



ADDIS ABABA UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

DEPARTMENT OF ACCOUNTING AND FINANCE

RE-IMAGING LITERACY AS A DRIVER FOR FINANCIAL
INCLUSION IN ETHIOPIA:

EMPIRICAL INSIGHTS INTO DIGITAL-FINANCIAL LITERACY, INTEREST-
FREE BANKING, AND MOBILE BANKING USAGE ACROSS SOCIOECONOMIC
HETEROGENEITY.

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APPROVAL AND SIGNATURE SHEET

This dissertation, entitled “*Re-imaging Literacy as a Driver for Financial Inclusion in Ethiopia: Empirical Insights into Digital-Financial Literacy, Interest-Free Banking, and Mobile Banking Usage across Socioeconomic Heterogeneity*,” is submitted to the Department of Accounting and Finance, School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Finance. We, the board of examiners, have read and evaluated this dissertation and examined the nominee. We recommend the dissertation be accepted as partial fulfillment of the requirements for the *Degree of Doctor of Philosophy in Accounting and Finance, with a specialization in Finance*.

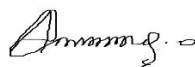
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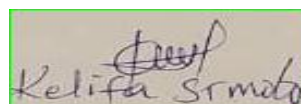
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DEDICATION

*“TO MY LATE FATHER, CHILDHOOD BREADWINNERS, AND RESILIENT
CHILDREN.”*

AUTHOR'S STATEMENT

I, **Abdella Hussen Mudessir**, would like to declare that this dissertation entitled “*Re-imagining Literacy as a Driver for Financial Inclusion in Ethiopia: Empirical Insights into Digital-Financial Literacy, Interest-Free Banking, and Mobile Banking Usage across Socioeconomic Heterogeneity.*” is my original work, and none of the essay has been submitted to any other institution elsewhere to award any degree. All sources of information, ideas, and views in this dissertation are duly acknowledged.

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Signature:

A handwritten signature in black ink, enclosed in a green rectangular border. The signature is stylized and appears to be the name 'Abdella Hussen Mudessir'.

Date: September, 2025

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ACRONYMS, ABBREVIATIONS, AND SYMBOLS

AFI: Alliance for Financial Inclusion

AME: Average Marginal Effect

CSA: Central Statistics Agency

DFL: Digital Financial Literacy

DFS: Digital Financial Services

ESS: Ethiopian Socioeconomic Survey

FA: Financial Attitude

FB: Financial Behavior

FFIs: Formal Financial Institutions

FI: Financial Inclusion

Findex: Global Financial Inclusion Index

FinTech: Financial Technology

FK: Financial Knowledge

FL: Financial Literacy

GAFI: Global Alliance for Financial Inclusion

GSMA: Global System for Mobile Communications Association

HHs: Households

ICC: Intra-class Correlation Coefficients

ICT: Information and Communication Technology

IFB: Interest-Free Banking

KMO: Kaiser-Meyer-Olkin

LMM: Linear Mixed-Effects Model

LR: Likelihood Ratio

MEM: Mixed Effects Model

MFS: Mobile Financial Services

MM: Mobile Money

MoE: Ministry of Education

NBE: National Bank of Ethiopia

NFIS: National Financial Inclusion Strategy

OECD: Organization for Economic Co-operation and Development

PCA: Principal Component Analysis

REML: Restricted Maximum Likelihood

SACCO: Savings and Credit Cooperative

SDG: Sustainable Development Goals

TFL: Theory of Financial Literacy

TPA: Theory of Planned Behavior

UNCDF: United Nations Capital Development Fund

WB: World Bank

WBG: World Bank Group

2SLS: Two-Stage Least Squares

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GENERAL ABSTRACT

This study analyzes the multifaceted role of digital financial literacy (DFL) and financial literacy (FL) in advancing holistic financial inclusion within Ethiopia's diverse socioeconomic heterogeneity. Drawing on nationally representative data from the Ethiopia socioeconomic survey (ESS), the research employs robust mixed-effects economic modeling to investigate how DFL and FL influence three interconnected areas of financial inclusion: interest-free banking (IFB), traditional financial services, and digital financial inclusion through mobile banking. The finding reveals that both DFL and FL are critical, statistically significant predictors of financial inclusion, with DFL exerting the strongest influences on the usage of IFB and digital financial services. The data insight analysis uncovers pronounced disparities in literacy and inclusion by region, gender, income, and religion, with rural, female, and low-income groups facing persistent barriers. Remarkably, the research demonstrates that enhancing DFL and FL not only increases the likelihood of adults using IFB and conventional financial services but also helps bridge the digital divide, particularly in mobile banking uptake. The study emphasizes the necessity of context-sensitive, dual-literacy interventions and the leveraging of community networks such as *Equb and Idir* to foster resilience and inclusion. Policy recommendations include the need for targeted literacy training and curriculum redesign, digital infrastructure expansion, and the tailoring of financial products to local values and needs with grassroots community-empowering economic systems. By integrating advanced econometrics techniques and focusing on Ethiopia's socioeconomic disparities context, this deep data-driven research offers practical recommendations to policymakers and practitioners seeking to solve financial exclusion

and achieve realized true, robust, multidimensional inclusion. The dissertation synthesis concludes that closing Ethiopia's financial inclusion gaps requires a holistic, strategic, innovative approach that combines literacy, technology, and adaptive policy, ensuring social justice and equitable access and usage for all segments of society.

Keywords: Digital Financial Literacy, Financial Inclusion, Interest-Free Banking, Mobile Banking, Socioeconomic Disparity, Ethiopia.

CHAPTER 1: GENERAL INTRODUCTION

1.1. BACKGROUND AND CONTEXTUALIZATION

Technology-driven financial inclusion is widely recognized as a powerful enabler for achieving multiple United Nations Sustainable Development Goals (SDGs). By expanding access to and utilization of financial services through digital technologies, countries can reduce poverty, foster innovation, decrease inequalities, and strengthen cross-national partnerships for sustainable development, as asserted by the World Bank Group (2021), Suhrab et al. (2023), Lee et al. (2022), and Liu and Guo (2023).

UN member states reached an agreement known as the Addis Ababa Action Agenda during the 3rd International Conference on Financing for Development (FfD), which was held in July 2015. In this agenda, nations committed to transitioning from financial exclusion to fostering inclusive and sustainable growth. In 2021, 76% of adults worldwide held an account at a formal financial institution or through a mobile money provider. This ratio leaves approximately 1.4 billion adults, or around 24%, unbanked and excluded from accessing formal financial services (Demirgüç-Kunt et al., 2022). Low-income economies gain greater advantages from the financial inclusion advancements propelled by mobile technology (Demirgüç-Kunt et al. 2018). For example, according to the World Bank G20 Financial Inclusion Indicators, the number of mobile money accounts has surpassed that of traditional bank accounts by a ratio of 2:1. Despite this, income inequalities still exist, particularly in rural areas and among women in poorer regions, as a result of a lack of infrastructure, education, and financial literacy (Tay et al. (2022), Demir et al. (2020), and Ji et al. (2019)).

In this, critics argued that financial exclusion is not only due to a lack of infrastructure but also due to systematic structural, religious, and cultural misalignment; digital anxiety; and colonial legacies in fintech designs and practices (Tay et al., 2022; Wang et al., 2021). In reality, we also observe negative consequences of inclusion through financial technology (fintech). The paradox of inclusion, such as mobile money's expansion, often relates to the fact that fintech integrates the poor into exploitative systems, transforming users into data commodities serving global interests, as noted

by Zuboff (2019). And Ouma (2020) added that fintech algorithmic bias disproportionately exploits informal workers under the rhetoric of financial inclusion, as exemplified by Taylor (2012) and the Andhra Pradesh debt trap leading to catastrophic social outcomes, including borrower suicides. Similarly, IMF and WB structured procedures are monetizing poverty through high-interest debt models, prioritizing debt repayment over local development (Hickel, 2017; Ozili, 2021a, 2021b).

In contrast to an interest-based economy, the Islamic economic model of financial inclusion, as outlined by Chapra (2000) and Siddiqi (2006), is characterized by being asset-backed and Shariah-compliant. It emphasizes banking and finance practices that avoid usury while prioritizing shared risk and productivity. Islamic finance adoption is driven by religious compliance and ethical financial imperatives, ensuring financial inclusion in predominantly Muslim regions. According to Ahmed (2020) and Ahroum et al. (2020), Islamic cooperative banks provide agricultural project finance through Musharakah profit-sharing contracts to advance local social entrepreneurship without predatory debt. Similarly, Scholz (2016) and North (2007) argued that the localization of financial technology platforms through grassroots alternatives like SACCO in Ethiopia and *Equb* and Iddir social networking increases trust in financial inclusiveness. Yet mainstream conventional institutions reject asset-backed models of Islamic finance. Others countered empirically that the Islamic finance model contributes to financial inclusion, social entrepreneurship, and advanced sustainable development goals (Ozdemir et al., 2023; Farihana & Rahma, 2020; Harahap, 2023; Khmous & Besim, 2020).

In this study, based on the synthesis from literature influenced by Ozili's (2018, 2021a, 2021b, 2021c, 2020) contextualized reimagined meaning of optimal financial inclusion in the future of the digital age and dual banking and ecosystem, it is defined as a system where all individuals, businesses, and governments, irrespective of socioeconomic status, geographic location, or religious affiliation, have equitable access to a diverse range of affordable and appropriate financial products and services. These services are provided ethically and sustainably through traditional interest-based and interest-free Shariah-compliant channels in a business model (Aziz 2020; Hassan et al. 2020). Digital technology serves to improve efficiency, lower prices, and

broaden reach for these services. Thus, optimal financial inclusion in the digital age requires maximizing the benefits of financial services for all segments of society, promoting economic welfare and growth, poverty reduction, and social development in pursuit of common goals (Kanwal et al., 2023; Tay et al., 2022; and Gabor & Brooks, 2017).

As technology revolutionizes access to financial products and finances, the concept of dual literacy, encompassing both financial literacy and digital financial literacy (DFL), has emerged as critical to enhancing financial inclusion. Particularly, digital financial literacy, when combined with general financial literacy, acts as a vital facilitator of strong financial inclusion.

These concepts are relevant, considering Ethiopia's vision for the Digital Transformation Strategy (2021–2030) targets digital ID, payment systems, e-governance, and e-commerce (African Union, 2020). According to studies conducted by Al-Khowaiter (2020), Setiawan et al. (2022), and Kass-Hanna et al. (2022), digital-financial literacy combines the ability to use digital tools (for example, mobile technology) with knowledge of financial concepts, enabling individuals to confidently navigate digital financial services. These 21st-century skills, digital-financial literacy (DFL) and financial literacy (FL), empower individuals not only to understand financial concepts but also to effectively use rapidly expanding digital financial platforms in Ethiopia, such as mobile money and internet banking, including Telebirr, HelloCash, Chapa, Safari M-Pesa, Kacha, and Kifiya.

The Ethiopian financial ecosystem is further shaped by culturally and religiously compliant financial services like interest-free banking (IFB) and micro-finance services, which align with Islamic economic principles and cater primarily to the religious and ethical finance needs of Muslim populations.

In Ethiopia, despite recent improvement in access to formal financial services, digitalization, and IFB expansion, significant barriers remain (NBE, 2021–25; World Bank, 2024). According to the World Bank Findex database² (Ethiopia, 2021), Ethiopia increased from 22% in 2014 to 46% in 2021, yet differences persist due to

² <https://microdata.worldbank.org/index.php/catalog/5853>

socioeconomic factors such as income inequality, gender gaps, and limited access to digital financial technologies.

Furthermore, emerging regional economy-focused studies (Gafoor and Amilan (2024), Seiawan et al. (2021), Hasan et al. (2021), Aziz & Naima (2021), Aziz (2022), and Shubhangi Singh et al. (2020)) reveal that higher-level adult DFL/FL drives financial inclusion and economic empowerment, while low DFL/FL is central cause of financial exclusion. Ozili (2025) links financial inclusion to religion and the presence of Islamic finance. Prior studies affirmed that achieving true financial inclusion requires strong financial literacy, digital literacy, and practical skills (Golden & Cordie, 2022; Klapper & Lusardi, 2019).

Despite DFL/FL-linked financial inclusion's critical importance, there remains a significant empirical gap in fully understanding the key drivers of financial inclusion within the Ethiopian context due to multiple complex and interrelated factors, many of which have not been adequately investigated by prior studies, as explained a below. This study therefore aims to fill crucial knowledge gaps by empirically investigating how multidimensional literacy promotes financial inclusion across Ethiopia's diverse contexts, thereby providing policymakers and stakeholders with insights informed by religious and technological factors to design inclusive finance strategies tailored to grassroots communities.

1.2. CONCISE LITERATURE REVIEW

1.2.1. THEORETICAL UNDERPIN

The theoretical frameworks that underpin current research queries on digital and financial literacy, as well as financial inclusion, reflect the various features of these perspectives. Atkinson and Messy (2013) and Demirgüç-Kunt et al. (2018) discuss the social psychology/cognitive capability approach, institutional (Scott, 2014), established behavioral and financial literacy frameworks, and Islamic finance socioeconomic perspectives. The concepts of FL business schooling equip individuals with basic financial concepts and skills rooted in general education. This literacy also includes understanding interest rates, inflation, and budgeting to make informed

financial decisions (Klapper & Lusardi, 2019; Ozili, 2020a, 2021c). DFL enables secure and effective DFS use, while high FL without DFL limits usage (Ozili, 2018; and Lyons et al., 2020). This concept includes specialized competencies necessary for navigating digital financial systems and tools, such as digital banking proficiency, mobile app navigation, financial security practices, big data analytics, and advanced skills in digital regulatory compliance (Morgan & Trinh, 2019).

The concise review below highlights the relevance of these concepts for financial inclusion when they align with the theoretical and empirical underpinnings.

First, highly cited institutional theory research such as Zins and Weill (2016), Zins & Weill (2016), Nkoa & Song (2020), Nsiah & Tweneboah (2023), and Aracil et al. (2021) contends that successful financial institutions and regulatory frameworks are essential to creating an equitable financial ecosystem. From those priors, it is known that financial inclusion rates are greater in nations with developed banking systems. The study conducted by Nkoa & Song (2020) and Nsiah & Tweneboah (2023) confirmed the hypothesis that the presence of high-quality institutions will boost financial inclusion (FI) in Africa by promoting penetration, accessibility, and lowering obstacles to financial services usage and inclusion. Aracil et al. (2021) confirm that the quality of financial institutions in developing nations has a stronger impact on financial inclusion than in developed ones. However, critics of institutional theory argue that Williamson (2009) overlooked the interactions between formal and informal organizations. According to the author, the effectiveness of institutional policies usually depends on how well they are integrated within the informal constraints of social norms and cultural practices. Williamson, against institutionalization, argued that informal institutions, especially in low-income nations where formal institutions may be fragile or little enforced, are significant determinants of developmental outcomes. In this view, trust and communal solidarity may facilitate financial transactions in the absence of formal legal structures. Given related earlier concerns, Dacin et al. (2002) and Meyer & Höllerer (2014) draw attention to the necessity of a more nuanced perspective that takes institutional change rather than homogeneity of phenomena over time. Despite these critics, this theory is relevant in this study, as strong institutions decode how financial regulations from central banks like the National Bank of Ethiopia (NBE), revenue authority directives, and religious

institutions' rules shape formal financial products' availability and legitimacy in Ethiopia. In the same vein, this theory guides us to explain why Ethiopian banks launched IFB windows (NBE Directive 2013, 2019 revised) to align with religious norms and national NFIS policy integration.

Secondly, the Capability Approach theory (Sen, 1999, Nussbaum, 2011): Frames financial inclusion as expanding individuals' substantive freedoms to achieve well-being, beyond nominal account possession, emphasizing literacy and empowerment.

This concept, Sen (1999), highlights the necessity of data evidence to authentically capture individuals' real opportunities and make autonomous decisions, emphasizing not only access to resources but also the genuine freedom to utilize them for well-being. It also resonates with legal and socio-technical critiques provided by Noble (2018) concerning digital data justices and equitable access in socioeconomic technology contexts, relevant to understanding barriers and enabling factors within Ethiopia's rapidly evolving financial ecosystem. Furthermore, it aligns with Olizi's (2020c), (2021b) critiques of optimal financial inclusion claims for IFB, which must be affordable, appropriate, and empowering (not just available for collecting savings), and helps explain why account ownership differs from usage in queries, such as assessing whether women truly lacked the capability to leverage IFB despite having access. This framework also aligns with contemporary policy agendas concerning inclusive developments, such as the United Nations' Sustainable Development Goals (SDGs) that focus on empowering individuals and communities through expanded capabilities and equitable opportunities. In Ethiopia, national strategies like the Digital Ethiopia and the National Financial Inclusion Strategy (I & II) similarly prioritize enhancing adult capabilities through digital literacy, financial education, and inclusive financial services to enable meaningful economic participation.

Thirdly, the theory of planned behavior (Ajzen, 1991) is relevant to the core idea that attitudes, subjective norms, and perceived control shape behavioral intentions. The study illuminates how individual intention to adopt IFB and digital finance derives from attitudes, subjective norms (notably religious peer pressure in the Muslim community), and perceived behavioral control influenced by digital literacy. Raut, R. applies the theory of planned behavior. In their studies, Raut (2020) and Akhtar & Das (2019) found that an individual's financial knowledge, attitudes, and behaviors

can predict their intention to utilize financial services. Shih and Chen's (2022) research in Taiwan confirms the same result.

Fourthly, another significant hypothesis in the field of finance studies is based on concepts from social psychology. According to Sherman et al. (2015), social psychology emphasizes the influence of individual behaviors and psychological factors on human actions. Similarly, Bandura's (1977) social cognitive theory underscores the centrality of self-efficacy and the dynamic interplay between individual capabilities and environmental factors, which directly inform digital and financial literacy's role in shaping financial behaviors.

The fifth relevant work is the theoretical foundation provided by Chapra (2000) and Siddiqi (2006). In this Islamic economic model, the IFB adoption is driven by religious compliance requirements, embedding ethical financial imperatives essential for the majority Muslim regions and cities' administration in Ethiopia, such as Somali, Afar, Harar, and Dire Dawa. Several sources, including OECD (2013), Atkinson & Messy (2012), and Ozili (2020a), outline the financial literacy theoretical framework. Financial inclusion requires literacy in three dimensions: knowledge (concepts), attitudes (trust), and behavior (saving/borrowing habits), which are operationalized through validated PCA scores as the six theoretical bases provide empirical granularity.

The Technology Acceptance Model (Davis, 1989), the **last relevant concept**, states that users adopt technology (e.g., mobile banking) if they perceive it as useful and simple to use. The Technology Acceptance Model provides a useful starting point for interpreting the low adoption of digital financial services among elders, which is attributed to their complexity. According to Lyons et al. (2020) and Ozili (2018), adult behavior plays a crucial role in facilitating financial inclusion in the digital era. Ozili (2020a, 2021a, 2021b) provides empirical evidence suggesting that institutionalized financial inclusion is contributing to the financialization of poverty, the erosion of benefits, and the promotion of complex digital currency systems. There is a consensus that financial knowledge, attitudes, and behaviors can serve as predictors of an individual's intention to utilize financial services.

1.2.2. Empirical Evidence: Influence of Digital and Financial Literacy on

Financial Inclusion.

Research on financial literacy, particularly digital financial literacy, is growing, with a focus on its relationship with financial inclusion. Empirical studies revealed financial literacy significantly enhances individuals' ability to access and use financial services, especially among rural and economically vulnerable populations (Hasan et al. (2021) and Allgood et al. (2015)). Financial literacy is essential for financial stability, security, and better savings habits (Lusardi & Mitchell, 2014; Lusardi & Mitchell, 2011; Allgood and Walstad, 2016; and Sayinzoga et al., 2016). Studies have shown a significant correlation between financial literacy and confidence in one's finances, as well as the use of financial services (Morgan and Long, 2020, and Yin Yin et al., 2020). Digital financial literacy (DFL) is a specialized subset of financial literacy that focuses on navigating digital platforms for financial transactions (Grohmann et al. (2018); Hasan et al. (2021); Morgan, et al. (2019); and Ozili (2018).

As more financial services are provided online, DFL is becoming more significant. Studies have shown that increased DFL could lead to higher adoption and better usage of digital financial services, supporting financial inclusion efforts, especially in developing economies (Lyons et al., 2020; Demirgüç-Kunt et al., 2018). DFL is essential for risk awareness and promoting confidence in digital systems. Initiatives aimed at enhancing DFL can significantly improve overall financial inclusion by addressing specific barriers faced by underserved populations, as claimed by Lo (2021), Panos & Wilson (2020), Kass-Hanna et al. (2022), Zins & Weill (2016), and Demirgüç-Kunt et al. (2018). In Ethiopia, financial inclusion remains below that of sub-Saharan African countries, with barriers such as lack of finance, distance, and documentation persisting, as claimed by Baza & Rao (2017) and Dinku (2019).

1.2.3. DEMOGRAPHIC AND SOCIOECONOMIC FACTORS AFFECT FINANCIAL INCLUSION.

This study also seeks to identify the key socioeconomic and geographic factors that affect financial inclusion in sub-national settings. Empirical studies have demonstrated that various socioeconomic and geographic factors influence financial inclusion in subnational settings. Key individual-level factors such as gender, age,

wealth, and education, alongside macroeconomic indicators such as GDP growth, the availability of financial institutions, and the degree of business freedom, serve as critical predictors of financial inclusion (Noor et al. (2020) and Assuming et al. (2018)). Furthermore, studies by Xu (2020) and Erlando et al. (2020) emphasize the pivotal role of socioeconomic factors in enhancing financial inclusion, financial literacy, and the adoption of technology.

They revealed that financial inclusion (FI) increases economic growth and poverty reduction while increasing income disparity. Social trust is a positive factor of financial inclusion, improving poor formal institutions and low educational levels, as claimed by Dong et al. (2010), Sekyi et al. (2019), and Nordjo & Adjasi (2019). Digital financial inclusion and gender-responsive agricultural finance innovations can help achieve sustainable development (Adegbite and Machethe (2020); Awotide et al. (2015); and Moahid and Maharjan (2020)).

Financial inclusion is crucial for women's economic empowerment, but challenges persist due to disparities in financial literacy levels across age, gender, marital status, and employment status (Abraham et al., 2023, and Bajaj & Kaur, 2022). Under another of Ethiopia's FI studies, Mossie (2023), Bekele (2022), and Bashiru et al. (2023), gender, age, marital status, level of education, wealth, and employment are among the demographic factors that substantially impact financial inclusion. For instance, age, use, financial literacy, and mobile banking positively influence financial inclusion in Africa, whereas barriers and income negatively impact it. But the authors Abdu & Adem (2021) ignored FL and DFL. In line with these priors, technology, residence, proximity to financial services, mobile phone ownership, financial literacy, and being an urban resident positively correlate with financial inclusion in Ethiopia.

Furthermore, recent studies indicate religious and cultural variations also influence financial inclusion. For instance, Giday (2023) and Mossie (2023) assert that Muslims have a lower financial inclusion rate compared to non-Muslims.

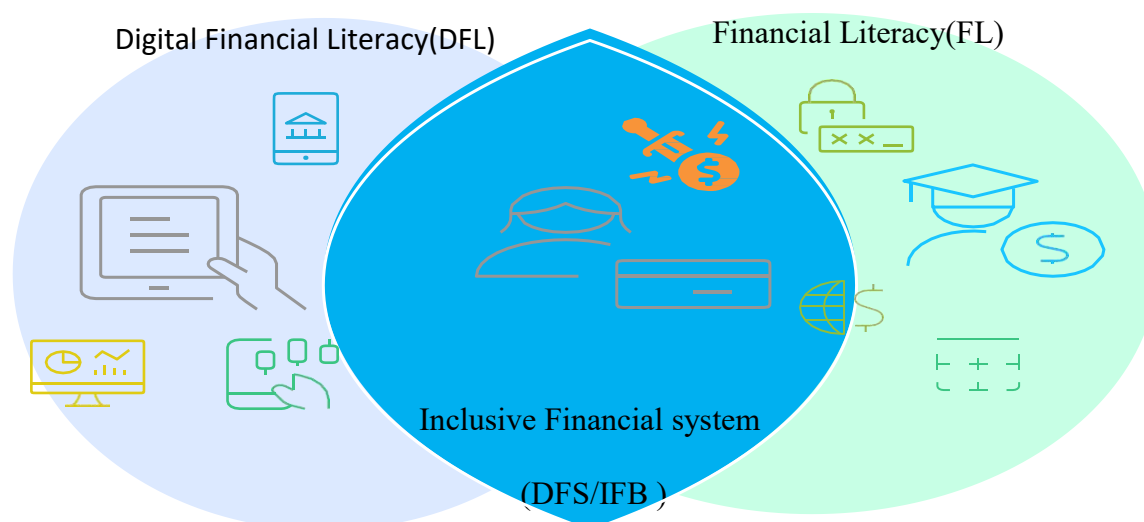
Generally, thus, empirical studies have shown that financial and digital financial literacy are powerful enablers of financial inclusion, especially when tailored to the needs of underserved grassroots populations. Strengthening both forms of literacy,

alongside addressing socioeconomic barriers, is essential for inclusive economic growth and poverty alleviation.

The study leverages multi-theoretical and empirical insights to design the General CFW, as illustrated in [Figure 1.1](#), which depicts the relationship between financial inclusion and both Digital Financial Literacy (DFL) and Financial Literacy (FL).

The study focuses on the specific socio-cultural contexts of Ethiopia to operationalize and interconnect indicators for financial literacy and digital financial literacy, with the aim of promoting inclusion. Additionally, we emphasize the significance of behavioral psychology, technological factors, critical institutional perspectives, religious influences, and multidimensional approaches to literacy (Branch, 2014; Ozili, 2020a; Setiawan et al., 2022) as foundational principles for interpreting the study results and guiding practices.

Figure 1.1 The CFW relationship illustrates how financial inclusion relates to the DFL and FL.



Sources: The author's design is based on reimagined concepts from Lyons et al. (2020), Hasan et al. (2021), Morgan et al. (2019), and Ozili (2020a).

1.3. STATEMENT OF THE PROBLEM

Ethiopia's financial inclusion setting presents a complex and multifaceted challenge shaped by its rich social and cultural diversity and inclusion variation in language, ethnicity, geographic residency, and religious affiliation. The Ethiopian government's Financial Inclusion Strategy (NFISI & II) has catalyzed development such as the inclusion of an Islamic finance window under a single regulatory framework and considerable digital transformation efforts, aiming to reduce gender, religious, and urban-rural disparities (NFIS; Pragma, 2020; NBE, 2021–25; World Bank, 2024). Despite significant progress, political disparities persist across gender, regional, and socioeconomic contexts.

Specifically, the Shariah-compliant IFB services theoretically fulfill the same role as traditional banks, but they must adhere to Shariah rules and principles, which include ethical values and compliance, with trust serving as a form of collateral. Many Ethiopian financial institutions are offering IFB products & services, which include profit-and-loss sharing accounts, interest-free loans, and Sharia-compliant microfinance—designed to serve both Muslim and non-Muslim clients. According to Abdullahi & Othman (2021), the adoption of Islamic microfinance leads to improved financial inclusion in Nigeria. Hasan and Lu (2023) reaffirm that financial inclusion enhances the achievement of sustainable development goals.

According to Al-Wreiket et al. (2020), Hagawe et al. (2023), and Kassim (2016), the benefits of this emerging business model are challenged due to a lack of practical knowledge, a shortage of qualified expertise, an absence of regulatory and product innovation, and limited product and service offerings. Moreover, the variance in banking and tax rules, combined with a lack of important information about the economic advantages of Islamic finance, has limited shariah-compliant IFB services from fully achieving their goal of including more people in the financial system, as researched by Warde (2010), Boukhatem and Moussa (2017), Dawood et al. (2022), and Muryanto (2022). In Ethiopia, there is less IFB awareness to use, especially in rural and non-Muslim areas; informal finances are preferred; 34% of formal financial institutions' branches are in Addis Ababa; and rural women are underserved. Barriers

such as cost, distance, misconceptions, low literacy, and cultural or language limitations hinder the translation of inclusive financial benefits.

Central to enhancing financial inclusion are the concepts of dual literacy, encompassing both financial literacy and digital literacy. A core dimension underpinning these challenges involves the dual role of digital financial literacy (DFL) and financial literacy (FL) as foundational enablers that influence adoption and effective use of financial products and services, including IFB and mobile banking. Empirical studies revealed financial literacy significantly enhances individuals' ability to access and use financial services, especially among rural and economically vulnerable populations (Hasan et al. (2021) and Allgood et al. (2015)). This evidence shows that higher FL is associated with increased engagement in positive saving behaviors, reduced reliance on informal borrowing, and improved decision-making regarding financial products. Cross-country analyses confirm that FL not only complements financial infrastructure but can also substitute for it in improving access to finance, with particularly strong effects on the use of financial services (Allgood et al., 2015; and Grohmann et al., 2017). Beyond short-term financial education, it has strong effects on long-term financial behavior but insignificant effects on short-term behaviors, claimed Wagner and Walstad (2018).

As technology advances, digital financial literacy (DFL) has emerged as a critical complement to traditional financial literacy (FL), revolutionizing access to financial products and services. Specifically, the exponential growth in mobile banking technology suggests potential to bridge financial inclusion gaps (Adel, 2024; Ozili, 2018; and Lyons et al., 2020). In the digital age, DFL is a key driver of the adoption and effective use of digital financial services. Prior studies indicated that DFL, combined with internet access, significantly increases the likelihood of using digital financial products, thereby improving financial access and inclusion. The findings of Hasan et al. (2021) and Wagner and Walstad (2018) support this conclusion. However, large portions of mobile owners remain inactive users of digital financial services, indicating unresolved literacy, trust, and usability challenges (Sahay et al., 2022, and Ozili, 2018). Existing studies often treat financial literacy and digital literacy separately (Lyons et al. (2020)), overlook the unique operational dynamics of interest-

free banking, or fail to integrate contemporary digital financial usage perspectives, resulting in fragmented understanding (Sawada (2022) and Adel (2024)).

Nonetheless, there is a limited empirical understanding of how financial and digital literacies operate across Ethiopia's diverse socioeconomic settings, particularly in relation to religiously tailored products like interest-free banking (IFB) and the rapidly evolving digital finance sector. The existing local literature often overlooks the diversity among Ethiopian adults regarding their literacy levels, religious norms, and access to digital resources, leading to generalized policy recommendations that fail to achieve tailored impacts.

According to relevant local insights (Giday, 2023; Mossie, 2023; Abraham et al., 2023; Desalegn & Yemataw, 2017; and Aman et al., 2021), Ethiopia faces challenges such as low digital literacy rates, uneven infrastructural development, and religious and cultural barriers that hinder the adoption of innovative financial solutions like shariah-compliant interest-free banking (IFB) and mobile money platforms. These studies found that socioeconomic factors such as income, education, profession, and geographic location play a substantial role in financial inclusion outcomes.

The high variation of financial inclusion across regions, genders, religious groups, and urban-rural divides signals complex barriers beyond mere access—highlighting deficiencies in literacy, trust, and capability to fully leverage financial services. True financial inclusion extends beyond mere access to financial services; it represents social equity and ecosystem justice, which together enhance living standards and ensure sustainable, equitable access to resources.

In this context, the pathways for systematic change from financial exclusion to inclusion depend on recognizing DFL and FL as both a technical skill and a social determinant. *This study presents the following core research question:*

How does Digital Financial Literacy (DFL) significantly influence Financial Inclusion (FI) in the context of Ethiopia?

How does financial literacy (FL) significantly influence financial inclusion (FI) in the context of Ethiopia?

What are the key demographic, socioeconomic, and geographic factors affecting financial inclusion in subnational settings?

Although DFL and FL are important, the key drivers of financial inclusion in Ethiopia remain insufficiently explored due to multiple complex factors that prior studies have not fully investigated, *as the research gap explained below shows.*

First, these prior studies (Giday, 2023; Achew et al., 2021; and Desalegn & Yemataw, 2017) focus on national-level CSA statistics and do not adequately explore how financial inclusion varies by region, rural vs. urban, religion, gender, or age. For example, while the findings of these studies indicate that there is a persistent lack of heterogeneity and an in-depth analysis of demographic, socioeconomic, religious, or regional disparities, they particularly fail to control for intersecting variables such as gender, age (both young and older adults), rurality, and low-income vulnerable communities, despite having sufficient sample representations.

Secondly, prior research largely relies on account ownership and saving rates to measure financial inclusion (Mossie, 2022; Kebede et al., 2020; Lakew & Azadi, 2020; and Dinku, 2019), neglecting disaggregated actual usage of financial services, the availability of innovative products, and the frequency of their use. This approach overlooks whether account holders actively use their accounts, enhance their livelihoods, or address inequality, which limits policymakers' ability to design targeted interventions.

Thirdly, researchers have understudied the role of Shariah-compliant interest-free banking services as a tool for financial inclusion, particularly for Muslim populations excluded from interest-based financial systems due to religious beliefs. Although NFIS II acknowledges the potential of IFB (CSA, 2024), research on its adoption, usage, and socioeconomic impacts remains limited. Studies, like Giday (2023) and Desalegn & Yemataw (2017), make no distinction between IFB and traditional financial service usage, which hinders effective targeted policy formulation and implementation. Similarly, although digital and innovative financial service usage via mobile money is recognized as imperative, empirical insight into its adoption, usage disparity, and its effectiveness specifically among women and rural and religious

groups is limited. Previous studies were overly cautious and did not include the effects of religion.

Fourth, a critical limitation in prior Ethiopian studies is the use of general education attainments as the primary measure of literacy when examining financial inclusion. Fourthly, a critical limitation in prior Ethiopian studies was the use of general education attainment as the primary measure of literacy when examining financial inclusion. This method fails to capture the effects of more relevant and advanced competences, specifically DFL and FL, on an individual's ability to access and effectively use financial services. While education provides foundational skills, it does not necessarily equip adults with the digital or financial skills needed to navigate increasingly tech-driven digital ecosystems, such as mobile banking and digital payments. Furthermore, no studies have investigated how differences in digital adoption, such as those based on age or gender, exacerbate financial exclusion. Consequently, the nuanced effects of Digital Financial Literacy (DFL) and Financial Literacy (FL) on Financial Inclusion (FI) remain under-explored, and interventions based on traditional general education fail to address the real barriers faced by excluded populations.

Fifthly, previous studies (Abreham & Lamessa, 2023; Menza et al., 2024; and Mossie, 2023) estimated financial inclusion results without considering the dependency of adults on financial and social behaviors. They handled individuals as independent observers because they mostly applied the ordinary least squares (OLS) econometric modeling technique, which assumes independent observation. These methods do not account for how household or sociocultural financial behaviors, social norms, and shared group dynamics drive individual financial decisions (Kaplan et al., 2021). In this case, these oversights can result in a limited or incomplete understanding of financial inclusion drivers and barriers, as financial behaviors are frequently shaped by collective practices and dependencies. Particularly in environments where informal saving groups, family, and friend-based decision-making are prevalent, this approach stands out from previous studies. In this study, the author accounted for these adult social dependencies, used Heckman selection bias analysis, addressed the effect of informal (*Equb*) saving, and applied bivariate

analysis to quantify the magnitude of the practical effect of heterogeneity on financial inclusion and digital mobile banking adoption.

The strategy employed delivery channels in the NFIS-II; for instance, the expansion of IFB products and services, along with DFS, serves as essential enablers. Delivery channels can only be effective if they take into account the spatial heterogeneities of the country. Such consideration includes recognizing the diverse economic transactions that occur in different geographical areas, the varying livelihood opportunities available in various regions, and the disparities in well-being that exist throughout the country. This lack of consideration hinders the creation of inclusive policies that cater to Ethiopia's diverse socioeconomic and religious contexts. This study also focused on addressing the challenges of developing effective strategic interventions that utilize Digital Financial Literacy (DFL) and Financial Literacy (FL) tools, especially in relation to Ethiopia's socioeconomic diversity.

Therefore, this research aims to address the pressing problem of a critical research gap by empirically examining how dual literacy influences financial inclusion outcomes across different demographic and socioeconomic groups, focusing specifically on digital financial literacy, adoption and usage of IFB, and innovative mobile banking financial services. This insight is critical for advancing tailored, evidence-based financial inclusion policies that recognize Ethiopia's unique socio-religious, behavioral, and technological context, ultimately contributing to designing effective policy interventions that promote equitable financial access, inclusion, and empowerment across Ethiopia.

1.4. THE OBJECTIVE OF THE STUDY

1.4.1. THE GENERAL OBJECTIVE OF THE STUDY

This dissertation study aims to conduct an empirical investigation into how Digital Financial Literacy (DFL) and Financial Literacy (FL) skills can overcome socio-behavioral impediments to financial inclusion in the diverse context of Ethiopia by utilizing innovative digital financial services and IFB solutions.

