge financial performance was a return on asset, or ROA.

Elbethel Darge submitted a paper titled "The Effect of Technological Innovation Uptake on the Financial Performance of Commercial Banks in Ethiopia" to Addis Ababa University in April of 2021. Eviews 9 was used to analyze secondary data that was obtained from the banks' published annual reports. For seven years (2015–2021), an econometric regression model was employed to ascertain the relationship between technological innovation and financial performance. According to the study, Ethiopian commercial banks' financial performance benefits from technological innovation. The study's findings showed that the number of people using mobile banking and opening new savings accounts significantly and favorably impacted commercial banks' return on assets (ROA). On the other hand, the quantity of point-of-sale terminals and debit cardholders has no bearing on the financial performance of banks, whereas the number of ATMs had a negative and significant impact on the ROA of commercial banks. The study's conclusion stated that financial innovation improved Ethiopian commercial banks' financial performance and suggested that commercial banks focus more on raising public awareness of financial innovation services.

2.6 Summary and Research Gap

In conclusion, various researchers have conducted several studies to ascertain how technological innovation effect the financial performance of commercial banks across numerous nations. These studies' findings are largely consistent. While a few studies found that certain variables had a negative or insignificant impact on commercial banks' financial performance, the majority of the studies found that the variables had a positive and significant impact.

Most studies conducted in Ethiopia on technological innovation centered on the uptake, prospects, obstacles, and advantages of electronic banking, along with customers' contentment with this mode of payment. This suggests that a crucial area of research in Ethiopia is determining how technological innovation impact the financial performance of commercial banks. The purpose of this study will be to close this gap in the literature by

determining the effect of technological innovation implementation on the Return on Asset (ROA) of particular Ethiopian commercial banks.

2.7 Conceptual framework

These kinds of studies will use dependent variables ROA to gauge financial performance. Independent variables include bank size, debit cards, point-of-sale (POS) terminals, ATMs, mobile banking, Internet banking, and software investments. An illustration of the key concepts, variables, and relationships discovered in a research study is called a conceptual framework. The research problem, questions, and theories are summarized clearly and concisely and are shown below.

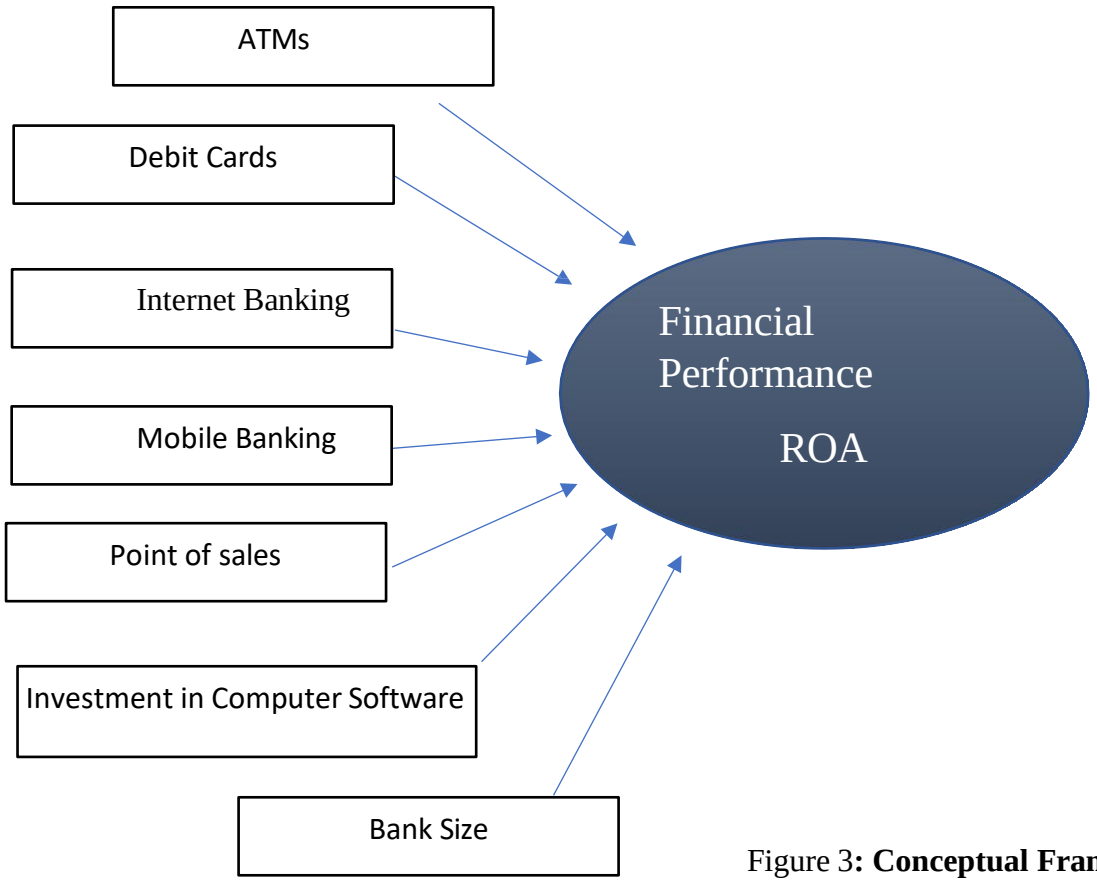


Figure 3**: Conceptual Framework**

Source: Developed by the researcher based on various literature.

Chapter Three

3. Research Methodology and Design

3.1 Introduction

This chapter investigates into the methodological framework employed to achieve the research objectives. It will meticulously dissect each stage of the research process, including the chosen research design, the sources of data utilized, the target population under investigation, the sampling techniques implemented to select participants, and the specific methods used to analyze the collected data.

3.2 Research Methodology

A quantitative approach was employed to achieve the research objective. This approach utilized panel data, which, as Greene (2003) highlights, offers distinct advantages over traditional time series or cross-sectional data. Panel data allows for the detection and measurement of statistical effects that wouldn't be possible with either of the aforementioned methods. Additionally, it helps mitigate estimation biases that might arise from aggregating data points from various groups into a single time series (Greene, 2003). The data for this study was sourced from secondary sources.

3.3 Research Design

This chapter through into the methodological approach adopted for this research. A descriptive research design serves as the cornerstone of the study (Creswell & Creswell, 2018). This aligns perfectly with the research objective, which centers on describing the influence of technological innovation on the financial performance of commercial banks in Ethiopia. Descriptive research excels at painting a clear picture of a phenomenon or relationship between variables, making it ideal for exploring the effect of technological innovation in this context.

To achieve this objective, the study leverages panel data. This type of data offers a distinct advantage over traditional cross-sectional or time-series data sets (Greene, 2003). Panel data allows us to observe the same entities (commercial banks in this case) over multiple time periods (ten years in this study). This longitudinal perspective provides richer insights into how technological innovation describes within these banks and how it might influence their financial performance over time.