1.4.2. SPECIFIC OBJECTIVES.

- ❖ Identify the influence of digital and financial literacy on interest-free banking financial service usage.
- ❖ Examine how digital and financial literacy are linked to the usage of digital financial services through mobile banking.
- ❖ Empirically investigate the effects of digital and financial literacy on optimal financial inclusion.

1.5. METHODOLOGY: OVERVIEW OF DATA, VARIABLE DEFINITIONS, AND ESTIMATION STRATEGY

1.5.1. DATA, MIXED EFFECT ESTIMATION STRATEGY

To accomplish general and specific research objectives presented in section 1.4, the research draws on robust empirical evidence from the nationally representative Ethiopian Socioeconomic Survey (ESS) 2018/19. The sample consists of 14,846 adults from Finland (FI), 5,125 adults who own mobile devices and use financial services, and 3,757 adults participating in the Interest-Free Banking (IFB) model.

Utilizing a hybrid mixed-effects quantitative empirical modeling framework, the method accounts for dependencies in household-level financial behaviors while capturing unobserved heterogeneity at individual, household, and regional levels. This approach is justified by McNeish and Kelly (2019), who emphasize that mixed-effects models with restricted maximum likelihood (REML) provide unbiased and efficient estimation in clustered and hierarchical data structures typical of ESS. Additionally, methodological insights from Meteyard and Davies (2019) and Schunck and Perales (2017) reinforce the importance of carefully modeling random effects and addressing potential endogeneity to produce robust and generalizable findings.

The author's preference for the ESS 2018/19 dataset, especially its financial inclusion module, is well-suited for this study's investigation because it includes the

first-time collection of detailed financial literacy and inclusion indicators, such as novel IFB services usage among a broader demographic of Ethiopian adults aged 18 to 65 years, unlike prior waves (1, 2, and 3) of data collection from the years 2011/12.

The data collection was conducted through a collaborative design between the World Bank and the ESS program, ensuring rigorous methodological standards, representative sampling, and high-quality data collections. This cooperative facilitated the design of a comprehensive, contextually tailored questionnaire linking detailed individual and household information, rendering the dataset a valuable asset for examining Ethiopia's socioeconomic conditions and nuances of financial inclusion.

1.5.2. PCA VARIABLE CONSTRUCTION AND VALIDATION

Financial inclusion(FI), Digital Financial Literacy (DFL) and Financial Literacy (FL) scores were constructed using Principal Component Analysis (PCA), a statistical technique that reduces data complexity while preserving important information. Their estimation KMO and eigenvalue tests confirmed the validity and reliability of the data. Dependent: General financial inclusion (FI) indicators (account ownership, savings, credit access, and insurance). Main Predictors: Digital Financial Literacy (DFL), Financial Literacy (FL).

Additional variables include the general education attainment level, employment status, income as proxied by frequency of saving, age, gender, religion, rural or urban classification, distance to the nearest financial institution (DIST_FFI), and regional categorical dummies. Social capital includes informal savings group participation (*Equb*), household ID identifiers, and mobile phone ownership. The study focuses on adults aged 18 to 65, specifically examining those who have access to conventional financial services and use IFB and mobile banking services as well as those who do not. APPENDIXES 1 presents the definitions and measurement symbols, as well as the predicted hypothesis indicators for the variables that influence financial inclusion, IFB, and mobile banking usage outcomes, along with their corresponding sources.

1.5.3. PCA METHODS

The mean scores of FI, FL, and DFL were calculated in this investigation using PCA methods and complying with procedures in previous works by Camara and Tuesta (2014), Mukherjee and Sood (2020), and Nguyen (2020).

A statistical method called PCA creates linear combinations of the original variables to minimize the dimensionality of the data. Optimize variance and identify important data trends. Lu and Johnstone (2009) state this. It helps researchers simplify large datasets into informative components, which are easier to visualize for further analysis and interpretation. Gass & Varonis (1984). And as stated by Jolliffe & Cadima (2016), the PCA functions to attain a linear combination of all variables in a data set such that the causal variance is acquired.

The principal axis method extracts variance and creates orthogonal factors, known as principal components (PCs). PCs are linear combinations of original variables, weighted by their contribution to explaining variance in a specific orthogonal dimension, as claimed by Mingione (201). [Table 1.1](#) provides a summary of the principal component dimension indicator. In the following sections, we will outline the details of the PCA methods employed, along with the corresponding indicator variables.

1. Measuring Financial Inclusion (FI) scores

Financial inclusion (FI) scores As asserted by Sharma et al. (2023) and Pesqué-Cela et al. (2021), FI is multidimensional and encompasses all access, usage, and quality dimensions of financial services provided to users in the digital age. Thereby, the latent variable FI is a linear combination of these three dimensions, i.e.,

$$FI_i = w_1 D_i^a + w_2 D_i^U + \mu_i \tag{1.1}$$

where FI_i is a aggregated FI index of the i^{th} adult, w_1 , and w_2 are the relative weight of each dimension, D_i^a , and D_i^U are the dimensions of access, usage and quality, respectively and μ_i is the variation due to error.

The dimensions of access and usage in turn are determined by the combined the indicators described in equations (1.2) and (1.3). However, due to a lack of individual adult-level data, the quality dimension is excluded from the construction of an aggregate FI score. Access to and utilization of financial institution services are considered critical indicators for FI, according to Hanur & Goshu (2023).

$$D_i^a = X_{ai}^T \beta + \varepsilon_i \quad (1.2)$$

$$D_i^U = X_{Ui}^T \theta + \Psi_i \quad (1.3)$$

where X_a , and X_U are a vector of variables that determine access, usage and quality dimensions, respectively, β , and θ are vectors of parameters to be estimated and ε_i , and Ψ_i are error terms in access, usage and quality dimensions, respectively.

Next , The unobserved endogenous variables (D_i^A and D_i^U) and (β , and θ) in the system of equations ((1.2)) and ((1.3)) are estimated by PCA.

Then, the results are used to determine the two dimensions as a linear combination of the explanatory variables in each equation.

In the second stage, the same procedure, as described in the first stage, was applied to estimate the weights of the two dimensions and the overall FI score by replacing the estimated values of D_i^A and D_i^U into equation ((1.1)).

2. Scores for Measuring Financial Literacy (FL)

Using the same PCA strategies, FL may be represented as a linear mix of financial knowledge, attitude, and behavior. Therefore, the latent variable FL score is defined by the linear combination of all three dimensions in equation (1.4) below.

$$FL_i = w_1 D_i^K + w_2 D_i^A + w_3 D_i^B + \omega_i \quad (1.4)$$

where FL_i is a aggregated FL score of the i th adult, w_1, w_2 and w_3 are the relative weight of each dimension, D_i^K, D_i^A and D_i^B are the dimensions of knowledge, attitude and behavior, respectively and ω_i is the variation due to error.

The estimated values of the parameters are used to determine the predicted value of each dimension as a linear combination of the explanatory variables in each equation .

Then, the dimension of financial knowledge, attitude and behavior are estimated by PCA. That is, the unobserved endogenous variables (D_i^K, D_i^A and D_i^B) and the parameters (β_K, θ_A and π_B) in the system of equations of (1.5), (1.6) and (1.7) are estimated by PCA. That is

$$D_i^K = X_{Ki}^T \beta_K + \varepsilon_{Ki} \quad (1.5)$$

$$D_i^A = X_{Ai}^T \theta_A + \Psi_{Ai} \quad (1.6)$$

$$D_i^B = X_{Bi}^T \pi_B + \gamma_{Bi} \quad (1.7)$$

Where X_K, X_A and X_B are vectors of variables that determine financial knowledge, attitude and behavior, respectively, β_K, θ_A and π_B are vectors of parameters to be estimated and $\varepsilon_{Ki}, \Psi_{Ai}$ and γ_{Bi} are error terms in financial knowledge, attitude and behavior equation, respectively.

The estimated values of the parameters are used to determine the predicted value of each dimension as a linear combination of the explanatory variables in each equation.

In the second stage, we combined the three-dimension a aggregated score into an aggregate financial literacy score of financial literacy by forming a weighted linear combination of the dimension scores indexes that were computed in the first stage.

We adopted a similar PCA construction approach to Nguyen (2020). The researchers used the same procedure as in stage one to estimate the weight of each dimension and the overall financial literacy score by substituting the predicted value into equation ((1.4)).

3. Scores for Measuring Digital Financial Literacy(DFL)

There are myriad forms of DFL indicators. However, because of the availability of data, in this study to construct the DFL index, we considered individuals' digital financial services usage as an output measure (practical) of financial technology (FinTech) products, such as the use of online banking, mobile banking, ATMs, and agent banking, as explanatory indicators of DFL by adults in Ethiopia. By the procedure, the latent explanatory variable DFL is a linear combination of these four dimensions, i.e.,

$$DFL_i = w_1 D_i^O + w_2 D_i^M + w_3 D_i^{Ag} + w_4 D_i^{ATM} + \omega_i \quad (1.8)$$

Where DFL_i is a composite DFL score of the i th adult, w_1, w_2, w_3 and w_4 are the relative weight of each dimension, $D_i^{online}, D_i^{Mobile}, D_i^{Agent}$ and D_i^{ATM} are the dimensions of use of Online banking, mobile banking, use of ATM and Agent banking, respectively and ω_i is the variation due to error.

Like in the aggregated score of FL, each PC in the composite score of DFL is a linear combination of variables that determine each component. We used the same procedure in stage one to estimate the weight of each dimension and the overall DFL index by replacing the predicted value of $D_i^{Online_use}, D_i^{Mobile_use}, D_i^{Agent_use}$ and $D_i^{ATM_use}$ into equation (1.8) .

1.5.4. VALIDITY AND RELIABILITY OF THE PCA-CONSTRUCTED VARIABLES

Verifying the degree of estimated power of the FI, FL, and DFL scores supporting measurement validity is crucial before using PCA results for additional analysis, as asserted by Mazziotta & Pareto (2019) and Xiao et al. (2017). Accordingly, first, an

eigenvalue scree plot aids in decision-making by visually displaying the eigenvectors on a plot of post-estimation analysis arranged in descending order. Previous studies by Luo & Li (2016), Alhalaseh (2024), and Hizgilov & Silber (2020) indicate that PCA eigenvalue approaches, which integrate eigenvalues and variations in eigenvectors, more reliably identify the rank of the matrix's order operation than conventional methods.

The PCA procedural validity analysis using KMO methods verifies that FI latent indicators such as formal financial service usage, access indicators, and saving and frequency of saving meet above the minimum requirements as shown in [Table 2.1](#)

Similarly, scree [Figure 2.2](#) and [TABLE 2.2](#) KMO testing of the FL validates that FL score variation can be accurately predicted from the information retained from financial knowledge and financial attitude indicators, and for DFL scores, internet banking abilities and skills serve as important indicators of differences in adult mean scores for DFL.

The resulting estimated PC score values were then employed for further analysis in both descriptive and econometric models, in accordance with the specific research objectives under each paper's order.

1.6. THE SIGNIFICANCE OF THE STUDY

This study outcome contributes to the development of optimal financial inclusion in Ethiopia in many ways, as explained below.

1.6.1. Contextual nuance fills in the empirical gaps.

This study is among the first to empirically analyze holistic financial inclusion in Ethiopia, employing a multidimensional approach. Prior studies, such as Achew et al., 2021, and Mossie, 2022, primarily used access or account ownership metrics to compare Ethiopia with other countries. This dissertation conceptualizes FI as a dynamic process shaped by integrating emerging drivers: digital and financial literacy, religious and social dependency, and technology adoption. This interdisciplinary lens

allows for a deeper understanding of how these factors interact to either facilitate or hinder inclusion, specifically for marginalized groups.

1.6.2. Theoretical and Methodological Innovation

This study was distinctive in its integration of behavioral and social change theories (Ajzen, 1991; Bandura, 1977), financial literacy frameworks (Lusardi &1, 2014), Islamic finance principles (Khan, 1991), and technology acceptance models (Venkatesh & Davis, 2001). This approach enables a richer, more reliable understanding of how these factors correlated to shape financial inclusion outcomes. Methodologically, the research advances the field by moving beyond OLS and independence assumptions, instead modeling the collective, context-dependent nature of adults' financial behaviors and decisions.

1.6.3. New Empirical Evidence on Dual Literacy and Interest-Free Banking

A key empirical contribution is the demonstration using nationally representative data that digital financial literacy (DFL) and financial literacy (FL) are the most significant and synergistic predictors of financial inclusion, surpassing the effect of general education alone. The study also provides the first rigorous, context-sensitive evidence on the unique role of Shariah-compliant interest-free banking (IFB) in promoting inclusion among Ethiopia's Muslim and religiously excluded populations (CSA, 2024). By distinguishing IFB from conventional financial services, the research enables more effective, targeted policy interventions.

TABLE 1.1 SUMMARIZED PRINCIPAL COMPONENT DIMENSION INDICATOR

Summarized Principal component Dimension indicator			
Dimension	Variables	Description	
FL i	Knowledge (D ^k)	X_K	
		Know About inflation	Yes=1 and no=0
		Know about interest rate	Yes=1 and no=0
		know how much money the HH has able for day-to-day spending	Yes=1 and no=0
		Know where to complain	Yes=1 and no=0
		Know the benefit of bank account	Yes =1 and no =0
		know how to open a bank account	Yes=1 and no=0
	Attitude (D ^A)	X_A	
		TTrust FFI	Yes=1 and no=0
		Where prefer to save	Formal =1 and informal=0
	Behavior (D ^B)	Saved in cash for <i>Equb</i>	Yes=1 and no=0
		X_B	
		Financial resilience	Yes=1 and no=0
		Saved for emergencies	Yes=1 and no=0
health or medical expenses		Yes=1 and no=0	
DFL	to start or grow a business	Yes=1 and no=0	
	Online banking	Yes=1 and no=0	
	Mobile banking	Yes=1 and no=0	
	Agent banking	Yes=1 and no=0	
FI	Access (D ^a)	ATM	Yes=1 and no=0
		X_a	
		Distance from FFI (dist)	The distance of the ith adult from the nearest FFI in KM
		Complex Procedures	Yes=1 and no=0
	Usage (D ^U)	No Document	0
		EPENSIVE to open account	Yes=1 and no=0
		X_U	
		Account ownership	Yes=1 and no=0
		Saved in Banks	Yes=1 and no=0
		Has formal insurance	Yes=1 and no=0
		Used Internet banking	
Used ATM	Yes=1 and no=0		
Used interest free banking	Yes=1 and no=0		
Used MMB ,	Yes=1 and no=0		
Frequency of usage	Daily, 1 weekly,2 monthly,3.....		

1.6.4. Policy and Practice Implications

This dissertation directly informs regulatory and policy innovation by: 1. Advocating for adaptive, exclusion-risk-sensitive financial policies that blend Shariah-compliant and conventional systems. 2. Recommending dual-literacy (DFL/FL) interventions and upskilling programs tailored to rural, female, and low-income populations. 3. Supporting the expansion of mobile technology and platform cooperatives as tools for bridging digital divides and empowering marginalized groups, as noted by the World Bank (2022) and Demirgüç-Kunt et al. (2022).

1.6.5. Advancing the Globally Aligned Local Financial Inclusion Agenda

This study provides a scalable, context-sensitive model for other diverse, low-income, and multi-religious countries by situating the Ethiopian adults' case within larger debates on digital transformation, reimagining decolonized development finance, and the SDGs (Zuboff, 2019; Ouma, 2020; Scholz, 2016; North, 2007). Its findings significantly support Ethiopia's National Financial Inclusion Strategy II, digital economy strategy, and SDGs (especially poverty, quality education, gender equality, reduced inequality, and goal partnership), as well as tangible approaches for inclusive, sustainable development.

Therefore, this dissertation offers a pioneering, empirically grounded, and contextually nuanced contribution to the understanding and practice of financial inclusion in Ethiopia. By integrating behavioral, social, technological, and religious dimensions, it provides a robust foundation for adaptive, equitable, and sustainable financial inclusion and innovative policy and implementation, serving as a foundation for similar contexts globally.

1.7. SCOPE OF THE STUDY

The analysis, which is based on the 2018/19 ESS hierarchical clustered data, focuses on Ethiopia, nine federal regional states, and two municipal administrations. Additionally, since 2023, the SNNP region has been divided into four distinct regions:

Sidama, Southwest Ethiopia, South Ethiopia, and Central Ethiopia; however, the data remains representative of all the current states in Ethiopia.

The operational definition of optimum financial inclusion aligns with the previously mentioned works of Ozili, while also adapting the concept for the future of IFB Shariah-compliant finance. The data set definitions for this study are based on operational definitions from the 2018/19 ESS wave 4, FI module, which were gathered by CSA and the World Bank. However, the concept of inclusion more broadly denotes the general principle of ensuring equal access and participation across various domains (Llewellyn, 2024; Buch, 2017), not limited to finance. It can refer to social, economic, or political inclusion, encompassing a wide range of groups and contexts beyond financial services. In the scope of this study, financial inclusion is operationalized as a specific subset of the broader concept of inclusion. It focuses on the adoption and usage of financial systems and services. Aligned to this, the authors employed mixed-effect modeling. Based on the survey data's nature, a clustering structure was employed in selecting variables that take socioeconomic factors into consideration.

This paper focuses on Ethiopia's unique socioeconomic context, examining the effects of digital-financial literacy on financial inclusion across urban and rural and regional populations. Aligned with the aim of the study, it considers diverse financial systems usage, such as interest-free banking and mobile banking platforms, while accounting for variations in gender, income levels, education, and geographic disparities. The analysis draws on a country-specific micro-level clustered data set and leverages theoretical and empirical implications from global studies on financial inclusion determinants.

1.8. LIMITATIONS OF THE STUDY

This study acknowledges certain limitations while offering helpful information regarding the dual role of DFL and FL in Ethiopia's financial inclusion efforts.

The one recognizable weakness comes due to data constraints: the reliance on only the existing ESS waves and the financial inclusion data set limits the ability to capture

progress trends post-2020. For example, financial developments include the Fintech-like TeleBirr mobile money expansion, the COVID-19-induced digital acceleration, and recent regulatory reforms.

Additionally, the study's focus on Ethiopia's specific single micro database may not fully measure the complexities of financial behaviorists and tech adoption across various regions and populations. Furthermore, the focus on available demand-side factors at individual and household levels, literacy, and demographics excludes critical supply-side dimensions, including banking institutional side fees, product design, agent networking availability, and regulatory constraints.

Similarly, the study limits scope by not considering the impact of emerging digital risks or cybersecurity and fraud issues on financial inclusion. These demands are separate from complementary trend studies. Furthermore, the reliance on self-reported adult financial inclusion survey measures introduces risks of recall bias and social desirability bias, which affects the results of principal component analysis (PCA) literacy constructs' power prediction accuracy. To address these limitations, the study employed a hybrid mixed-effects modeling approach coupled with rigorous triangulation options. This methodological rigor, grounded in both theoretical frameworks and empirical evidence, ensures nuanced interpretation and enhances the relevance and applicability of the policy recommendation within the Ethiopian .

1.9. STRUCTURE OF THE STUDY

This dissertation document is separated into five chapters in accordance with the 2021 AAU Article-Compilation-Based PhD Dissertation Writing Guideline (AAU Dissertation Guideline 2021, pages 19-25). With the exception of chapter 1: General introduction and chapter 5: General conclusion and recommendations, the remaining chapters are structured as follows: Introduction, literature review (optional based on publisher requirements), data and estimation approach, findings and discussion, robustness testing, conclusion, and recommendations, with each chapter further divided into sections and subsections. This dissertation follows the stated guideline of an article compilation format, with chapters 2, 3, and 4 relating to the study's General objective and each addressing the three specific research objectives with unique

empirical outcomes. All three chapters use the Ethiopian Socioeconomics Survey (ESS) 2018-19 dataset and mixed-effect modeling, with the exception of chapter 4, which additionally uses the Heckman selection correction.

The researcher presents a study in Chapter Two (2) on the influences of digital and financial literacy on interest-free banking (IFB) shariah-compliant businesses as tools for financial inclusion. This chapter has been published in the Ethiopian Journal of Business and Economics (EJBE 2024)³.

In Chapter Three(3), the researcher investigates digital/financial literacy, as well as demographic and socioeconomic key determinant factors, by linking them with optimal financial inclusion and controlling socioeconomic heterogeneity. The outcome variable FI is measured by access and usage indicators constructed using PCA. The separate manuscript for this chapter will be published soon⁴.

In Chapter Four(4), the author discusses the robust multidimensional influence of digital and financial literacy on digital financial inclusion, primarily through the adoption and use of mobile banking in the context of socioeconomic disparities in Ethiopia. The authors used hybrid econometrics, which includes bivariate testing, Cohen's-d effect size tests, mixed logit/probit modeling, Heckman selection bias, and 2SLS instrumental variable endogeneity robustness testing in a novel way in this chapter. Similarly, they have prepared a standard manuscript for this chapter, adhering to the requirements of high-quality standard journals. The fifth chapter(5), which synthesizes the empirical findings from each paper, provides the conclusion and practical policy recommendations.

³ Article 1 link <http://ejol.aau.edu.et/index.php/ejbe/issue/view/966>

⁴ Article 2 link <https://track.elsevier.com/?uuiid=a07e0276-8944-4cbe-9366-267290fbc064>

CHAPTER 2: INTEREST-FREE BANKING FINANCIAL INCLUSIONS⁵⁶

ABSTRACT

This study aimed to investigate the influence of financial and digital literacy on the use of interest-free banking services as a policy tool for financial inclusion in Ethiopia. The study used Ethiopia's country-specific Socioeconomic Survey (ESS) data, which included clustered dataset structures such as regional, place, household, and individual differences. Descriptive statistics were used to demonstrate variation in digital financial literacy, financial literacy, and IFB service use among adults in the country. Mixed-effects Econometric modeling was estimated by applying within-household random variance-controlled maximum likelihood techniques in STATA algorithms. These methods aim to estimate the fixed effects and random variations in IFB use among adults efficiently while capturing cluster-specific deviations. These modeling and estimation techniques provide a powerful and flexible approach to ensuring robustness and trustworthy findings in survey data contexts. The findings show that adults' digital financial literacy, financial literacy, IFB service use, and other characteristics of the financial literacy mean score are distributed asymmetrically among geographical places, genders, incomes, and religious affiliations. Additionally, insight results demonstrate that digital and financial literacy-restricted random effects predictor parameters have a positive and significant influence on IFB usage. This evidence implies that enhancing adults'

⁵ This paper is published in the Ethiopian Journal of Business and Economics, Vol. 14, No. 1 (2024), with the title 'The Influence of Digital and Financial Literacy on Interest-Free Banking. Financial Inclusions: Insight from Ethiopia's Country-Specific Socioeconomic Survey 2018–19' link of the first article:<http://ejol.aau.edu.et/index.php/ejbe/issue/view/966>

⁶ Correspondent author: Abdella Hussen Mudessir; co-authors: Abbi M. Kedir and Abebaw Kassie

digital and financial knowledge, attitudes, and behaviors results in a significant increase in financial inclusion in Ethiopia at Citrus Paribus. Lastly, robust policy intervention goals should be tailored to the values and principles of the IFB model rather than implementing a uniform traditional approach to financial inclusion. The holistic strategic solution for efficient digital-financial literacy and innovative financial products and services development required to be prioritized focuses on underserved communities, such as gender, unemployment, rural, geographical, religious, and other persistent impediments that have contributed to Ethiopia's involuntary financial exclusion.

Keywords: *digital financial literacy, financial inclusion, interest-free banking, Islamic finance, socioeconomic disparity*

2.1. INTRODUCTION

Prior studies on financial inclusion argue that adults need tailored financial services based on the realities of local jurisdictions, and their experiences can boost sustainable development and inclusive growth (Uddin et al. (2020), Amaro et al. (2019), Demirgüç-Kunt et al. (2013), (2015), and (2017), and Abedifar et al. (2016)).

Particularly, according to the World Bank (2021), Demirgüç-Kunt et al. (2018), Trends, G. (2017), and Wang & Fu (2021), technology-integrated financial services have garnered an increasing amount of interest recently due to being linked to at least eight of the United Nations' 17 Sustainable Development Goals.

Integrating into homegrown economic reforms, called Ethiopia 2030: Particularly aligned with the SDGs, Ethiopia is working on the programs of the National Financial Inclusion Strategy (NFIS) and national digital transformations. Ethiopia's financial inclusion and digital transformation policies benefit from the rigorous empirical evidence and theoretical insights this study provides.

The concept of financial inclusion (FI) encompasses all access, usage, and quality dimensions of financial services and products provided to users (Kumari, 2021). Financial inclusion requires a simultaneous realization of the accessibility, usage, and benefits of financial services so as to promote financial well-being as well as economic and social inclusion in a society (OECD, 2013).

More importantly, optimal financial inclusion, according to Ozili (2021b) and the Independent Evaluation Group (2023), also includes sharia-compliant financial services, or specifically the IFB service provision process, that grants access to financial services aligned with digital technology at a price that is affordable to the poorest and most excluded communities.

In Ethiopia, financial inclusion policy reforms driven by public demand facilitated the launch of IFB Windows in 2013 by the NBE and are aimed at reducing financial exclusion. This reform process later on in 2019 enabled the creation of full-fledged IFB banks, ZamZam SC Bank, Hijra Bank SC, and others under formulation. NBE Directive SBB/72/2019 defines IFB

business as ‘banking business that mobilizes or advances funds in a manner consistent with Islamic law or sharia principles.’ Nowadays, many formal financial institutions and microfinance institutions in Ethiopia offer Sharia-compliant, interest-free banking and financial services.

While these products were initially developed to cater to the needs of the Muslim community for financial inclusivity, they are currently open to all individuals and businesses, regardless of religious affiliation.

However, despite the incremental progress, Ethiopia is characterized by poor financial inclusion (Pragma, 2020; ESS, 2018–2019; and World Bank Findex, 2017). Only 35% of the population owns a bank account compared to 83% in Kenya and 50% in Rwanda. Only 0.5% of farm workers receive payments via a bank account; many SMEs obtain finance from the informal financial sectors of *Equb and Idir*; also, lack of adequate financial resources, distance, religion, and undocumented status are important barriers to financial inclusion. The other problem is that the distribution of financial institutions is highly skewed toward urban areas. The 2019 CEPHEUS reports reveal that Addis Ababa houses 34.4% of bank and insurance branches, thereby excluding the rural poor from accessing banking services.

And as Berhanu et al. (2020) found, financial inclusion strategies are not as successful as in other East African countries. Their study also found that Ethiopians prefer informal savings clubs to formal financial institutions. According to Desalegn and Yemataw (2017), interest-free banking is less known among individuals, households, and the community, despite its higher usage among rural adults.

Studies have found that Ethiopian bank clients and SMEs do not make proper use of interest-free financial goods and services. The perception among the non-Muslim community that shariah-compliant financial products are exclusively for Muslims presents a significant challenge. This group often expresses skepticism about the underlining motives of these financial models, fearing they may promote the Islamic religion or potentially displace conventional banking systems (Uddin et al., 2020; Su’un et al., 2018; and Ibrahim et al., 2024). Furthermore, according to Ali, 2020; Aman et al., 2021; and Hailu & Bushera, 2020,

the use of Arabic terminology and related language creates comprehension difficulties for many Ethiopian customers, compounded by sociocultural complexities that affect the broader acceptance and integration of these products.

On the other hand, there is a persistent need for the government to implement enabling policies (Desalegn and Yemataw (2017)) to reduce gender, religion, and urban-rural inequalities and promote financial inclusion in Ethiopia.

As financial services shift to digital platforms, understanding how both traditional and digital financial literacy influence access and usage is essential, particularly in developing economies. According to Brennen and Kreiss (2016), this process of change in the financial system is often referred to as 'digitalization,' which is the transition of businesses through the use of digital technologies, products, and services.

Specifically, the digital age demands digital financial inclusion, which refers to the use of digital technologies to expand access to financial services for underserved populations (Golden and Cordie (2022), Morgan et al. (2019), and the Toronto Centre (2019)). They also assert a close relationship between this concept and financial literacy, the capacity to comprehend and effectively manage financial products and services. According to the World Bank (2018b), one of the main obstacles to adult financial inclusion is a lack of financial literacy. In the same vein, Ethiopia faces challenges in accessing formal financial services due to poor financial and digital literacy, cash usage, and unbanking, as indicated by Kim (2018).

The "Digital Ethiopia for All" policy recognizes that the lack of adequate digital skills in Ethiopia limits the adoption of digital initiatives across various sectors, hindering communities from accessing financial services and other opportunities; in this context, to promote digitalization integrated with an inclusive financial system,

What is the influence of digital and financial literacy on interest-free financial service use in the context of an Ethiopian local setting? And,

How do adult demographic, socioeconomic, and geographic characteristics and variations influence IFB use?

Islamic finance perspectives prior research (Siddique et al., 2022; Zauro et al., 2020; El Qorchi, 2005; Ahmed, 1991) shows that non-interest finance promotes economic growth and justice. According to Abedifar et al. (2015) and Iqbal & Mirakhor (2011), these institutions benefit from promoting financial inclusion by upholding the key principles of social justice, ethical and religious considerations, and resource sharing between the haves and have-nots. Others also assert that this alternative finance can create tailored financing options for rural MSMEs in agriculture, livestock, and cottage industries, and they aspire to reach underserved communities, build entrepreneurial abilities, grow their businesses, and empower women by encouraging them to participate actively in economic activities and achieve financial inclusion (Naceur et al., 2015; Ahmed, 2020; Kabeer, 2005).

Ethiopia lacks knowledge regarding how digital and FL affect adult financial inclusion and the use of interest-free banking products. Previous studies (Aman et al., 2021; Ali, 2020; Hailu & Bushera, 2020; Fikadu, 2016; and a few others) have not addressed the basic research questions mentioned above.

In this regard, it becomes imperative to explore how adult digital and financial literacy influence financial inclusion via IFB services, with particular attention to local contexts and sub-national realities.

To address these gaps, this study has two key objectives: firstly, to analyze the influence of digital and financial literacy on adult IFB financial inclusion in Ethiopia, and secondly, to investigate the effect of demographic, socioeconomic, and geographic disparity on IFB financial inclusion.

Henceforward, policymakers and financial service providers can use the findings of this study to progressively improve financial inclusion and the development of digital financial services in the Sharia-compliant banking industry. Additionally, this study empirically supports capacity-building interventions in digital and financial literacy. This study also contributes to the growing popularity of interest-free banking and finance products and services among a wide range of diverse socioeconomic groups.

2.2. REVIEW OF LITERATURE

2.2.1. THEORETICAL AND CONCEPTUAL REVIEW:

Theoretically, Shariah-compliant banks serve the same role as traditional banks but must follow Shariah rules and principles. Muslim believers Trade (halal) and transactions are governed by *Allah's (SWT)* Divine decree in Surah Al-Baqarah, *verse 275*, which defines permitted trade and prohibited interest. The most well-known Sharia regulation in Islamic financial theory is the prohibition of usury. In finance, lenders and borrowers cannot charge or pay interest, also known as *riba* in Arabic.

The ban has been explained in five ways: it is unfair; it corrupts society; it suggests the improper possession of other people's property; the ultimate consequence is negative; and, ultimately, it demeans and reduces human personality (Chong and Liu 2009). Shariah-compliant banking practices prohibit individuals from earning interest on loans to prevent capital owners from becoming wealthy at the expense of borrowers. According to studies conducted by Aracil (2019), Musa et al. (2020), and Sembiring and Muhajir (2024), scholars have identified six types of ethical principles that can guide shariah-compliant transaction activities: sincerity, brotherhood, truthfulness, trust, science and technology, and justice. Both Hebrew and Christian scriptures forbid interest. According to Warde (2010), Catholic monks in the medieval period believed interest rates were “particularly devastating to the poor.” So Franciscan monks offered loans, on which they made no profit. Housby (2013) indicates that several secular institutions, for example, offer "ethical" mutual funds that do not invest in tobacco or weapons. The author also notes that many non-Muslims see this industry as an attractive alternative to ethical banking and socially responsible investing.

As a result, these financial models are rapidly expanding, with an increasing number of new market entrants reaching over one billion consumers (Global Financial, 2022). This means that this paradigm is impacting achieving the SDGs and eradicating financial exclusivity in Muslim and non-Muslim countries alike. Thorough studies conducted by Demirgüç-Kunt et al. (2013) show that Shariah-based finance promotes social inclusion, environmental friendliness, and development. Similarly, according to Yusha'u and Servaes (2021), the IFB Financial

Model can provide five routes for achieving the SDGs: financial stability and financial inclusion (FI), reducing vulnerability, social and environmental activities, and infrastructure financing.

In addition, financial exclusion refers to measures that prevent certain social groups and individuals from participating in the organized financial system. In this study, we use "optimal financial inclusion" as a proxy for IFB, as noted by Allen et al. (2016). Financial inclusivity, narrated and discussed in our analysis, is constructed on the operational concepts of FI given by Ozili (2020) and the Independent Evaluation Group (2023), which is one process that grants access to basic financial services supported by digital technology and provides basic financial services at a price that is affordable to the poorest and most excluded population, and such a price is similarly required to be enough to support the provision of such financial services with sustainability.

Furthermore, based on the work of Cámara and Tuesta (2014), inclusive financial systems mean financial systems that maximize usage and access while minimizing involuntary financial exclusion (taking into account the context of diverse social-economic demographic variables such as age, gender, race, geographical region, disability, or financial capabilities of adults in Ethiopia). However, Kedir and Kouame (2022) argue that "access to an account" may not mean "use of an account.

More importantly, financial literacy plays a key role in bridging the gap between users and Shariah-compliant financial services. Greater financial literacy promotes better understanding and acceptance of financial services, according to the OECD (2020) and Morgan (2021). On the flip side, as argued by Ali (2017), financial illiteracy can lead to low usage of Islamic banking products, showcasing a need for education programs tailored to Islamic finance. According to Ozili's (2020) theory of FL, financially literate users have a willingness to participate in the formal financial sector. According to him, FL and financial capability are different concepts. The latter refers to an individual's knowledge, skills, and attitude (KSA), which ultimately influence their behaviors and ability to effectively use financial products for their benefit. But FL includes understanding the basic concepts and information.

Fintech is driving the current shift toward digital financial literacy (DFL), which goes beyond basic financial literacy (FL). Individual competency in understanding risks, digital financial risk controls, and consumer rights and redress procedures—which encompass the notions of DL and FL as postulated by Morgan et al. (2019)—as well as knowledge of digital financial products and services are all included in this, and the research of Tchamyou et al. (2019) examined financial digitalization's impact on eradicating financial exclusivity in high-income inequality African states.

The aforementioned authors assert that current research strategies should incorporate the profound concept of DFL. DFL is a crucial enabler that blends traditional and digital financial literacy to improve access to and utilization of digital financial services. Finally, digital transformation is on the policy agenda of the Ethiopian government, like many LDCs. Unvarying challenges in data security, privacy, and the digital divide can impede the effective use of technology in promoting financial inclusion (Quresh et al., 2023).

2.2.2. INFLUENCE OF DIGITAL FINANCIAL LITERACY ON IFB USES: EMPIRICAL

Prior empirical studies lack clarity on how digital and financial literacy influence the use of Shariah-compliant financial services. Possumah et al. (2018) and Su'un et al. (2018) found that perceived understanding, benefit, innovativeness, religious promotion, customer attitude, and Sharia compliance significantly influence interest-free banking usage among Ghana's three major religious groups, including non-Muslim respondents. Growing empirical evidence suggests that increased individual awareness and knowledge of Shariah-compliant products promotes the steady growth and expansion of investment goods and services to meet rising demand.

For example, Muslichah and Sanusi (2019) found that FL had a stronger influence on business participants' intentions to utilize shariah-compliant banking services than religiosity and attitude. In addition, the findings of Astuti (2023) show a positive and significant relationship between FL and commitment to the interests of Islamic banking students. Similarly, Allgood and Walstad (2016) found a strong relationship between financial literacy and confidence in financial decision-making. Studies by Lusardi and Mitchell (2014) and Fernandes et al. (2014)

show that positive attitudes contribute to financial inclusion by increasing the search for and use of financial products and services.

Studies by Ozili (2021) and Albaity and Rahman (2019) also support this. Higher financial literacy levels are positively correlated with the intention to use financial services, but this relationship changes when there is a positive attitude towards Islamic banks.

Therefore, the above-mentioned studies predict a positive correlation between financial literacy and Islamic financial inclusion.

Today, as a result of increased FinTech, people are switching to DFL, not FL. Nurkholik (2024), Dogra and Kaushal (2023), and Hargitay and Hinnant (2008) found that digital literacy (DL) has a positive effect on intentions to use financial products and services. They highlighted that deep learning is very useful in predicting people's digital activities, such as searching for information and using financial products and services.

Research by Asad et al. (2023) and Usman and Hussain (2022) shows that user attitude is the most crucial element in adopting fintech, while user creativity serves as a key predictor in both direct and indirect ways. Furthermore, according to Hoque et al. (2022), FL does not have a significant effect on IFB acceptance, but ethical practices, religious values, and institutional reputations impact attitudes towards Shariah-compliant banking services.

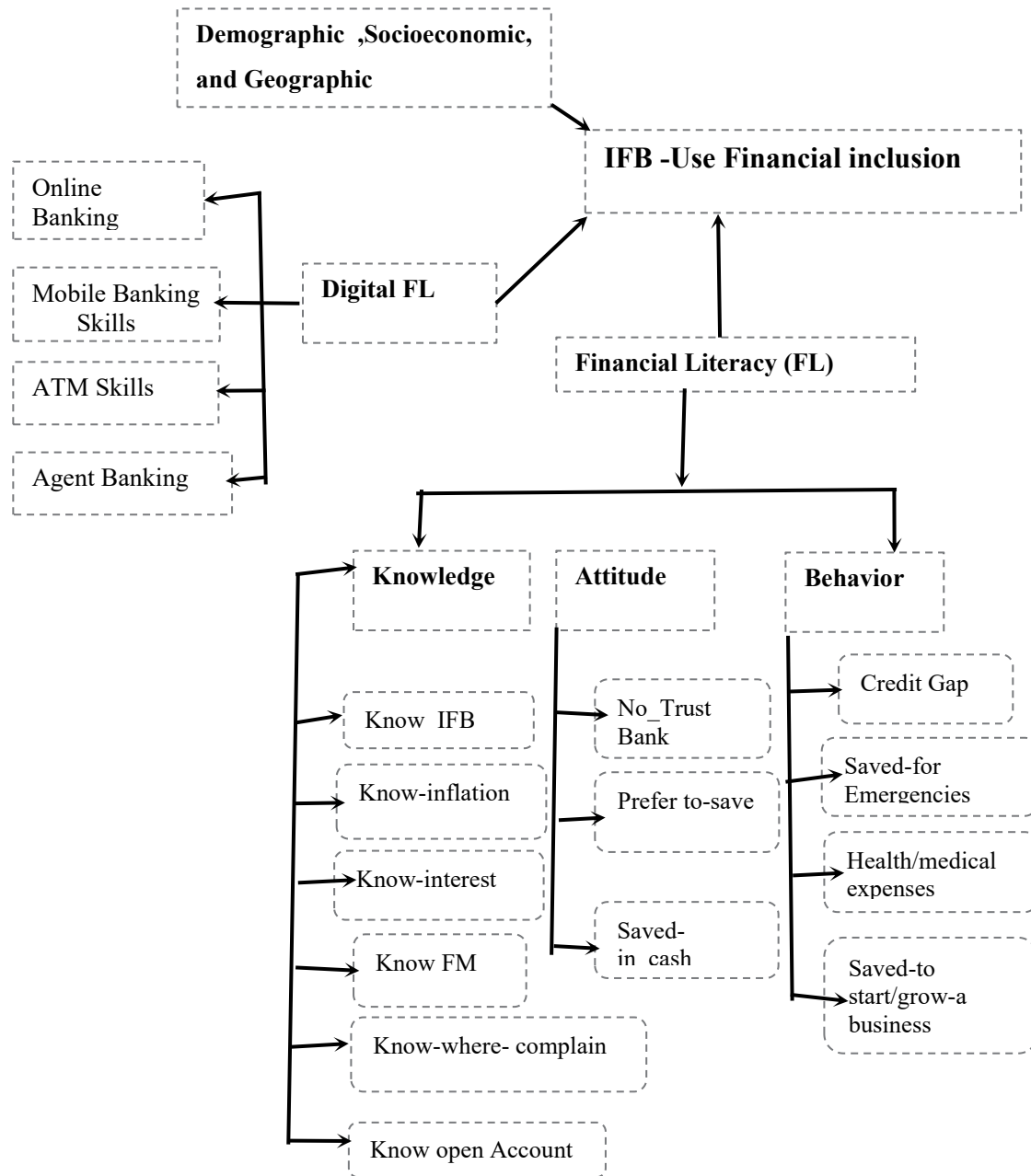
Regarding the influence of demographic, socioeconomic, and geographic factors on IFB acceptances, Demiurge-Kunt et al. (2013) and Zins and Weill (2016) found significant inequalities between Muslims and non-Muslims due to demographic and socioeconomic variables. The same finding was made by Potrich et al. (2015): lower income and education levels are associated with lower financial literacy and reduced use of shariah-compliant banking. As revealed by studies (Datta & Manjula (2019); Uddin et al. (2020); Amaroh et al. (2019); Demirgüç-Kunt et al. (2015) and (2013)), adult financial well-being is also influenced by factors like gender, income, education, and age, with education and income having a greater impact. Lack of sharia financial literacy negatively influences acceptance of IFB financial services (Daradkah et al., 2020).

A similar study by Aman et al. (2021) highlighted the importance of community awareness, religious connotations, and government regulatory support in influencing IFB acceptance in Ethiopia, drawing on successful examples from other countries. There have been only a few notable attempts to study the influence of DFL on IFB service usage for inclusive financial systems in Sub-Saharan Africa (SSA), particularly in Ethiopia, which has a highly diverse adult population. Given the recent rise in policy efforts to enhance financial inclusion aligned with digitization while taking national circumstances into account, it is imperative to study the influence of DFL on IFB service use in the Ethiopian adult context.

Finally, the CFW presented in Figure 2.1 was developed based on an existing deep theoretical and empirical literature review showing expected relations between current study variables and was mostly guided by the studies of Golden and Cordie (2022); Ozili (2020a); Ozili (2021c); and Morgan et al. (2019).

Accordingly, the following two key primary hypotheses ([APPENDIXES 1](#)) were evaluated in the context of Ethiopia under *Cirrus Paribus*: The first hypothesis (H1) is that digital financial literacy (DFL) has significantly positive influences on adults' use of IFB services. Secondly (H2): Financial literacy (FL) has a significant positive influence on IFB service usage.

FIGURE 2.1 THE CONCEPTUAL FRAMEWORK FOR IFB FINANCIAL INCLUSION



Source: Authors designed based on tested concepts by Golden and Cordie (2022);Setiawan et al (2021),Ozili (2021), and Yang et al (2020).

2.2.3. THE DATA AND ESTIMATION STRATEGY

2.2.3.1. TYPE OF DATA AND STUDY VARIABLES MEASUREMENTS

The study uses data from the 2018–19 ESS-FI Module, a household survey by the Ethiopian Central Statistics Agency with WB aimed at measuring progress in Ethiopia's Financial Inclusion Strategy (NFIS). It focuses on access to finance, account ownership, financial service use (including IFB use), digital financial services (ATMs, mobile money, online banking, debit cards, and credit cards), and digital and financial literacy (knowledge, attitudes, and behaviors). The survey includes representatives from 6,700 households across nine regions, two cities, both rural and urban areas, and 565 enumeration areas, totaling 14,862 adults.

This clustered data also includes 5,342 diverse individual insights. For example, one adult responded to the question about the use of financial services: *“In the past 12 months, have you used any of the following services (ATM/debit card, online banking, mobile banking, agent banking, interest-free banking)?”* These responses from financial service users include both Muslims and non-Muslims. Of the 5342 respondents, 3310 individuals are EOTC, 733 are Protestants, 1231 are Muslims, and the remaining 68 are from other religious groups, including Catholics, Wakefata, and pagans. This means that the adults selected as the unit of analysis represent a diverse religious group.

This ESS 2018/19 data, particularly the FI module, is preferred for this research due to its collaborative nature, ensuring high-quality data collection, representative sampling, contextually structured comprehensive questionnaire design, and linkage with detailed adult information, making it a valuable resource for studying the socioeconomic conditions and financial inclusion in Ethiopia.

Specifically, the researchers operationally defined the dependent variable, the use of IFB services, as a binary variable with a leveled value of 1 if the adult has used IFB products and services during the specified period and 0 otherwise.

Financial literacy (FL), which is multidimensional and measured by including a linear combination of an individual's financial knowledge, attitude, and behavior (OECD, 2018), and adult DFL are measured by digital service usage skills indicators (Ravikumur et al., 2022), such as internet banking, mobile banking, ATM use, and agent banking, as explanatory indicators of DFL score levels among Ethiopian adults.

The study surveys use indicators to measure the financial literacy sub-dimension, following the methodology employed by the OECD/INFE 2023 and Yang et al. (2020), and these indicators include the following: First, FL's financial knowledge sub-dimension indicator is measured by the understanding of IFB services, inflation, interest, awareness of financial management, knowledge of where to file complaints, and how to open an account at a formal financial institution.

As shown in CFW Figure 2.1, financial attitude is a sub-dimension measured by adult responses to bank trust, formal versus informal saving preferences, and attitude toward cash savings at home questions. Then, financial behavior was measured in adult responses to the questions about the credit gap, saving behavior for emergencies, medical and health expenses, and saving behavior to start or grow a business.

Further, the above key explanatory variables, such as the FL mean score, DFL score, and the three FL indicator sub-dimensions, are computed using the PCA method using Stata 15 software. Finally, many demographic, socioeconomic, and geographic householders provide explanatory factors for the demand for IFB services and the hypothesized signs of the parameters of the model defined as described in APPENDIXES 1: provides the compiled variables, descriptions, and hypothesized signs of the parameters, all supported by relevant literature.

2.2.3.2. METHODS OF DATA ANALYSIS

The techniques of the principal component analysis (PCA):

PCA is a statistical method for minimizing the dimensions of a large multidimensional variable while maintaining the majority of its information. The works of Abdi and Williams

(2010) and Al-Kandari and Jolliffe (2005) support this information. As a result, the PCs are linear combinations of the original variables, weighted according to how they contribute to explaining variance in a specific orthogonal dimension. PCA is suitable for investigating financial literacy, digital literacy, and financial service use using clustered data. It ensures the validity of measurement scales and can be used as predictors in regression models to examine the effects of financial services, particularly IFB financial products, in prior adult literacy studies (Bates et al., 2015; Gelman & Hill, 2007).

In this study, two stages of PCA are used to compute the mean score of FL and DFL using the methods of Camara and Tuesta (2014), Mukherjee and Sood (2020), and Nguyen (2020).

The first stage of the PCA estimates the three variables of financial literacy (FL), which are multidimensional and include a linear combination of an individual's financial knowledge, attitude, and behavior (OECD, 2018). Following the tested examples of Prasad et al. (2018) and Ravikumur et al. (2022), adult DFS scores are calculated by digital service usage skills indicators, such as internet banking, mobile banking, ATM use, and agent banking, as explanatory indicators of DFL score levels among Ethiopian adults.

In the second stage, we combined the three-dimension score indexes to arrive at an aggregate financial literacy score by computing a weighted linear combination of the dimension score from the first stage. Furthermore, the weights were calculated using a multivariate PCA min-max technique.

This study employed the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, supplemented by eigenvalue scree plot analysis, to assess the reliability and power of PCA-constructed FL and DFL scores. The KMO statistic assesses the proportion of variance among variables that might represent common variance, indicating the adequacy of partial correlations required for factor analysis (Kaiser, 1974).

More precisely, the KMO test quantifies the degree to which each variable can be predicted without error by the other variables in the set, with values ranging between 0 and 1. Scores near to 1 indicate that the correlation patterns are sufficiently compact, implying that the PCA

construct will likely produce distinct and reliable factors. Conversely, lower values suggest that the data may not be suitable for dimension reduction techniques.

In social science studies, KMO values are commonly interpreted along the following benchmarks: Values from 0.90 to 1.00 are deemed "marvelous," indicating excellent sampling adequacy; 0.80 to 0.89 are considered "meritorious"; 0.70 to 0.79 "middling"; 0.60 to 0.69 "mediocre"; and 0.50 to 0.59 "miserable," though still deemed acceptable for PCA. Values below 0.50 are generally regarded as unacceptable for factor analysis, indicating insufficient sampling adequacy (Field, 2018; Kaiser, 1974).

As reported by Lyons & Kass-Hanna (2021) and Lusardi and Mitchel (2014), financial literacy and DFL scores are multidimensional components, so they are best represented by two underlying dimensions or indicators rather than a single index or score. To measure adult literacy, the OECD (2018) and Lusardi & Mitchell (2014) used a scoring system where individuals are categorized based on the number of correct answers to financial literacy questions. For example, a score above 3 out of 5 indicates positive attitudes or behaviors, while a score of 5 or more correct answers out of 7 is required to be considered financially literate. Others (Mandell, 2009) have employed more intricate classifications, dividing levels into categories like poor, fair, outstanding, very outstanding, and exceptional.

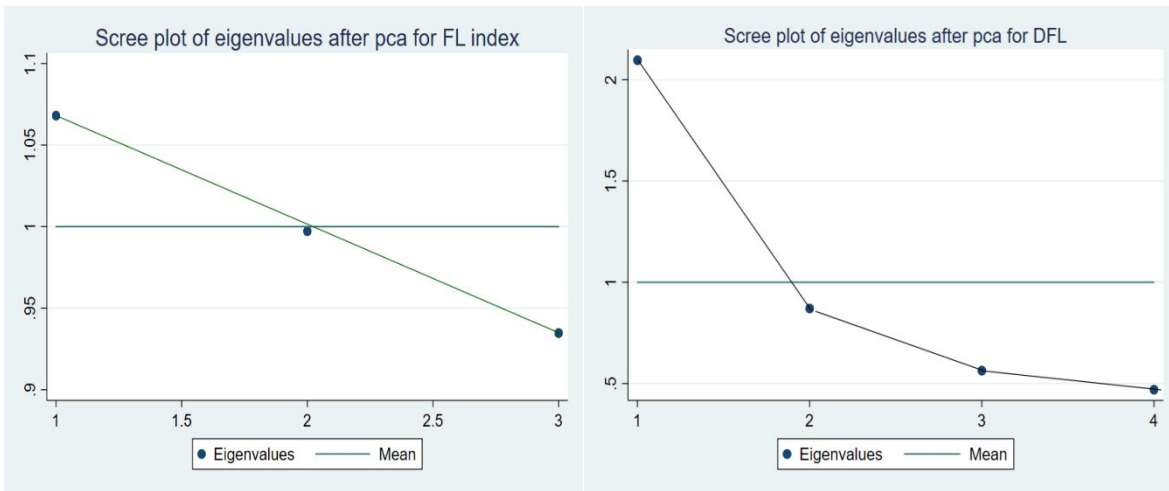
Financial literacy, knowledge, behavior, and attitude scores of more developed economies are higher than those of the least developed countries (OECD, 2018; Mandell, 2009). This implies there is no clear consensus on a cut-off score rate for financial literacy, as it likely depends on the specific context and the level of knowledge deemed necessary for financial well-being.

However, the general practices show that a score above 50% is mostly considered a baseline for financial literacy, with higher scores indicating greater literacy (OECD, 2022; OECD/INFE, 2020, and 2021).

In this research, PCA analysis results in [Table 2.1](#) and [Table 2.2](#) show these selected PC components meet the basic requirements of FL and DFL indicator measurement practices. For example, the KMO measure value for FL score index 0.501 and DFL index 0.692 is $KMO > 0.5$. Therefore, our sample is adequate, allowing us to use PCA score indicators to analyze the

adult literacy status. Furthermore, double-check that researchers have tested an eigenvalue scree plot. An eigenvalue scree plot helps in decision-making by visualizing eigenvectors on a plot for simple analysis. This result in Figure 2.2 clearly illustrates that at inflection points, retention of two components from FL score indicators and DFL, as adult literacy measurements, have a strong connection and are positively correlated.

Figure 2.2 Scree plots of the eigenvalues of FL and DFL.



Source(s): Drawed by the authors on Stata 15,2025

Guided by the methods used by Lever (2017) and mentioned above, the eigenvalue rule was used to figure out the members of the major components.

The first-stage PCA result for the financial knowledge sub-dimension indicator, knowledge of IFB services (0.36) and adult knowledge of inflation (0.17), has the highest weighted score. One can see that, for these two indicators, each dimension has an eigenvalue greater than 1. It is important to notice that for the knowledge dimension, these two components cumulatively explain 52.7% of the variance in adult financial literacy.

Similarly, the indicator variables No_Trust_Banks and Where_prefer_to_save in the current research have eigenvalues greater than one and have the necessary proof to utilize these components to explain changes in financial attitudes. Additionally, in Table 2.1, both principal components (PCs) in the financial behavior sub-dimension—1.083 for the credit gap and 1.017 for savings for emergencies—exhibit higher eigenvalues. This suggests that the data is more reliable for analyzing financial behavior.

Table 2.1 The KMO and Eigenvectors of Sub-dimension FL Scores

1 Financial_Knowledge				2 Financial_Attitude			
Variable	CUM	Eigenvalue	KMO	Variable	CUM	Eigenvalue	KMO
Know_IFB service	0.359	2.157	0.744	No_Trust_Bank	0.333	1.104	0.493
Know_Inflation	0.527	1.006	0.735	Prefer informal	0.667	1.003	0.495
Know_Interest	0.679	0.911	0.745	Saved in Cash	1.000	0.893	0.497
Financial Management	0.795	0.695	0.702				0.495
KNOW where to complain	0.900	0.633	0.759				
Know how to open Account	1.000	0.598	0.757				
		0.743					
3. Financial behavior				4 Financial_Literacy score			
Variables	Cum	Eigenvalue	KMO	Variables	Cum	Eigenvalue	KMO
Credit gap	0.25	1.083	0.52	Knowledge	0.333	1.068	0.501
Saved for emergence	0.50	1.017	0.49	Attitude	0.667	0.977	0.503
Saved for medical	0.75	0.996	0.484	Behavior	1.000	0.935	0.501
SAVED_Start Business	1.000	0.904	0.486				0.501
			0.490				

Source(s): Calculated by the authors using PCA on Stata 15,2025

Finally, Table 2.2 also shows the weights for the indicators in the DFL dimension. The first three indicators can predict individual-level DFL of 88.3% (online banking skills, mobile banking skills, and use of ATMs). The use of online banking is the most important indicator in defining the DFL score dimension, with a proportion of 0.524. Therefore, the skills related to using adult digital financial products, especially online banking, serve as a strong explanatory variable for measuring DFL skills.

TABLE 2.2 THE KMO AND EIGENVECTORS RELATED TO DFL SCORES.

Variable	Weight	Cum	Eigenvalue	KMO
Online Banking skills	0.524	0.524	2.067	0.683
Mobile Banking skills	0.218	0.742	0.870	0.678
ATM skills	0.141	0.883	0.564	0.704
Agent Banking	0.117	1.000	0.470	0.717
				0.692

Source(s): Calculated by the authors using PCA on Stata 15,2025

Econometrics models Specification: IFB usage

The goal of this study is to analyze the influence of FL and DFL on IFB use among Ethiopian adults. In this scenario, along with digital and FL as independent variables, the dependent variable, which is IFB usage by adults, is expected to be influenced by a variety of demographic and socioeconomic characteristics.

This study utilizes the Ethiopian Socioeconomic Survey (ESS) 2018/19, which contains multilevel data with a hierarchical structure. In this structure, individuals are nested within households, which are further nested within geographic regions and socio-demographic clusters, including urban-rural residents, religious affiliation, and gender.

The dependent variable, IFB usage, is binary, coded as 1 if an adult uses IFB and 0 otherwise. A binary logistic regression framework naturally suits modeling these dichotomous outcomes at the individual level.

The classical binary logit model assumes that observations are independent; however, in this study, the observations regarding IFB usage by adults cannot be assumed to be independent. This is due to the possibility of intra-household correlation, which contradicts the assumption that the actions of adults within the same household are independent.

Thus, the generic linear mixed-effect models (LMM), Equation 2.1, include fixed effects and deviations that are equivalent to traditional OLS standard regression coefficients and are calculated directly, as well as random effects that are assumed based on their estimated variances and co-variance. The LMM model specification equation is expressed as follows:

In particular, adults within the same household may demonstrate correlated behaviors regarding IFB usage, which can be influenced by shared environments, economic factors, or normative values. For example, household members share information, financial resources, financial decision-making dynamics, or social dependency norms that jointly affect their banking choice or IFB usage behaviors. Such dependency threatens the validity of standard errors and parameters estimated if unaccounted for (Hox, Moerbeek, and Van de Schoot, 2017).

Although heterogeneity in individuals' IFB usage status within households exists, the independency assumption across individuals' clusters in the same household or family, geographic regions, or cluster remains questionable. Ignoring this clustering risks biased inference and inefficient estimation.

To address these estimation issues, the study adopted a mixed-effect regression model (also known as hierarchical or multilevel logistic regression). This modeling strategy accommodates the nested data structure by including fixed effects for observed co-variate (e.g., FL, DFL, socioeconomic) and random intercepts capturing unobserved heterogeneity at multiple levels—specifically at the household and region levels. This approach explicitly models intra-class correlation, improving standard error estimation and yielding more reliable parameter inference (Snijders & Bosker, 2011).

Furthermore, restricted maximum likelihood (REML) estimation is utilized to produce unbiased variance component estimates, and intra-class correlation coefficients (ICC) are computed to quantify the proportion of population variance attributable to household and regional clustering (Raudenbush & Bryk, 2002).

The application of mixed-effects modeling is widely recognized as the preferred technique for analyzing clustered outcomes, particularly in complex survey designs like the ESS (Williams, 2018; Kilian & Kelava, 2023). This framework allows for decomposition of variance components across individuals, households, and contextual socioeconomic levels, thus offering richer insights into the hierarchical determinants of IFB usage.

Thus, the generic linear mixed-effect models Equation (2.1), include fixed effects and deviations that are equivalent to traditional OLS standard regression coefficients and are calculated directly, as well as random effects that are assumed based on their estimated variances and co-variance. The LMM model specification equation is expressed as follows

$$\text{IFB_usage}_i = \beta_1 \text{FL}_i + \beta_2 \text{DFL}_i + Z_i' \mu_i + \epsilon_i \quad (2.1)$$

Where: IFB_usage_i is interest-free banking usage for individual i ; individual adults are in household i ; or adult observations identified by individual $_i$ are using the interest-free banking service. DFL and FL are the design matrices for the fixed effect variables; β_1 and β_2 are the vectors of fixed effect coefficients that measure how DFL_i and FL_i scores affect IFB usage. Z_i' is the design matrix, which is a vector for the random effect variables containing demographic, socioeconomic, and geographic attributes of the i -th individual. The vector μ_i represents the random effect coefficients, while ϵ_i denotes the residual error term for the i -th individual. In the current model, the null hypotheses are that adult actions randomly vary within the same HHs but are the same (fixed) across other HHs.

The assumption is that ϵ_i i.i.d. $N(0, \sigma^2)$. Which means adult independence hypothesis $H_0 \beta=0$ and $H_1 \beta \neq 0$.

However, in our clustered data nature, each observation of adult IFB use is unlikely to be independent of one another because the activities of adults in the same place or household may be correlated or dependent. These multilevel hierarchical cluster data can violate assumptions of independence for adults, resulting in biased estimates and incorrect inferences. Greene (2018) reaffirms that the endogeneity problem is common in economics and behavioral finance and could arise due to reverse causality.

Thus, the primary reason for using fixed effects in mixed-effect modeling is to control for unobserved cluster-specific effects, which can help address endogeneity concerns for relevant omitted variables (Kilian and Kelava, 2023; Leszczensky and Wolbring, 2022). According to the authors mentioned above, mixed-effects modeling implies that the explanatory factors are uncorrelated with the error term and that any association between the explanatory variables and the error term is caused by unobserved cluster-specific effects. Therefore, to address these issues, the researchers used the restricted maximum likelihood (REML) specification approach, as stated in Equation (2.2). The intercept model of adult IFB use is objectively assessed by clustering individual adult random variances across households while fixed within the same HHs. The estimation was done using maximum likelihood. This diagram is a mathematical representation of the study's modeling equations

$$\text{IFB_usage_i} = \beta_1 \text{FL}_i + \beta_2 \text{DFL}_i + \sum_{i=1} Z_i u_i + \epsilon_i \quad (2.2)$$

According to a mixed effect modeling specification requirement that predictor variables do not vary within residuals, residual errors ρ_i in REML are assumed to be randomly correlated across household clusters. This means that the null hypothesis in this modeling method is that adult action is the same (fixed) within the same household while randomly varying across other households.

That is, within the same household, adult dependency assumptions hypotheses $H_0 \beta=0$ and $H_1 \beta \neq 0$)

Furthermore, for better modeling robustness, choose between logistic and mixed effects; for comparative purposes, simple logit-probit modeling estimations by maximum likelihood methods were also included in the output result analysis section.

2.2.4. EMPIRICAL RESULTS, ANALYSIS, AND DISCUSSION.

2.2.4.1. DESCRIPTIVE STATISTICS ANALYSIS

Summary statistics of PCs analysis results of FL and DFL scores for each sub-dimension of FL are presented below in Table 2.3.

TABLE 2.3 SUMMARY STATISTICS: FINANCIAL AND DIGITAL LITERACY SCORES OF ADULTS IN ETHIOPIA

Variable	Financial Knowledge_Score	Financial Behavior_Score	Financial Attitude_Score	Financial Literacy_Score	DFL_score
Mean	6.03e-09	8.13E-09	-7.80E-09	-2.24e-10	-1.46e-08
Std. Dev.	0.580	0.451	0.573	0.565	1

Source(s): Calculated by the authors using PCA on Stata 15,2025

The PCA scores summary of descriptive statistics indicates that the mean scores for financial knowledge and financial behavior components of financial literacy (FL) among adults in Ethiopia are both positive and negative. Conversely, the mean scores for the overall FL score, as well as attitudes toward formal financial institutions (FFIs) and financial activities among Ethiopian adults, are negative. Furthermore, the standard deviations of financial knowledge, attitude, and aggregated FL averages surpass the standard variances of financial behavior scores by more than 0.5.

This finding suggests that adults exhibit greater diversity in their financial literacy regarding financial inclusion and financial concepts. It is critical to interpret these mean scores of financial knowledge and behavior toward financial services and financial activity. This positive behavior encourages them to actively seek and utilize financial products and services, contributing to their financial inclusion. Equally important is

positive financial knowledge. Adults are more likely to engage in responsible financial practices and enhance their financial inclusion.

Adult attitude is measured by respondents who answered financial attitude questions such as if they had any failed credit financing trials and their attitude toward saving for emergencies, medical expenses, and starting a business. The result reflects the negative experiences of adult individuals. Similarly, the research results for the aggregated financial literacy (FL) score indicate negative values below one across the aggregated dimensions, confirming prior empirical claims by Kass-Hanna et al. (2022) that Ethiopian adults' FL levels have a poor track record even when compared to the sub-Saharan average. Furthermore, the mean score of the PC-predicted DFL of adults in Ethiopia is shown as negative, indicating from our survey data a low level of DL literacy among adults in the country. Table 2.4 presents comparative statistics on the descriptive results of IFB use and FL scores for adults in Ethiopia, categorized by urban and rural areas.

TABLE 2.4 MEAN IFB USE AND FL SCORES OF ADULTS IN ETHIOPIA BY URBAN AND RURAL AREAS.

Variable	Mean Urban	Mean Rural	dif	St Err	t value	P-value
Financial Knowledge_score	.132	-.155	.288	.009	30.75	0.0000
Financial Attitude_score	.055	-.065	.12	.009	12.90	0.0000
Financial behavior_score	.093	-.11	.203	.007	28.70	0.0000
Financial literacy_score	.159	-.19	.348	.009	38.65	0.0000
Digital Financial literacy_score	1.035	1.006	.029	.002	12.95	0.0000
IFB usage	1.874	1.863	.011	.012	0.85	0.3850

Source(s): Calculated by Authors using PCs from ESS 2018/2019 data,2025

As seen in Table 2.4 above, the P-values of the t-test for the difference in mean scores of the aggregate FL score and all dimensions of FL are less than 0.05 for the adult group in place, i.e., rural-urban effects. This conclusion implies that in Ethiopia, there is a statistically significant difference in mean scores of the aggregate FL and all dimensions

of the FL of adults between urban and rural areas of the country. Similarly, the mean scores of DFL show there is a statistically significant difference between urban and rural areas of the country. Relative to urban and rural residents, adults (i.e., age 18+) scored a low mean of DL. This indicates that rural adults in Ethiopia have marginalized literacy (both digital and financial) compared to their urban counterparts. Abebe and Deneke (2015) and Ziyn Engdasew (2012) reported the same results. As they revealed, rural communities in Ethiopia suffer major barriers to education and training opportunities compared to their urban counterparts. However, the P-values of the t-test of IFB usage imply no significant disparity in the use of IFB financial services between urban and rural, as they are larger than 0.05. In addition to the difference in literacy and IFB use among adults between rural and urban areas of Ethiopia, the researcher has assessed whether the difference exists gender-wise. This may help identify whether gender discrimination in IFB Finance and FL among adults exists in the country. The researcher compared the mean scores of FL, DFL and IFB Finance in Ethiopia to determine gender differences in literacy. The [Table 2.5](#) presents the results of t-tests.

TABLE 2.5 MEAN IFB USE, DFL AND FL SCORES OF ADULTS IN ETHIOPIA BY SEX.

Variable	Mean Male	Mean Female	Diff	St Err	t value	P-value
Financial-knowledge score	.018	-.016	.034	.009	3.6	0.001
Financial attitude score	.003	-.003	.006	.009	.5	0.606
Financial behavior score	.021	-.018	.038	.007	5.15	0.000
Financial literacy_score	.03	-.026	.056	.009	5.85	0.000
Digital FL_score	1.03	1.012	.018	.003	7.6	0.000
IFB usage	1.862	1.885	-.022	.009	-2.45	0.140

"Mean Male" and "Mean Female" represent the average scores for mean IFB use, DFL, and FL among adults in Ethiopia, compared across two samples grouped by sex. "Dif" is calculated as Mean1 minus Mean2. For instance, in the data for the Financial Knowledge score (line 2), "Mean1" refers to the mean financial knowledge score for males, while "Mean2" indicates the mean financial knowledge score for females. The "T value" and "P-value" are obtained from Welch's two-sample t-test, which uses Satterthwaite's degrees of freedom to account for unequal variances. High T values and a P-value of less than 0.05 suggest significant differences in financial knowledge scores between genders.

Source: Authors computation using ESS 2018/2019 data,2025

The data insight evidence reveals that, compared to males, the mean of adult females computed negative for financial attitude (-0.003), indicating males have a better positive financial attitude. Surprisingly, for the mean of IFB use, females (1.885) and adults have slightly higher IFB use than males (1.862). However, the P-values of the t-test result in mean scores of aggregate attitude and IFB use between male and female adults in Ethiopia are p values of 0.606 and 0.14, respectively. Since these P-values are larger than 0.05, the researchers failed to reject the null hypothesis of no significant difference in mean scores of aggregate attitude and IFB use between male and female adults in Ethiopia at the 5% level of significance.

The p-values from the t-test indicate statistically significant differences in all dimensions of financial literacy (FL) and digital financial literacy (DFL), including FL, knowledge, and financial behavior, between male and female adults in Ethiopia, with values less than 0.05. This suggests that there are notable differences in the means of FL and other FL and DFL measures among Ethiopian male and female adults at the 5% significance level. Furthermore, these differences are both positive and significant. The findings reveal that the mean scores for knowledge, behavior, and the overall combined FL and DFL scores are significantly lower for Ethiopian female adults compared to their male counterparts. This supports the assertion that women's financial literacy is a crucial factor influencing the use of inclusive financial banking (IFB) services among both men and women. Enhancing women's financial literacy promotes greater gender and cultural diversity and inclusivity (Hasan and Hoque, 2021; Khan et al., 2019).

As one can see in the result in [Table 2.6](#), adults in Addis Ababa have the highest positive FL mean scores (0.252), followed by those in Tigray (0.103). A statistically significant low mean FL score was revealed for Somali (-0.261), Oromia (-0.088), Afar (-0.072), and SNNP (-0.042). This analysis of single-year (2018–19) observation of survey data indicates that, compared to adults in Addis Ababa.

TABLE 2.6 FL SCORE BY GEOGRAPHICAL REGIONS

Region	Mean1	Mean2	dif	St Err	t value	p value
Addis Ababa	-.04	.252	-.29	.015	-18.75	0.0000
Tigray	-.01	.103	-.113	.015	-7.3	0.0000
Harar	-.002	.019	-.021	.019	-1.1	0.2790
Gambela	-.001	.011	-.011	.019	-.6	0.5380
Benishangu Gumuz	-.001	.008	-.009	.018	-.5	0.6350
Dire-dawa	.001	-.009	.01	.015	.65	0.5150
Amhara	.002	-.017	.018	.014	1.35	0.1780
SNNP	.005	-.042	.046	.015	3.2	0.0020
Afar	.005	-.072	.077	.017	4.55	0.0000
Oromia	.011	-.088	.1	.015	6.45	0.0000
Somali	.027	-.261	.288	.015	19.65	0.0000

Dummy *Mean1=No **Mean2=Yes "Mean1" and "Mean2" show average financial literacy (FL) scores for each geographical region group being compared. "Dif" is Mean1 minus Mean2. For example, in the information presented for Addis Ababa (line 2), "Mean 1" refers to the mean FL score for non-Addis Ababa adults, while "Mean 2" indicates the mean FL score for adults residing in Addis Ababa. "T value" and "P-value" are derived from Welch's two-sample t-test using Satterthwaite's degrees of freedom for unequal variances; high t values and $p < 0.05$ indicate strong, significant differences in FL scores between the regions.

Source: Authors computation using ESS 2018/2019 data,2025

Additionally, the study used an F-test to investigate whether group means in DFL and FL, as well as all dimensions of FL scores of adults across various geographic locations and religious affiliations of the adults, differ statistically significantly. This procedure may be necessary since IFB financial inclusion calls for providing financial services and products that align with the community's social and religious values.

The Somali region's unique situation of low financial literacy (FL) (-0.261) compared to positive usage of IFB ($\beta=0.0445$, REML model) and mobile banking ($\beta=0.777$, $p<0.001$; Heckman model in chapter (4) challenges traditional metrics that link financial inclusion—especially IFB and digital financial inclusion—to formal education and

extended schooling-based financial literacy. These findings effectively convey the importance of socio-cultural, contextual trust/attitude factors and informal social learning/networks in the Somali region's financial settings. It also highlights the relevance of IFB services that align with local religious values, referencing theories such as Social Learning Theory (Bandura, 1977) and the Diffusion of Innovations theory (Rogers, 2003), as well as works by Chapra (2000) and Siddiqi (2006). This approach enhances inclusion in low-literacy contexts. Further discussions are provided in *Regional Disparities 4*.

Therefore, it is crucial to explore how these factors can be integrated into financial literacy programs to foster greater community engagement. By leveraging the existing informal and formal networks and trust within specific regional contexts, financial institutions can tailor their services to meet the unique needs of the population, ultimately promoting economic empowerment and social well-being.

TABLE 2.7 F-TEST COMPARING THE DIFFERENCES IN IFB USE AND FL OF ADULTS BY REGION AND RELIGION

Variable	Region		Religion	
	F-score	p-value	F-score	P-value
Financial knowledge_score	95	0.0000	19	0.0000
Financial attitude_score	24	0.0000	13	0.0000
Financial behavior_score	89	0.0000	72	0.0000
Financial literacy_score	81	0.0000	63	0.0000
Digital financial literacy_score	11	0.0000	12	0.0000

Source: Authors' computation using ESS 2018/2019 data, 2025

As shown in *Table 2.7*, all p-values from F-tests, which indicate statistically significant variations in mean DFL scores and all FL subdimensions across different regions of the country and among adults with varying religious affiliations, are 0.0000. This suggests that there is a statistically significant difference in mean literacy scores among adults in the country concerning geography and religious affiliation, confirming Bandura

(1977), Chapra (2000), Siddiqi (2006), Ozili (2021), Yang et al. (2020), and the World Bank (2022).

2.2.4.2. ECONOMETRICS REGRESSION ANALYSIS

Table 2.8 below displays the econometric regression results regarding the influence of DFL and FL on IFB service usage. Logit-probit models (columns 2 and 3) and then the linear mixed effect model (column 4) were estimated consecutively, followed by fitting within householder random variance controlled maximum likelihood (REML columns 5).