The focus of the study narrows to ten methodically selected commercial banks operating within Ethiopia. The selection process for these banks is elaborated upon in a subsequent section, ensuring the sample is representative of the broader Ethiopian commercial banking landscape. By employing a descriptive research design with panel data and a targeted sample of Ethiopian banks, the study is well-positioned to illuminate the relationship between technological innovation and financial performance within this specific context.

3.4 Source of Data

In line with the quantitative approach of this research, secondary data sources were leveraged to gather the necessary information. Specifically, the study relied on published annual reports of the ten selected commercial banks in Ethiopia. These annual reports offer a wealth of quantitative data on various financial metrics, allowing for a comprehensive assessment of the banks' financial performance. By utilizing this readily available data source, the research ensures consistency and avoids the need for primary data collection methods that could be time-consuming or resource-intensive.

3.5 Population

The research observes to the established concept of a population as defined by Babbie (2017), encompassing the entire set of elements (commercial banks in Ethiopia) from which data can be drawn and generalizations can be conditional. Mugenda and Mugenda (2018) further emphasize that a population shares a specific characteristic, in this case, being a commercial bank operating within Ethiopia. These banks include Abbay Bank, Abyssinia Bank, Awash Bank, Commercial Bank of Ethiopia, Dashen Bank, Lion International Bank, Nib International Bank, United Bank, Wegagen Bank, and Zemen

Bank. By focusing on this clearly defined population, the research ensures that the findings are relevant and generalizable to the broader Ethiopian commercial banking sector.

3.6 Sampling Design and Techniques

This research employed purposive sampling, a non-probability sampling technique. Unlike random selection, purposive sampling allows researchers to strategically choose participants based on specific criteria. In this study, the focus was on banks demonstrably engaged in technological innovation. Furthermore, the availability of sufficient data for analysis was crucial. By selecting banks that met these criteria, the research aimed to gain insights from institutions actively shaping the Ethiopian banking landscape through technological advancements. Purposive sampling offers distinct advantages for this study. Firstly, it ensures the inclusion of information-rich cases – banks at the forefront of technological innovation. Their experiences and data provide valuable insights into the impact of these advancements on financial performance. Secondly, focusing on banks with sufficient data availability eliminates the risk of drawing conclusions from incomplete information. This strengthens the internal validity of the research and allows for more robust analysis of the relationship between technological innovation and financial performance.

3.7 Method of Analysis

The research leverages a quantitative approach to analyze the collected data. Descriptive statistics will be employed to summarize and characterize the key variables of interest, providing a foundational understanding of the data set (Field, 2018). These statistics will be presented in tables, offering a clear visual representation of central tendencies and variability within the data.

To research deeper into the relationship between technological innovation and financial performance, the study will utilize classical linear regression modeling (Hair et al., 2019). This statistical technique allows for the exploration of how changes in independent variables (measures of technological innovation) influence the dependent variable

(financial performance). In this context, financial performance will be measured by Return on Assets (ROA), a widely used indicator of profitability.

The independent variables encompass various aspects of technological innovation adopted by the banks. These include internet banking, mobile banking, ATMs, debit cards, and POS terminals. By incorporating these diverse measures, the study aims to capture the multifaceted nature of technological innovation within the banking sector. Additionally, software investment and bank size will be included as a control variable to account for its potential influence on financial performance.

Through a combination of descriptive statistics and regression analysis, the research seeks to identify clear patterns and relationships between technological innovation and financial performance in Ethiopian commercial banks. These findings will contribute valuable insights to the ongoing conversation surrounding the role of technology in driving financial success within the banking industry.

3.8 Model specification and operational definition of variables

3.8.1 Model Specification

This section dig in into the conceptual model that will be used to illuminate the relationship between technological innovation and financial performance within Ethiopian commercial banks. The model draws inspiration from established research in the field, building upon the insights of previous scholars. By integrating these existing frameworks, the study aims to develop a comprehensive model that accurately reflects the specific context of the Ethiopian banking sector.

The following sections will meticulously separate the proposed model, outlining the key variables, their hypothesized relationships, and the rationale behind these connections. This exposition will ensure a clear understanding of the theoretical underpinnings guiding the empirical analysis.

ROA = α + Number of ATMs + Number of Debit Card Holders +Number of Internet Banking Users + Number of Mobile Banking Users + Number of POS

terminals + Investment in Computer software + Bank Size + £

$$\mathbf{ROA_{it} = \alpha_i + \beta 1*NATM_{it} + \beta_2*NDC_{it} + \beta 3*NIB_{it} + \beta 4*NMB_{it} + \beta 5*NPOS_{it} + \beta_6 INVC_{it} + \beta_7*SIZE_{it} + £_{it}}$$

Where:

ROA - Return on Assets for bank i at time t

$NATM_{it}$ - Number of ATMs for bank i at time

NDCit - Number of Debit Card Holders for bank i at time t

NIB_{it} - Number of Internet banking users for bank i at time t

NMB_{it} - Number of Mobile Banking users for bank i at time t

$NPOS_{it}$ – Number of Point of Sale (POS) Terminals for bank i at time t

$INVC_{it}$- Investment in computer software i at time t

$SIZE_{it}$ – Bank Size for bank i at time t

£ = error term

3.9 Operationalization of study variables

3.9.1 Dependent Variables

This study employs Return on Assets (ROA) as the primary metric to assess the financial performance of the commercial banks. ROA, as defined by Brigham and Ehrhardt (2020), is a profitability ratio that indicates the proportion of a company's revenue generated by its assets. In simpler terms, it reveals how effectively a bank is utilizing its assets to generate profits. ROA is generally preferred in this context due to its focus on asset utilization, which aligns more directly with the research objective of evaluating how technological innovation impacts the financial performance of the banks.

3.9.2 Independent Variables

The technological innovation in this study is measured using ATMs, debit cards, mobile banking, Internet banking, and POS terminals. Here is a quick definition of these variables:

A, ATMs

Automated teller machines (ATMs) have revolutionized banking by empowering customers with self-service options for managing their finances (e.g., withdrawals, balance inquiries). These 24/7 machines provide convenient access, reduce operational costs for banks, and ultimately enhance customer satisfaction and retention rates (American Bankers Association, 2023).

B, Debit Cards

Debit cards have become a cornerstone of everyday financial transactions, offering a blend of practicality and responsible spending habits (Calvert, Slade, & Davies, 2018). Unlike credit cards, which extend credit, debit cards function by directly deducting purchases from the user's checking account (Board of Governors of the Federal Reserve System, 2023). This eliminates the risk of overspending associated with credit limits. Furthermore, debit cards allow for cash withdrawals at ATMs and provide a convenient method for making in-store and online payments. In essence, debit cards empower users with real-time control

over their finances, promoting responsible budgeting and streamlined financial management.