TABLE 2.8 ECONOMETRICS MODELING OF IFB USAGE (DEPENDENT VARIABLE)

Variables (at their mean score)	Logit	Probit	Linear-Mixed Effect (Random)	REML(within-HH FE)
DFL	2.693***(13.25)	1.386***(13.16)	0.270***(14.81)	0.255***(14.67)
Financial Literacy	0.884***(7.07)	0.445***(6.91)	0.0465***(6.54)	0.0441***(6.13)
Knowledge	0.690**(3.07)	0.319** (2.65)	0.0427** (2.8)	0.0359* (2.33)
Behavior	0.121*(2.04)	0.0728*(2.26)	0.00778(1.83)	0.00593(1.41)
Attitude	-0.00744(-0.11)	-0.000984(-0.03)	0.000244 (-0.05)	-0.00172 (-0.32)
Demographic, socioeconomic, and geographic effects				
SEX	0.248(1.86)	0.138(1.9)	0.0177(1.85)	0.0183*(2.17)
AGE	-0.0268(-1.11)	-0.0108(-0.81)	-0.00205(-1.15)	-0.00108(-0.64)
age2	0.000271(0.99)	0.000107(0.7)	0.000022(1.09)	0.000011(0.58)
Distance from _FFI	-0.00227(-1.54)	-0.00126(-1.49)	-0.00018(-1.49)	-0.00023(-1.65)
Rural resident	-0.0613(-0.36)	-0.0431(-0.45)	-0.00519(-0.39)	-0.0065(-0.45)
Shock	0.126(1.0)	0.0745(1.08)	0.0126(1.38)	0.0141(1.51)
Informal (<i>Equb</i>)	-0.540***(-3.4)	-0.280**(-3.23)	-0.040***(-3.61)	-0.037***(-3.47)
Own mobile	0.0116(1.07)	0.00654(1.11)	0.000879(1.01)	0.000545(0.63)
Unemployed	-0.117(-0.88)	-0.0517(-0.71)	-0.0115(-1.18)	-0.00641(-0.68)
Financial capability	-0.0633(-0.15)	-0.0308(-0.13)	0.0111(0.4)	0.0156(.57)
Education	0.0118(1.96)	0.00702*(2.19)	0.000715(1.65)	0.000699(1.63)
Religion _EOTC base				
Catholic	0(.)	0(.)	-0.0249(-0.52)	-0.027(-0.58)
Protestant	-0.437(-1.55)	-0.19(-1.41)	-0.0208(-1.42)	-0.0246(-1.52)
Muslim	3.42***(20.17)	1.82***(21.84)	0.40***(32.7)	0.40***(28.9)

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Others (Pegan	0.818(0.74)	0.427(0.79)	0.0167(0.22)	0.017(0.22)
Region (Addis Ababa base)				
Afar	0.625(1.65)	0.327(1.66)	0.0463(1.69)	0.0512(1.69)
Amhara	-0.0568(-0.15)	-0.0348(-0.18)	-0.00316(-0.16)	-0.00585(-0.26)
Oromia	1.655***(4.68)	0.865***(4.84)	0.128***(5.68)	0.136***(5.45)
Somali	0.606(1.36)	0.304(1.26)	0.0279(0.73)	0.0445(1.05)
BG	0.285(0.69)	0.114(0.53)	0.0018(0.07)	0.000689(0.02)
SNNP	0.787*(2.04)	0.344(1.73)	0.0470*(2)	0.0434(1.68)
Gambella	0.305(0.72)	0.125(0.58)	0.0109(0.47)	0.0106(0.41)
Harar	0.783*(2.31)	0.396*(2.29)	0.0605**(2.77)	0.0534*(2.17)
Continued		Region (Addis Ababa base)		
Tigray	-0.468(-1.42)	-0.278(-1.70)	-0.0327(-1.88)	-0.0294(-1.48)
Dire Dawa	0.538(1.63)	0.273(1.63)	0.0271(1.35)	0.0266(1.17)
_cons	-5.734***(-7.51)	-3.090***(-7.60)	-0.0864(-1.66)	-0.100*(-1.97)
N	3757	3757	3791	3791
Pseudo R2	0.4136	0.4104		
LR Chi2(29)	1228	1218.78		
Log-likelihood	-870.7	-875.34	-485.33	-359.42
Wald chi2(30)			2006	1656
AIC	1801.4	1810.7	1036.7	784.8
BIC	1988.4	1997.6	1242.6	990.8

N.B.: The figures in parentheses represent *t*-values, also known as *t*-statistics. $p < 0.05$, * $p < 0.01$, *** $p < 0.001$

Source. Stata Output,2025

2.2.4.3. ROBUSTNESS TESTING:

Table 2.8 and Table 2.9 exhibit the models' post-estimation extra-diagnostic test results. As demonstrated in nested models. The result table shows that the fitted fixed mixed-effects REML (columns 5) is a better estimator than all other models, achieving the lowest desired values of Akaike's Information Criterion (AIC) (784.8) and Bayesian Information Criterion (BIC) (990.8).

This implies mixed-effects modeling is preferred over the logistic regression results of logit and probit. According to McNeish and Kelley, 2019: McNeish, D. (2017) and McNeish, D., & Stapleton, L. M. (2016), the advanced performance of mixed effects modeling in the context of clustered survey data originates from its ability to appropriately handle correlation, flexibility in modeling hierarchical structures, robustness to unequal cluster sizes, improved variance estimation, and the ability to incorporate multiple levels of covariates. These benefits contribute to more trustworthy and valid conclusions in this research investigation that used clustered data.

TABLE 2.9 RESULT ROBUSTNESS TESTING

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
Household_id: Identity				
var(_cons)	.0371133	.002379	.0327316	.0420816
var(Residual)	.0402785	.0017299	.0370267	.0438158
LR test vs. linear model: chibar2(01) = 251.84			Prob >= chibar2 = 0.0000	

Source :Calculated by the authors on Stata 15 ,2025

Next, for the decision between random and fixed-effect ML estimation, As seen in Table 2.8, and Table 2.9, the p-value of the Wald test for the overall significance of the model and the LR test for the REME model is 0.0000. Thus, the null of all coefficients of the explanatory variables is zero and can be rejected at the 5% level of significance. That is, the explanatory variables included in the model jointly explain a significant portion of the variation in the dependent variable; hence, the overall significance of the model is achieved at the 5% level of significance.

Besides, from the LR test result, the null of the random mixed-effect model is better than the fixed effect model and can be rejected at the 5% level of significance, implying that the REML model, by accounting for the dependence of the observations clustered within HHs, performs better than the linear mixed-effect model.

This shows that it would be a mistake to simply use the linear mixed effect result estimated by considering traditional random variables independent of adults.

As a result, the within-HHs fixed mixed effect model estimate provides theoretically sound interpretations for a larger population context, which aids in understanding adult Ethiopian individuals IFB usage. Analysis of IFB use by adults in the same family is dependent on other adults within the same HH while independent or randomly varies with other adults across HHs. This method also helps to account for differences between individuals, as the researchers included adults in the same HHs as a fixed effect. Therefore, the study used the results of the within-household variance-controlled REML model (column 5) for further interpretations and discussions.

2.2.5. RESULTS INTERPRETATION AND DISCUSSIONS

2.2.5.1. DIGITAL AND FINANCIAL LITERACY INFLUENCES ON IFB SERVICE USE

As seen in [Table 2.8](#), Column 5, the P-value of the coefficients of DFL and FL scores is less than 0.05.

A p-value less than 0.05 typically indicates that the effect is statistically significant, suggesting that both the DFL and FL scores have a meaningful impact on the likelihood of using Islamic banking services.

Particularly, the positive coefficients of 0.255 of the DFL score in the model are statistically significantly different from zero at the $p < 0.001$ level of significance. This test result indicates a one-unit increase in adult skills in DFL will lead to 0.255 points on mean increases in IFB use. Also, the positive coefficient of 0.0441 of the FL score indicates a one-unit increase in FL scores improves adults' IFB financial inclusivity by 0.0441 points on average. This finding is also statistically significant ($p < 0.001$). This suggests that both DFL and FL scores are good predictors of whether individuals will use the IFB service or not. This finding is consistent with the findings of Choung et al. (2023), Prete (2021), and Ozili (2021c).

Financial literacy is conceptually multidimensional. As can be seen in result [Table 2.8](#), the results revealed that IFB service usage is positively influenced by adult knowledge and behavior sub-dimensions of financial literacy. It suggests that the knowledge score's beta coefficient is ($\beta=0.0359$, $P<0.01$), meaning that the higher adult financial knowledge of the IFB service core principle and values increases the likelihood of the use of Shariah-compliant banking services.

The effect of adult financial attitudes is negative on the use of IFB services. Bunyamin & Mutlu (2017) argued that this negative perception among some adults results from the claim that IFB products are more expensive compared to conventional ones. However, the finding is statistically insignificant at a 5% p-value, except for financial knowledge.

The research results confirm that those who are financially literate are more likely to understand financial concepts, products, and services. According to Astuti (2023), this competence enables them to make more informed decisions, compare available options, and select appropriate financial products that suit their needs.

The likelihood of adults using formal financial institutions and profiting from financial inclusion therefore rises. Consider that actual importance does not always follow from statistical significance. Previous research, like Zulkhibri (2016), Khan et al. (2022), and Shinkafi et al. (2019), claimed that financial inclusion is sensitive to individual proficiency. The availability of Islamic financial services and products does not guarantee a rise in financial inclusion unless people recognize the importance of these products in handling their finances (Khan and Bhatti (2000) and Obaidullah (2005)).

Moreover, IFB services encompass a wide range of non-interest financial products, all deeply embedded in social trust and sharia compliance (Musa & Nor, 2024; Yusufarto et al., 2022; Dusuki & Abdullah, 2007). These priorities suggest that a cultural and normative factor determines usage in Ethiopia and similar contexts. Future empirical work should quantitatively compare IFB and conventional banking costs and explore usage patterns across different services to better elucidate these complex trade-offs. The negative coefficient observed for financial attitude ($p > 0.05$) and the insignificant effect

of distance from financial infrastructure (FFI) have been noted as relevant for financial inclusion.

Financial attitudes, despite being statistically non-significant, may still embody important behavioral and psychological dimensions that influence financial inclusion and warrant further investigation, as these attitudes shape trust and willingness to engage with financial services (Beatty & Fothergill, 2017). Similarly, the lack of significance for distance from FFI could reflect the mitigating role of digital financial services or alternate informal financial mechanisms reducing the direct impact of physical proximity (van Deursen & van Dijk, 2019). Ignoring these factors risks overlooking critical nuanced barriers or enablers; therefore, these results are interpreted through the concepts of behavioral theory and contextual dynamics to provide a fuller understanding of their potential indirect or conditional influence on financial inclusion outcomes (Lusardi & Mitchell, 2014).

2.2.5.2. DEMOGRAPHIC, SOCIOECONOMIC, AND GEOGRAPHIC EFFECTS ON IFB USE

The influence of women on IFB use is illustrated in Table [Table 2.8](#), Column 5, which reveals that the positive coefficient and significant ($p < 0.05$) effect of females on IFB use indicate that women are more likely to use IFB compared to men.

Although gender bias due to within-household observational correlation is controlled in the fixed-effect REML results, this study refutes prior claims that being female created a significant statistical difference in acceptance of IFB financial services. The same result for Indonesia, Bangladesh, Turkey, and Uganda was confirmed by Datta & Manjula (2019), Naceur et al. (2015), Baele et al. (2014), and Mohieldin et al. (2011). These prior studies argue that the combination of principles and values—religious preferences, experience of financial exclusion, and socioeconomic factors—leads to a positive relationship between being a woman, being unemployed, living in a rural area, and using shariah-compliant financing services.

However, according to Abedifar et al. (2016) and (2013), gender differences are mixed, as the findings are inconclusive regarding the positive or negative effects of gender on shariah-compliant banking and finance use.

Age influences on IFB use: Age has a negative coefficient, and age squared has a positive coefficient, indicating that age has a non-linear causal effect on IFB finance use among adults in Ethiopia. However, the statistical significance of both effects is low. This finding suggests there is no clear evidence that age significantly influences IFB usage in this REML model, which controls for within-household fixed effects. Khmous and Besim (2020) found that being male and older positively impacts Islamic financial inclusion in MENA countries.

Education and mobile phone ownership: Replication of well-established results, educational attainment, and owning a mobile phone positively affect the probability of using IFB services, indicating common patterns across different contexts with prior results of Ali and Ghildiyal (2023), Kurunkatil (2019), Fungáčová and Weill (2015), and Demirgüç-Kunt et al. (2018).

However, Khmous and Besim (2020) and Baele et al. (2014) claim that the IFB service preference by these demographic groups is due to the high quality of education, the absence of interest, and the availability of business start-up support from the IFB financial institutions.

Additionally, the results of this study contrast with those of Albaity & Rahman (2019) and Ahmad & Al-Zu'bi (2011), who contend that the lack of digital skills associated with owning a mobile phone does not positively influence the usage of IFB services. They claim adult clients' trust and use of Shariah-compliant financial services might be adversely affected by data security and privacy concerns, such as the possibility of data theft.

Shock and Financial Capabilities: This study finds a positive correlation between an individual's financial capabilities and the shock resilience effect on IFB use.

The ability to save 600 ETB, equivalent to \$21 in 2018/19, at least once a year, is an

average measure of financial ability and a proxy for income. This implies that lower-income adults are more likely to utilize IFB services.

Likewise, those who are shocked or worried about their ability to pay for unexpected costs are more likely to use IFB services. However, at a 5% significance level, neither financial capacity nor shock resilience showed any clear variance in the use of IFB by individuals living in Ethiopia.

Informal (*Equb*) saving: Adults who prefer to save money in the informal financial sector have a negative and significant effect on the use of formal financial services through interest-free banks (IFBs). Our modeling results indicate that informal saving (*EQUB*) has a statistically significant negative influence ($\beta = -0.037, p < 0.001$) on financial inclusion in IFBs. Conversely, a decrease in informal savings for *Equb* is likely to increase the likelihood of using formal interest-free financial services. This finding contradicts results from a study conducted in the West African Economic and Monetary Union (WAEMU) countries by Coulibaly & Sirpé (2023) and Abdesamed & Wahab (2015), who claimed that informal savings positively influence individuals' behavior toward formal savings. In this context, bridging informal savings with formal financial inclusion requires a strategy that includes partnering with institutions and social trust-based *Equb* groups, designing IFB products that align with cultural values, enhancing financial literacy, and strengthening regulations to foster inclusive and culturally sensitive financial integration. Additionally, future research should explore the reasons individuals prefer informal *Equb* savings over formal financial services.

Rural Residents and Unemployment: From the above [Table 2.8](#), individuals who live far from FFI, being rural residents and unemployed adults, are less likely to use IFB financial services than their counterparts. This insight is consistent with prior studies by Lyons et al. (2020), Giday (2023), and Desalegn & Yemataw (2017). On the flip side, FinTech's game-changing function promotes adult financial inclusion regardless of residential location or proximity to FFI, as it is not constrained by physical accessibility. For example, according to Ali (2020), some microfinance institutions in rural areas, such as Somali, Harar, and Dire Dawa Microfinance S.S. and Oromia Credit Saving Sharing

Company (OCSSCO), provide savings and credit services based on Shariah principles, thereby increasing the financial inclusion of rural residents and unemployed adults.

Adult religious affiliation also influences the use of IFB. Protestant Christians and Catholics showed a negative correlation between their use of IFB services and the EOTC Christian religion. Muslim adults and other religions (Wakfeta and Pagan) exhibited favorable sentiments about IFB inclusivity.

In this sense, compared to their orthodox Christian counterparts, Muslim adults have a much higher probability (at a 1% level of significance) of utilizing IFB services. According to prior support by Abedifar et al. (2016), Naceur et al. (2015), and Demirgüç-Kunt et al. (2015) and (2013), shariah-compliant banking and finance provide an alternative for individuals who prefer interest-free financial services due to religious beliefs, resulting in an increase in the financial inclusivity of adult Muslims. However, it is debatable whether the policy (Hailu et al., 2019) resulting from NBE's 2019 launch of the IFB service as part of the 2013 national financial inclusion reform has enhanced adult Muslims' financial inclusion in Ethiopian financial institutions.

Regional Geographical Location Influence on IFB Use: The regional variation in IFB use in Ethiopia is also revealed by the positive and statistically significant coefficients of Oromia and Harar at 1% and 5% significance levels, respectively.

Accordingly, compared to adults living in Addis Ababa, the capital city, adults living in the Oromia and Harari regional states of Ethiopia have shown a strong likelihood of using the IFB service. Adults living in Afar, Somalia, SNNP, Dire Dawa, and the IFB service showed a similar positive correlation. While being an adult from the Amhara and Tigray regional states has been negatively related to IFB service use, keeping other things constant, the latter result is insignificant at 5%.

2.2.6. CONCLUSION AND IMPLICATIONS

2.2.6.1. CONCLUSION:

In this study, the mixed effect model was used, which accounts for the nested structure of the data by including both fixed effects, deviations, and random effects across households. The robustness test of the modeling confirmed that this approach is trustworthy and valid, leading to an unbiased conclusion.

To begin, the findings revealed that both digital and financial literacy among Ethiopian adults have significant positive influences on their ability to use IFB financial services. As per the study, higher levels of these literacies are associated with more informed adult financial decisions, which in turn enhance adult IFB financial inclusivity.

Second, the survey result uncovers that women are more likely to use shariah-compliant financial services (IFB) than men, and similarly, shocked adults and lower-income adults are more likely to use this alternative financing. This makes IFB services and products a more important model for gender, lower-income groups, adult financial resiliency, and well-being.

Third, the study found that informal saving for *EQUB*, higher educational attainment, and owning a mobile phone positively affect the probability of using IFB services. Specifically, mobilizing savings from informal institutions, e.g., institutionalizing digital ROSCA (*EQUB*), has a beneficial influence on IFB financial inclusion.

Fourth, the data highlights that rural adults, the unemployed, and those living far from FFI hubs are less likely to use Shariah-compliant financial services. This insight, consistent with prior studies, confirms persistent adult financial exclusivity. Finally, the study concludes significant regional and religious affiliation disparities in using IFB services in Ethiopia.

2.2.6.2. POLICY RECOMMENDATIONS:

The following policy recommendations were forwarded to various government, federal, and regional organizations and individuals, such as the National Bank of Ethiopia (NBE), the Ministry of Innovation and Technology (MinT), the Ministry of Education, NGOs, public and private financial institutions, and fintech companies that are working to promote digital transformation and financial inclusion in Ethiopia.

First, strengthening and developing comprehensive digital and financial literacy programs aligned with the initiatives that focus on promoting an optimal, digital, and inclusive financial system among adults, especially women, rural, and lower-income groups. This can involve creating national plans, integrating digital financial education into school curricula, training and educational procedure reforms, conducting awareness campaigns on IFB education (for educators and institutions), and developing DL training programs and modules. Regulators, fintech companies, IFB service-providing financial institutions, and other stakeholders could collaborate through public-private partnerships to promote financial inclusion. Such collaboration could also involve encouraging value-based financing, knowledge-sharing and capacity-building programs, and facilitating learning experiences and adaptations. Tailoring the content and delivery of such education to the diverse socioeconomic and demographic contexts of adults is also crucial.

Second, prioritize investments in digital infrastructure to improve internet connectivity and mobile network coverage, particularly in rural and underserved areas. This could be done by fostering public-private partnerships to accelerate infrastructure development, ensuring that affordable technology solutions, such as low-cost smartphones, are accessible to low-income individuals. The Digital Ethiopia strategy points out the need for such collaborations to enhance digital access and inclusion.

Third, promote gender inclusivity in financial services, including financial institutions and government bodies. We must encourage financial institutions and government bodies to innovate and promote financial products specifically for women, acknowledging their higher engagement with IFB services. This will be possible by creating awareness

campaigns and supporting networks that empower women to utilize financial services and enhance their financial decision-making capabilities. Such offerings could also include savings accounts with IFB principles or micro-financing options that cater to women entrepreneurs.

Fourth, establish a supportive regulatory framework with the National Bank of Ethiopia (NBE) and other regulatory bodies. It is advised to create a supportive, transparent, and flexible regulatory environment that encourages innovation in digital financial services and IFB human resources developments to serve users and strengthen institutions.

This could include educational and training procedure reforms to facilitate the entry of IFB educational and training institutions and enable licensing processes. It recommends policymakers use the IFB model for future inequality reduction and regular monitoring of policies and regulatory frameworks to maximize benefit. This aligns with the Homegrown Economic Reform Agenda, which aims to liberalize key sectors and promote inclusivity.

Fifth, Foster Community-Based Financial Solutions: Support the integration of informal savings groups, such as *EQUB*, into the formal financial system. Provide training and resources to these adults, helping them transition to using formal banking services and improve their financial well-being. This approach can leverage existing community trust and networks to promote IFB services.

Sixth, address regional disparities in adult financial inclusion: Despite the high demand for Islamic financial banking (IFB) products, particularly among the Muslim population across Ethiopia's regions, challenges such as limited awareness and regulatory constraints—especially regarding financing—hinder service expansion. It is essential to develop region-specific strategies that take into account local socioeconomic conditions and cultural factors influencing financial behavior. Policymakers should implement targeted outreach programs in rural and remote areas to enhance awareness of IFB services. Additionally, strategic and innovative regulations can create enabling environments for market growth when local governments align their plans with national

financial reform agendas. This approach will support banks in expanding IFB offerings that align with both social and commercial objectives.

2.2.7. FURTHER RESEARCH AND LIMITATIONS:

The study on IFB service-linked digital financial literacy for financial inclusion is too broad and requires deep micro-level studies for specific social demographic groups. It also needs a national, updated survey to reassess the digital financial literacy gap. The study's limitations include the absence of supply-side data and more years of baseline data.

CHAPTER 3: GENERAL FINANCIAL INCLUSION⁷⁸

Abstract

This study examined the influence of financial and digital financial literacy on financial inclusion in an Ethiopian sub-national context. This study utilized data from Ethiopia's country-specific Socioeconomic Survey (ESS) 2018–19. Two methods were applied to data analysis. First, individual bivariate analysis of digital financial literacy, financial literacy, and financial inclusion among different individuals was shown using descriptive statistics and principal component analysis (PCA) techniques. Second, a variation of the mixed-effects maximum likelihood model was used for econometric analysis. The study reveals an uneven distribution of adults' digital and financial literacy across various regions, genders, rural areas, ages, incomes, and religions. The results of the mixed-effect regression demonstrate a positive correlation between digital and financial literacy scores and financial inclusivity. Digital and financial literacy are pivotal lifetime skills for financial inclusion, while socioeconomic and regional disparity demand context-tailored solutions. Policymakers must prioritize dual intervention, enhancing financial literacy by incorporating financial literacy education and digital skills through technology to achieve the transition from structured exclusion to robust inclusivity. It is critical to provide enabling conditions for financial innovations that develop financial products and solutions that reflect the social and regional disparity of the country's diverse communities and groups, which promote digital and financial inclusion.

Keywords: *digital financial literacy, financial literacy, financial inclusion, socioeconomic disparity, Ethiopia.*

⁷ This chapter under review is a preprinted article version publicly available (link <https://ssrn.com/abstract=5238562>) and is expected to be published by the Social Science and Humanity Open, Ref.: Ms. No. SSHO-D-25-00912. This journal is a high-quality publication by the Scopus-indexed Elsevier publisher group.

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3.1. Introduction

The nations in the world have made financial inclusion (FI) and digitalization priorities for policy because they are acknowledged as among the most important components of inclusive growth and economic development (Yaqin & Safuan (2023); Yang & Zhang (2020); and Kanungo & Gupta (2021)). And according to Parvin & Panakaje (2022) and Khera et al. (2022), financial inclusivity is essential for boosting social values, financial well-being, and creating prosperous and healthy futures for all populations.

The National Financial Inclusion Strategy (NFIS) in 2016 and the National Digital Payment Strategy (NDPS) in 2020 outline Ethiopia's commitment to digital progress, innovation, and economic development through enhanced digital accessibility and financial inclusion, among other major efforts. Tasks like Digitruck Ethiopia and Fayda's digital digitalization project aim to improve digital literacy by giving underserved communities access to technology and education, enhance financial inclusion, and modernize public services. This approach implies that the realization of these opportunities is also contingent upon individuals' ability to effectively navigate the digital financial ecosystem. These objectives are critical for achieving a goal where 70% of Ethiopians are digitally skilled and aligned with other targets (Union, A., 2020; Ahmed Ali, 2025; GSMA, 2023a). Additionally, adult financial innovations can promote sustainable development and assist the nation in reaching its SDGs by 2030.

Conceptually, digital and financial literacy are essential in today's digital age. According to Golden and Cordie (2022) and Lyons et al. (2020), digital literacy involves using digital devices and technologies for information retrieval, creation, evaluation, and communication. It equips individuals with the specific skills to access information, communicate online, and use digital tools for personal and professional tasks.

However, financial literacy, as defined by Lyons et al. (2021), is a multidimensional behavioral concept that includes knowledge about financial concepts and products, communication skills, financial ability, real use of financial instruments, and confidence in past financial decisions.

As stated by these authors, DFL combines financial knowledge with digital skills to enable informed financial decisions in the digital realm. This implies that both forms of literacy are crucial for navigating and thriving in the digital world.

In the current study, the idea of FI in the digital age refers to fair, equal, and attainable access to financial services for all, especially underserved and economically marginalized segments (Rawat et al., 2023). As asserted by Gabor and Brooks (2017), a clear beneficial impact of financial inclusion comes with a request that development interventions must be coordinated through networks of tech companies, philanthropic funding, development nonprofits, and government entities.

Prior studies consistently affirmed that FI necessitates addressing issues such as basic connectivity, financial literacy, and social awareness. (Aziz & Naima, 2021, and OCED, 2013). The World Bank (2018b) reported the same conclusion: a lack of financial literacy is one of the main obstacles to adult financial inclusion. The bank also asserts that adults' ability to use digital means, particularly digital financial services like digital wallets, mobile banking, and FinTech services, is expanding.

According to "Digital Ethiopia for All," deployment of digital initiatives across all sectors of Ethiopia is limited, caused by a lack of basic digital skills and awareness. As per an IFC (International Finance Corporation) estimate, by 2030, well over 230 million jobs in Sub-Saharan Africa will require digital upskilling or reskilling.

Despite these progressive ongoing initiatives, insights from WB financial inclusion data from 2011 to 2022 show that Ethiopia has one of the lowest levels of financial inclusion when measured in all areas of access, usage, and awareness of digital technology. For instance, in 2022, approximately half of Ethiopian adults with bank accounts utilized them for savings, compared to roughly 1/3 of adults with mobile money accounts (which accounted for only 5% of all accounts) who did the same. Families, friends, and savings clubs continue to be effective means of saving money; in 2022, 30% of adults borrowed from them, whereas borrowing via FFI decreased from 7% in 2014 to 4.6% in 2022, as indicated by Demirgüç-Kunt et al. (2022). Despite 5% of adults making utility payments

and 79% relying on cash transactions in 2022, the remaining 16% likely use alternative payment methods such as informal channels, delayed payments, or combined modes. This situation highlights persistent reliance on cash and non-digital means, underscoring significant barriers to full digital financial inclusion (Demirgüç-Kunt et al., 2022; Suri, 2022; World Bank, 2021).

Digital financial inclusion faces challenges that require evidence-based improvements through social inclusion, financial literacy, lack of trust, and data privacy concerns. Ensuring accessibility and the effective use of financial services by rural populations is particularly important (Mossie, 2023; Mossie, 2022; Parvin & Panakaje, 2022).

Therefore, basic literacy and mobile internet awareness continue to be significant issues in Ethiopia, particularly affecting the 77% of the population living in rural areas, where there is a national gender gap of 14.8%. According to Lyons (2020), Parvin & Panakaje (2022), and Wang & Fu (2021), FI enables illiterate individuals and underprivileged groups who risk falling behind financially and technologically. Across Ethiopia, millions of adults are excluded from the formal financial system, not only due to a lack of infrastructure but also due to a systematic structure, cultural misalignment, and digital anxiety. Critics argued that agency, dignity, and belonging, rather than account numbers, measure financial inclusion. However, there are still unanswered questions regarding the effectiveness of literacy in facilitating the use of inactive accounts. This conclusion implies that it is essential to study FI alongside redefined future literacy.

In this context, understanding how adult FL and FL influence financial inclusion becomes imperative, with particular attention to local contexts and sub-national realities.

Prior studies indicate that higher levels of financial literacy, including digital financial literacy, were associated with increased financial inclusion and savings behavior (Golden & Cordie, 2022; Morgan et al., 2019; Sayinzoga et al., 2016; and YinYin et al., 2022). On the other hand, financial exclusion harms individuals and communities.

Other studies have shown that individuals with higher levels of digital and financial literacy are more likely to utilize formal banking services, make informed financial

decisions, and build savings buffers for emergencies (Lusardi & Tufano, 2015). Linking financial inclusion and FinTech, Demirgüç-Kunt et al. (2018) revealed an increased DFL could lead to higher adoption and better usage of digital financial services, supporting financial inclusion efforts, especially in developing economies.

Despite its significance, the relationship between digital financial literacy and financial inclusion remains less known, particularly within the Ethiopian local challenges context.

Existing literature predominantly focuses on developed economies, leaving a notable gap in understanding how digital and financial literacy interventions can drive financial inclusion in diverse countries like Ethiopia. There are research gaps, particularly in Ethiopia, that investigate the relationship between digital and financial literacy and financial exclusion, taking into account how socioeconomic status, gender, and age influence adults' access to and use of formal financial services, particularly among Ethiopia's marginalized groups (Mossie, 2022; Kebede et al., 2020).

This study has three key objectives: first, to analyze the influence of digital financial literacy on adult financial inclusion; second, to determine the effect of financial literacy on adult financial inclusion in Ethiopia; and third, to investigate the effect of demographic, socioeconomic, and geographic disparity on financial inclusive in the Ethiopian local context.

To align with the study objectives, the author employs institutionalist and behavioral social perspectives to develop hypotheses and define key variables, including financial inclusion, financial literacy, and indicators of digital financial literacy, while focusing on psychological theories and multidimensional approaches to literacy.

The institutional theory perspective, as articulated by Meyer and Rowan (1977) and Gabor & Brooks (2020), highlights how formal rules, policies, and the coordinated networks of financial institutions, philanthropic organizations, nonprofits, and government entities collectively influence the accessibility and adoption of financial services. This perspective is pertinent to the operational analysis of how informal rules, norms, and structures that shape behavior and societal expectations affect both individual

and collective behaviors within financial systems (Ozili (2020a) and (2022), Gomes et al. (2020), Maison (2019), and Yeo et al. (2023)).

Bandura (1977) and Ajzen (1991) discuss the theory and practice of behavioral social psychology. Rooted in psychological and behavioral theories, this perspective focuses on how an individual's attitude, social norms, perceived behavioral control, and multidimensional literacy influence financial behavior and the adoption of financial services (Branch, 2014; Ozili, 2021; Setiawan et al., 2022).

In this context, cognitive biases, emotions, social norms, and perceived control profoundly influence financial decisions. The link between financial literacy (FL) and behavioral outcomes shows that higher FL enhances confidence, reduces susceptibility to biases, and increases the likelihood of adopting sound financial behaviors and new technologies, as these sources cited above indicated.

These theoretical and empirical concepts are also relevant for assessing the variation in financial inclusion outcomes driven by socioeconomic and demographic elements such as gender, rural-urban residency, age, education level, income and employment, mobile phone ownership, and geographic region, which reflect unequal access and usage (Gomes et al. (2020), Maison (2019), and Yeo et al. (2023); World Bank, 2022).

Following that, the synthesis of theoretical and empirical tests of what is known was done, and to develop the following three key hypothesis tests were conducted.

Hypothesis 1 (H1): Adults' digital financial literacy (DFL) has a significant positive influence on financial inclusion. i.e., H1: $\beta > 0$. The studies conducted by Lyons et al. (2020), Golden and Cordie (2022), and Ozili (2020a) support this hypothesis.

Hypothesis 2 (H2): Financial literacy (FL) has a strong positive influence on financial inclusion. i.e., H2: $\beta > 0$. (Lusardi & Mitchell, 2014; Oberrauch et al., 2025; and Ozili, 2020a)

Hypothesis 3 (H3):

Demographic (gender, rural, age, education), socioeconomic (income, employment status, own-mobile), and regional place factors have a significant influence on financial inclusion in Ethiopia. H3: $\beta \neq 0$. (Sharma & Vidyashree, 2025; Mandala et al., 2025; World Bank, 2022)

In doing so, the study provides insightful evidence to academics, practitioners, and policymakers who are working to advance digital and financially inclusive sustainable development.

3.2. The Data and estimation strategy of the study

3.2.1. Data, variable definitions, and measurements

The study utilized a secondary cross-sectional dataset obtained from the Ethiopia Socioeconomic Survey (ESS) 2018/19. The purpose of this multi-topic ESS-FI module was to collect data to measure progress in financial inclusion indicators for the Ethiopian National Financial Inclusion Strategy in collaboration with the World Bank.

The data collection instruments were structured by focusing on access to finance, account ownership, financial service use (including IFB use), digital financial services (ATMs, mobile money, online banking, debit cards, and credit cards), and digital and financial literacy (knowledge, attitudes, and behaviors). And the survey has representatives of 6,700 households across nine regions, two cities, rural and urban areas, and 565 enumeration areas.

In addition, pertinent socioeconomic and demographic information about households was incorporated into the survey questions. This ESS-2018-19⁹ dataset is an example of grouped, nested data that contains data at individual and state levels or individual, state,

⁹ *The data is available through the world bank microdata library website:*

<https://microdata.worldbank.org/index.php/catalog/3823>

and country levels. Adults within the treatment group, adults within states, and individuals within communities or nations at the sub-national level are all included in this constructed data. As noted by Cameron & Miller (2015) and McNeish & Kelley (2019), it is pertinent to rigorous and superior behavioral finance, psychology, and educational policy research.

According to the current study objectives, the researchers were able to examine the individual financial inclusion nexus of financial literacy variances between gender, age, income level, education, regional disparities (locations), religion, and employment thanks to this micro-level cluster data.

Variable measurements: The dependent variable, financial inclusion (FI) measurement, includes three sub-dimensions: access, usage, and quality of financial services.

To measure adult access to finance, six indicators are used: the complexity of the procedure to open bank accounts, the cost of opening bank accounts, proxies for financial inclusion (FFI), documentation barriers, the expensiveness of formal insurance, and the distance from adults to formal insurance providers.

On the other hand, the usage dimension of financial inclusion is further divided into ownership of accounts at formal financial institutions (FFIs), ownership of formal insurance, saving in FFIs, financial service use, and frequency of saving in FFIs. Specifically, financial service use is measured by five indicators, such as the use of mobile banking, online banking, ATMs, agent banking, and interest-free banking services.

As one can see, the key independent variable is financial literacy (FL), which is multidimensional and measured by including a linear combination of an individual's financial knowledge, attitude, and behavior as guided by the OECD's (2018) and Lusardi and Mitchell's (2014) approach. Following that, the study used the proven techniques from OECD/INFE 2023 and Yang et al. (2020) to measure the three sub-dimensional indicators of financial literacy.

These include the following: (1) financial knowledge is measured by adults' understanding of inflation, interest, and interest-free banking services; their awareness of day-to-day financial management; their knowledge of where to file complaints; their knowledge of the benefits of bank accounts; and their knowledge of how to open an account at a formal financial institution.

(2) Financial attitude indicator: Trust FFI, where you prefer to save, formal or informal, and save at home in cash; and (3) Financial behavior indicators: shock resilience, credit gap, saving for emergencies, health or medical expenses, and saving to start or grow a business.

The DFL was measured using adult online banking capabilities, mobile banking competency, ATM proficiency, and agent banking-specific skills, in accordance with Ravikumar et al. (2022), Oh et al. (2020), and Prasad et al. (2018).

3.2.2. Methods of data analysis and estimation strategy

1. PCA methods

This investigation used PCA methods to calculate mean scores of FI, FL, and DFL. PCA minimizes data dimensions, optimizes variance, and identifies trends as practiced by Camara and Tuesta (2014), Mukherjee and Sood (2020), and Nguyen (2020). It simplifies large datasets into informative components for further analysis and interpretation. PCA aims to obtain a linear combination of variables for causal variance (Gass & Varonis, 1984; Jolliffe & Cadima, 2016).

The principal axis method extracts variance and generates Principal Components (PCs), linear combinations of original variables, weighted by their contribution to explaining variance in a specific orthogonal dimension (Mingione, 2011).

Thus, the description of PCA methods used is presented as follows. Financial literacy (FI) is a multidimensional concept that encompasses access, usage, and quality dimensions of financial services provided to users in the digital age. The latent variable FI is a linear combination of these dimensions, with access and usage determined by combining

indicators. Access and utilization of financial institution services are considered critical indicators for FI.

Scores for measuring financial literacy (FL) are represented as a linear mix of financial knowledge, attitude, and behavior. The latent variable FL score is defined by the linear combination of all three dimensions: knowledge, attitude, and behavior. The researchers applied the STATA PCA multistage procedure prior to practice (Sharma et al. (2023), Pesqué-Cela et al. (2021), Nguyen (2020), and Hanur & Goshu (2023)) to estimate the weights of each dimension and the overall FL score. Scores for measuring digital financial literacy (DFL) are also used, considering individuals' digital financial services usage as an output measure of financial technology (FinTech) products. The latent explanatory variable DFL is a linear combination of these four dimensions, with online banking, mobile banking, ATM, and agent banking as explanatory indicators. The researchers used the same procedure to estimate the weights of each dimension and the overall DFL scores.

Following FI and DFL/FL score estimation, the authors tested the measurement validity and reliability of the outcome predicting power (Mazziotta & Pareto, 2019, and Xiao et al., 2017).

The study uses an eigenvalue screen plot to visually display eigenvectors in descending order, indicating that PCA eigenvalue approaches are more reliable than conventional methods (Luo & Li (2016), Alhalaseh (2024), and Hizgilov & Silber (2020)). First, the study's scree plot shows that the financial inclusion score, as well as both financial and digital financial scores at the mean level, are closely related and positively correlated. This result indicates that these key variables can measure significant adult financial inclusion disparity. The authors then conducted Kaiser-Meyer-Olkin (KMO) tests to confirm the validity of the study's findings by practicing Cerny & Kaiser (1977) and Shrestha (2021).

Table 3.1 and APPENDIX B 1 presents the PCA procedural validity analysis using KMO methods, confirming that FI latent indicators, including formal financial service usage, access indicators, and saving frequency, meet minimum requirements.

TABLE 3.1 THE KMO AND EIGENVALUES OF FINANCIAL INCLUSION SUB DIMENSIONS

Variable	Comp1	Comp2	Comp3	Comp4	Comp5	Weight	Cum	KMO
Frequency of saving	0.621	0.416	0.101	0.144	0.641	0.324	0.324	0.549
Account Ownership	-0.158	0.044	0.735	0.644	-0.135	0.201	0.524	0.546
Formal Insurance usage	-0.087	0.112	-0.67	0.727	-0.047	0.197	0.721	0.746
ACCESS to Finance	-0.33	0.897	0.002	-0.19	-0.28	0.174	0.895	0.708
Financial service Use	0.686	0.084	-0.05	0.018	-0.722	0.105	1.000	0.712
Eigenvalue	1.618	1.003	0.982	0.872	0.525			0.567

The study indicates that the step-by-step processes used to compute the PCA results meet the requirements for sample adequacy and reliability. The KMO values for the FI mean score, FL mean score, and DFL mean score are 0.567, 0.501, and 69.2, respectively.

The study also uses two latent dimensional indicators to evaluate financial and digital literacy, revealing that the frequency of saving and the use of financial services are the most significant factors in explaining the financial inclusion score dimension (Lusardi and Mitchel (2014) and Lyons & Kass-Hanna (2021)). For example, the frequency of saving (1.618) and the use of financial services (1.003) are the most significant indicators in explaining the financial inclusion score dimension, which measures a 52.4 percent variation (Table 3.1).

The financial literacy sub-dimension variable, financial knowledge, is explained by two indicators: adult knowledge of inflation and awareness of interest-free banking services. The data is particularly useful for analyzing financial behavior, particularly the credit gap (1.083) and emergency savings (1.017). Adults considered financially included are using formal financial services and have access to formal financing, taking their self-response score higher than 0.5 in this context (OECD, 2018). Lusardi and Michell (2014). The

same works for the DFL/FL means score analysis (refer to [APPENDIX B 1](#)). Consequently, the validation tests and the scores for FI, FL, and DFL confirmed that PCA techniques are reliable for use in additional descriptive and econometric models.

2. Econometric Model Specification of Financial Inclusion(FI)

The Model of Financial Inclusion (FI): Due to real-world datasets that comprise both numeric and categorical elements, mixed data clustering techniques have become increasingly popular recently in data science algorithms, as asserted by Khan and Ahmad (2019).

Because the nature of multilevel survey data is inherently hierarchical, mixed-effects models handle estimate issues by nesting the data by geographic region, location, gender, religious affiliation, and family member.

Mixed-effect models (MEM) are statistical techniques that combine fixed and random effects to analyze hierarchical data structures. Kilian and Kelava (2023) assert this point. According to Meteyard and Davies (2019) and Schunck and Perales (2017), these models are useful for analyzing clustered survey data in research on financial behavior and literacy. MEM enhances statistical power, estimates accuracy, and accommodates missing data. It also improves the transparency and productivity of study findings.

This method is particularly applicable to the study of FL, DFL, and FI outcome variation, applying adult data that extends from regional cities to insight analysis at the woreda level. According to Lyons et al. (2020) and Hasan et al. (2021), adult financial literacy and DFL differ not just among people but also between states and demographic groups. Additionally, this mixed-effects technique is very useful for capturing the variation in adult financial behavior across diverse demographic and geographic contexts.

This standard linear mixed effects modeling (LMM,Equation (3.1) specification is based on guidance from McNeish and Kelly (2019) for applying clustered survey data models.

$$FI_i = \beta_1 FL_i + \beta_2 DFL_i + Z_i \mu_i + \epsilon_i \quad (3.1)$$

Where for i =adult observations is the aggregated FI score for the i^{th} individual, DFL and FL are the design matrix for the fixed effect variables, β_1 and β_2 are the vectors of fixed effect coefficients that measure the extent to which FL and DFL score affect FIs, Z_i is the design matrix a vector for the random effect variables that contains demographic and socioeconomic attributes of the i^{th} individual, μ_i is the vector of random effect coefficients, and ϵ_i is the residual error term for the i^{th} individual.

The estimation assumption is the individual adult independence hypothesis that $\epsilon_i = i.i.d. N(0, \sigma^2)$ or $H_0:\beta=0$ and $H_1:\beta > 0$.

However, the behaviors of adults in the same location or home could be interrelated; hence, it is doubtful that any adult FI observation is independent of the others due to the hierarchical clustered data structure. As indicated in the previous sections, this approach might lead to a biased and erroneous assessment (Greene, 2018).

To address the limitations of the conventional ordinary least squares (OLS) standard regression linear mixed model (LMM), Kilian and Kelava (2023) and Leszczensky and Wolbring (2022) have confirmed the effectiveness of using the residual mixed effects model, also known as the restricted maximum likelihood (REML) specification approach. Therefore, by clustering individual adults across households using maximum likelihood, the intercept model of adult financial inclusion (FI) is objectively measured through correlated residual mixed effect modeling (REML), as shown in Equation (3.2). Applying this modeling formula:

$$FI_{ij} = \beta_1 DFL_{ij} + \beta_2 FL_{ij} + Z_i \mu_i + \epsilon_i \quad (3.2)$$

Where FI_{ij} : Financial inclusion for individual i , in household j , FL_{ij} and DFL_{ij} for Financial literacy score and Digital Financial literacy score for individual i in household j . Particularly, This model ((3.2) accounts for variation across individuals regarding unobserved characteristic captured by the random effect.

Following a mixed effect modeling specification requirement that predictor variables not co-vary with residuals (i.e., $Cov[X, u] = Cov[X, r] = 0$), the residual errors are assumed to be correlated within the same family individual, i^{th} , in household j , while varying across i^{th} individual from different clustered households j , or region.

The assumption that the adult dependency: null hypothesis $H_0 \beta=0$ and alternative hypothesis $H_1 \beta \neq 0$ are assumed to be true, which serves as an inference about dependencies within and between cluster effects.

Furthermore, the conditional marginal fixed effect model MFE, Equation(3.3) is developed and estimated using the formula below to clarify the significance of population factors. This model aims to clarify the significance of population-level variation and to enhance the selection process between fixed effects-based margins at the mean and mixed random effects. In a marginal effect model, it is unlikely that the fixed effects of variables are considered for the entire population mean variance and deviation.

Therefore, while keeping all other factors constant, the researchers calculated how a one-unit increase in each independent variable affects the probability of financial inclusion, giving a mathematical overview of this relationship.

$$\frac{\partial P(FI=1)}{\partial X_k} = \beta_k \tag{3.3}$$

Where: β_k is the coefficient (effect) of the k -th covariate X_k , X is the vector of explanatory variables (e.g., FL, DFL, socioeconomic factors, etc.), and β is the vector of coefficients. and the expression $p(FI=1|X, \alpha_j)$ is the likelihood of Financial Inclusion (FI); the outcome variable equals 1, conditioned on covariates X and fixed effect expressed as α_j .

APPENDIXES 1, presents the description/measurement and the predicted hypotheses indicators of the list of variables that influence financial inclusion, along with the sources listed.

3.2.3. Empirical Results, Analysis, and Discussion.

3.2.3.1. Bivariate descriptive Relationship Analysis:

In this section of the study, a bivariate descriptive analysis is presented to compare the mean scores of various dimensions of Financial Inclusion (FI) and Financial Literacy (FL), as well as dimensions of Digital Financial Literacy (DFL), among adults across different locations, genders, and religious backgrounds.

1. Financial inclusion: Rural-urban disparity

Table 3.2, displays the relationship analysis that compares the mean scores of Financial Inclusion (FI) alongside its sub-dimensions and Financial Literacy (FL) among adults in Ethiopia, categorized by urban and rural areas.

Table 3.2 Mean FI and FL scores of adults in Ethiopia by urban and rural areas.

Variable	Mean Urban	Mean Rural	Difference	P-value
Aggregate access score	0.101268	-0.11981	0.221085	0.0000
Usage of formal financial services score	0.100224	-0.11078	0.211010	0.0000
Account ownership score	0.078331	-0.08658	0.164917	0.0000
Formal insurance score	0.016752	-0.01851	0.035269	0.0000
Saving in FFI score	0.059917	-0.06623	0.126147	0.0000
Frequency of saving in FFI score	0.065218	-0.07209	0.137309	0.0000

"Mean Urban" and "Mean rural" show average financial inclusion (FI) and financial literacy scores when rural vs. urban are compared. "Dif" is Mean1 minus Mean2. "T value" and "P-value" are from a two-sample t-test with unequal variances.

The p-values indicate that the t-tests for differences in mean scores across all dimensions of FI are less than 0.05, revealing a statistically significant disparity between urban and rural adults in Ethiopia.

Access and usage: The mean access score for urban adults is 0.101268, whereas the mean access score for rural people is -0.11981. This negative access score for rural adults signifies below-average financial access compared to the overall mean, highlighting substantial disparities where urban adults experience significantly higher levels of financial services accessibility ($p < 0.0001$).

Regarding financial service usage, urban people have an average score of 0.100224, whereas rural adults have a mean score of -0.11078. This difference is 0.211010 ($p < 0.0001$). This significant disparity suggests that urban dwellers have far more access to and usage of financial services than those in rural areas.

Account ownership: The mean score for urban dwellers is 0.078331, but the mean score for rural dwellers is -0.08658, showing a 0.164917 ($p < 0.0001$) difference. This implies that formal financial institution accounts are more likely to be owned by urban individuals.

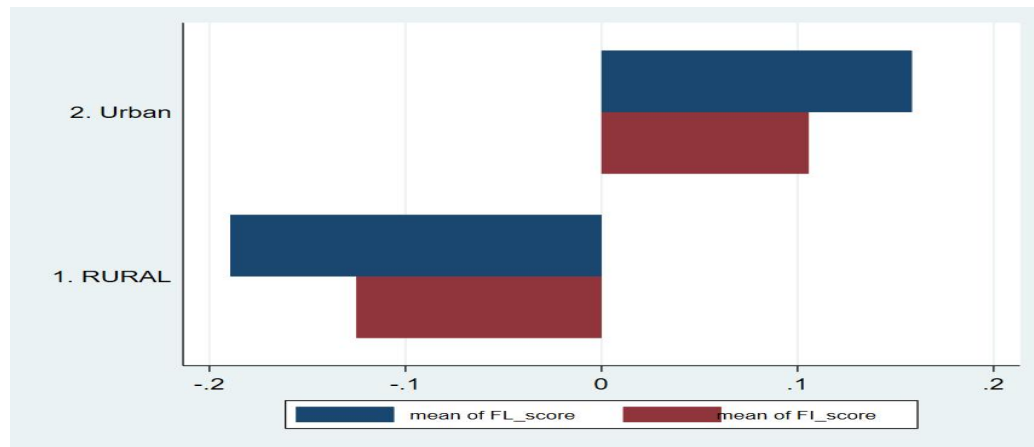
On the matter of saving, the study reveals a significant disparity in savings behavior and frequency between urban and rural adults, with urban adults scoring an average of 0.065218 and rural adults scoring -0.07209, respectively.

The usage of formal insurance services showed a significant difference of 0.035269 ($p < 0.0001$) between urban and rural individuals, with the former scoring an average of 0.035269 and the latter -0.01851.

Urban adults exhibit significantly higher scores in account ownership, frequent savings behaviors, and use of formal insurance services compared to rural adults. This result reaffirms financial access and usage disparities across these dimensions, which show all differences significant at $p < 0.001$.

To further visualize, [Figure 3.1](#) represents the mean FL and FI scores for adults based on their place of residency in Ethiopia. The result reveals a negative mean of FL and FI score metrics for rural adults, substantiating the marginalization of rural adults to seize advantage from the services of FFIs in Ethiopia.

FIGURE 3.1 MEAN FI AND FL SCORES BY PLACE



These findings underscore the marginalization faced by rural residents regarding both FI and financial inclusion, suggesting that they are at a disadvantage when it comes to harnessing the benefits offered by accessing and using formal financial institutions (FFI).

This conclusion was in line with earlier research by Demiruc-Kunt et al. (2018), Yang et al. (2020), and Mudessir et al. (2024), which indicated that rural populations continue to experience systemic obstacles when striving to access and use financial services.

2. Financial inclusion and gender disparity

Finance is one of the key ingredients necessary for ensuring economic and social development. In this regard, ensuring an inclusive financial system for women is a key element to ensuring inclusive growth for women. In this study, the researchers compared the mean scores of the multidimensional financial inclusion analysis with financial literacy to determine gender disparity.

Table 3.3, illustrates the mean scores for different dimensions of FI and FL by gender in Ethiopia. The results are as follows:

TABLE 3.3 MEAN FI SCORES OF ADULTS IN ETHIOPIA BY SEX.

Variable	Mean Male	Mean Female	Difference	t value	P-value
Aggregate access score	0.002091	-0.00184	0.003931	0.35	0.7375
Aggregate usage score	0.079060	-0.07039	0.149452	12.28	0.0000
Account ownership score	0.050219	-0.04471	0.094932	10.81	0.0000
Formal insurance score	0.008510	-0.00757	0.016087	2.2	0.0267
Usage of formal financial services score	0.083962	-0.07476	0.158718	12.042	0.0000
Saving in FFI score	0.050957	-0.04537	0.096328	9.80	0.0000
Frequency of saving in FFI score	0.046151	-0.04109	0.087241	12	0.0000
Financial Inclusion (FI) scores	0.00697	-0.00613	0.01310	1.2	0.2622
Financial Literacy (FL) scores	0.0296103	-0.02618	0.05580	5.87	0.0000

NB. "Mean Male" and "Mean Female" show average financial inclusion (FI) scores for men and women, respectively. Difference, or 'Dif,' is calculated as mean(Male) minus mean(Female). "t-value" and "P-value" come from a two-sample t-test with unequal variances using Satterthwaite's degrees of freedom.

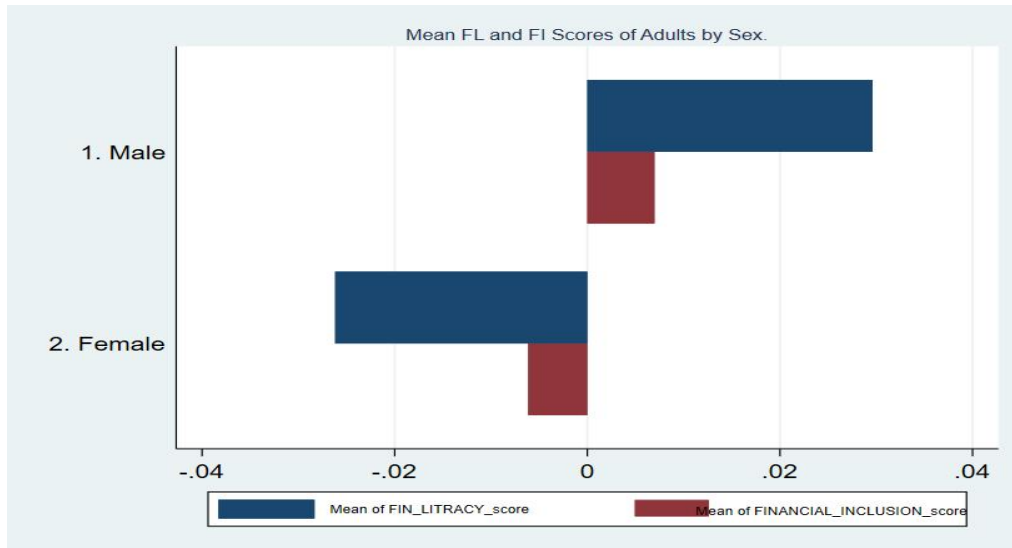
Access and usage: Males have a mean score of 0.002091, while females show a negative mean of -0.00184, resulting in no statistically significant difference ($P=0.7375$). Account usage means 0.07906 for males, compared to -0.07039 for females, with a statistically significant difference ($p<0.0001$). This suggests that men are more likely to utilize financial services than women. For opening an account at a financial institution, males score 0.050219, while females score -0.04472, which is a significant difference to $p<0.0001$.

Formal insurance account scores have a mean score of 0.008510, and females show -0.00757, which is significant at $p<0.0267$.

Financial service usage, which is indicated by the usage of formal financial services such as Internet banking, mobile banking, ATM, and IFB services, revealed a substantial difference at $P<0.0001$. Furthermore, there was a significant gender difference in the amount and frequency of savings in FFI.

The visualized data in [Figure 3.2](#) shows male adults have positive scores for aggregated financial inclusion and higher levels of financial literacy, while female adults exhibit negative scores, highlighting gender disparity.

FIGURE 3.2 FIGURE MEAN FI AND FL SCORES BY SEX



While males generally revealed in better outcomes in terms of account ownership and usage of formal financial services, there is no absolute optimum value access score. Instead, a higher positive score indicates better access compared to the mean, while a negative score signals below-average access.

The lack of significant differences in aggregated access scores suggests that both genders may encounter similar challenges regarding financial inclusivity. This finding collaborates with Mossie (2022), Sakyi-Nyarko et al. (2022), and Roy & Patro (2022)

3. Regional disparity

Table 3.4: summarizes the mean financial inclusion scores across different regional states and city administrations in Ethiopia.

TABLE 3.4 MEAN FINANCIAL INCLUSION (FI) BY GEOGRAPHICAL REGIONS.

Geographical Regions	Mean1	Mean 2	Dif	St Err	t value	P-value
Addis ababa	-.034	.214	-.247	.007	-32.25	0.0000
Tigray	-.013	.117	-.129	.008	-15.95	0.0000
Dire-Dawa	-.008	.086	-.093	.017	-5.75	0.0000
Oromia	-.01	.083	-.092	.009	-9.6	0.0000
SNNP	-.007	.067	-.073	.008	-9.25	0.0000
Ahmara	-.007	.058	-.065	.009	-7.2	0.0000
Harar	.002	-.02	.022	.059	.35	.7100
BG	.002	-.035	.037	.016	2.35	.018
Gambela	.008	-.103	.111	.017	6.65	0.0000
Afar	.013	-.18	.194	.013	14.25	0.0000
Somali	.051	-.494	.545	.025	21.65	0.0000

Dummy *Mean1=No **Mean2=yes

"Mean1" and "Mean2" show average financial inclusion (FI) scores for each geographical region group being compared. "Dif" is Mean1 minus Mean2. "T value" and "P-value" are from a two-sample t-test with unequal variances using Satterthwaite's degrees of freedom. Large t values and $p < 0.05$ indicate strong, significant differences in FI scores between the regions. For example, in the information presented for Addis Ababa (line 2), "Mean 1" refers to the mean FI score for non-Addis Ababa adults, while "Mean 2" indicates the mean FI score for adults residing in Addis Ababa.

From [Table 3.4](#), it is visible that low negative mean scores of FI exist in the five emerging regions: Somali (-0.494), Afar (-0.18), Gambela (-0.103), Benishangul Gumuz (-0.035), and Harar (-0.02) regional states. Positive scores indicate above-average financial inclusion compared to the national sample mean, while negative scores indicate below-average financial inclusion.

The Somali regional state is the lowest scorer of mean FI, followed by the Afar regional state. Adults in Oromia reported a lower positive mean Financial Inclusion (FI) score of 0.083. Despite being one of the largest regions, Oromia faces challenges related to accessibility and awareness of financial products.

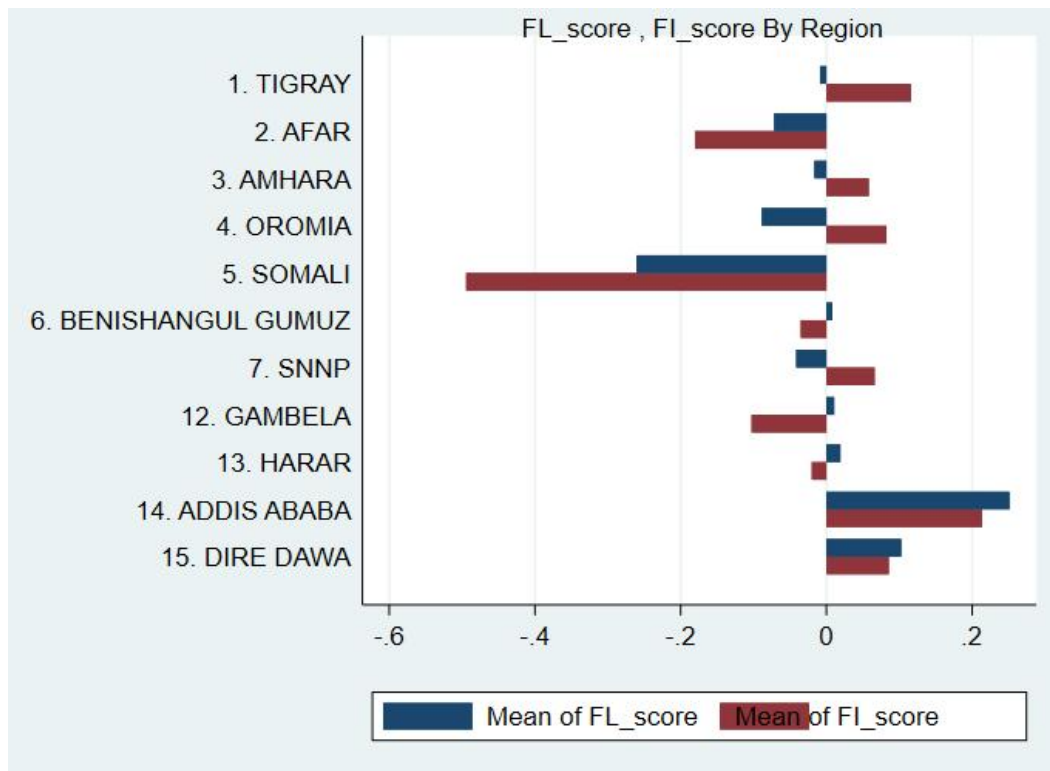
The Addis Ababa city administration had the highest positive mean FI score (0.214), followed by the Tigray regional state (0.117). This implies that, compared to adults living

in the capital city of Addis Ababa, those residing in the Somali, Gambela, and Afar regional states are more likely to experience substantial exclusion as well as limited access to and usage of formal financial services in Ethiopia.

The micro-level disaggregated result of FI in [Figure 3.3](#) Mean FI and FL scores by Region indicate that the four emerging regions—Afar, Somalia, Gambela, and Benishangul Gumuz—have negative mean scores for adult financial inclusivity. The regional states of Somalia, Afar, and Gambella have consistently shown the lowest mean FI scores in that order. However, the city administrations of Addis Ababa have the highest positive mean FI scores, followed by those of Tigray and Dire Dawa.

Regarding FL, Similarly, [Figure 3.3](#) shows that Somalia, Oromia, Afar, and SNNP had negative mean FL scores, which have compounded the effects of financial exclusion. Positive FL scores were found consistently in Addis Ababa, Dire Dawa, and Harar.

FIGURE 3.3 MEAN FI AND FL SCORES BY REGION



The significant disparity between urban cities like Addis Ababa and more rural regions such as Somali demonstrates that access and usage of financial services are not uniformly distributed across Ethiopia, which aligns with studies of the World Bank (2021).

4. Religious affiliation on Financial inclusion

This data insight also details differences in FI based on adult's religious affiliation as presented in Table 3.5 below.

TABLE 3.5 FINANCIAL INCLUSION SCORE BY RELIGIOUS

	Mean1*	Mean2**	dif	St Err	t value	p value
EOTC	-.089	.107	-.197	.012	-16.4	0.000
Muslims	.08	-.134	.214	.011	18.6	0.000
Catholic	.001	-.105	.106	.053	2	.046
Protestant	-.004	.021	-.024	.011	-2.3	.021
Others	.001	-.065	.065	.043	1.5	.133

Dummy *Mean1=No **Mean2=yes

"Mean1" and "Mean2" denote the average financial inclusion (FI) scores for the two religious groups being compared. "Dif" represents the difference between these means, calculated as Mean1 minus Mean2. The "t value" and "p value" are results from a two-sample t-test with unequal variances, utilizing Satterthwaite's degrees of freedom. For example, in the row 2 analysis of EOTC, the term "Mean1 average" in the religion columns indicates the FI score for individuals affiliated with Non-EOTC religions compared to those affiliated with EOTC.

According to their self-reported answers, Muslims have a negative mean financial inclusion (FI) score of -0.134, while Catholics have a slightly lower negative score of -0.105. On the other hand, EOTC members have a positive mean score of 0.107. The highest positive mean FI score is registered for EOTC (0.107), followed by Protestant (0.021). The findings indicate that adult members of the EOTC have a higher likelihood of being included in the country's financial system, which is statistically significant at $p < 0.01$.

This discrepancy implies that a person's religious convictions affect whether they interact with the official financial system or not. Adults may turn to unofficial financial methods

as alternatives, which might result in decreased FI rates, similar to claims by Ghosh (2020) and Demirgüç-Kunt et al. (2018).

3.2.3.2. Econometric Regression Analysis

The mixed-effect econometrics modeling findings are shown in Table 3.6 were estimated using the mixed-effect maximum likelihood Stata 17 syntax command, which is shown below. To for adult financial behavior within the same household dependency, a linear mixed model (LMM, column 2) was estimated first, then residual maximum likelihood (REML, column 3) was fitted. The findings of the nested marginal effect were then presented (MFE columns 4).

TABLE 3.6 ECONOMETRICS MODELING OF FINANCIAL INCLUSION(DEPENDENT VARIABLE)

Variables (at their mean)	Standard LMM*	REML**	MFE***(dy/dx)
Financial literacy	0.00711***(6.54)	0.00681***(6.06)	0.00681***(6.06)
Digital Financial literacy	0.137***(35.31)	0.135***(36.70)	0.135***(36.70)
Demographic, socioeconomic, and geographic effects			
Distance	-0.0106***(-12.42)	-0.0106***(-11.81.)	-0.0106***(-11.81)
Rural	-0.00528***(-3.78)	-0.00520**(-3.21)	-0.00520**(-3.21)
AGE	0.000937***(5.16)	0.000974***(5.80)	0.000974***(5.80)
age2	-0.00000706***(-3.55)	-0.00000769***(-4.15)	-0.00000769***(-4.15)
Female	0.000921(0.79)	0.000266(0.26)	0.000266(0.26)
Unemployed	-0.000953(-0.79)	-0.000912(-0.78)	-0.000912(-0.78)
EDUC_ATTAINMENT	0.000599***(9.35)	0.000565***(8.99)	0.000565***(8.99)
Income : (Daily save)			
Save_600 ETB (Weekly)	0.0273***(7.42)	0.0277***(7.79)	0.0277***(7.79)
Save_600_ETB(Monthly)	0.00511**(2.71)	0.00694***(3.76)	0.00694***(3.76)
Save_600 ETB(Annually)	-0.00251(-0.82)	-0.00269(-0.91)	-0.00269(-0.91)
Shock Resilience	0.00622***(5.33)	0.00541***(4.48)	0.00541***(4.48)
Religion :EOTC reference			
Catholics	0.0128*(2.31)	0.0104(1.71)	0.0104(1.71)
Protestant	-0.00909***(-4.68)	-0.00872***(-3.87)	-0.00872***(-3.87)
Muslims	0.00329*(2.08)	0.00217(1.17)	0.00217(1.17)
Others (Pegan & wakefena)	-0.00143(-0.22)	-0.00237(-0.35)	-0.00237(-0.35)

	Region Dire Dawa(base)		
Region Addis Ababa	0.00669**(2.69)	0.00789**(2.58)	0.00789**(2.58)
Afar	-0.0204***(-7.02)	-0.0194***(-5.67)	-0.0194***(-5.67)
Amhara	0.00544*(2.03)	0.00620(1.93)	0.00620(1.93)
Oromia	-0.00383(-1.47)	-0.00165(-0.53)	-0.00165(-0.53)
Somali	-0.0172***(-6.26)	-0.0167***(-5.03)	-0.0167***(-5.03)
BG	-0.00939**(-3.04)	-0.00899*(-2.43)	-0.00899*(-2.43)
SNNP	0.00272(0.96)	0.00342(1.01)	0.00342(1.01)
Gambela	-0.0210***(-7.04)	-0.0207***(-5.8)	-0.0207***(-5.8)
Harar	0.000920(0.34)	0.00210(0.64)	0.00210(0.64)
Tigray	0.00428(1.54)	0.00580(1.74)	0.00580(1.74)
Constant	0.0427*** (6.85)	0.0448*** (7.31)	0.0448*** (6.54)
Diagnostic tests			
N	14193	14193	14193
AIC	-36935.0	-38064.6	-38064.6
BIC	-36708.2	-37837.8	-37837.8
Log likelihood	18497.507	19062.3	
Wald chi2(27)	1.7E+06(p>0.0000)	1.51E+06(p>0.0000)	
LR test		1129.58(prob>=0.0000)	

NB *** p<.01, ** p<.05, * p<.1 ,*linear mixed model,** residual maximum likelihood
***marginal fixed effect

3.2.3.3. Regression output results and robustness testing

The robustness test of the econometrics regression results was examined using post-estimation diagnostic tests, including the Wald test, likelihood ratio, consistent key coefficient significance, and model selection tests (AIC and BIC), as shown in [Table 3.6](#).

First, the nested model fitness estimation using REML has an AIC value of -38064.6 and a BIC value of -37837.8, whereas LMM has an AIC value of -36939 and a BIC value of -36227.3, as shown in the bottom part of the result table. This means that the REML

model has a better fit in comparison since its AIC and BIC scores are lower. Şen & Cohen, A. (2023) and Likhachev (2017) found that AIC and BIC values strike a compromise between model complexity and fit.

Next, the consistent significance of key variables Coefficients in [Table 3.6](#):The consistency of key variable coefficients across the three models indicates the robustness of mixed effects modeling results. For instance, the coefficient in DFL is close to 0.135 for all of these models, and they are all statistically significant at $p < 0.01$. This implies that DFL positively influences financial inclusion outcomes. 0.00711 (LMM) and 0.00681 (REML and marginal fixed effect) are the coefficients for FL, and they are all significant at $p < 0.01$. This consistency indicates that generic financial literacy regularly influences financial inclusivity. The trustworthiness of the results is further supported by the demographic coefficient (age and age squared), socioeconomic factors (income as a proxy for savings, education, and financial resilience), and the consistent geographic disparity of the same locations throughout all models.

Hypothesis testing using the Wald and Likelihood Ratio (LR) test:

Wald Test: Assume the same random and fixed effects by taking a weighted average of variance estimates within and across household clusters, which is similar to the traditional OLS estimation of adult independence. The null hypothesis (adult independence hypothesis of the linear mixed model) is strongly rejected, and the full model is significant, according to the Wald test statistic for model fitness (p -value = 0.0000) with a large number of the Chi-square distribution. Since the within-the-same-family-correlated model assumption is more effective, this test result contradicts the LMM assumption.

Likelihood Ratio (LR) Test: According to Schunck & Perales (2017), LRT is a truly valid robustness test for nested models to compare within and between cluster variance estimates of standard errors, which is a regression-based option to the Hausman specification test.

In this study, the estimate of household control in a mixed-effects model (REML) yields two outcomes: fixed-effects coefficients that remain constant within the same household individuals (dependence). Additionally, random effects coefficients are changed depending on how people are grouped across households (adult independence).

The LT test is used in this instance to compare a ratio of two maximizations: the reduced model's (LR random) maximized values of the likelihood under null hypotheses and the full model's (LR fixed), which contains all of the parameters and assumptions of the reduced model plus additional parameters, maximized values of the likelihood under alternative hypotheses.

The null hypothesis that the fixed effects do not explain the variation in financial inclusion is rejected at 5%, according to the LR test's statistical significance ($\chi^2=1129.56$, p-value of 0.0000), which is consistent with the Wald test.

This indicates that permitting variation across the different household groups while controlling for adult similarity within the same family caused explanatory (at least one predictor) effects on the response variable financial inclusion. The test demonstrates that adult clustering within households has significant effects on the study's outcome variables related to financial inclusivity. They also imply that a poor comprehension of data variability would result from neglecting this adult random dependency. This test result suggests that an unbiased estimation of variance components is beneficial for a more accurate analysis of significance for fixed effects.

On top of hypothesis testing, the researchers compared REML and conditional marginal effect models. The unbiased model was validated using post-estimation standard errors estimates of the marginal effects of margins at means. As shown in [Table 3.6's](#) columns 3 and 4, the estimate findings revealed that both REML and marginal fixed effect produced equivalent outcomes. The techniques previously used by authors include running REML with nested marginal deviation. Seltman (2009), Mize et al. (2019), and Taylo and Verbyla (2018) all advocate for an emphasis on the marginal effects of fixed effects. They established that, within the context of mixed-effect models or behavioral finance

studies, the conditional marginal fixed effect yields robust and theoretically sound interpretations of the results.

In conclusion, while accounting for variability, mixed-effect modeling techniques, such as correlated and random fixed-effect models, offer greater flexibility in interpreting findings. The study also demonstrates that adequate data sampling supports the Householder-Varying Slopes hypothesis. This aids in understanding the reliability of mean disparity interpretations and discussions at the individual or population level. Similar to the conditional marginal fixed effect model estimates, related random-effects models, or REML, offer theoretically sound discussion and interpretations of the results in relation to adult financial inclusion in Ethiopia.

3.2.4. Discussion of Mixed-Effect Financial Inclusion Regression Results

Digital Financial Literacy on FI: According to research results in [Table 3.6](#), the DFL coefficient is 0.135 ($p < 0.01$), indicating an extensive and powerful positive causal effect on financial inclusions. Adults' opportunity to be financially inclusive rises by 13.5 percentage points, on average, for every unit increase in their DFL level. This finding confirms that increasing digital literacy greatly enhances the ability of individuals to acquire and make use of financial services. It also *validates Hypothesis 1*. The outcome supports the findings of Ozili (2021), who pointed out that digital literacy is essential for understanding contemporary financial ecosystems, especially in poor nations where digitalization is spreading. Furthermore, this outcome is consistent with research by Golden and Cordie (2022) and Ozili (2021), which found that putting a higher priority on DFL results in greater financial inclusion.

Financial literacy influence on FI: The coefficient for FL is 0.00681 ($p < 0.01$). Although this effect is smaller than that of DFL, it still underscores the importance of overall financial education in fostering optimal inclusivity. The results indicate that a one-unit increase in the mean score of financial literacy (FL) among adults raises the likelihood of financial inclusion (FI) by 0.681 percentage points on average. The implication is that promoting financial knowledge, awareness, attitude, and behavior

improves the FI of adults in Ethiopia. This result is consistent with Lyons et al. (2020), Fong et al. (2020), and Klapper et al. (2015), who found that higher levels of financial literacy correlate with increased financial inclusiveness and resiliency. The analysis indicates that dual literacy, specifically the combination of DFL and FL, is the driving force behind the failure to *reject Hypothesis 2* and the issues of effective financial inclusion.

Distance on FI: The distance variable from the urban center of the Formal Financial Institution (FFI) has a substantial negative coefficient (-0.0106, $P < 0.001$), indicating that distance is a major and resilient barrier to receiving financial services.

The study's findings are consistent with those of the World Bank (2022) and Yang et al. (2020), who found that the farther an adult Ethiopian lived from an urban center, the less likely they were to be financially active.

Effect of Urban vs. Rural on Financial Inclusion: The rural dummy variable's coefficient is -0.256 ($p < 0.05$), indicating that urban dwellers are more likely to be financially included than their rural counterparts, despite major differences in access to and use of financial services between the two regions. This conclusion is consistent with the empirical findings of Yang et al. (2020) and Shinkafi (2019).

Income influences on FI: weekly and monthly savings of 600 ETB have coefficients of 0.0277 and 0.00694 ($p < 0.01$), respectively. The result indicates that higher savings correlate with increased financial inclusion. However, the ability to save ETB 600 at least once a year is negatively (-0.00269) related to the likelihood of adults in Ethiopia being financially included. This implies that, compared to the base daily saving category of 600 ETB in the higher income distribution, being in a lower saving category reduces the likelihood of adults achieving financial inclusivity. This finding corroborates with many prior studies, for example, Lyons et al. (2020) and Demirgüç-Kunt et al. (2018).

Unemployment and FI: Adult work offers revenue streams that promote access to finance, but unemployment is directly linked to financial exclusion. The negative coefficient (-0.000912) of unemployment factors indicates that out-of-work individuals in

Ethiopia have a negative correlation with inclusiveness. This result is consistent with previous outcomes from the World Bank (2022).

Education: The positive and significant coefficient for education (0.000565, $P < 0.01$) replicates prior studies by Klapper et al. (2015), Lusardi & Messy (2023), Datta & Manjula (2019), Uddin et al. (2020), and the World Bank (2022). This supports the established evidence that educational attainment improves financial inclusion through increased literacy and access to services.