Debit cards are practical because they let users' quickly complete self-service tasks like making deposits, withdrawing cash, paying bills, and transferring funds between accounts. They can also lessen the need for you to carry cash, though there may occasionally be fees associated with using these cards. Kagan, J. (2021, December 6)

C, Internet Banking

Customers of banks and other financial institutions can perform a variety of financial transactions via the website or mobile application of the financial institution thanks to an Internet banking system. It goes by the names web banking and online banking as well. Almost all of the services typically provided by a local branch are now offered to clients using online banking, including deposits, transfers, and online bill payments. Frankenfield, J. (2023, April 10)

D, Mobile Banking

A bank or other financial institution that offers mobile banking enables its clients to carry out financial transactions from a distance using a mobile device, like a smartphone or tablet. It goes by the names web banking and online banking as well. Nearly all of the services typically provided by a local branch are also offered to customers using mobile banking, including online bill payments, transfers, and deposits. Chen, J. (2019, June 26).

E, POS terminals

Retail locations use a hardware system called a Point-of-Sale (POS) terminal to process card payments. It has software installed that can read debit and credit card magnetic strips. Sales transactions such as deposits, cash withdrawals, bill payments, and account transfers are processed by POS terminals. The National Cash Register (NCR) created the first point-of-sale (POS) system in the 1980s by integrating new technologies like bar codes and scanners to transform manual cash registers into mobile sale systems. POS terminals come

in a variety of forms, with contactless options for newly popular mobile payment methods and portable devices that are either proprietary or third-party. Software-based point-of-sale (POS) systems that can be installed on tablets or other mobile devices are becoming more and more popular. Halton, C. (2021, August 24).

3.9.3 Control Variable

Bank financial performance is influenced by various internal factors, including asset quality, asset management, liquidity, management caliber, and financial risk. The financial performance of commercial banks is also influenced by external factors such as GDP, inflation, interest rates, and exchange rates. Bank size and investment in computer software was employed as a control variable to prevent the exclusion of crucial variables. The natural logarithm of a bank's total asset value is used to calculate the size of the bank (Laeven et al. 2014).

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.1 INTRODUCTION

This chapter enquires into the fascinating question: how have technological innovations effected the financial performance of Ethiopian commercial banks? The researcher will be analyzing data from ten Ethiopian banks for the period 2014-2023. Using Eviews-8 software, will explore panel data, which considers information across multiple years for each bank, providing a snapshot of all banks at a single point in time. To get a clear picture, we'll begin with descriptive statistics, summarizing the key characteristics of the banks' performance and technology adoption. Before diving deeper, the researcher perform diagnostic tests using reliable secondary data to ensure the robustness of our findings. These tests will scrutinize the data for potential issues like inconsistencies in error distribution (heteroscedasticity), correlations between errors over time (autocorrelation), misleading relationships between independent variables (Multicollinearity), and the normality of error terms. By interpreting the results, the researcher finally unveil the story: how technological advancements have shaped the financial health of these Ethiopian banks.

4.2 Descriptive Analysis

According to Warrens (2013), descriptive statistics act as a translator, condensing complex data sets into a more manageable and understandable form. This process reveals the characteristics of the data and the relationships between variables, offering a foundational step for any research endeavor. It precedes inferential statistics, which delve deeper to draw conclusions about larger populations based on smaller samples. Descriptive statistics encompass several key elements: identifying the types of variables present (nominal, ordinal, etc.), analyzing the frequency of occurrences, pinpointing measures of central tendency (mean, median, mode), and gauging the spread or variation within the data (through measures like standard deviation or range). By providing this initial snapshot,

descriptive statistics pave the way for a more nuanced understanding of the data and prepare the ground for further statistical exploration.

This section delves into the heart of our data, providing a detailed portrait of the variables under investigation. We'll be scrutinizing the financial performance of the Ethiopian banks, measured by their Return on Assets (ROA). On the other side of the equation, we'll examine the independent variables – the technological advancements we suspect may be influencing these financial results. These include internet banking, mobile banking, and the presence of automated teller machines (ATMs) within each bank. Through descriptive statistics, we'll gain a clear understanding of the distribution and characteristics of both the banks' financial health and their level of technological adoption. This initial exploration will pave the way for further analysis, allowing us to uncover the potential connections between technological innovation and financial success.

Table 4.1 summarizes the results of our descriptive statistics analysis. This table paints a clear picture of the data by presenting various statistical values for each variable. We'll be looking at measures like the mean (average), median (middle value), minimum and maximum values (data's extremes), and standard deviation (spread of the data). By interpreting these values, we can gain valuable insights into the financial performance of the banks (measured by ROA) and their adoption of technological advancements (internet banking, mobile banking, and ATMs). This initial exploration allows us to understand the overall landscape before diving deeper into the analysis and uncovering the potential relationships between technology and financial success.

Table 1Summary of Descriptive Statics

	ROA	ATM	NDC	NIB	NMB	NPOS	INV	SIZE
Mean	3.492960	2.161320	5.082166	3.771028	4.815548	2.438177	8.350131	10.57749
Median	3.330941	2.285534	5.384004	4.006187	5.122139	2.460145	8.409436	10.50355
Maximum	6.701462	3.602060	6.732394	6.301030	6.718502	4.411216	9.955564	12.11591
Minimum	0.496350	0.477121	1.342423	1.000000	1.176091	0.698970	7.258656	9.504713
Std. Dev.	1.153594	0.584018	1.142447	1.300166	1.306957	0.808075	0.534521	0.558979
Skewness	0.215482	-0.143253	-1.613396	-0.542982	-1.135556	0.341426	0.144104	0.770187
Kurtosis	3.269377	3.632495	5.337458	2.677684	3.932734	2.933123	3.046669	3.574003
Jarque-Bera	1.076226	2.008901	66.14955	5.346693	25.11642	1.961494	0.355173	11.25929
Probability	0.583849	0.366246	0.000000	0.069021	0.000004	0.375031	0.837289	0.003590
Sum	349.2960	216.1320	508.2166	377.1028	481.5548	243.8177	835.0131	1057.749
Sum Sq. Dev.	131.7471	33.76659	129.2133	167.3527	169.1056	64.64554	28.28554	30.93334
Observations	100	100	100	100	100	100	100	100

Source: Eviews 8 output

This analysis examines various aspects of 100 banks. The average Return on Assets (ROA) sits at 3.49, with a median of 3.33, indicating a typical level of profitability across the institutions. The number of ATMs per bank falls around 2.16 on average, while internet banking (NIB) boasts a higher average value of 5.08. Mobile banking (NMB) shows a similar average of 3.77. Interestingly, the number of Point-of-Sale terminals (NPOS) and investments in computer software (INV) both average around 4.82 and 2.44, respectively. Bank size itself holds an average of 8.35.

4.3 Model Validity

The researcher employed a strong econometric model to ensure the validity of their findings. This multiple regression model included one dependent variable, seven independent variables. Before running the analysis in Eviews-8, they meticulously checked all the assumptions underlying the classical linear regression model (CLRM). To address Multicollinearity, a correlation matrix was used to identify any problematic correlations among the independent variables. Normality of the error terms was assessed using skewness, kurtosis, and the Jarque-Bera test. White's test ensured the absence of heteroscedasticity (unequal variance), and the Breusch-Godfrey test checked for autocorrelation (errors influencing each other). The following section will delve into the results of these tests.