Aging for financial inclusion: According to a study of adult age, age has a non-linear, significant causal impact on adult financial inclusion in Ethiopia; this effect is shown by both the positive and significant coefficients of age and the negative and significant coefficients for age-squared. In other words, growing older improves FI in adults up to certain age limits, but thereafter, aging has a negative impact on it. The significance level for both results is $p < 0.01$. The results support other studies that suggest aging increases financial management skills and confidence. Klapper (2015) and Ozili (2021) claim that because people's levels of technological familiarity vary with age, returns decrease.

Gender inequalities in financial inclusion: The positive coefficient of 0.000266 for the female variable is not statistically significant. This suggests that gender may not be a significant predictor in the context of mixed-effect modeling. The study's findings dispute the controversial notion that there is a sizable gender difference between men and women. The outcome runs counter to studies that show continuing gender inequalities in financial inclusion, such as Demirgüç-Kunt et al. (2018). Research by Mossie (2022) in Ethiopia, Sakyi-Nyarko et al. (2022) on household financial resilience in Ghana, Mndolwa & Alhassan (2020) on financial inclusion in Tanzania, and Kulkarni & Ghosh (2021) on digital financial services in India supports these findings. Therefore, the authors contended that the majority of the gender difference in financial inclusion may be explained by inferior financial knowledge, attitudes, and digital literacy, along with factors related to saving and borrowing, as well as socioeconomic and psychological characteristics. However, in accordance with Robson & Peetz (2020), a comprehensive

and inevitably mature contextual reality-tailored explanation of the reasons behind the gender gap is still a priority for academic study in the future.

Shock Resiliency: The shock resilience variable has a coefficient of 0.00541 ($P < 0.01$), indicating that higher levels of resilience improve the chance of financial inclusion. This substantial positive connection suggests that individuals are better prepared to confront unforeseen financial troubles. This competence is linked to overall financial stability and effective financial management, which enhances their financial inclusion. This finding aligns with the conclusions of Ozili (2021).

Religion's effects on FI: This study demonstrates that adult religious affiliation has profound implications for FI as well. Protestant Christians and followers of other religions (pagan and Wakefeta) had a lower average FI score compared to members of the EOTC Christian faith. In this regard, adults who identify as Protestant are typically far less financially included than their Orthodox Christian counterparts; in contrast, adults who identify as Catholic and Muslim exhibit positive financially inclusive behaviors comparable to those of EOTC believers.

The presence of negative values for the Protestant religion suggests that these are not simple dummy variables (0 or 1) but instead represent principal component analysis (PCA) scores derived from multiple related indicators (Daher et al. 2025; Mustonen et al. 2019; Kaur & Kaur 2021).

Financial inclusion PCA scores (outcome) can take on negative values because they represent PCA calculated from standardized latent factors that capture variation across religions, rather than just simple category labels. This analysis employs group-specific sample sizes (e.g., Gambela, which is predominantly Protestant) and variances, with significance indicating meaningful variation in financial inclusion among groups such as EOTC, Protestants, and Muslims.

Disparities between geographic regions: The study result demonstrates notable regional variations, with negative coefficients found in areas such as Afar (-0.0194, $p < 0.01$), Somalia (-0.0167, $p < 0.01$), and Gambela (-0.0207, $p < 0.01$). In comparison to other

locations, our study confirms that the degree of financial inclusion among adults living in these places is lower, which reaffirms the claims of historical underinvestment in these regions. However, when all other factors are held constant, adults in the regional states of Addis Ababa (0.00789, $p < 0.05$), Amhara (0.00620), Tigray (0.0058), SNNP (0.00342), and Harar (0.00210) are more likely to be part of Ethiopia's financial ecosystem than adults in Dire-Dawa. The result highlights the need for targeted intervention to address regional disparities, the same as noted by the World Bank (2022) and Yang et al. (2020), which emphasizes the importance of localized, tailored strategies to improve optimal financial inclusivity.

3.2.5. Conclusion and Recommendations

This study used mixed-effect modeling with clustered data to examine how DFL/FL influences FI in the context of socioeconomic heterogeneity. Robustness tests validate the results for an objective conclusion. Accordingly, this study concludes

- (1) The financial and digital literacy (DFL/FL dual effect) significantly influences adult financial inclusion. Higher levels of these literacies lead to better financial decision-making, which improves financial inclusivity.
- (2) Regional challenges such as disparities, gender, income, financial literacy deficits, and religious affiliation also determine financial inclusion. Adults from four regions (i.e., Somali, Afar, Gambella, and Benishangul Gumuz) showed a high likelihood of financial exclusion.
- (3) Gender gap: Rural adults face more barriers to accessing inclusive formal financial services, implying gender- and rural-tailored specialized strategies. Similarly, religious affiliation also influences financially inclusive outcomes, demonstrating the importance of inclusive, innovative financial policy design and practices.
- (4) Income stratification via saving behavior is correlated with financial inclusion, with higher rates of financial inclusion observed in adults who save frequently, weekly, or monthly. However, adults with lower incomes face significant barriers to accessing financial services.

(5) Ages revealed non-linearity with financial inclusion. In this case, older age-related technophobic attitudes affect financial inclusion outcomes.

(6) Adult resiliency is crucial for advancing financial inclusivity dynamics, as the finding revealed. This indicates that individuals who are better equipped to handle financial shocks are more likely to engage with formal finance. Therefore, this study reaffirmed both traditional and contemporary frameworks regarding the complex reality of inequality in access to finance within the Ethiopian context, where exclusion is multifaceted, necessitating collaboration to redesign the existing approach for future improvements.

Recommendation 1: Design and implement dual integrated educational programs focused on digital and financial literacy. Given the significant impact of adult digital and financial literacy on inclusivity, it is essential to implement and expand comprehensive, tailored educational programs for various demographic groups. Rural residents, women, and unemployed youth should receive special attention. These programs should address fundamental digital skills and highlight the practical applications of digital and financial tools. Additionally, the initiative should aim to align financial education within national educational systems with school curricula at both the primary and secondary levels, fostering early financial awareness and decision-making skills.

2. Expand rural banking networks: Increase the presence of financial service agents in rural and underserved areas to provide easier access to digital financial services, thereby bridging the urban-rural divide in financial inclusion. This may involve creating supportive environments that promote the development of financial products and services accessible to rural communities at potentially low transaction costs.

3. Gender-intentional policymaking: Develop and enforce policies that specifically aim to close the gender gap in financial inclusion, which includes ensuring women have access to digital tools and financial education programs.

4. Promote affordable access to technology by lowering the fees and taxes on mobile devices and data services, with a focus on lower-income individuals to boost mobile

money adoption. Re-skilling and lowering literacy among adults, including older populations, with digital skills can prevent decreases in financial inclusion and increase engagement with financial services and instruments.

5. Design innovative policies and regulations with effective implementations: Design/improve practices and encourage regulatory frameworks for fintech, digital financial services, and new financial innovations (such as shariah-compliant Islamic finance) to foster user and service provider trust while guaranteeing the safety of adult consumers and the dependability of services. In this context, these innovative policies should be adaptive, prevent sensitive inclusion-exclusion risks, and focus on de-risking.

6. Data-driven policy developments: Utilize large datasets from national surveys, such as initiatives at the UNCDF and the Ministry of Innovation and Technology, along with international best practice benchmarks, to continuously assess and adjust policies that address the evolving financial access needs of the Ethiopian population.

7. The enduring notable regional differences suggest that specific approaches are required to promote adult financial inclusion (e.g., startup credit availability, resource allocation) in severely marginalized areas like Afar, Gambela, and Somali. Legislators ought to reevaluate regionally focused programs that tackle regional financial inclusion issues. These tactics might involve community-based initiatives and programs that increase upskilling on financial services to their advantage, leading to increased engagement in finance.

8. Lastly, addressing the disruptive impact of digitalization requires active financial community collaboration. All stakeholders should work in cooperation (e.g., PPP) to advance digital financial service security users' concerns through robust fintech or technology regulation (Reg-tech), improve internet connectivity in remote rural areas, and address the digital divide by increasing access to affordable digital financial services and digital literacy programs. Additionally, establishing clear regulatory frameworks and offering incentives for users and providers will encourage responsible investments in

digital financial services, ensuring consumer protection and accessibility for all diverse citizen groups.

3.2.6. Further study and limitations

The study could benefit from additional supply-side data and does not include information on financial inclusion following the 2018/19 trend. Therefore, the authors invite other researchers to collaborate on this ongoing agenda.

CHAPTER 4: DIGITAL FINANCIAL INCLUSION THROUGH
MOBILE BANKING¹⁰¹¹

Abstract

In Ethiopia, digitalization is an active policy agenda. This study investigated the influences of digital and financial literacy in driving digital financial service (DFS) usage, employing socioeconomic empirical survey data. Authors applied the bivariate and hybrid modeling to address hierarchical Heckman selection bias simultaneously with robust interpretations. The bivariate test results uncover critical disparities in DFS and demographic and socioeconomic heterogeneity; for example, adults with high digital literacy scores have 68.1 percentage points higher adoption than the digitally illiterate. The nested regression result confirms that dual literacy (DFL/FL) is a strong predictor of digital financial inclusion after adjusting for 61.8% intra-household dependency. This insight suggests that digital literacy can bridge the digital divide. Rurality and the gender gap persist, but the divide is based on ownership disparity, not behavioral differences in

¹⁰ Chapter 4 of the dissertation was first presented at Wolkite University's 6th National Annual Research Conference in Ethiopia. The abstract is available in the conference book.

After receiving feedback, the paper was revised, including changes to the title and the updated model results. The revised paper was then presented at the Ethiopian Economic Association's 22nd International Conference on the Ethiopian Economy on July 19, 2025.

This full paper, titled "Digital and Financial Literacy as Policy Drivers of Mobile Banking-Based Financial Inclusion: Empirical Evidence from Ethiopia's Evolving Socioeconomic Disparities," has been accepted for publication in the Ethiopian Journal of Economics. It will appear among the leading selected papers published in the 22nd International Conference Proceedings.

Note that the initial abstract from Wolkite University's conference differs significantly from the most recent version, ensuring academic integrity. For more information, visit the EJE link: <https://eea-et.org/ethiopian-journal-of-economics-publications/#> and abstract link: <https://www.wku.edu.et/en/images/Conference/Abstract%202025.pdf>.

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usage. Younger adults drive both mobile ownership and usage more than older adults. Somali has made progress, but Gambela, BG, and Afar show lower usage. Digital finance access is further stratified by income. These findings emphasize the need for tailored remedies. Providing comprehensive dual upskilling and reskilling not only increases account numbers and expands ICT development but also enhances access to technology, dignity, and a sense of belonging. Similarly, innovative regulatory designs are income-inclusive, adaptive, exclusion risk-sensitive, and sustainable solutions for shifting from exclusion to inclusion. Aligning digital ecosystem policy with socioeconomic heterogeneity enables an active stakeholder to achieve shared goals, ensuring no one is left behind in the digital finance revolution.

Keywords: Digital Financial Literacy, Financial Literacy, Financial Inclusion, Ethiopia, Socioeconomic Disparity, Mobile banking.

4.1. Introduction

Financial inclusion, a cornerstone of the United Nations Sustainable Development Goals (SDGs), remains inaccessible for millions in developing economies, where structural barriers perpetuate socioeconomic disparities (Elmassah and Mohieldin, 2020; Demirguc-Kunt et al., 2022; Demirguc-Kunt, Pedraza, and Ruiz-Ortega, 2020). Ethiopia, like many developing nations, is undergoing a significant digital transformation, with digital financial services (DFS) emerging as a critical component of its ecosystem inclusivity strategy, according to studies by Achew et al. (2021) and Menza, Jerene, and Oumer (2024). Studies revealed that digitalized finances, by significantly reducing the transaction cost of financial service provisions, contribute a lot to reaching a large portion of the unbanked segment of society. In this case, broadening DFS has the potential to transform financial development by increasing financial inclusion, promoting transparency and fairness, providing convenience for the delivery of goods and services, opening jobs and business opportunities, reducing poverty, and driving innovation in line with the promise of the African Union Agenda 2063 and the Sustainable Development Goals as asserted (African Union, n.d., and UNSGSA, 2018).

According to Ozili (2018), Mu et al. (2022), and Kedir and Kouame (2022), digital finance refers to financial services delivered via digital platforms, including mobile money, online banking, and agent banking, which enable transactions such as payments, savings, and credit without physical bank infrastructure.

Ethiopia's 2020 digital transformation strategy (2021-2030) focuses on national digital ID, digital payments, e-governance, and e-commerce and aligns with specific goals like the National Financial Inclusion Strategy and the National Digital Payments Strategy, which aim to transform the digital ecosystem and build a cashless and holistic inclusive economy (African Union, n.d., 2020). Those initiatives aim to broaden access to financial services, particularly for the unbanked and underbanked population, fostering economic empowerment and robust, inclusive growth (Elmassah and Mohieldin, 2020, and Shaikh et al., 2023). However, this country continues to confront contextual obstacles in

accomplishing these national/regional objectives (GSMA, 2022, 2023a, and Yang et al., 2020).

Accessing and utilizing financial services is severely affected by gender and rural-urban divides, with particularly vulnerable groups such as women, young people without jobs, those in poverty, and small business owners being disproportionately excluded. The low level of financial literacy (FL) and a lack of required skills to use banking technology further hinder digitalized financial inclusion, as claimed by Agar et al. (2020), Setiawan et al. (2022), and Wang et al. (2022).

In Ethiopia, DFS encompasses platforms like Telebirr, HelloCash, Chapa, Safari M-Pesa, Kacha, and Kifiya, among the major players setting milestones on DFSs. These platforms aim to expand financial access in underserved rural and pastoralist regions. Despite efforts, DFS usage remains low owing to infrastructural deficiencies, necessitating digital literacy re-skilling initiatives to let adults take advantage of digital Ethiopia projects (NBE, 2021; Ahmed Ali, n.d.; Hordofa, 2024).

Financial services face significant challenges in terms of accessibility and availability. The effectiveness of DFS adoptions depends on how willing the users are to take up and use the provided services. In this regard, financial and digital literacy significantly impact bridging digital divides. (Hasan et al., 2021; Lyons & Kass-Hanna, 2021)

The concepts of FL underlined the understanding and use of financial concepts: interest rates, inflation, and budgeting to make informed decisions (Klapper and Lusardi 2019; Ozili 2021). DFL's new advanced skills represent the application of financial knowledge to securely and effectively use digital tools (e.g., mobile apps, debit and credit cards, and ATMs) to access financial services. They require technical proficiency to navigate digital interfaces and mitigate fraud and data breaches, and adults require adaptive skills to analyze digital financial products (OECD/INFE, 2023). By fusing financial decision-making with digital capability, DFL goes beyond FL. For instance, a person with high financial literacy (FL) may understand compound interest but might not possess the

digital literacy required to fully utilize mobile banking (Lyons & Kass-Hanna, 2021, and Morgan and Trinh, 2019).

This phenomenon is particularly prevalent in economies where contextual socioeconomic problems persist. FL is hindered by its deficits in general education; just 18% of citizens understand interest rates, while 30% distrust formal financial institutions (CSA 2018, 2020, 2023). Furthermore, Ke, D. (2017) contended that cultural norms further restrict women's financial inclusion because males dominate financial decision-making. Digital exclusions are further extended by substantial internet connection disparities (22% rural versus 65% urban), a lack of digital skills among the rural majority of adults, and the fact that just a lower number of women utilize mobile money compared to males (Tindi, 2025, and Hernandez et al., 2024).

Prior studies synthesized from literature argued Ethiopia's financial inclusion ecosystem is marked by a paradox: while mobile banking and digital financial technology drivers promise to leave no one behind for economic liberation, their designed practices often entrench top-down hierarchies structured as asserted in (Crenshaw, 2013; Scholz, n.d.; Suri and Jack, 2016), excluding rural residents, women, pastoralists, and diverse minorities. Only 3% use mobile banking, and 14% use digital financial services (UNCDF, August 08, 2024), while financial exclusion is high at 64%, lagging behind many countries (GSMA, 2023b, and the PSI, 2024).

Advancing adults' digital financial literacy skills (DFL and FL) enhances adoption and usage of digital financial services across diverse socioeconomic groups (Choung et al., 2023; Golden and Cordie, 2022; Klapper and Lusardi, 2019; Lusardi and Messy, 2023; Prasad et al., 2018; Yang, Wu, and Huang, 2020). In regional economies, tech-driven digital/financial literacy enhances practical adoption drivers and overall financial well-being. However, low levels of digital and financial literacy can exacerbate financial exclusion, as evidenced by various studies. Therefore, enhancing adult digital literacy is crucial for promoting financial inclusion (Gafoor and Amilan (2024), Seiawan et al. (2021), Hasan et al. (2024), Jünger and Mietzner (2020), and Shubhangi Singh et al. (2020)).

Conversely, there remains a critical gap in understanding how these literacies influence DFS in the specific localized, challenging context of Ethiopia. Particularly, there is a lack of studies on how FL and DFL affect the adoption and effective use of digital financial services via mobile banking, accounting for socioeconomic disparities that characterize the Ethiopian localized contexts. Additionally, minimizing the gender gap in digital financial inclusion necessitates a better comprehension of the unique challenges women encounter when striving to access and use the emergent DFS, which are connected to their lower financial and digital literacy status, as well as a special awareness of how to lessen current socioeconomic inequalities (Ahmed Ali, 2025; GSMA 2023b; PSI newsletter 2024). This study is unique in that it examines the nexus of DFL/FL for DFS in Ethiopia's contextual challenges, accounting for socioeconomic correlation, where rural-urban divides, gender disparities, and regional inequalities persist.

Consequently, this study aims to investigate the significant influences of DFL and FL skills as catalysts for leveraging digital financial inclusion in Ethiopia, accounting for heterogeneity. Specifically, this study addresses the knowledge gap by 1) analyzing the influences of DFL/FL on advancing DFS usage in Ethiopia and 2) examining how adult contextual demographic, socioeconomic, and geographic factors exacerbate usage of DFS. To achieve these objectives, the researchers have employed mixed-effect logit/probit Heckman selection modeling by utilizing nationally representative data from the 2018-19 Ethiopia socio-economic survey with a financial inclusion module.

The study hypotheses outlined in [APPENDIXES 1](#) are grounded in a theoretical framework that encompasses behavioral and social change, technology acceptance, and multidimensional approaches to literacy, all of which are aligned with the contextual heterogeneity of Ethiopia.

In doing so, the study contributes valuable insights for policymakers, practitioners, and stakeholders in designing targeted interventions and policies that bridge the gaps in digital financial inclusion through a robust, tailored approach to digital and financial literacy in Ethiopia.

The next sections of this chapter are structured as follows: Firstly, we provide an explanation of the data, the methodological foundations of FL/DFL PCA scores, and the mixed-effect logit/probit modeling strategy. Then, a discussion follows the presentation of the results with robustness testing. The final section includes the conclusion, recommendations, and future research directions.

4.2. Data and Estimation strategy

4.2.1. The Data and Variable Measurements

This study employed the 2018/19 Ethiopia Socioeconomic Survey (ESS4)¹². This data is a nationally representative, survey conducted by the central statistical agency in collaboration with the World Bank. The survey interviewed 6,700 households across the country, including an observation of 14,862, of which the authors used mainly a sample of 5,125 adults aged 18 and above, all of whom reported on their use of digital financial services and have access to a mobile phone.

The ESS4 provides extensive socioeconomic and demographic information: age, gender, education (years of schooling), employment status, expenditure, and geographic location (rural/urban, regional state). Crucially, the module includes financial literacy and financial inclusion status measuring questions.

These variables allow for a reliable analysis of variation in financial exclusion and inclusion across regions and the effect of socioeconomic factors on digital financial inclusion.

The variable measurement of digital financial service adoption and usage (DFS) is based on respondents' answers to the question: *Have you used any of the following services in*

¹² The original data are available from the World Bank Microdata Library:

<https://microdata.worldbank.org/index.php/catalog/3823> .The refined modeling dataset is available from the corresponding author on reasonable request.

the last 12 months: ATM/debit/credit card, mobile banking, internet banking, agent banking, or interest-free banking? particularly to measure the outcome-dependent variable. Adoption and usage of digital financial services, as well as ownership of a mobile money account and actual use of mobile money by the user, are defined by a binary answer variable with a value of 1 or 0, respectively.

Financial literacy is a key variable, measured through sub-dimension indicators: financial knowledge (knowledge of inflation, interest, and budgeting); financial behavior (credit gap financing, emergency savings, and saving to start a business); and financial attitude (trust in formal financial institutions, financing preferences, and home cash saving). The level of digital financial literacy (DFL) is measured by how well Ethiopian adults can skillfully use available financial services. This includes online and mobile banking, using debit and credit cards at ATMs, agent banking, and the Interest-free banking (IFB) services.

Age, gender, employment status, mobile phone ownership, income as a proxy for frequency of saving, education, respondents' geographic location, urban-rural divide, and distance from FFI were the additional variables chosen to assess the heterogeneity of demographic, socioeconomic, and geographic characteristics as independent variables.(refer [APPENDIXES 1](#))

4.2.2. Data Estimation Strategy

1. PCA Constructing Financial Literacy (FL) and Digital Financial Literacy (DFL)

This study used Stata 17 software to construct a reliable measure of financial literacy (FL) and digital financial literacy (DFL) via principal components analysis (PCA). The use of PCA allowed for the decrease of dimensionality while keeping important information and properly measuring latent variables. The PCA in a two-stage approach, guided by procedures used in previous publications by Camara and Tuesta (2014), Mukherjee and Sood (2020), and Nguyen.

To begin this PCA estimate technique, use STATA software to create distinct PCAs for each FL multidimensional indicator, such as knowledge, attitude, and behavior, for FL and DFL subdimensions. In the second stage, dimension scores are aggregated into composite scores, which are weighted by explained variance.

This study recognizes that the FL multidimensional variable encompasses not only general financial knowledge but also adult financial attitudes and behaviors aligned with prior studies (Rai, et al.; Kadoya & Khan, 2017; Chu, et al., Lusardi & Mitchell, 2014).

In the first stage of PCA FL score estimation, unobserved endogenous sub-dimensional (knowledge, behavior, and attitude) indicators were assessed, and then the resulting dimension indices were combined into an aggregate FL score using weighted scores. This method acknowledges that each dimension contributes differently to overall financial literacy, aiming to capture a more comprehensive measure of FL.

Similarly, the DFL score was constructed using the PCA score approach, emphasizing the practical application of digital financial services. Given the data from ESS2018/19 availability, indicators such as the use of online banking, mobile banking, ATMs, and agent banking were used as measures of aggregate digital financial literacy skills (Prykaziuk & Khodakivska (2023), Lo (2021), and Golden & Cordie (2022)). This latent variable DFL score was derived through a weighted linear combination of these indicators.

2. Assessment of Measurement Validity and Reliability

To ensure the measurement reliability and validity of the FL and DFL scores, first, the PCA estimation result ([APPENDIX B 1](#)) which indicated that FL and DFL score components cumulatively explained 68% and 72% of the variance, respectively, exceeding the 60% threshold for robustness (Sharma et al., 2023), and corresponds with the claims of Hair et al. (2019). Secondly, PCA out of FL/DFL estimates is theoretically aligned with the aforementioned prior studies that reflect the methods, linking literacy to individual decision-making capability measurement analysis. The result corresponds with the technology acceptance models (Venkatesh et al., 2003). Thus, an individual is

deemed literate if their PCA score on the correct answers to financial and digital literacy questions is above average or mean (DFL/FL score). In line with previous research by OECD (2020), Hasan et al. (2021), and Setiawan et al. (2021). Conversely, a person with a DFL/FL score of less than 0.5 is deemed illiterate in financial and digital literacy. These estimated PC score outcomes were then used in bivariate descriptive and econometric models for further analysis.

3. Mixed effects modeling estimation strategy

The choice of mixed-effect logit and probit models aligns with the hierarchical structure of the EES4 datasets, where individual units of analysis are nested within households and regions.

In this context, the OLS main assumption of adult independence (i.e., *independent identically distributed (IID)* $N = (0, \delta^2)$) does not hold in situations where there is financial behavior interdependence among adults in the same region, city, and household, making OLS an unreliable estimator (Burn and Harrison, 2019; and Embaye et al., 2021).

To overcome the limitation of OLS, Gomes et al. (2020) and Chu et al. (2010) suggest that household finance studies employing mixed-effect models that take hierarchical dependency into survey datasets increase modeling performance by controlling for heterogeneity between observed and unobserved correlations. The same suggestion was made by Robson and Peetz (2020) that by offering simultaneous estimates, supporting complex experimental designs, and accounting for nonsystematic response sets and variables, mixed-effects modeling improves behavioral economic demand analysis. Those priors revealed that household finance studies data are complex and interdependent, with social factors, peer effects, and financial literacy playing a role in their decision-making process, as asserted by Al-Khowaiter (2020), Aziz and Naima (2021), and Gabor and Brooks (2017).

The authors justification for the use of mixed-effect logit/probit models in this Ethiopia-region-focused study using EES4 microdata is aimed at accounting for disparities between observable and unobserved differences (Kaplan et al., 2021).

Contextually, the adoption of digital financial services and the use of digital payment systems by adults within the same household, region, and place of residence are likely to be positively correlated based on their individual demographic and socioeconomic features. On the other hand, this dependence control is considered by mixed effect modelling (MEM) using the assumption of adult financial behavior dependency modeling maximum likelihood (*ML*) estimator. Thus, Equation ((4.1)) and ((4.2)) present mixed-effect logit/probit modelling specifications.

Model 1: Mixed effect logit

This logistic mixed effect modeling Equation((4.1)) specification applied clustered survey data models guidance mainly from McNeish and Kelly (2019).

$$\begin{aligned}
 Pr(DFSU_{ij} = 1) & & (4.1) \\
 & = LOGIT^{-1}(\beta_0 + \beta_1 DFL_{ij} + \beta_2 FL_{ij} + \beta_3 PLACE_{ij} \\
 & + \beta_4 SEX_{ij} + \beta_5 AGE_{ij} + \beta_6 AGE2_{ij} + \beta_7 EMP_{ij} \\
 & + \beta_8 Mobile_{ij} + \beta_9 WEEKLY_{ij} + \beta_{10} MONTHLY_{ij} \\
 & + \beta_{11} QUARTERLY_{ij} + \beta_{12} SEMIANNUAL_{ij} + \beta_{13} ANNUAL_{ij} \\
 & + \beta_{14} REGION_{ij} + \beta_{15} EDUC_{ij} + u_j)
 \end{aligned}$$

Where: $Pr(DFSU_{ij}=1)$ is the probability for adult *i* in household *j* chooses to use DFS adoption and usage.

*logit*¹, refer to the inverse logit function and it measures the natural log of the odds of choosing to use DFSU (1) relative to not choosing to the *i* individual(0) which transforms the linear predictors into a probability between 0 and 1.

Where, *Hierarchy* adult ij observations (i) nested within households j . Mixed-effects model subscripts estimate algorithms use both *fixed and random effects*.

Fixed effect estimate is the $DFSU_i$ binary outcome (1=DFSU; 0=not use).

β_0 :is the intercept or constant coefficient of predictors($\beta_1, \beta_2, \beta_3 \dots \beta_n$) included like DFL, FL, and other measures. Socioeconomic disparity (rural, gender, age, income) for DFSU.

In a random or restricted mixed-effects (*REME*) estimate, a *hierarchy ij* of adult observations nested within households accounts for variation (correlation or dependency) and Coefficients ($\beta_1, \dots \beta_{15}$) are predictors, and for explanatory and control variables DFL and FL regarding unobserved characteristics captured by the random effect predictors to measure socioeconomic disparity (rural, gender, age, and income) for DFSU.

u_j :is the household specific intercept Predictors control variables are assumed to be correlated within household clusters, as per a mixed effect modeling specification requirement assumed to be normally distributed with mean 0 and variance σ^2_{μ} .

Random effect : $\mu_j \sim (0, \sigma^2_{\mu})$ The assumption that the adult dependency: null hypothesis $H_0 \beta=0$ and alternative hypothesis $H_1 \beta \neq 0$ are assumed to be true, which serves as an inference about dependencies within and between cluster effects.

Model 2: mixed effect probit

$$\begin{aligned}
 Pr(DFSU_{ij} = 1) &= \Phi(\beta_0 + \beta_1 DFL_{ij} + \beta_2 FL_{ij} + \beta_3 PLACE_{ij} + \beta_4 SEX_{ij} \\
 &+ \beta_5 AGE_{ij} + \beta_6 AGE2_{ij} + \beta_7 EMP_{ij} + \beta_8 Mobile_{ij} \\
 &+ \beta_9 WEEKLY_{ij} + \beta_{10} MONTHLY_{ij} + \beta_{11} QUARTERLY_{ij} \\
 &+ \beta_{12} SEMIANNUAL_{ij} + \beta_{13} ANNUAL_{ij} + \beta_{14} REGION_{ij} \\
 &+ \beta_{15} EDUC_{ij}) + u_j
 \end{aligned}
 \tag{4.2}$$

Where ,Hierarchy: Same as melogit;Link function , $\Phi(.)$ denotes the cumulative distribution function (*cdf*) ,others terms are defined similarly to the logit model.

In this study, the STATA 17 maximum likelihood (ML) estimation is employed , which enables investigators to account for a complex of clustered survey designs and imputed variables and is similar to that employed by Clark and Moore (2011) and Kim (2025). Mixed-effect MLE estimation separates household-specific variability (random dependency) from population-level fixed deviation (i.e., HHs level in this case). Furthermore, after the estimation of logit/probit by maximum likelihood, the authors computed the marginal effects for probit models for each covariate by using the margins at means to determine the marginal effects of each explanatory variable on the dependent variable to interpret change in probabilities on average marginal effect (AME) and model robustness testing.

Heckman Selection probit(heckprob)

In order to further advance this study's results' robustness, the authors used a Heckman two-stage selection model (1979) with mobile ownership (adoption) modeled Equation (4.3) as the selection equation to correct for potential bias in the outcome models Equation((4.4).

Model 3 :Selection Equation (Own_Mobile)

$$OWN_MOBILE_i^* = \theta_0 + \theta_1 EDUC_i + \theta_2 PLACE_i + \theta_3 AGE_i + \theta_4 AGE2_i + \theta_5 SEX_i + \omega_i \quad (4.3)$$

WHERE:

$$OWN_mobile_i = \begin{cases} 1 & \text{if } Own_mobile_i^* > 0, \\ 0 & \text{otherwise.} \end{cases}$$

Model 4 :Outcome Equation (proxy by Used Mobile Banking):

$$\begin{aligned}
 DFSU_i^* = & \mu_0 + \mu_1 DFL_i + \mu_2 FL_i + \mu_3 Place_i + \mu_4 AGE_i + \mu_5 AGE2_i & (4.4) \\
 & + \mu_6 EMPLOYED_i + \mu_7 WEEKLY_i + \mu_8 MONTHLY_i + \mu_9 QUARTERLY_i \\
 & + \mu_{10} SEMIANNUAL_i + \mu_{11} ANNUAL_i + \mu_{12} REGION_i + \xi_i
 \end{aligned}$$

$$DFSU_i = \begin{cases} 1 & \text{if } DFSU_i^* > 0 \text{ and } OWN_mobile_i = 1, \\ Unobserved & \text{otherwise.} \end{cases}$$

Where ,Error Structure:Standard errors ω_i and ξ_i follow a bivariate normal distribution:

$$\begin{pmatrix} \omega_i \\ \xi_i \end{pmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \right)$$

And $Rho(\rho)$: the correlation between the selection and outcome equations. μ_0 and θ_0 are intercepts under models 4 and 3. μ and θ are coefficients for the predictors under these models.

The Heckman selection model corrects for selection bias by employing a probit model with correlated errors, represented as $Rho(\rho)$. It is assumed that excluding education from the outcome equation is necessary to verify validity.

This methodology within the Heckman model acts as a robust estimation technique that effectively isolates the causal effects of education on outcomes. Its reliability hinges on the validity of the exclusion restriction and the inclusion of pertinent variables.

As shown in the bottom of [Table 4.4](#), the Heckprobit outcome model in line 4 and the selection model in line 5 are well-fitted. Joint significance and selection bias are confirmed by Wald $\chi^2(1)=513.91$, highlighting the necessity for the mobile ownership Heckman selection correction model.

4.3. Empirical Results, Analysis, and Discussion.

4.3.1. Bivariate descriptive analysis

The bivariate t-test is summarized in [Table 4.1](#) and [Table 4.2](#). Cohen's d effect size and a two-sample bivariate approach are used to estimate it. As described below, the results show notable disparity by gender and between rural and urban dwellers in DFS adoption, DFL, and FL.

1. Rural deficits in DFS, DFL, and financial literacy

This study's findings reveal rural deficits in DFS, DFL, and FL. In this case, the urban residents are 7.5% more likely to use DFS than rural residents ($p < 0.001$), with a small effect size (Cohen's $d = 0.226$). Similarly, the financial literacy gap is strong (34.8% difference) with a large effect size ($d = 0.646$). Additionally, urban residents marginally outperform on digital literacy, though this difference is statistically significant ($p < 0.05$). This data insight, finding the DFS gap ($d = 0.226$) and FL gap ($d = 0.646$), represents a small to medium practical effect.

2. Gender disparities in digital financial inclusion.

The finding indicates general gender gaps persist across all indicators, with male-headed households and female-headed households facing distinct challenges. For example, adult females' adoption of DFS is statistically significant at 5.3-7.1% lower than that of males, indicating a minimal to small practical relevance ($d = 0.160-0.218$). Financial literacy has a high DFL than for those with low DFL (76.8% vs. 8.7%; $t = -28.55$, $p < 0.001$), and the effect magnitude was an unmatched Cohen's d of -2.33.

TABLE 4.1 DFS, DFL, AND FL COMPARISON BY URBAN AND RURAL AREAS AND GENDER

Rural vs.Urban	Mean1 Urban	Mean2Rural	dif(M1- M2)	t	P	Cohen's d ,95%C
DFSU	14.1%	6.6%	7.5%	7.85	0.000	0.226[0.156,0.297]
DFL	6.4%	4.6%	1.8%	2.3	0.02	0.075[0.005,0.145]
FL	15.9%	-19%	34.8%	38.65	0.000	0.646[0.612,0.680]
DFS, DFL, and FL By Gender.						
DFS >Eemale	15.1%	9.8%	5.3%	5.95	0.000	0.16 [0.106,0.214]
Head Female	14.1%	7%	7.1%	6.15	0.000	0.218[0.139,0.298]
DFL >Female	7.4%	4.4%	3%	4.75	0.000	0.127[0.073,0.181}
DFS>Female Head	7.1%	3%	4.1%	5.15	0.000	0.175[0.095, 0.254]
FL >Female	3%	-2.6%	5.6%	5.85	0.000	0.099[0.066,0.132]
FL >Female Head	3.8%	0.2%	3.6%	2.45	.014	0.065[0.013,0.118]

NB: The gaps in DFS adoption, Digital Financial Literacy (DFL), and Financial Literacy (FL) are presented as differences in percentage means calculated as Mean1 minus Mean2 (M1 - M2). For example, for rural vs. urban comparisons, "Mean1" represents urban values and "Mean2" rural values; for gender comparisons, these represent male and female groups, respectively. The "dif" column indicates the differences between groups, showing positive values when the first group has higher measurements. The "t-value" and "P-value" are statistics from Welch's two-sample t-test, considering unequal variances with Satterthwaite's degrees of freedom. Cohen's d, along with 95% confidence intervals, quantifies the standardized effect size calculated as $(M1-M2) / \sqrt{(SD1^2+SD2^2)/2}$. Cohen's d interpretation follows Brydges (2019): trivial (<0.2), small (0.2-<0.5), medium (0.5-<0.8), and large (≥ 0.8).Brydges (2019)

Table 4.2, Shows that DFS adoption was 68.1 percentage points higher for people with higher DFL skills. This is consistent with findings from throughout the world that digital financial inclusion is fueled by DFL, as indicated by abilities like web-based navigation, financial services, and mobile money applications (CSA, 2021; World Bank, 2021).