4.3.1 Variance Inflation Factors

Variance Inflation Factors (VIF) serve as a diagnostic tool in regression analysis to pinpoint Multicollinearity, a situation where independent variables are highly correlated [Investopedia]. This correlation inflates the variance of estimated coefficients, hindering their reliability and interpretation [Corporate Finance Institute]. To the rescue comes VIF, quantifying the severity of Multicollinearity for each independent variable by revealing how much its coefficient's variance is inflated due to correlations with other predictors in the model [Penn State (n.d.).]. While there's no perfect threshold, a VIF below 5 suggests

minimal Multicollinearity, between 5 and 10 indicates a possibility but may not be critical, and above 10 points towards a serious concern that could affect the model's reliability [4]. If faced with high VIFs, corrective actions like removing highly correlated variables, combining them, or using dimensionality reduction techniques can be implemented [Investopedia]. By analyzing VIFs, you can proactively address Multicollinearity and ensure your regression model yields more trustworthy and interpretable results [Corporate Finance Institute].

Table 2 **Variance Inflation Factors**

Variance Inflation Factors
Date: 05/26/24 Time: 14:49
Sample: 1 100
Included observations: 100

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	28.44255	2463.397	NA
ATM	0.184865	80.19905	5.406396
NDC	0.074965	176.0862	8.389466
NIB	0.018051	24.84930	2.616428
NMB	0.049503	106.6746	7.250347
NPOS	0.162157	92.56878	9.079066
INV	0.255842	1551.253	6.267612
SIZE	0.223390	2170.664	5.984881

Source: Eviews 8 output

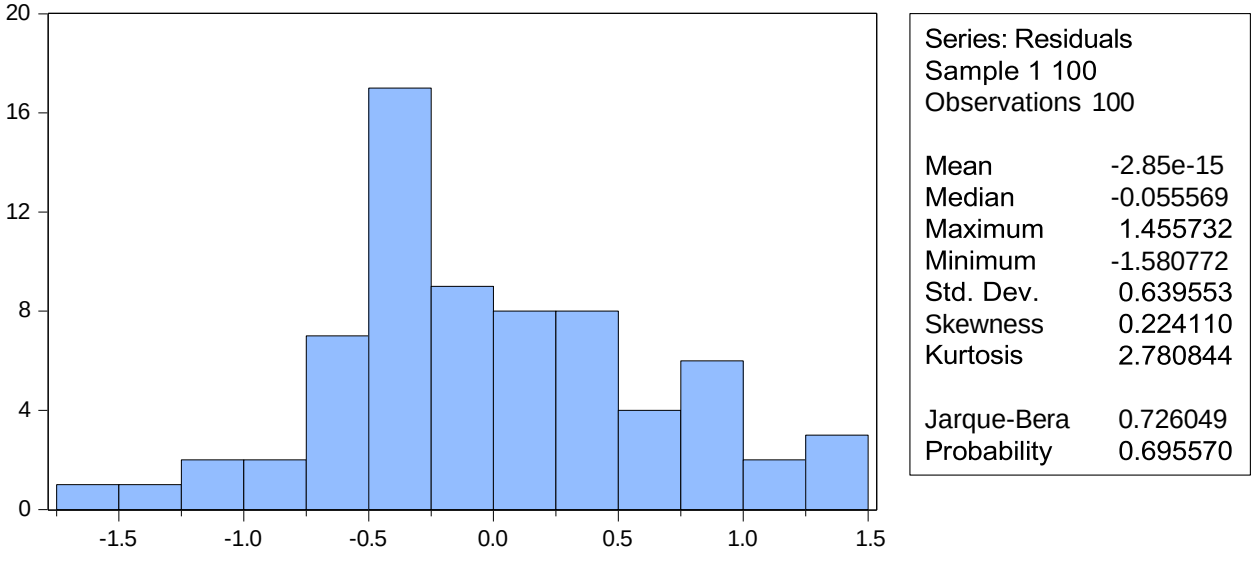
This analysis examines a sample of 100 banks out of a larger dataset collected. It focuses on eight variables including factors like the number of ATMs (ATM) and bank size (SIZE). An important concept explored here is Multicollinearity, which refers to high correlations between variables in a regression model. To assess this, values called Variance Inflation Factors (VIF) are calculated. VIFs above 5 or 10 suggest potential Multicollinearity issues.

Looking at the results, some variables like ATM and NMB have relatively low centered VIFs (around 5-9), indicating a lesser concern for Multicollinearity. Therefore, the researcher concluded that there is no Multicollinearity issue between the independent variables.

4.2.3 Normality Test

To assess the normality of the error terms, the researcher employed a multi-pronged approach. Visual inspection of the histogram will reveal a bell-shaped curve if the data is normally distributed [Kurtosis & Skewness Explained in Simple Terms, Agresti & Moodie, 2018]. Statistically, skewness measures the asymmetry of the data (0 indicates perfect symmetry), while kurtosis reflects the peak's height and sharpness compared to a normal distribution (3 for a normal curve) [Understanding Normality Tests, McLeod, 2015]. Finally, the Jarque-Bera test provides a statistical verdict on normality. Ideally, the residuals should resemble a bell curve (as seen in the histogram) and the Jarque-Bera test should be statistically insignificant (according to Brooks, 2014), signifying that normality is an acceptable assumption for this analysis. The following section will delve into the results of these tests.

Figure 4**: Normality Test**



Source: Eviews 8 output

Examining the residuals of our regression model reveals a distribution that's close to normal, with a slight tilt towards negative values. While the mean is near zero (0.0000000000285), the median (-0.1556792) suggests a minor bias. The spread of the data ranges from -1.807725 to 1.455632 with a standard deviation of 0.69. Interestingly, the kurtosis (2.78) indicates the distribution is slightly more peaked than a normal one, and the positive skew (0.28) confirms the observed leftward tilt. However, the Jarque-Bera test (p-value = 0.69) assures us that this deviation from perfect normality is statistically insignificant.

4.2.4. Heteroscedasticity Test

To ensure the validity of the regression analysis, the researcher investigated whether the error terms exhibited homoscedasticity, a fancy term indicating constant variance (Wooldridge, 2010). In simpler terms, we want to avoid a scenario where the spread of the errors keeps changing throughout the data. White's test was employed to check for the presence of heteroscedasticity (unequal variance) in the residuals. The following section will discuss the results of this test.

Table 3**: Heteroscedasticity Test: White**

Heteroskedasticity Test: White

F-statistic	1.380622	Prob. F(35,64)	0.1307
Obs*R-squared	43.02084	Prob. Chi-Square(35)	0.1655
Scaled explained SS	57.31066	Prob. Chi-Square(35)	0.0101

Source: Eviews 8 output

The F-statistic (1.38, p-value = 0.13) indicates no significant departure from the assumption of homoscedasticity (constant variance of residuals). On the other hand, the chi-square test for heteroscedasticity yields a p-value of 0.01, raising a potential concern about unequal

variances. However, the observed R-squared (43.02) and scaled explained sum of squares (57.31) suggest a decent fit of the model to the data with a moderate explanatory power. Therefore, we don't reject the hypothesis of homoscedasticity at 5% significance level.