TABLE 4.2 DFS ADOPTION AND USE BY EMPLOYMENT, MOBILE OWNERSHIP, AND INCOME

Variable	Mean1	Mean2	dif(M2- M1)	t	pv	Cohen's d 95% CI
DFL	8.7%	76.8%	68.1%	-28.55	0.000	-2.334[-2.542,-2.126]
Employed	10.6%	14.3%(yes)	3.6%	-4.05	0.000	-0.110[-0.165,-0.056]
Mobile	4.4%	14.3%(yes)	10%	-11.3	0.000	-0.300[-0.375,-0.225]

*NB: The DFS adoption gap is reported as the difference in percentage means calculated as Mean2 minus Mean1 (M2 - M1). Here, "Mean1" and "Mean2" represent the proportion of DFS adoption or usage within two comparison groups defined by variables such as digital literacy score, employment, mobile ownership, or income. The "dif" column shows this difference (Mean2 - Mean1). The "t value" and "*p value" indicate the statistical significance of the difference, derived from Welch's two-sample t-test using Satterthwaite's degrees of freedom for unequal variances. Additionally, Cohen's d, along with the 95% confidence interval for effect size, is calculated using the formula $|M_1 - M_2| / \sqrt{[(SD_1^2 + SD_2^2)/2]}$. The interpretation of Cohen's d is as follows: The interpretation: $|d| < 0.2$: Trivial, $0.2 \leq |d| < 0.5$: Small, $0.5 \leq |d| < 0.8$: Medium, and $|d| \geq 0.8$: Large (Brydges, 2019).*

3. Employment and Mobile ownership

The result reveals employed adults have only 3.6 percentage points higher DFS adoption than unemployed peers (14.3% vs. 10.6%; $t = -4.05$, $p < 0.01$), with a trivial effect size ($d = -0.11$), as shown in **Table 4.2**. In the case of mobile ownership, it demonstrated 10 percentage points higher DFS adoption than non-owners (14.3% vs. 4.4%; $t = -11.30$, $p < 0.001$), with a small practical size effect ($d = -0.30$). While mobile access is important, Ethiopia's 35% mobile ownership gender gap (GSMA, 2023) and low digital literacy (12% of rural users understand app security; Tesfaye & Kebede, 2022) reveal that ownership alone cannot drive inclusion without targeted digital upskilling.

4. Regional place disparity

Table 4.3 and provide a detailed breakdown of regional and inter-regional disparities in DFS adoption, DFL, and FL.

DFS adoption and usage by region: The Somali region demonstrates the largest gain at +29% compared to 12.3% in non-Somali regions ($t = -4.15$, $p < 0.001$). This corresponds to a medium effect size ($d = -0.500$, 95% CI [-0.683, -0.316]), highlighting significant

adoption advantages in the Somali region. Likely, Harar exhibits a 7.1 percent increase ($t=-3.9, p<0.001$), with a small practical effect ($d=-0.213$).

Gambela shows a 6.3 percent mean point deficit in DFS usage ($t=4.3, P<0.001, d=0.187, 95\% CI [0.077, 0.297]$), which reflects lower adoption and usage rates compared to other regions. In contrast, the Addis Ababa administration shows minimal disparity ($t=0.95, p=0.3320$, with a trivial effect size $d=0.029$). This indicates that urban-centric infrastructure in Addis Ababa may have mitigated some of the barriers seen in other regions as presented below.

TABLE 4.3 DFS ADOPTION AND USAGE BY REGION

VARIABLE	Mean1(%)	Mean2(%)	dif(M2-M1)	t	*pv	*Cohen's d ,95%CI
AFAR	12.8	11.9	0.9	.4	0.674	0.028[-0.107,0.163]
AHMARA	13.3	8.4	0.5	3.7	0.001	0.145[0.054,0.236]
OROMIA	12.6	15.1	-2.6	-1.4	0.169	-0.077[-0.179,0.026]
SOMALI	12.3	29	-16.7	-4.15	0.001	-0.500[-0.683,-0.316]
BG	12.9	11	1.8	.85	0.408	0.055[-0.083,0.194]
SNNP	12.9	12	0.9	.5	0.605	0.027[-0.077,0.130]
GAMBELA	13.2	7	6.3	4.3	0.001	.187[0.077,0.297]
Continued						
HARAR	12.1	19.2	-7.1	-3.9	0.001	-0.213[-0.306,-0.120]
TIGRAY	13	11.2	1.8	1.25	0.221	0.054[-0.037,0.144]
DD	12.6	14	-1.4	-.95	0.339	-0.042[-0.124,0.041]
AA	13.1	12	1	.95	0.332	0.029[-0.031,0.090]

*NB: The DFS adoption gap is reported as the difference in percentage means calculated as Mean2 minus Mean1 (M2 - M1). Here, "Mean1" and "Mean2" represent the proportion of DFS adoption or usage within two comparison groups defined by region. The "dif" column shows this difference (Mean2 - Mean1). The "t value" and "*p value" indicate the statistical significance of the difference, derived from Welch's two-sample t-test using Satterthwaite's degrees of freedom for unequal variances. Additionally, Cohen's d, along with the 95% confidence interval for effect size, is calculated using the formula $|M_1 - M_2| / \sqrt{[(SD_1^2 + SD_2^2)/2]}$. The interpretation of Cohen's d is as follows: The interpretation: $|d| < 0.2$: Trivial, $0.2 \leq |d| < 0.5$: Small, $0.5 \leq |d| < 0.8$: Medium, and $|d| \geq 0.8$: Large (Brydges, 2019).*

Digital Financial Literacy (DFL): APPENDIX C 1,DFL gaps are smaller but still significant in certain regions. Gambela lags with a 4.1 percent on mean deficit ($t=4.65$,

$p < 0.001$), corresponding to a small effect size ($d = 0.169$). Aligned with DFS adoption, Somali region adults exhibited a 5.5% mean percentage of extra digital skills than others ($t = -1.95$, $p = 0.052$), but it was insignificant and a small to trivial effect size. ($d = -0.231$). Surprisingly, the Oromia region shows a significant positive 4.3 percent digital skills than others ($t = -2.75$, $P = 0.006$), with a small practical policy effect size ($d = -0.178$).

Regions/cities such as Afar and Amhara displayed average differences with small effect sizes ($d = 0.145$ and $d = 0.087$, respectively), while there was no significant difference in Addis Ababa compared to DFL between Addis and other region adults (urban or rural) ($t = -0.25$, $p < 0.799$; $d = -0.008$).

Financial Literacy (FL): Findings from this bivariate test revealed strong FL disparities, with Somali adults information results indicating the largest gap of 28.8% ($t = 19.65$, $p < 0.001$). The result corresponds to a medium to large effect size ($d = 0.514$, 95% non-zero CI [0.455, 0.573]), arguably indicating Somalia's largely pastoralist community exclusion from formal financial education despite high DFS adoption rates in the region (APPENDIX C 1). Addis Ababa mirrors this result with a 29% point difference compared to non-Addis Ababa adults ($t = -18.75$, $p < 0.001$, $d = -0.5220$), reaffirming the exclusion of the other region adults from formal financial education. Additionally, Dire Dawa shows a significant FL difference at 11% ($t = -7.3$, $p < 0.001$, $d = -0.199$), while Gambela reports no significant gap with inter-regional general analysis ($t = -0.6$, $p = 0.538$, $d = -0.020$).

The study's bivariate analyses align with Endashaw and Shumetie's (2023), Breuning and Majeed's (2020), Luo et al.'s (2020), and Jamil's (2021) in finding that policy setbacks exacerbate persistent inequality, including rural-urban divides, gender gaps, income, employment, and mobile and digital divides. Furthermore, regional disparity studies using the two-sample t-test and effect size metrics for adults DFS, DFL, and FL revealed a persisting difference in digital financial inclusion across Ethiopia's regions. In the next section, mixed effects Regression results and discussion follow.

4.3.2. Mixed effects Results Robustness Testing

4.3.2.1. *Mixed-effect modelling outcomes fitness*

Table 4.4: The output of mixed-effect logistic models estimated in Stata ML by including random intercepts at the household-level individuals grouping shows that unobserved household characteristics account for 61.8% of the variation in DFS adoptions. It is evidenced by the constant coefficient region to the household ($\beta=5.32$, $p<0.001$). In accordance with suggestions for clustered binary outcomes (Huang 2021, Angrist & Picchike, 2009), the mixed logit model (AIC=2734.4) fits marginally, outperforming the probit specification (AIC=2737.5) by a little margin, (% changing AIC=3.4, % change BIC=3.4).

The Wald χ^2 test reveals mixed logit/probit; both models show a highly significant fit ($P=0.0000$), with the mixed probit having a higher χ^2 (246.65 vs. 201.46), suggesting stronger predictor significance, but substantive conclusions can align.

Additionally, the LR test ratio ($\text{prob} \geq 0.0000$) supports retaining the random effects structure over a standard linear mixed effect model, which mirrors the OLS model.

Therefore, the results of both mixed logit/probit models are employed side by side for interpretations and discussions. More importantly, the researchers used hybrid/mixed-effect logit output for interpretability along with Heckman selection.

TABLE 4.4 Hybrid Modeling (DFS adoption and usage via mobile banking usage)

DFSU	Mixed effects		Heckman selection ¹³	
	(2)	(3)	(4)	(5)
DFL	5.655***(12.83)	2.997***(14.38)	1.794***(18.99)	
FL	0.382*(2.32)	0.187*(2.18)	0.108*(1.98)	
EDUC	0.0844***(9.58)	0.0446***(9.81)		0.0617***(22.21)
Rural	-0.507(-1.80)	-0.265(-1.81)	0.524***(5.32)	-1.290***(-33.41)
Female	-0.514**(-3.18)	-0.270**(-3.18)	0.0485(0.92)	-0.270**(-3.18)
AGE	0.0131(0.38)	0.00875(0.48)	-0.0509***(-3.68)	0.114***(17.13)
age2	-0.000336(-0.79)	-0.000192(-0.86)	0.000551**(3.12)	-0.00123***(-16.1)
EMPLOYED	0.373*(2.18)	0.186*(2.06)	0.102*(1.96)	
Own_mobile	0.722*(2.26)	0.369*(2.25)		
<i>≥600 ETB saving frequency</i>				
Weekly	1.424***(4.58)	0.759***(4.56)	0.397***(4.17)	
Monthly	0.763***(3.92)	0.404***(3.93)	0.192**(3.29)	
Quarterly	0.618*(2.22)	0.328*(2.22)	0.173*(2.17)	
Semiannually	0.805*(2.03)	0.447*(2.16)	0.213(1.84)	
Annually	-1.097(-1.56)	-0.556(-1.54)	-0.319(-1.40)	
<i>Region (refer to Addis Ababa)</i>				
AFAR	0.256(0.57)	0.134(0.57)	0.0881(0.62)	
AMHARA	0.0820(0.23)	0.0539(0.29)	0.0832(0.90)	
OROMIA	0.726*(2.08)	0.384*(2.09)	0.191(1.83)	
SOMALI	2.235***(4.57)	1.194***(4.62)	0.777***(4.37)	
BG	0.0406(0.09)	0.0409(0.17)	-0.0785(-0.58)	
SNNP	0.182(0.50)	0.108(0.56)	0.0854(0.77)	
GAMBELA	-0.493(-1.17)	-0.253(-1.15)	-0.121(-1.04)	
HARAR	1.052***(3.39)	0.555***(3.38)	0.333***(3.51)	
TIGRAY	0.0558(0.16)	0.0351(0.20)	0.118(1.09)	
DIRE DAWA	0.610*(2.06)	0.324*(2.09)	0.170*(1.98)	
_cons α	-7.031***(-8.05)	-3.757***(-8.33)	-0.141(-0.53)	-2.401***(-16.04)

¹³ The Heckman probit model (usage) estimated 11,751 STATA observations, with 4,336 adult data selected (adoption) due to mobile banking and mobile phone usage, while 7,415 were not selected.

Continued.

Robustness tests

var(_cons[REGI	5.318***(4.68)	1.413***(4.98)		
ON>household_ id])				
N	5125	5125	11751	4336
AIC	2722.7	2726.1	11578.4	11578.4
BIC	2899.3	2902.7	11799.6	11799.6
Log likelihood	-1334.34	-1336	-5759	-5759
Wald chi2	201.46(P=0.0000)	246.65(P=0.0000)	513.91	147
LR test (vs. Linear)	120.13(P=0.0000)	111.49(P=0.000)		
ICC or	0.6178,SE=0.05	0.58.6, SE=0.05	-0.896***(-12.15)	-0.896***(-12.15)
			Rho -0.71	

NB. t/z statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Line 2 : *melogit* 3: *meprobit* 4: *heckprobit* outcome 5: *heckman* mobile selection

4.3.2.2. Endogeneity testing

First, to validate FL's instrumental strength in order to correct any problematic effect of using education and financial literacy as IVs, which prior(Lusardi & Mitchell,2014).suggests that financial literacy is endogenous (e.g., correlated with unobserved factors affecting FL such as family background and cognitive skills) and cannot serve as a valid and unbiased estimator with education as an exogenous variable. *The follow-up question is, how does financial literacy, instrumented by traditional education (e.g., structured long schooling), drive digital financial inclusion?*

The study used IVs (2SLS) with robustness checks causal effect of Education with FL for which results presented in [Table 4.5](#).

TABLE 4.5 IVs 2SLS EDUCATION INSTRUMENTED FOR FL

DV (Edu>FL)	First stage IV			Second stage IV		
	coef	SE	Z	coef	SE	Z
Educational	0.011***	0.0005	21.92			
FL				1.106***	0.15	7.21
Rural	-0.245***	0.01	-24.54	-0.25***	0.076	3.28
Female	-0.026***	0.009	-2.89	-0.02	0.0147	-1.1
Age	0.0073***	0.0014	5.2	0.0038	0.0034	1.13
A2	-0.001***	0.00001	-4.6	-0.000	0.00004	-0.85
Constant	-0.13***	0.032	4.06	-0.29**	0.103	-2.76
Diagnostics	Random = 0.272(SE = 0.005)			UI (K-Paap LM): $\chi^2(1) = 105, p = 0.0026$		
	***p < 0.01, **p < 0.05, *p < 0.1*			Weak (K-Paap Wald F): 164.52		
				Hansen J statistic: 0.000 (exactly identified)		

The 2SLS test's F-statistic (first-stage F-statistic, 87; Prob > F = 0.0000) and second-stage Wald F-statistic (105) exceed the Stock-Yogo critical value of 16.38 for a 10% maximum IV size, indicating a strong instrument. The results also support the Hanseb J and Kleibergen-Paap rk LM statistic, implying the use of education as an instrument is significant and not weak.

The finding reveals financial literacy combined with education has a strong, positive causal driving effect on mobile money usage ($\beta=1.106$, robust SE=0.15, $P<0.001$), implying A one-unit increase in financial literacy supported by a higher level of education is associated with a 1.1 mean increase in the likelihood of accepting mobile money financial services. This insight highlights how education intersected with financial education, boosting digital financial services adoptions and usage (Güney, 2023).

Then, to address potential problems of endogeneity between mobile banking usage and Internet banking digital financial literacy (DFL), similarly, the authors tested the 2SLS approach (Shaikh et al., 2023 & Tay et al., 2022).

The strength of the first-stage Mobile Banking Usage (MBU) tools for predicting DFL is demonstrated by their statistical significance ($\beta = 0.345$, $p < 0.001$). Both the first and second stage data reveal that the instruments are relevant and do not exhibit any weak instrument concerns. They also validate the strengths and reject the null hypothesis

Table 4.6 IVs 2SLS DFL instrumented for Mobile banking

DV(DFL > MBU)	First stage			Second stage		
	coef	Robust SE	Z	coef	Robust SE/t	Z
DFL(IV)				2.899***	0.172	16.84
MBUIV)	0.345***	0.02	16.84			
FL	0.007	0.005	1.32	-1.31	0.015	-1.31
Rural	0.006	0.008	0.8	-0.018	0.022	-0.80
Female	-0.012*	0.006	-2.06	0.033**	0.016	2.03
Age	0.0001	0.001	0.09	-0.0003	0.003	-0.09
Age2	-0.000003	0.00001	-0.23	0.00008	0.00003	0.23
Constant	0.019	0.006	0.87	-0.054	0.062	-0.87
Diagnostics	Random = 0.043 (SE = 0.002)			UI (K-Paap LM): $\chi^2(1) = 206.54$, $p = 0.000$		
	***p < 0.01, **p < 0.05, *p < 0.1*			Weak (K-Paap Wald F): 283.29		
	Hansen J statistic: 0.000					

Specifically, second-stage results instrumenting DFL for Mobile banking usage. The 2SLS estimate reveals a substantial positive effect of DFL on Mobile banking usage adoption ($\beta = 2.899$, $p < 0.001$), which is bigger than the first stage estimate ($\beta=0.345$), indicating that the endogeneity problem was corrected in the second stage([Table 4.6](#))

Thus, the 2SLS approach resolves endogeneity bias, establishing that digital financial literacy (DFL) has a strong, causal effects on mobile money adoption. And education attainment is a valid and strong instrument for financial literacy, addressing the endogeneity issue that plagued the previous analysis. The instrument, i.e., DFL for usage and Educ for FL 2SLS tests, passes validity tests. The result signals for

policymakers to prioritize scaling dual DFL/FL digital literacy programs to enhance financial inclusion.

4.3.2.3. Heckman selection bias testing

In the context of digital financial inclusion via mobile money derived from mobile ownership, *the question is, are mobile phone ownership (adoption) decisions distinct from mobile money usage?* The assumption is that adoption starts by owning a mobile; selection bias negatively affects usage while adoption increases usage. To structure the analysis, we hypothesize the test of Heckman selection bias as:

Mobile ownership(adoption) is a necessary condition for mobile money usage, with younger adults (aged 18≥) significantly higher adoption and usage due to greater tech-savviness compared to older (aged2) adults in Ethiopia.

Priors validate the hypotheses (Venkatesh et al., 2003 & Demirgüç-Kunt et al., 2018), but without mobile ownership difference selection bias analysis. Accordingly, this study (i.e., the case of Ethiopia) uses a Heckman two-stage selection model (1979), with mobile ownership (adoption) modeled as the selection equation to correct for potential bias. The Heckprobit result is shown in nested Table 4.4.

4.3.2.4. Heckman Sample Selection Bias correction and instrument validity

The DFS outcome model(I.e Heckprobit [Table 4.4](#)line 4) joint significance is shown by Wald $\chi^2(1)=513.91$), which also validates that the outcome and selection models are well-fitted (Prob> $\chi^2=0.0000$, Log pseudo likelihood=-5759.22). Similarly, the Wald Test of Independence test ($\chi^2(1) = 147.71$ ($p < 0.001$)) validates the selection bias exists, reinforcing the need for the mobile ownership Heckman selection correction model.

According to the hyperbolic arctangent of rho = -0.896 , $p < 0.001$), indicating a strong negative correlation ($\rho = -0.71$) between the residual error terms of the selection and outcome equations. After correction, digital financial literacy and financial literacy

remained strong predictors of mobile money usage ($\beta = 1.794, p < 0.001$; $\beta = 0.108, p = 0.048$) as presented in Table 4.4's line 4.

Instrument Validity of DFL, FL, and Education and Heckman correction : The selection equation includes education, which is excluded from the outcome equation. This satisfies the exclusion restriction, as education likely affects mobile ownership but not usage directly (Arora & Lochab, 2018) after controlling for other covariates (as shown in 2SLS Education for financial literacy). The significance of education in the selection equation ($\beta=0.0617, p < 0.001$) and nonsignificance in the outcome model (not included) support instrument validity (Wolfolds & Siegel, 2019).

Due to unobserved household-level characteristics, the better-fitted melogit findings are biased on the coefficient (for example, accurate on the direction (+-), but insignificant for age, age² and rural effects). But when sample selection bias is taken into account, the Heckman selection shows that gender and rural residence are the main factors influencing mobile ownership (adoption), although age has a nonlinear effect on both ownership and usage. In order to ensure that estimates for key DFL and FL variables are truthful, the Heckman model's correction for selection bias is validated by the substantial ρ ($\rho = -0.714, P < 0.001$). For example, the melogit model coefficient ($\beta=5.65, p<0.001$) for DFL appears exaggerated for practical effect analysis. However, following Heckman selection bias adjustment, the DFL coefficient appears to have a practical effect, supporting DFL's dominance in the mobile banking usage study.

4.3.2.4.1. Hybrid modeling approach for enhanced practical implication

The key robustness testing analysis finding is that the Heckprobit model detects selection bias, and the melogit/meprobit models fit marginally as shown by lower AIC/BIC but do not account for selection bias. In particular, mixed-effect ML explicitly models hierarchical/clustered data, which often improves fit (lower AIC/BIC) by controlling for unobserved heterogeneity. *Which model should be used for better theoretical and practical interpretations ?*

This study employed multiple estimation approaches by nesting models, mixed effects logit/probit, 2SLS IVs, and Heckman selection models, where across-model comparisons revealed highly fitted while selection and outcome meprobit models agree on coefficients.

In this case, a hybrid approach or reporting by focusing on cluster-adjusted results leads to rigorous interpretation (Angrist and Pischke, 2009; Ullmann et al., 2021; Absalom et al., 2020), which is also more advantageous for emphasizing those models/instruments outcomes and behavioral and economic practical implications.

The 2SLS approach resolves endogeneity bias, establishing that digital financial literacy (DFL) has a strong, causal differential on mobile money adoption. And education attainment is a valid and strong instrument for financial literacy, addressing the endogeneity issue that plagued the previous analysis. The instrument, i.e., DFL for usage and Educ for FL 2SLS tests, passes validity tests.

Therefore, hybrids and multi-modeling approaches (melogit/probit, 2SLS via IVs, and Heckman) are optimizing the role of household clustering (melogit) and selection bias (Heckprobit) and IVs (2SLS IVs instrumental validation, revealed methodologically rigorous outcome interpretations, policy relevance). These methodologies collectively enhance understanding of the complexities surrounding digital financial inclusion, particularly in diverse socio-economic contexts of Ethiopia. By integrating these advanced econometric analytical techniques, researchers can provide deeper insights into adult financial behavior and inform policymakers on effective strategies to promote financial inclusion.

The findings suggest that while mobile ownership is a crucial starting point (validating the hypotheses), it is the intersection of factors such as user education and within-household social influences that drive the actual adoption of mobile money services. Additionally, the Heckman selection model highlights the importance of accounting for potential biases in the data estimation, ensuring a more accurate representation of the factors influencing mobile money usage across different rural, gender, and age groups.

4.4. Discussion and Interpretations

4.4.1. *The influence of literacy as a catalyst to bridge the digital divide*

Digital financial literacy (DFL) emerges as the strongest predictor of DFS adoptions. A one-unit increase in adults' DFL score raises the log-odds of adoption by 5.65-fold ($p < 0.001$) in the mixed logit model and 2.99 ($p < 0.001$) in the probit, underscoring its centrality to overcoming technological barriers. The Heckman correction ($\beta = 1.794$, $p < 0.001$) reinforces the validity of the findings, suggesting that DFL significantly ***influences user adoption and engagement in mobile banking platforms.***

The analysis reveals FL has a smaller but significant effect: a one-unit increase raises log-odds by 0.38 ($p < 0.05$) in mixed logit and 0.187 ($p < 0.05$) in mixed probit modeling. This mirrors global findings where FL alone is insufficient without complementary digital skills, aligning Kenya's and India's DFS adoption trends (Tony & Desai, 2020; Lyons, A., et al., 2020; and Amnas, M., et al., 2024). But after selection correction, this finding is against the finding of no gender gap in DFS adoption when literacy is controlled (Siddiq & Scherer, 2019; Borgonovi et al., 2021).

General education significantly predicts DFS usage, with a logit odds ratio of 0.0844, indicating that each extra year of education increases the likelihood of DFS adoption by 23% ($\beta = 0.0844$, $P < 0.001$). In other words, individuals with more years of education can better grasp and use digital money than those with a lesser level of education. Education plays a dual role: it represents ownership in Heckman and usage in Melogit, highlighting its broader influence on inclusive finance ($\beta = 0.062$, $P < 0.001$). The result is consistent with the aforementioned and comparable to Oberrauch et al. (2024). Therefore, adult literacy status in general, as well as FL and DFL in particular, has a significant positive influence on digital financial inclusion (i.e., *reject the null hypothesis of H1 and H2*).

4.4.2. Demographic and Socioeconomic Heterogeneity

Rural and Gender Differential: The results presented in Table 4.4 show the heterogeneity in financial inclusion based on rural residency and gender.

The negative sign of the coefficient of rural residency implies that rural adults are 50% ($\beta = -0.507$) less likely to adopt DFS than their urban counterparts. The melogit result indicates that unobserved household-level factors, captured by the random intercept, are responsible for the effect of rurality. Heckman selection agrees; rural residents exhibit a 1.29-unit lower probability of mobile ownership ($\beta=-1.29, p<0.001$).

The same Table 4.4, Line 4 Rural residents are 52.4% more likely to utilize mobile banking ($\beta = 0.524, p < 0.001$) when infrastructure limitations in mobile connection and digital access are addressed (ITU, 2023). After correcting for residence clustering, the urban-rural usage disparity narrows, suggesting that household features (social dependency, shared resources, access to mobile technology) mitigate rural disadvantages.

Similarly, this finding presents that women face 51% lower odds of adoption ($\beta = -0.270, p < 0.01$), reflecting continued lagging in using DFS (i.e., consistency with low DFL and FL scores presented in the prior bivariate testing), which Melogit revealed a gender disparity that is masked by household-level clustering. The Heckman mobile selection model yields similar results regarding this issue. *The result validated hypotheses 3 and 4.*

However, the outcome model line 4 indicates gender differences in usage are statistically insignificant ($\beta=0.049, p=0.356$). This suggests that once females overcome ownership deficits, their usage patterns align with males. The key insight is that gender gaps come primarily from ownership disparity, not behavioral differences in usage. Robust intervention could mitigate this inequality.

Thus, despite assertions of progress, millions of rural citizens and women remain excluded from digital financial services via mobile technology, echoing the traditional financial exclusion of earlier times. This indicates that there must be redoubled efforts to transition from exclusion to inclusion.

Mobile ownership as a gateway: The logistics mixed-effect estimation finding reveals that mobile ownership is positively associated with the likelihood of using mobile money banking, and the estimate is statistically significant ($\beta = 0.722$, $P < 0.05$). The Heckman selection equation ($\beta = 0.062$, $p < 0.001$) indicates that mobile ownership is as critical a gateway to usage as education is. Implying usage of mobile technology not only enhances access to financial services but also empowers individuals to make informed economic decisions. This connection marks the importance of integrating educational initiatives with mobile technology to foster greater financial inclusion. This result validates the hypothesis that mobile technology facilitates digital finance access depending on digital consumer protection (Bongomin & Ntayi, 2020; Della Peruta, 2018).

Income and employment influence on DFS: Individuals who save weekly or monthly amounts of 600 ETB or more have a 3.87 times greater likelihood of adopting DFS ($\beta=1.424$), while those saving less frequently have a 0.763 times larger possibility ($\beta=0.763$, $p<0.001$), as expected. Quarterly/semiannual frequent savers have also demonstrated statistically significant relationships with DFS use ($\beta=0.618$ and $\beta=0.805$, $p<0.05$). Poorer groups have less access to digital finance, as indicated by a negative 1.1 times lower mobile money adoption probability ($\beta=-1.097$). Income stratification's negative effect on the poorest adults is consistent after Heckman's selection bias correction.

Furthermore, at the 5% level of significance, employment has a substantial influence on the likelihood of individuals using mobile banking digital financial services. Employed individuals are 37.3% more likely than jobless counterparts to use digital financial services ($\beta=0.373$, $p<0.05$).

Aging Nonlinear Effects: Age-related mixed-effect logit is not significant ($p = 0.432$) because of the bias caused by household-level heterogeneity. Regarding these biases, Heckman selection is strongly correct in representing the actual on-the-ground reality of digital equity in finance across all age groups. Specifically in this case, Heckman's selection equation in Table 4.4, column 5, indicates each additional year of age increases mobile ownership probability by 0.114 units ($\beta=0.114$, $p<0.001$). The age-squared

negative quadratic term ($\beta=-0.0012$, $P<0.001$) indicates that the returns on mobile ownership decrease as age increases. The turning points are observed at 47.5 years.

$$\text{Age} = \frac{0.114}{2 \times 0.0012} = 47.5 \text{ years.}$$

The meaning is that mobile ownership likelihood peaks around age 47.5 and declines afterward, reflecting lower tech adoption among older citizens. From a financial behavior perspective, the result implies younger adults drive both mobile ownership and usage, aligning with their greater tech familiarity; older users may face usability challenges, probably distrust of digital platforms, or prefer traditional financial services. This finding retains the above hypotheses.

4.4.3. Regional Disparities

Regional disparities are equally pronounced: residents of Somalia demonstrate 2.3 times higher log odds of adoption ($\beta=2.27$, $p<0.001$) compared to adults in Addis Ababa, likely due to Somalia's reliance on cross-border trading and on diaspora remittances. In contrast, regions like Afar show no significant gains ($\beta=0.256$, $p<0.01$). This finding validates Hypothesis 5 (Mustafa et al., 2023).

This unique Somali case refutes the hypothesis that people in relatively developed urban places (such as Addis Ababa) are more likely to use digital financial services than those in less developed areas. While failing to reject previous hypotheses for regions such as Gembella and BG, as demonstrated, they are negative users, which persists even after the adjustment for selection bias in the Heckman outcome model.

The Somali region's findings offer fresh perspectives on digital finance inclusion's intersection with education. Specifically, the region's high DFS adoption and high DFL but low FL paradox suggest that individuals may become adept with digital tools, such as mobile money applications, without a formal education. The findings align with previous research by Endashaw and Shumetie (2023), Gas (2017), Moret (2016), and McBride and Liyala (2021) on Somali region adults' cross-border commercial activity with Somalia, Djibouti, and Kenya, including the influence of diasporas. Furthermore, this conclusion

correlates to the key principles of Social Learning Theory (Bandura, 1977) and the diffusion of innovations (Rogers, 2003), as writers stated learning happens through observation, imitation, social interaction, and users' perceived ease of use and rewards.

By showing a neighbor how to use a payment app, for example, DFL can spread virtually through peer networks, paving the way for digital service adoption even in situations where FL is not present. Of the 72% of rural Kenyans who use M-Pesa, only 34% know compound interest (Global Findex, 2021), while urban middle-aged Indian professionals are aware of inflation and savings, but only 22% use digital wallets due to lack of trust (Joshi et al., 2019 and Chawla & Joshi, 2019).

The fundamental conclusion is that mobile banking through smartphone ownership eliminates digital finance exclusion in low-income regions without the requirement for physical banking access or costly expenditures. Therefore, as a lesson from India's support for smartphones in rural areas (Cornelli et al., 2024), governments and fintech companies may prioritize tailored literacy and digital infrastructure policy intervention for advancing inclusion in the context of systematic/geographic socioeconomic disparity with less capital investment and controlled corruption.

4.5. Conclusion and actionable recommendations

4.5.1. Conclusion

This study demonstrated the critical role of adult dual literacy drivers via digital and financial literacy upskilling (DFL/FL) in bridging Ethiopia's financial exclusion to inclusion. The study specifically targeted underserved rural residents, women, low-income groups, the unemployed, and those with skill deficiencies.

The hybrid approach (mainly, mixed logit/probit with Heckman selection) robustly confirms that hierarchical socioeconomic disparities and emerging digital exclusion facilitated by mobile technology continue inequality, with rural residents facing significant barriers to accessing financial resources and women lagging behind men in using digital mobile banking services. The aging effect on digital finance is more

favorable for the young than the old, making aging challenging. The Somali region's higher adoption of mobile banking without strong financial literacy (FL) reveals persistent regional disparities, reflecting uneven policy practices.

Furthermore, both bivariate and hybrid regression analyses consistently showed that DFL was the most important predictor of digital financial services inclusion. This aligns with Ethiopia's Digital & Financial Inclusive Ecosystem Strategic Solution (2021–2030). Additionally, the analysis revealed that implementing DFL tools in conjunction with general and financial education can significantly empower marginalized communities to utilize mobile technology. Thus, this paper contextualized DFL/FL, interrelated concepts, as key enabler tools for inclusion aspirations aligned to the on-ground reality of exclusion, contributing to the transition paths to robust, sustainable, inclusive development.

4.5.2. Recommendations:

To address both persistent inequality and the emerging digital divide, policymakers and regulators should consider the following actionable recommendations.

First, expand and redesign comprehensive dual literacy (digital and financial literacy) upskilling/reskilling and educational programs tailored to diverse demographic groups, including rural residents, women, religious groups, and unemployed youth. These programs should emphasize practical digital skills, such as effective use of mobile banking financial services, including IFB products that comply with shariah law. Additionally, integrate both digital and financial literacy education into school curricula to foster early financial awareness and enhance decision-making skills among young learners. When implementing these initiatives, thoughtfully consider the associated teacher training costs and potential curriculum overload to ensure their feasibility and effectiveness. And Partner with local iddir and *Equb* networks to launch literacy programs grounded in platform cooperativeness concepts.

Second, regional differences necessitate specific strategies for promoting adult financial inclusion in marginalized regions like Gambela, Afar, BG, etc. Legislators should reevaluate regionally focused programs that tackle regional financial inclusion issues.

Financial services providers should tailor their strategies and approaches to local languages and cultural nuances to avoid the inclusion-exclusion paradox of de-risking.

Thirdly, promote affordable access to mobile technology: Reduce costs and taxes on mobile devices and data services to make technology more affordable, particularly targeting lower-income individuals to increase mobile money adoptions. We should leverage the high adoption and usage of mobile money in the Somali region as a social learning experience.

Fourth, intentional policy-making focused on gender and rural communities: Develop and enforce policies that specifically target the gender and rurality gap in financial inclusion. This should include ensuring that underserved rural women have access to digital tools and financial education programs. For example, the plan includes integrating Islamic micro-products into Telebirr, promoting the use of sharia-compliant financial products for various religions, and ensuring that the service is neutral regarding religious beliefs. The proposal includes introducing a regulatory framework under NBE with liquidity management tools that comply with Sharia.

Lastly, to address the disruptive impact of digitalization requires active financial community collaboration. Stakeholders should collaborate on innovative fintech regulation, improving internet connectivity in remote areas, and addressing the digital divide. Adaptive and exclusion risk-sensitive regulatory frameworks and incentives are necessary to encourage responsible and ethical investments in digital financial services, uphold social values, and ensure consumer protection and accessibility for diverse citizen groups.

4.6. Future research

Future researchers advise using longitudinal post-2018/19 data and interdisciplinary collaboration to evaluate structural changes in holistic financial inclusion and the impact of technology on digital financial service

CHAPTER 5: GENERAL CONCLUSION AND RECOMMENDATIONS

This chapter provides the conclusion and practical policy implications, synthesizing the empirical findings from the three connected studies previously presented. First, we present the link between IFB financial inclusion and DFL/FL(2). Then, we discuss how diverse adult DFL/FL skills and demographic and socioeconomic disparities affect optimal financial inclusion in an orderly manner(3). Following that, we empirically synthesize the multidimensional effects of digital and financial literacy on the usage of digital financial services through mobile banking(4). This analysis highlights the importance of tailored DFL/FL skills in serving multiple purposes, accounting for adult financial behavior dependency.

These study findings also illustrate the importance of customized educational programs that address these disparities, taking into account the deeper contextual socio-economic dynamics of religion and the socio-economic heterogeneities that influence the success and sustainability of inclusion efforts. Ultimately, our findings highlight how to design innovative, adaptive, and targeted interventions by enhancing financial literacy, which will, in turn, promote greater financial inclusion across various demographics and socioeconomic challenges in Ethiopia. We present the conclusion and implications of each chapter below.

To begin, in the first study of IFB usage(2), the authors used mixed-effects modeling to address clustered and hierarchical data, showing that there are significant and positive effects of financial literacy and digital financial literacy skills on IFB service usage. IFB usage was found to have heterogeneity based on gender, rurality, education, mobile phone ownership, region, and religion, as indicated by empirical analysis. Our study's findings also showed a favorable correlation between women with IFB usage compared to males, which contradicts previous beliefs that being a woman reduces FI. It is implied that improving IFB service will lessen gender inequality and expand access to finance through, for example, Musharakah profit-sharing contracts, enabling them to pursue their entrepreneurial dreams free from predatory loans. The other paradox is that women in

Ethiopia exhibit lower financial literacy levels than men, while they tend to use IFB services more compared to men. This seemingly counterintuitive finding reflects the role of cultural and religious norms in shaping financial behaviors, especially among Ethiopia's substantial Muslims, for whom sharia-compliant products such as IFB are particularly significant (Chapra 2000, Siddiqi 2006). Behavioral frameworks like Ajzen's (1991) tested theory of planned behavior highlight that subjective norms and perceived social expectations can often have a stronger influence on financial service adoption than actual literacy levels. According to the capability approach articulated by Sen (1999) and Nussbaum (2011), achieving genuine financial inclusion requires not just the acquisition of advanced knowledge but also empowerment through services that are culturally sensitive and contextually appropriate. Consequently, while enhancing women's financial literacy remains essential, it must be complemented by tailored IFB product design and community outreach initiatives to fully foster gender-inclusive financial participation in Ethiopia. Furthermore, the key finding in this chapter is that adult religious affiliation influences adult financial behavior and financial inclusion outcomes, which has significant practical implications for reaffirming Islamic finance theory (Chapra 2000, Siddiqi 2006) towards addressing gender and urban-rural inequalities for enhanced financial inclusiveness in Ethiopia. Our findings are also consistent with previous empirical studies (Astuti, 2023; Setiawan et al., 2022; Johan et al., 2020), showing that non-interest, Shariah-compliant, or alternative ethical and social finance met the financial demands of both Muslim and non-Muslim groups. Financial knowledge, attitudes, and innovative thinking are important drivers in maximizing the utilization of Islamic financial services. The findings suggest that policy interventions should align with the values and principles of the IFB model to effectively promote financial inclusion.