4.2.5 Autocorrelation Test

To ensure the validity of the regression analysis, the researcher also investigated autocorrelation. Autocorrelation, as explained by Gujarati (2015), refers to the relationship between a variable's current value and its past values. In simpler terms, it checks if the errors from the model are correlated with each other over time. The classical linear regression model (CLRM) assumes that these errors are independent (no correlation). This study employed the Breusch-Godfrey Serial Correlation LM test to identify any patterns or correlations lurking within the error terms. The following section will delve into the results of this test.

Table 4**: Autocorrelation Test: Breusch-Godfrey Serial Correlation LM Test**

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.358059	Prob. F(40,52)	0.1489
Obs*R-squared	51.09213	Prob. Chi-Square(40)	0.1123

Source: Eviews 8 output

As can be seen from the table above, both p-values of the F-statistic (0.1489) and the Obs*R- squared (0.1123) are greater than 0.05. Therefore, we don't reject the hypothesis that there is no correlation between the error terms at 5% significance level.

4.2.6 Hausman Test

Two different panel estimator methodologies can be applied when working with panel data: Models of Fixed Effects (FEM) and Random Effects (REM)

In the most basic fixed effects models, all of the slope estimates are fixed both cross-sectionally and over time, while the intercept in the regression model is allowed to vary cross-sectionally but not over time. The random effects approach assumes that the relationships between the explanatory and explained variables are the same both cross-

sectionally and temporally, with distinct intercept terms for each entity that remain constant over time (Brooks, 2008). The Hausman Specification Test was used in this investigation to determine whether or not individual effects are random or fixed.

Table 5**: Hausman Test**

Correlated Random Effects - Hausman Test

Equation: Untitled

Test period random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Period random	9.691635	7	0.2067

Source: Eviews 8 output

As can be seen from the above table, the p-value is 0.2067, which is greater than 0.05. Therefore, the hypothesis that a random effects model is appropriate is not rejected.

4.3 Regression Analysis, interpretation and Discussion

This study employed regression analysis, a technique explained by Menard (2021), to explore the relationships between various factors and a bank's return on assets (ROA). The analysis aimed to determine if ATMs (NATM), Debit cards(NDC), internet banking (NIB), mobile banking (NMB),Point sales terminals(NPOS), Investment in computer software and bank size have a significant influence on ROA.

The investigation utilized Eviews 8 software and involved a panel dataset with 100 observations across ten commercial banks. For better proportionality in the model, all independent variables were transformed using natural logarithms, while ROA remained in its percentage format. The following equation represents the operational model used:

$$ROA_{it} = \alpha_i + \beta_1 * log10NATM_{it} + \beta_2 * log10NDC_{it} + \beta_3 * log10NIB_{it} + \beta_4 * log10NMB_{it} + + \beta_5 * log10NPOS_{it} + \beta_6 * log10INV_{it} + \beta_7 * log10SIZE_{it} + £_{it}$$

The following section will present the regression results and their interpretations, unveiling the impact of these control and independent variables on ROA.

Table 6**: Linear Regression Model**

Period random effects test equation:

Dependent Variable: ROA

Method: Panel Least Squares

Date: 05/28/24 Time: 09:11

Sample: 2014 2023

Periods included: 10

Cross-sections included: 10

Total panel (balanced) observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	35.07477	7.925799	4.425393	0.0000
ATM	-0.199113	0.457143	-0.435559	0.6643
NDC	-0.664514	0.315082	-2.109018	0.0380
NIB	-0.251541	0.160059	-1.571551	0.1199
NMB	0.640771	0.239043	2.680565	0.0089
NPOS	2.001134	0.571267	3.502977	0.0007
INV	-1.706315	0.552286	-3.089550	0.0027
SIZE	-1.942102	0.654663	-2.966568	0.0039

Effects Specification

Period fixed (dummy variables)

R-squared	0.581107	Mean dependent var	3.492960
Adjusted R-squared	0.418893	S.D. dependent var	1.153594
S.E. of regression	1.068227	Akaike info criterion	3.123549
Sum squared resid	94.71213	Schwarz criterion	3.566428

		Hannan-Quinn	
Log likelihood	-139.1774	criter.	3.302790
F-statistic	2.028451	Durbin-Watson stat	1.178883
Prob(F-statistic)	0.020180		

Source: Eviews 8 output

The relationship between the dependent and independent variables in the model is shown as follows based on the output above:

ROAit=35.1-0.199*NATMit-0.66*NDCit-0.25*NIBit+0.64*NMBit+2*NPOSit-1.7*INVit-1.9*SIZEit+£it

4.3.1 Interpretation of R-squared and Adjusted R-squared

R-squared is a valuable metric for assessing how well a regression model fits the sample data. However, it can be overly optimistic about how well it explains the variance in the broader population. This is because adding more independent variables to the model will tend to inflate the R-squared value, regardless of whether those variables truly improve the model's explanatory power. To address this shortcoming, statisticians use adjusted R-squared. This adjusted version takes into account the number of variables used in the model, providing a more accurate estimate of the variance explained in the population, rather than just the sample. In simpler terms, adjusted R-squared penalizes the model for complexity, ensuring a better reflection of its generalizability. (American Psychological Association (2020).

In this study, the R2 and adjusted R2 are 0.581107 and 0.418893, respectively. This implies that 41.8% of volatility in return of asset (ROA) is explained by volatilities in the independent and control variables. Thus, it can be concluded that number of mobile banking users, number of internet banking users, number of ATMs, number of debit cards holders, number of POS terminals, Investment in computer software and bank size collectively explain 41.8% of the change in ROA. The remaining 58.1% of the variability in ROA is left unexplained by the explanatory variables included in the study.

4.3.1.1 Automated teller Machine and Financial performance

ATMs and ROA have a negative, albeit negligible, association at the 5% significance level, as the above table demonstrates. According to the coefficient of -0.199, this association is statistically negligible at the 5% significance level.

This result is in line with Damtew's (2016) findings, but it differs from those of Haabazoka (2018), Chaarani & Abiad (2018), and Darge, E. (2022) who found that ATM use and financial performance were positively correlated.

Although ATMs are easily accessible and convenient, their detrimental effects on Ethiopian commercial banks' financial performance can be attributed to a number of factors, including startup costs, ongoing expenses, rivalry, client behavior, and difficulties with risk management. As the banking industry develops, maintaining long-term profitability requires optimizing ATM strategy.

4.3.1.2 Debit Cards and Financial Performance

At the 5% significance level, the study's findings show that debit cards and ROA have a negative relationship. The coefficient of -0.664514 indicates that, at a 5% significance level, a 1% increase in the number of DC will, on average, result in a 66.4% decrease in ROA, while other parameters being constant. This association is statistically significant.

This discovery aligns with the findings of Darge, E. (2022) and Temam (2018).That, however, runs counter to Damtew's (2016) findings, which indicated a favorable correlation between debit cards and the financial standing of commercial banks. Temam (2018) suggests that the manufacture cost of debit cards may be the cause of the negative correlation between ROA and debit cards. Another reason could be a lower ROA brought on by COVID-19 and the conflict in the nation's north.

Debit cards, while convenient for customers, can be financially challenging for banks. Implementation and maintenance are expensive, transaction fees eat into profits, and debit cards don't generate interest income like loans. On top of that, banks face risks from overdrafts, chargebacks, and potentially low customer adoption due to competition and consumer preference for other payment methods.

4.3.1.3 Internet Banking and Financial Performance

A negative correlation has been seen between internet banking and ROA at the 5% significance level, as table 6 demonstrates. The association is statistically insignificant at the 5% significance level, with a coefficient of -0.251541 showing that, if all other variables remain constant.

This discovery aligns with the findings of a study carried out by Haabazoka (2018). Yet, research by Darge, E. (2022) and Chaarani & Abiad (2018), who carried out a related study in Ethiopia and Lebanon, likewise produced a different outcome.

Internet banking is efficient and convenient, but it has a negative influence on Ethiopian commercial banks' financial performance due to installation costs, security threats, acceptance difficulties, operational problems, competition, regulatory compliance, and customization restrictions. Resolving these issues is essential to optimizing the advantages of online banking as the banking industry changes.

4.3.1.4 Mobile Banking and Financial Performance

At the 5% significance level, mobile banking and ROA have a positive relationship, as the table above illustrates. According to the coefficient of 0.640771, a 1% increase in mobile banking users will typically result in a 64.1% rise in ROA, leaving other parameters constant. This link is it is statically significant at the 5% significant level.

This result is likewise in line with Haabazoka's (2018) findings, however it differs from those of Chaarani & Abiad (2018) and Darge, E. (2022) who found a substantial and negative correlation between mobile banking and financial performance.

Improvements in productivity, enhanced client reach and loyalty, higher transaction volumes, efficient risk management, and technology developments are the main reasons for the favorable link seen between mobile banking and financial performance.

4.3.1.5 Point of sales (POS) and Financial Performance

The result of the study reveals that number of POS terminals have a positive and significant relationship with ROA at 5% significance level. The coefficient 2.001134 implies that holding other factors constant, a 1% increase in the number of POS terminals will on average result in a 200.1% increase in ROA and this relationship is statistically significant at 5% significance level.

This discovery aligns with Temam's (2018) and Darge, E. (2022) findings. Additionally, POS terminals and ROA were discovered to be positively correlated by Kalluri (n.d.) and Darge, E. (2022). Conversely, the research carried out by Damtew (2016) shown an inverse correlation between ROA and POS terminals.

POS terminals are a win-win for banks. They boost transaction volume and fees, offering a new and steady source of income. Customers appreciate the convenience and security of cards, leading to loyalty and stable deposits. Reduced cash handling saves banks money, and offering POS services keeps them competitive in a digital age, attracting new customers and expanding financial inclusion.

4.3.1.6 Investment in Computer Software and Financial Performance

The result of the study reveals that number of investment in computer software have a negative and significant relationship with ROA at 5% significance level. The coefficient -1.706315 implies that holding other factors constant, a 1% increase in the investment in computer software will on average result in a 170.6% decrease in ROA and this relationship is statistically significant at 5% significance level.

According to this study, purchasing software has a statistically significant negative effect on return on assets (ROA; coefficient = -1.7). This is consistent with earlier studies that emphasize the value of technological expenditures made by financial organizations.

While computer software expenditures have the potential to be beneficial, expenses, misunderstandings, difficulties with integration, the need for training, risk, complexity, and maintenance are the key reasons why they have a negative effect on Ethiopian commercial

banks' financial performance. Care must be taken when making significant software investments as banks continue to digitize.

4.3.1.7 Bank size and Financial Performance

At the 5% significance level, the study's findings show a negative and significant link between bank size and ROA. A 1% increase in bank size will, on average, result in a 194.2% fall in ROA, according to the coefficient -1.942102, which indicates that this link is statistically significant at the 5% significance level. This association also holds true for other parameters.

This result is comparable to that of Alfadhli & Alali (2021). Abebe (2019), on the other hand, observed different correlations in their investigation of the impact of bank size on the profitability of commercial banks, which revealed a positive and substantial link.

Although larger banks have economies of scale, operating costs, market saturation, capital adequacy, diversification, and difficulties with asset growth are the reasons behind their detrimental effects on Ethiopian commercial banks' financial performance. Sustainable profitability requires finding a balance between efficiency and growth.

4.4 Results vs Hypothesis

Not all the research findings played out as predicted! We'll explore the surprising results alongside those that confirmed our initial hypotheses in the following section.

H1: Automated teller machines (ATMs) have a positive and significant effect on the financial performance of commercial banks in Ethiopia

Contrary to our initial hypothesis, the research did not identify a positive and significant relationship between Automated teller machines (ATMs) and ROA. In fact, the findings suggest a negative, albeit insignificant, association between NATMs and ROA. This unexpected outcome compels us to reject the hypothesis regarding mobile banking's impact on financial performance (Hair et al., 2019).

H2: Debit cards have a positive and significant effect on the financial performance of commercial banks in Ethiopia.

Our initial hypothesis anticipated a positive and significant relationship between number of debit card usage (NDC) and ROA. However, the study results revealed a negative association between these variables, with the impact of debit cards on ROA being statistically significant. This unexpected finding necessitates the rejection of our hypothesis regarding the positive influence of debit cards on financial performance (Hair et al., 2019).

H3: Internet banking has a positive and significant effect on the financial performance of commercial banks in Ethiopia.

Our hypothesis posited a positive and significant relationship between number of internet banking utilization and ROA. However, the study results revealed a negative, albeit insignificant, effect of internet banking on ROA. Given this unexpected outcome, we are compelled to reject the hypothesis regarding internet banking's positive influence on financial performance (Hair et al., 2019).

H4: Mobile banking has a positive and significant effect on the financial performance of commercial banks in Ethiopia.

To convey positive outcome, the research findings aligned with our initial hypothesis. The results demonstrated a positive and significant relationship between mobile banking utilization and ROA. This outcome supports the notion that mobile banking contributes to a bank's financial performance (Hair et al., 2019).

H5: Point of sale (POS) terminals have a positive and significant effect on the financial performance of commercial banks in Ethiopia.

Reinforcing our initial hypothesis, the study results revealed a positive and significant relationship between NPOS terminal usage and ROA. This finding aligns with the notion that NPOS terminals contribute to a bank's financial performance by facilitating electronic transactions (Lee & Ryu, 2018).

H6: Investments in computer software have a positive and significant effect on the financial performance of commercial banks in Ethiopia.

Our initial hypothesis anticipated a positive and significant relationship between investments in computer software and ROA. However, the study results revealed a surprisingly negative, yet statistically significant, association between these variables. This unexpected outcome necessitates the rejection of our hypothesis regarding the positive impact of software investment on financial performance (Chen et al., 2023).

H7: Bank size has a positive and significant effect on the financial performance of commercial banks in Ethiopia.

Contrary to our initial hypothesis, the study did not reveal a positive and significant relationship between bank size and ROA. Instead, the findings suggest a negative, albeit significant, association between these variables. This unexpected outcome compels us to reject the hypothesis regarding the positive influence of bank size on financial performance (Beck et al., 2013).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

The journey of discovery continues! This section unveils the key findings of the research, translates those findings into clear conclusions, and offers recommendations that can propel future research or inform practical applications.

5.1 Summary of Major Findings

This research delves into the critical question: how does technological innovation influence the financial performance of commercial banks in Ethiopia? To address this question, the study employs Return on Assets (ROA) as the dependent variable, a widely accepted measure of a bank's profitability.

Independent variables, representing various aspects of technological innovation adopted by the banks, were incorporated into the analysis. These include:

- Number of ATMs
- Number of debit card holders
- Number of internet banking users
- Number of mobile banking users
- Number of POS terminals

Investment in computer software and bank size was also included as a control variable to account for its potential effect on financial performance.

The study utilizes secondary data meticulously gathered from the published annual reports of nine strategically selected Ethiopian commercial banks. The data collection timeframe spans seven years, from 2014 to 2023. Descriptive statistics are employed to provide a clear picture of the relationships between the variables. Furthermore, a multiple regression analysis is conducted to delve deeper and examine the specific relationships between ROA and the various measures of technological innovation.

To ensure the robustness of the findings and the validity of the model, diagnostic tests were conducted. These tests addressed potential statistical issues such as heteroscedasticity

(unequal error variance), Multicollinearity (high correlation between independent variables), autocorrelation (correlation of residuals over time), and normality (distribution of errors).

By systematically analyzing the data and addressing these potential concerns, this research strives to illuminate the intricate link between technological innovation and financial performance within the Ethiopian banking sector. The following sections will unveil the key findings, the conclusions drawn from these findings, and recommendations for future research or practical applications.

The regression analysis revealed some interesting insights regarding the relationship between technological innovation and financial performance (ROA) in Ethiopian commercial banks. While some innovations exhibited positive associations with ROA, others presented negative but statistically insignificant effects.

Mobile banking and POS terminals emerged as the clear leaders, demonstrating a positive and statistically significant relationship with ROA. This suggests that banks with a higher number of mobile banking users and POS terminals tend to experience improved profitability.

On the other hand, ATMs, debit cards, internet banking, investment in computer software, and bank size all displayed negative relationships with ROA. However, it's crucial to note that the negative effect of ATMs and internet banking was not statistically significant. This implies that while there might be a weak negative association between these innovations and profitability, it's not conclusive evidence of a causal relationship.

The negative and statistically significant effect of debit cards and bank size warrants further investigation. Future research could explore potential explanations for these unexpected findings.

5.2 Conclusion

This study embarked on a journey to explore the intricate dance between technological innovation and financial performance within Ethiopia's commercial banking sector. While the findings paint a complex picture, they offer valuable insights for navigating the digital transformation landscape.

The positive and significant relationship between mobile banking and ROA stands out as a beacon of success. Banks that prioritize mobile banking solutions can leverage increased customer reach, loyalty, and transaction volumes to fuel profitability. Similarly, POS terminals emerge as another clear winner, boosting both bank and customer convenience while generating new revenue streams. However, the impact of other technological advancements presents a more nuanced story. ATMs, debit cards, and internet banking, while convenient, exhibited negative associations with ROA, albeit statistically insignificant for ATMs and internet banking. This suggests potential areas for optimization. Addressing factors like high setup costs, security concerns, and integration challenges could unlock the true potential of these technologies.

The negative and significant relationship between investment in computer software and ROA underscores the importance of strategic decision-making. While software can be a powerful tool, careful consideration of costs, training needs, and integration challenges is crucial to ensure a positive return on investment.

Finally, the negative association between bank size and ROA highlights the need for a balanced approach to growth. While larger banks may benefit from economies of scale, managing operating costs, market saturation, and asset diversification remains essential for sustainable profitability.

In conclusion, Ethiopian banks stand at a crossroads. By strategically leveraging mobile banking, POS terminals, and carefully chosen software solutions, they can unlock the digital dividend and enhance financial performance. However, a clear understanding of the potential drawbacks associated with other technologies, coupled with efforts to optimize their implementation, is crucial for navigating the path to sustained profitability in the digital age. Future research delving deeper into the specific reasons behind the unexpected

findings, particularly regarding debit cards and internet banking, could provide valuable guidance for optimizing these technologies within the Ethiopian context.

5.3 Recommendation

This study unveiled a fascinating, and sometimes conflicting, landscape regarding the impact of technological innovation on Ethiopian commercial banks' financial performance. While mobile banking and POS terminals emerged as clear winners, debit cards, internet banking, investment in software, and even bank size itself presented a more complex picture. Here are some key recommendations for Ethiopian banks to navigate this digital tightrope and unlock sustainable profitability:

- **Embrace Mobile Banking**: The positive and significant association between mobile banking and ROA underscores its importance. Banks should prioritize investments in mobile banking solutions to enhance customer reach, loyalty, and transaction volumes.
- **Optimize POS Terminal Strategies**: POS terminals offer a win-win situation, boosting both bank and customer convenience while generating new revenue streams. Banks should strategically expand their POS terminal networks to further capitalize on this opportunity.
- **Refine Other Technologies:** For debit cards, internet banking, and software investments, a focus on optimization is crucial. Addressing setup costs, security concerns, integration challenges, and training needs can unlock the true potential of these technologies and improve their return on investment.
- **Balance Bank Size and Growth:** While larger banks benefit from economies of scale, managing operating costs, market saturation, and asset diversification is essential. Striking a balance between efficiency and growth will ensure sustainable profitability.
- **Further Research on Debit Cards and Internet Banking:** The unexpected negative associations with debit cards and internet banking warrant further investigation. Future research delving deeper into the specific reasons behind these

findings can provide valuable guidance for optimizing these technologies within the Ethiopian context.

By implementing these recommendations and continuously seeking improvement, Ethiopian banks can harness the power of technology to enhance financial performance and solidify their position in the ever-evolving digital landscape.

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Appendix

Heteroskedasticity Test: White

F-statistic	1.380622	Prob. F(35,64)	0.1307
Obs*R-squared	43.02084	Prob. Chi-Square(35)	0.1655
Scaled explained SS	57.31066	Prob. Chi-Square(35)	0.0101

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Date: 05/26/24 Time: 14:38

Sample: 1 100

Included observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-258.7378	594.7418	-0.435042	0.6650
ATM^2	-10.82941	4.477160	-2.418813	0.0184
ATM*NDC	-3.385352	4.057076	-0.834431	0.4071
ATM*NIB	3.192602	2.865247	1.114250	0.2693
ATM*NMB	5.316205	3.743706	1.420038	0.1604

ATM*NPOS	6.207783	6.780790	0.915496	0.3634
ATM*INV	8.891260	6.841654	1.299578	0.1984
ATM*SIZE	-1.514890	9.796415	-0.154637	0.8776
ATM	-47.69190	86.48696	-0.551435	0.5833
NDC^2	-1.992700	1.488690	-1.338559	0.1854
NDC*NIB	-2.912348	2.101590	-1.385783	0.1706
NDC*NMB	2.875457	1.527853	1.882025	0.0644
NDC*NPOS	3.995809	4.408019	0.906486	0.3681
NDC*INV	4.160497	4.818267	0.863484	0.3911
NDC*SIZE	-0.683355	6.862930	-0.099572	0.9210
NDC	-17.80519	46.57263	-0.382310	0.7035
NIB^2	0.020494	0.381803	0.053676	0.9574
NIB*NMB	-0.134803	1.556259	-0.086620	0.9312
NIB*NPOS	1.439807	2.660387	0.541202	0.5902
NIB*INV	-1.092663	3.590036	-0.304360	0.7618
NIB*SIZE	-0.996725	3.082329	-0.323367	0.7475
NIB	25.37675	44.26986	0.573229	0.5685
NMB^2	-0.831597	1.038308	-0.800915	0.4261
NMB*NPOS	-3.508517	3.555624	-0.986751	0.3275
NMB*INV	-6.278383	4.631376	-1.355619	0.1800
NMB*SIZE	2.603803	6.055703	0.429975	0.6687
NMB	15.27584	49.52488	0.308448	0.7587
NPOS^2	-2.142081	4.206464	-0.509236	0.6123
NPOS*INV	-0.649395	7.036035	-0.092296	0.9268
NPOS*SIZE	-2.638337	6.204476	-0.425231	0.6721
NPOS	22.52962	81.86299	0.275211	0.7840
INV^2	-8.998905	7.622908	-1.180508	0.2422
INV*SIZE	13.32367	10.40083	1.281019	0.2048
INV	2.954948	72.81780	0.040580	0.9678
SIZE^2	-6.578351	4.701849	-1.399099	0.1666
SIZE	40.50106	117.3414	0.345156	0.7311

R-squared	0.430208	Mean dependent var	1.062238
Adjusted R-squared	0.398604	S.D. dependent var	1.894130
S.E. of regression	1.778261	Akaike info criterion	4.262862
Sum squared resid	202.3815	Schwarz criterion	5.200723
		Hannan-Quinn	
Log likelihood	-177.1431	criter.	4.642431
F-statistic	1.380622	Durbin-Watson stat	1.485691
Prob(F-statistic)	0.130664		

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.358059	Prob. F(40,52)	0.1489
		Prob. Chi-	
Obs*R-squared	51.09213	Square(40)	0.1123

Test Equation:

Dependent Variable: RESID

Method: Least Squares

Date: 05/26/24 Time: 14:43

Sample: 1 100

Included observations: 100

Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-11.84979	7.704758	-1.537983	0.1301
ATM	0.227060	0.543173	0.418025	0.6776

NDC	0.233836	0.410586	0.569518	0.5715
NIB	-0.546790	0.225649	-2.423188	0.0189
NMB	0.237058	0.339883	0.697468	0.4886
NPOS	-0.631690	0.610935	-1.033974	0.3059
INV	0.215451	0.604237	0.356568	0.7229
SIZE	1.035337	0.679813	1.522972	0.1338
RESID(-1)	0.382098	0.143656	2.659811	0.0104
RESID(-2)	0.088283	0.143363	0.615801	0.5407
RESID(-3)	-0.358706	0.152664	-2.349643	0.0226
RESID(-4)	-0.288470	0.157937	-1.826483	0.0735
RESID(-5)	-0.193765	0.157883	-1.227271	0.2252
RESID(-6)	0.063712	0.148770	0.428256	0.6702
RESID(-7)	-0.101040	0.149779	-0.674594	0.5029
RESID(-8)	-0.269673	0.163588	-1.648490	0.1053
RESID(-9)	-0.237322	0.162747	-1.458227	0.1508
RESID(-10)	-0.194371	0.165327	-1.175675	0.2451
RESID(-11)	0.062349	0.156281	0.398952	0.6916
RESID(-12)	-0.054222	0.154426	-0.351116	0.7269
RESID(-13)	-0.314352	0.166932	-1.883115	0.0653
RESID(-14)	-0.053427	0.163585	-0.326599	0.7453
RESID(-15)	0.192144	0.161882	1.186944	0.2406
RESID(-16)	0.002645	0.168559	0.015690	0.9875
RESID(-17)	-0.071261	0.184266	-0.386728	0.7005
RESID(-18)	-0.193289	0.184013	-1.050411	0.2984
RESID(-19)	0.227171	0.182382	1.245582	0.2185
RESID(-20)	-0.026863	0.189838	-0.141503	0.8880
RESID(-21)	-0.096227	0.199087	-0.483342	0.6309
RESID(-22)	0.108483	0.192963	0.562195	0.5764
RESID(-23)	-0.074350	0.188341	-0.394763	0.6946
RESID(-24)	0.130401	0.192063	0.678949	0.5002
RESID(-25)	0.059807	0.186741	0.320268	0.7500

RESID(-26)	-0.189655	0.191039	-0.992757	0.3254
RESID(-27)	-0.116377	0.184823	-0.629666	0.5317
RESID(-28)	-0.034456	0.183992	-0.187268	0.8522
RESID(-29)	0.125444	0.185856	0.674952	0.5027
RESID(-30)	-0.365267	0.193151	-1.891099	0.0642
RESID(-31)	-0.128038	0.195747	-0.654101	0.5159
RESID(-32)	0.039347	0.181133	0.217226	0.8289
RESID(-33)	-0.067346	0.190210	-0.354063	0.7247
RESID(-34)	0.022384	0.186158	0.120243	0.9048
RESID(-35)	-0.242578	0.181576	-1.335959	0.1874
RESID(-36)	-0.021393	0.179795	-0.118984	0.9057
RESID(-37)	0.091109	0.177654	0.512846	0.6102
RESID(-38)	-0.212153	0.178349	-1.189537	0.2396
RESID(-39)	-0.019673	0.182428	-0.107837	0.9145
RESID(-40)	-0.094698	0.175544	-0.539456	0.5919

R-squared	0.510921	Mean dependent var	1.40E-15
Adjusted R-squared	0.368869	S.D. dependent var	1.035842
S.E. of regression	0.999537	Akaike info criterion	3.143024
Sum squared resid	51.95181	Schwarz criterion	4.393505
		Hannan-Quinn	
Log likelihood	-109.1512	criter.	3.649116
F-statistic	1.155795	Durbin-Watson stat	2.148650
Prob(F-statistic)	0.304562		