Similarly, in the second paper of financial inclusion modeling(3), the authors used mixed-effects estimation methods to account for within-same-household adult financial dependency. The financial inclusion outcome variable is assessed through indicators of access and usage. Access is quantified using the aggregated PCA score derived from various access metrics, while usage is represented by formal account ownership, the frequency of savings, and the utilization of insurance services. The results align with the

IFB study, which indicates that both DFL and FL are significant predictors of financial inclusion. This implies the central role of DFL/FL in determining financial inclusion. The consistency of the results is further supported by the demographic coefficients (age and age squared), socioeconomic factors (income and education), and the findings related to geographic and religious disparities across these models. In this second study, the empirical analysis does not reveal gender differences, suggesting that after controlling for heterogeneity within the mixed-effects modeling context, gender may not be a significant predictor of financial inclusiveness. According to a recent study by Ozili(2025), financial inclusion effects vary by religion, and Islamic finance matters. The findings suggest that enhancing financial literacy and access can lead to improved financial outcomes for adults. Consequently, targeted interventions aimed at increasing both education and access to financial services may be key to encouraging greater financial independence in this demographic. Moreover, fostering collaboration between educational institutions and financial service providers could create a more robust framework for delivering these interventions. By tailoring programs to address the specific needs and barriers faced by various groups, stakeholders can better ensure that financial inclusiveness is achieved for all individuals, regardless of gender. Additionally, random effect estimation modeling robustly affirmed household dependency for both IFB and FI modeling. This shows that household structure and social reliance may play a more important role in determining financial inclusion than previously thought. This technique has been improved to investigate how the researchers interpret demographic and socioeconomic data, resulting in a more profound understanding of financial behavior across communities.

In the third study,chapter 4 ,the researcher examined digital financial inclusion through mobile banking usage as an outcome variable. The study used bivariate tests and hybrid modeling to address hierarchical data structures similar to the previous studies. This study addresses Heckman selection bias and endogeneity concerns by aligning theoretical and practical interpretations. The 2SLS instrumental variable testing technique validated the efficacy of the DFL, FL, and educational attainment instruments in estimating mobile money outcomes. Heckman's estimate using probit techniques found mobile ownership selection bias in the ESS data set, which is statistically plausible. After adjustment, digital

financial literacy and financial literacy were still significant predictors of mobile money usage ($\beta = 1.794$, $p < 0.001$; $\beta = 0.108$, $p = 0.048$). The predictive accuracy of DFL, FL, and education for DFI is consistent across mixed logit/probit and Heckman outcome models. This suggests that combining these literacies with education can accelerate fair societal development just as powerfully as policy measures. The empirical analysis of this study also revealed significant differences in DFS as well as socioeconomic and demographic variability. The Heckman adjustment exposed both gender and rurality differences in the use of mobile banking services. However, ownership inequality, not behavioral differences in usage, causes the disparity. Access to digital finance further varies by region, employment, income, age (nonlinearly), and educational attainment. These findings indicate behavioral differences. Ownership of digital devices and access to reliable internet are crucial factors that can enhance digital literacy and, consequently, financial inclusion. The implication is that addressing these disparities will require targeted interventions that not only promote digital literacy programs but also ensure equitable access to technology for underserved populations.

This study systematized findings and establishes adult digital-financial literacy (DFL and FL) as a catalytic driver of optimal financial inclusion in Ethiopia, reducing gender and rural disparities while enhancing employability, economic engagement, and complex decision-making capabilities. The discussed skills effectively integrate traditional social networking and innovative capital, like trust-based Iqub and Edir systems, with ethical digital finance infrastructures. This synthesis not only validates Ozili's (2025) claim about the religious inclusion nexus but also advances Sen's (1999) capability paradigm. DFL/FL offers multipurpose benefits. Upskilling and reskilling can be achieved through three channels: First, co-design culturally embedded DFL/FL curricula partnering with grassroots community and religious leader (i.e. making financial products natural) and social networks, integrating woman true empowerment approaches and Islamic finance principles and core values to overcome gender equality to access barriers in high potential region like Somali and afar; second, infrastructural investments requires context-responsive affordances: deploy not only online platforms but also offline infrastructures (e.g. TeleBirr, Safaricom, and others) through telecom cooperatives,

ensuring affordability aligns with Sen's(1999) Capability to avoid exclusionary pricing ; and thirdly, institute social Justice –centered governance via innovative regulatory to audit emerging fintech bias-mitigating credit scoring (Novel, 2018) , taxing Big Tech data extractions to fund literacy(Africa Data sovereignty initiatives ,2024; Kukutai and Taylor ,2016) Implement longitudinal monitoring and evaluation that synthesizes real-time, gender-disaggregated ethical financial behavior metrics along with institutional analytics. Considering the limitations acknowledged in section [1.8 page 27](#) , this study makes a significant and insightful contribution by demonstrating that transformative adult digital and financial literacy (DFL/FL) are effective and complementary tools for advancing optimal financial inclusion and supporting national digitization policy objectives. The findings reveal that adult DFL/FL upskilling and reskilling serve multiple critical purposes: they reduce gender and rural disparities, enhance adult employability and entrepreneurial skills, improve financial decision-making, and foster broader economic empowerment. These 21st-century applied competencies not only bridge the divide between traditional and digital financial systems but also equip individuals with the capacity to negotiate the complex, rapidly evolving modern digital-driven inclusive future ecosystem. By fostering a more inclusive financial ecosystem, this research introduces the inevitable pivotal role of adult DFL/FL in catalyzing sustainable social transformation and inclusive economic growth that fits all. The study thus provides robust empirical evidence supporting the integration of digital and financial literacy initiatives as cornerstones of Ethiopia's efforts toward equitable and expansive financial inclusion.

However, future research should prioritize the incorporation of longitudinal data and qualitative methods to provide a more comprehensive understanding of evolving post-2020 digital finance trends and their impact on financial inclusion in Ethiopia. The current study's cross-sectional design limits insights into temporal dynamics; longitudinal analyses would capture changes over time, while a qualitative approach can deepen understanding of cultural and technological, psychological, and structural barriers, including concerns related to digital colonialism and systemic risks posed by fintech developments, including new forms of inequality. Building on this, theory-linked mixed

methods research is essential to unpack the complexities of financial inclusion. The investigation could include an experimental evaluation of targeted literacy programs, Sharia-compliant IFB financial products, and innovative digital finance solutions, assessing their effectiveness on societal inclusion outcomes tailored to diverse socioeconomic groups. Future studies should also explore the broader socioeconomic implication of enhanced digital financial literacy (DFL). The task includes examining its influences on micro, small, and medium enterprises (MSMEs) with particular attention to youth employment, startups, productivity, and sustainability in women-led or owned and rural enterprises integrated with digital financial ecosystems. Rigorous analysis is warranted to examine how DFL and financial literacy affect tax compliance, state-owned public and private service delivery, entrepreneurship, and educational quality to inform policy and project program design. A crucial area for future research is the supply-demand linkage in financial inclusion, necessitating incorporation of fintech providers' perspectives, regulatory frameworks, and infrastructural limitations. Complementary cost-effective studies are needed to evaluate the integration of digital financial literacy into national educational curricula, including assessments of teacher training or retraining, curriculum development, and infrastructural requirements to ensure sustainable implementation.

Moreover, an interdisciplinary and collaborative agenda should focus on the intersections among DFL/FL initiatives, Islamic banking business models, digital payment systems, national ID, and their collective role in advancing financial inclusion and holistic digital transformation. Such collaborative efforts involving academics, practitioners, experts, and institutions across technology, training and education, and policymaking sectors can create robust, evidence-based solutions that empower individuals and communities and foster institutional resiliency. A multidimensional research approach will significantly advance knowledge, guide effective intervention, and underpin policies aimed at achieving sustainable financial inclusion and economic empowerment, placing people first.

REFERENCES

- Abdesamed, K., & Wahab, K. (2015). Owner/Managers' External Financing Used and Preference towards Islamic Banking. *World Academy of Science, Engineering and Technology, International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*, 9(9), 3257-3262.
- Abdi, H., & Williams, L. J. (2010). Principal component analysis. *Wiley interdisciplinary reviews: computational statistics*, 2(4), 433-459.
- Abdu, E., & Adem, M. (2021). Determinants of financial inclusion in Afar Region: Evidence from selected woredas. *Cogent Economics & Finance*, 9. <https://doi.org/10.1080/23322039.2021.1920149>.
- Abdu, M., Jibir, A., Abdullahi, S., & Rabi'u, A. A. (2018). Can Islamic banking and finance spur financial inclusion? Evidence from Sub-Saharan Africa. *CBN Journal of Applied Statistics*, 9(1), 77-104.
- Abdullahi, A., & Othman, A. (2021). Financial inclusion enhancement through the adoption of Islamic microfinance in Nigeria. *International Journal of Ethics and Systems*. <https://doi.org/10.1108/ijoes-02-2021-0040>.
- Abebe, W., & Deneke, D. (2015). Challenges of addressing the educational needs of rural communities in Ethiopia. *International Journal of Educational Development*, 41, 126-135. <https://doi.org/10.1016/j.ijedudev.2015.02.009>
- Abedifar, P., M. Ebrahim, S., Molyneux, P., & Tarazi, A. (2016). Islamic banking and finance: Recent empirical literature and directions for future research. *A Collection of Reviews on Savings and Wealth Accumulation*, 59-91.
- Abreham Adera & Lamessa T. Abdisa (2023) Financial inclusion and women's economic empowerment: Evidence from Ethiopia, *Cogent Economics & Finance*, 11:2,2244864, DOI: 10.1080/23322039.2023.2244864
- Achew, M. B., Ambel, A. A., Gradstein, H. L., Tsegay, A. H., Ul Haq, I., Varghese, M. M., & Yonis, M. B. (2021). Financial Inclusion in Ethiopia (No. 36030). *The World Bank Group*.
- Agarwal, S., Ghosh, P., Li, J., & Ruan, T. (2024). Digital payments and consumption: Evidence from the 2016 demonetization in India. *The Review of Financial Studies*, 37(8), 2550-2585.
- Ahmad, A., & Khan, S. S. (2019). Survey of state-of-the-art mixed data clustering algorithms. *Ieee Access*, 7, 31883-31902.

6. REFERENCES

- Ahmad, Z. (1991). Islam, poverty and income distribution. Leicester, UK: the Islamic foundation.
- Ahmed Ali, Abiy. 2025. Federal Democratic Republic of Ethiopia DIGITAL ETHIOPIA 2025-A STRATEGY FOR ETHIOPIA INCLUSIVE PROSPERITY.
- Ahmed, H. (2020). Islamic banking and the use of Shariah-compliant financial instruments to ensure access to finance for SMEs. In S.
- Ahroum, R., Touri, O., & Achchab, B. (2020). Murabaha and Musharakah Moutanaquissah pricing: an interest-free approach. *Journal of Islamic Accounting and Business Research*, 11, 201-215. <https://doi.org/10.1108/jiabr-12-2016-0147>.
- Akhtar, F., & Das, N. (2019). Predictors of investment intention in Indian stock markets. *International Journal of Bank Marketing*. <https://doi.org/10.1108/IJBM-08-2017-0167>.
- Albaity, M., & Rahman, M. (2019). The intention to use Islamic banking: an exploratory study to measure Islamic financial literacy. *International Journal of Emerging Markets*, 14, 988-1012. <https://doi.org/10.1108/IJOEM-05-2018-0218>.
- Alemayehu, A. S., & Haile, M. G. (2019). Determinants of financial inclusion in Ethiopia: Evidence from cross-sectional survey. *International Journal of Finance & Banking Studies*, 8(2), 74-86.
- Alhalaseh, R. (2024). Developing a financial literacy scale for Arab context: A case of university students. *Journal of Governance and Regulation*. <https://doi.org/10.22495/jgrv13i1siart10>
- Ali, A. S. (2020). Islamic micro finance services in Ethiopia: performances and implications for financial inclusion and poverty alleviation. *International Journal of Commerce and Finance*, 6(2), 159-169.
- Al-Khowaiter, W. (2020). Digital payment and banking adoption research in Gulf countries: A systematic literature review. *Int. J. Inf. Manag.*, 53, 102102. <https://doi.org/10.1016/j.ijinfomgt.2020.102102>.
- Allen, F., Carletti, E., Cull, R., Qian, J., Senbet, L., & Valenzuela, P. (2014). The African Financial Development and Financial Inclusion Gaps. *Journal of African Economies*, 23(5), 614-642.
- Allen, F., Demirgüç-Kunt, A., Klapper, L., & Peria, M. (2012). The Foundations of Financial Inclusion: Understanding Ownership and Use of Formal Accounts. *Banking & Insurance eJournal*. <https://doi.org/10.1016/J.JFI.2015.12.003>.
- Allgood, S., & Walstad, W. B. (2016). The effects of perceived and actual financial literacy on financial behaviors. *Economic inquiry*, 54(1), 675-697.

6. REFERENCES

- Allgood, S., Walstad, W., & Siegfried, J. (2015). Research on Teaching Economics to Undergraduates. *Journal of Economic Literature*, 53, 285-325. <https://doi.org/10.1257/JEL.53.2.285>.
- Al-Wreiket, A., Ashraf, A., Al-Sheyab, O., Hassan, M., & Julio, I. (2020). AAOIFI ACCOUNTING STANDARDS AND A THEORY OF INTEREST-FREE BANKING. *The Singapore Economic Review*, 1-41. <https://doi.org/10.1142/s0217590819420074>.
- Aman, A. W., Ali, A. S., & Yesufi, A. J. (2021). The potential critical success factors of full-fledged interest-free banks in Ethiopia. *Journal of Economics Bibliography*, 7(4), 211-230.
- Amaroh, S., & Istianah. (2020). Women and Islamic financial literacy. *PALASTREN*, 13(2), 259-274.
- Amnas, M. B., Selvam, M., & Parayitam, S. (2024). FinTech and financial inclusion: Exploring the mediating role of digital financial literacy and the moderating influence of perceived regulatory support. *Journal of Risk and Financial Management*, 17(3), 108.
- Angrist, J. D., & Pischke, J. S. (2009). Mostly harmless econometrics: An empiricist's companion. *Princeton university press*.
- Aracil, E. (2019). Corporate social responsibility of Islamic and conventional banks: The influence of institutions in emerging countries. *International Journal of Emerging Markets*, 14(4), 582-600.
- Arora, M., & Lochab, A. (2018). A study on post hoc analysis on education level in mobile banking. *Effulgence*, 16, 1-8.
- Asdullah, M., & Yazdifar, H. (2016). Evaluation of factors influencing youth towards Islamic banking in Pakistan. , 2, 217-223. <https://doi.org/10.21917/IJMS.2016.0030>.
- Astuti, A. (2023). The Relationship of Financial Literacy and Financial Inclusion in Attracting Student Interest to Become Customers Syariah Banking. *Journal of Accounting and Finance Management*. <https://doi.org/10.38035/jafm.v4i1.190>.
- Asuming, P. O., Osei-Agyei, L. G., & Mohammed, J. I. (2019). Financial inclusion in sub-Saharan Africa: Recent trends and determinants. *Journal of African Business*, 20(1), 112-134.
- Atkinson, A., & Messy, F. A. (2013). Promoting financial inclusion through financial education: *OECD/INFE evidence, policies and practice*.
- Awotide, B., Abdoulaye, T., Alene, A., & Manyong, V. (2015). Impact of Access to Credit on Agricultural Productivity: Evidence from Smallholder Cassava Farmers in Nigeria. . <https://doi.org/10.22004/AG.ECON.210969>.

6. REFERENCES

-
- Aziz, A., & Naima, U. (2021). Rethinking digital financial inclusion: Evidence from Bangladesh. *Technology in Society*. <https://doi.org/10.1016/j.techsoc.2020.101509>.
- Aziz, M. (2022). Digital Transformation Through Islamic Digital Banking For Financial Inclusion. *Proceeding of International Conference on Science and Technology*. <https://doi.org/10.36378/internationalconferenceuniks.v0i0.2818>.
- Azmeh, C. (2025). Financial globalization, Poverty, and inequality in developing countries: The moderating role of Fintech and financial inclusion. *Research in Globalization*, 100277.
- Baele, L., Farooq, M., & Ongena, S. (2014). Of religion and redemption: Evidence from default on Islamic loans. *Journal of Banking & Finance*, 44, 141-159.
- Bajaj, I., & Kaur, M. (2022). Validating multi-dimensional model of financial literacy using confirmatory factor analysis. *Managerial Finance*, 48(9/10), 1488-1512.
- Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of statistical software*, 67, 1-48.
- Baza, A. U., & Rao, K. S. (2017). Financial Inclusion in Ethiopia. *International Journal of Economics and Finance*, 9(4), 191. <https://doi.org/10.5539/ijef.v9n4p191>
- Beck, T., Demirgüç-Kunt, A., & Merrouche, O. (2013). Islamic vs. Conventional Banking: Business Model, Efficiency, and Stability. *Journal of Banking & Finance*, 37(2), 433-447.
- Beck, T., Demirgüç-Kunt, A., & Merrouche, O. (2018). Islamic Finance and Economic Growth: The Role of Institutions. *Journal of Comparative Economics*, 46(4), 920-938.
- Bensalem, S., & Bouherb, H. (2021). Analysis on Islamic Banking Financing Difficulties for SMEs Using Musharakah and Mudaraba Financing Instruments. *Al Bashaer Economic Journal*, 7(2).
- Berhanu Lakew, T., & Azadi, H. (2020). Financial inclusion in Ethiopia: is it on the right track?. *International Journal of Financial Studies*, 8(2), 28.
- Birch, K., Chiappetta, M., & Artyushina, A. (2020). The problem of innovation in technoscientific capitalism: Data rentiership and the policy implications of turning personal digital data into a private asset. *Policy studies*, 41(5), 468-487.
- Bongomin, G. O. C., & Ntayi, J. M. (2020). Mobile money adoption and usage and financial inclusion: mediating effect of digital consumer protection. *Digital Policy, Regulation and Governance*, 22(3), 157-176.
- Borgonovi, F., Choi, Á., & Paccagnella, M. (2021). The evolution of gender gaps in numeracy and literacy between childhood and young adulthood. *Economics of Education Review*. <https://doi.org/10.1016/J.ECONEDUREV.2021.102119>.

6. REFERENCES

-
- Boukhatem, J., & Moussa, F. (2017). The effect of Islamic banks on GDP growth: Some evidence from selected MENA countries. *Borsa Istanbul Review*.
<https://doi.org/10.1016/J.BIR.2017.11.004>.
- Branch, B. (2014). Institutional economics and behavioral finance. *Journal of Behavioral and Experimental Finance*, 1, 13-16.
<https://doi.org/10.1016/J.JBEF.2013.11.001>.
- Brennen, J. S., & Kreiss, D. (2016). Digitalization. *The international encyclopedia of communication theory and philosophy*, 1-11.
- Breunig, R., & Majeed, O. (2020). Inequality, poverty and economic growth. *International Economics*, 161, 83-99.
<https://doi.org/10.1016/j.inteco.2019.11.005>.
- Buch, C. (2017). Financial literacy and financial inclusion: priorities of the G20 German presidency. Speech presented at the 4th OECD/GFLEC Global Policy Research Symposium to Advance Financial Literacy: Addressing the Needs of Youth, Paris, France
- Bun, M., & Harrison, T. (2019). OLS and IV estimation of regression models including endogenous interaction terms. *Econometric Reviews*, 38, 814 - 827.
<https://doi.org/10.1080/07474938.2018.1427486>.
- Burgess, R., & Pande, R. (2005). Do rural banks matter? Evidence from the Indian social banking experiment. *American Economic Review*, 95(3), 780-795.
- Cámara, N., & Tuesta, D. (2014). Measuring financial inclusion: A multidimensional index. *BBVA Research Paper*, (14/26).
- Campbell-Verduyn, M., & Giumelli, F. (2022). Enrolling into exclusion: African blockchain and decolonial ambitions in an evolving finance/security infrastructure. *Journal of Cultural Economy*, 15, 524 - 543.
<https://doi.org/10.1080/17530350.2022.2028655>.
- Cerny, B., & Kaiser, H. (1977). A Study Of A Measure Of Sampling Adequacy For Factor-Analytic Correlation Matrices.. *Multivariate behavioral research*, 12 1, 43-7 . https://doi.org/10.1207/s15327906mbr1201_3.
- Chong, B. S., & Liu, M.-H. (2009). Islamic banking: interest-free or interest-based? *Pacific-Basin Finance Journal*, 17(1), 125-144.
- Choung, Y., Chatterjee, S., & Pak, T. Y. (2023). Digital financial literacy and financial well-being. *Finance Research Letters*, 58, 104438.
- Chu, H., Guo, H., & Zhou, Y. (2010). Bivariate random effects meta-analysis of diagnostic studies using generalized linear mixed models. *Medical Decision Making*, 30(4), 499-508.

6. REFERENCES

-
- Chu, Z., Wang, Z., Xiao, J., & Zhang, W. (2016). Financial Literacy, Portfolio Choice and Financial Well-Being. *Social Indicators Research*, 132, 799 - 820. <https://doi.org/10.1007/s11205-016-1309-2>.
- Clark, D. E., & Moore, L. (2011). Multilevel modeling. *In Injury research: Theories, methods, and approaches* (pp. 427-446). Boston, MA: Springer US.
- Colglazier, W. (2015). Sustainable development agenda: 2030. *Science*, 349(6252), 1048-1050.
- Coulibaly, M., & Sirpé, G. (2023). Financial dualism: An analysis of the effects of informal finance on formal finance in West African Economic and Monetary Union (WAEMU) countries. *African Development Review*. <https://doi.org/10.1111/1467-8268.12712>.
- Crenshaw, Kimberle (1989) "Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, *Feminist Theory and Antiracist Politics*. Vol. 1989.
- CSA. 2020. "Ethiopian Socioeconomic Survey (ESS) 2018/19: SURVEY REPORT." Central Statistics Agency of Ethiopia and World Bank.
- Daher, J., Mountjoy, M., & Khoury, D. (2025). An Online Nutrition Education Program Targeting Intentions and Related Determinants Towards Dietary Supplement Use: *An Application of the Theory of Planned Behavior*. *Nutrients*, 17. <https://doi.org/10.3390/nu17030557>.
- Daradkah, D. M., Alshbiel, S. O., & Al-Haraisa, Y. E. (2020). The impact of financial literacy on the use of Islamic banking services in Jordan. *International Journal of Innovation, Creativity and Change*, 13(5), 1-17.
- Darmansyah, D., Fianto, B., Hendratmi, A., & Aziz, P. (2020). Factors determining behavioral intentions to use Islamic financial technology. *Journal of Islamic Marketing*. <https://doi.org/10.1108/jima-12-2019-0252>.
- Datta, P. B., & Manjula, R. (2019). Women's entrepreneurial ventures under poverty: Innovation and sustainability in microfinance institutions. *Entrepreneurship & Regional Development*, 31(1-2), 102-120.
- Dawood, H., Al Zadjali, F., Al Rawahi, M., Karim, S., & Hazik, M. (2022). Business trends & challenges in Islamic FinTech: A systematic literature review. *F1000Research*, 11, 329.
- Della Peruta, M. (2018). Adoption of mobile money and financial inclusion: a macroeconomic approach through cluster analysis. *Economics of Innovation and New Technology*, 27(2), 154-173.
- Demirgüç-Kunt, A., Klapper, L. F., Singer, D., & Van Oudheusden, P. (2015). The global finindex database 2014: Measuring financial inclusion around the world. *World Bank Policy Research Working Paper*, (7255).

6. REFERENCES

-
- Demirguc-Kunt, A., Klapper, L., & Randall, D. (2014). Islamic finance and financial inclusion: measuring use of and demand for formal financial services among Muslim adults. *Review of Middle East Economics and Finance*, 10(2), 177-218.
- Demirgüç-Kunt, A., Klapper, L., Singer, D., & Ansar, S. (2022). *The Global Findex Database 2021: Financial inclusion, digital payments, and resilience in the age of COVID-19*. World Bank Publications.
- Demirguc-Kunt, A., Klapper, L., Singer, D., Ansar, S., & Hess, J. (2018). *The Global Findex Database 2017: Measuring financial inclusion and the fintech revolution*. World Bank Publications.
- Demirguc-Kunt, Asli, Alvaro Pedraza, and Claudia Ruiz-Ortega. 2021. "Banking Sector Performance during the COVID-19 Crisis | Elsevier Enhanced Reader." 2021.
- Demirgüç-Kunt, Asli, Leora Klapper, Dorothe Singer, and Saniya Ansar. 2022. *The Global Findex Database 2021 : Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19*.
- Demirgüç-Kunt, Asli, Leora Klapper, Dorothe Singer, Saniya Ansar, and Jake Hess. 2020. "The Global Findex Database 2017: Measuring Financial Inclusion and Opportunities to Expand Access to and Use of Financial Services." *World Bank Economic Review* 34. doi: 10.1093/wber/lhz013.
- Desalegn, G., & Yemataw, G. (2017). Financial inclusion in Ethiopia: Using LSMS (Ethiopia socioeconomic survey) data. *Ethiopian Journal of Economics*, 26(2), 31-58.
- Dinku, T. (2019). Financial inclusion in Ethiopia: Using core set of financial inclusion indicators. *Journal of Research and Opinion*, 6(7), 2369-2376.
- Directives to Authorize the Business of Interest Free Banking Directives Number SBB/72/2019
- Dogra, P., & Kaushal, A. (2023). The impact of Digital Marketing and Promotional Strategies on attitude and purchase intention towards financial products and service: A Case of emerging economy. *Journal of Marketing Communications*, 29(4), 403-430.
- Dong, F., Lu, J., & Featherstone, A. (2010). Effects of Credit Constraints on Productivity and Rural Household Income in China. *American Journal of Agricultural Economics*.
- Duvendack, M., & Mader, P. (2019). Impact of financial inclusion in low- and middle-income countries: A systematic review of reviews. *Campbell Systematic Reviews*, 15. <https://doi.org/10.4073/CSR.2019.2>.
- El Qorchi, M. (2005). Islamic finance gears up. *Finance and Development*, 42(4), 46.

6. REFERENCES

- Er, B., & Mutlu, M. (2017). Financial inclusion and Islamic finance: A survey of Islamic financial literacy index. *International Journal of Islamic Economics and Finance Studies*, 3(2).
- Erlando, A., Riyanto, F. D., & Masakazu, S. (2020). Financial inclusion, economic growth, and poverty alleviation: evidence from eastern Indonesia. *Heliyon*, 6(10).
- Ethiopia Country Focus Report. 2024. COUNTRY FOCUS REPORT 2024 Driving Ethiopia's Transformation The Reform of the Global Financial Architecture ETHIOPIA.
- Ethiopian Financial sector, Research and analytics, *CEPHEUS*, 2019.
- Farihana, S., & Rahman, M. (2020). Can profit and loss sharing (PLS) financing instruments reduce the credit risk of Islamic banks?. *Empirical Economics*, 61, 1397 - 1414. <https://doi.org/10.1007/s00181-020-01912-5>.
- Federal Republic of Ethiopia. (2019). a Homegrown Economic Reform Agenda: A Pathway to Prosperity.
- Fernandes, D., Lynch Jr, J. G., & Netemeyer, R. G. (2014). Financial literacy, financial education, and downstream financial behaviors. *Management Science*, 60(8), 1861-1883.
- Field, A. (2024). Discovering statistics using IBM SPSS statistics. *Sage publications limited*.
- Fikadu, G. F. (2016). Determinants of Access to Credit and Credit Source Choice by Micro, Small and Medium Enterprises in Nekemte, Ethiopia. *International Journal of African and Asian Studies* Www.Iiste.Org ISSN, 28, 11–27.
- Fong, J., Koh, B., Mitchell, O., & Rohwedder, S. (2020). Financial Literacy and Financial Decision-Making at Older Ages. FEN: *Experimental Finance (Topic)*. <https://doi.org/10.2139/ssrn.3710225>.
- Fungáčová, Z., & Weill, L. (2015). Understanding financial inclusion in China. *China Economic Review*, 34, 196-206.
- Gabor, D., & Brooks, S. (2017). The digital revolution in financial inclusion: international development in the fintech era. *New Political Economy*, 22, 423 - 436. <https://doi.org/10.1080/13563467.2017.1259298>.
- Garzaro, D., Varotto, L., & Pedro, S. (2020). Internet and mobile banking: the role of engagement and experience on satisfaction and loyalty. *International Journal of Bank Marketing*. <https://doi.org/10.1108/ijbm-08-2020-0457>.
- Gass, S., & Varonis, E. M. (1984). The effect of familiarity on the comprehensibility of nonnative speech. *Language learning*, 34(1), 65-87.

6. REFERENCES

-
- Gautam, R., Rastogi, S., Rawal, A., Bhimavarapu, V., Kanoujiya, J., & Rastogi, S. (2022). Financial Technology and Its Impact on Digital Literacy in India: Using Poverty as a Moderating Variable. *Journal of Risk and Financial Management*. <https://doi.org/10.3390/jrfm15070311>.
- Gelman, A., & Hill, J. (2007). Data analysis using regression and multilevel/hierarchical models. *Cambridge university press*.
- Ghosh, S. (2020). Access to and use of finance in India: does religion matter?. *Indian Economic Review*, 1-26. <https://doi.org/10.1007/s41775-020-00082-6>.
- Giday, H. G. (2023). Financial inclusion and its demand-side determinants: Evidence from Ethiopia. *Cogent Economics & Finance*, 11(1), 2186031.
- Golden, W., & Cordie, L. (2022). Digital Financial Literacy. Adult Literacy Education: *The International Journal of Literacy, Language, and Numeracy*. <https://doi.org/10.35847/wgolden.lcordie.4.3.20>.
- Gomes, F., Haliassos, M., & Ramadorai, T. (2020). Household Finance. *Financial Literacy eJournal*. https://doi.org/10.1596/978-1-4648-0342-0_ch6.
- Greene, W. H. (2018). *Econometric Analysis (Eighth Ed)*. *New York University*.
- Griesbach, C., Groll, A., & Bergherr, E. (2021). Addressing cluster-constant covariates in mixed effects models via likelihood-based boosting techniques. *Plos one*, 16(7), e0254178.
- Grohmann, A., Klühs, T., & Menkhoff, L. (2017). Does Financial Literacy Improve Financial Inclusion? Cross Country Evidence. *European Economics: Macroeconomics & Monetary Economics eJournal*. <https://doi.org/10.2139/ssrn.3034178>.
- Grohmann, A., Klühs, T., & Menkhoff, L. (2017). Does Financial Literacy Improve Financial Inclusion? Cross Country Evidence. *European Economics: Macroeconomics & Monetary Economics eJournal*. <https://doi.org/10.2139/ssrn.3034178>.
- Grohmann, A., Klühs, T., & Menkhoff, L. (2018). Does financial literacy improve financial inclusion? Cross country evidence. *World Development*. <https://doi.org/10.1016/J.WORLDDEV.2018.06.020>.
- GSMA. 2022. “State of the Industry Report on Mobile Money 2022.” Gsma.
- GSMA. 2023a. Mobile Money in Ethiopia: Advancing Financial Inclusion and Driving Growth.
- GSMA. 2023b. The Mobile Gender Gap Report 2023.

6. REFERENCES

- Güney, K. (2023). Considering the Advantages and Disadvantages of Utilizing Social Media to Enhance Learning and Engagement in K-12 Education. *Research in Social Sciences and Technology*, 8(2), 83-100.
- Hagawe, H., Mobarek, A., Hanuk, A., & Jamal, A. (2023). A unique business model for microfinance institution: the case of Assadaqaat Community Finance (ACF). *Cogent Business & Management*, 10. <https://doi.org/10.1080/23311975.2022.2135202>.
- Hailu, S. M., & Bushera, I. (2020). Interest Free Banking in Ethiopia: Prospects and Challenges. *International Journal of Islamic Economics and Finance Studies*, 6(2), 119-137.
- Hailu, S., Kapusuzoğlu, A., & Ceylan, N. (2019). The Role of Islamic Financial Product Innovation in Reduction of Financial Exclusion in Ethiopia. *Advances in Business Strategy and Competitive Advantage*. <https://doi.org/10.4018/978-1-5225-7180-3.CH024>.
- Harahap, B., Risfandy, T., & Putri, I. (2023). Islamic Law, Islamic Finance, and Sustainable Development Goals: A Systematic Literature Review. *Sustainability*. <https://doi.org/10.3390/su15086626>.
- Hargittai, E., & Hinnant, A. (2008). Digital inequality: Differences in young adults' use of the Internet. *Communication research*, 35(5), 602-621.
- Hasan, M., & Lu, Z. (2023). Nexus among financial inclusion and sustainability in Asia: role of banking sector. *Environmental Science and Pollution Research International*, 30, 62481 - 62493. <https://doi.org/10.1007/s11356-023-26028-y>.
- Hasan, M., Le, T., & Hoque, A. (2021). How does financial literacy impact on inclusive finance?. *Financial Innovation*, 7. <https://doi.org/10.1186/s40854-021-00259-9>.
- Hasan, M., Lu, Y., & Mahmud, A. (2020). Regional Development of China's Inclusive Finance Through Financial Technology. *SAGE Open*, 10. <https://doi.org/10.1177/2158244019901252>.
- Hasan, Morshadul, Thi Le, and Ariful Hoque. 2021. "How Does Financial Literacy Impact on Inclusive Finance?" *Financial Innovation* 7(1). doi: 10.1186/s40854-021-00259-9.
- Hassan, M., Banna, H., & Alam, M. (2020). Digital Financial Inclusion, Islamic Banking Stability and Sustainable Economic Growth. *Islamic Perspective for Sustainable Financial System*. <https://doi.org/10.26650/b/ss10.2020.017.06>.
- Hayes, T. (2024). Individual-level probabilities and cluster-level proportions: Toward interpretable level 2 estimates in unconfounded multilevel models for binary outcomes. *Psychological Methods*.
- Haynes-Bordas, R., Kiss, D. E., & Yilmazer, T. (2008). Effectiveness of financial education on financial management behavior and account usage: Evidence from a

6. REFERENCES

- 'second chance' program. *Journal of Family and Economic Issues*, 29(3), 362-390. <https://doi.org/10.1007/s10834-008-9115-x>
- Hendriks, S. (2019). The role of financial inclusion in driving women's economic empowerment. *Development in Practice*, 29, 1029 - 1038. <https://doi.org/10.1080/09614524.2019.1660308>.
- Hensher, D. A., & Greene, W. H. (2003). The mixed logit model: the state of practice. *Transportation*, 30, 133-176.
- Hernandez, K., Flynn, J., He, J., & Alsahi, H. (2024). *Towards digital inclusion in rural transformation*. Food & Agriculture Org.[Author][Author].
- Higgins, S., & Lustig, N. (2015). Can a poverty-reducing and progressive tax and transfer system hurt the poor?. *Journal of Development Economics*, 122, 63 <https://doi.org/10.1016/j.jdeveco.2016.04.001>.
- Hizgilov, A., & Silber, J. (2020). On Multidimensional Approaches to Financial Literacy Measurement. *Social Indicators Research*, 148, 787-830. <https://doi.org/10.1007/s11205-019-02227-4>.
- Hogarth, J. M., Anguelov, C. E., & Lee, J. (2004). Why don't households have a checking account? *Journal of Consumer Affairs*, 38(1), 1-34.
- Hoque, M., Rahman, M., Said, J., Begum, F., & Hossain, M. (2022). What Factors Influence Customer Attitudes and Mindsets towards the Use of Services and Products of Islamic Banks in Bangladesh?. *Sustainability*. <https://doi.org/10.3390/su14084703>.
- Housby, E. (2013). *Islamic and ethical finance in the United Kingdom*. Edinburgh University Press.
- Hox, J. J., Moerbeek, M., & van de Schoot, R. (2017). *Multilevel analysis: Techniques and applications* (3rd ed.). Routledge. <https://doi.org/10.4324/9781315650982>
- Huang, F. (2021). Alternatives to Logistic Regression Models when Analyzing Cluster Randomized Trials with Binary Outcomes. *Prevention Science*, 24, 398-407. <https://doi.org/10.1007/s11121-021-01228-5>.
- Hung, A., Parker, A. M., & Yoong, J. (2009). Defining and measuring financial literacy.
- Ibrahim, A. A., Hussein, J. M., & Kulmie, D. A. (2024). Islamic banking in Africa: A booming market with growing pains. *International Journal of Religion*, 5(9), 318-333.
- Islam, K., & Khan, M. (2024). The role of financial literacy, digital literacy, and financial self-efficacy in FinTech adoption. *Investment Management and Financial Innovations*. [https://doi.org/10.21511/imfi.21\(2\).2024.30](https://doi.org/10.21511/imfi.21(2).2024.30).

6. REFERENCES

- Jamil, S. (2021). From digital divide to digital inclusion: Challenges for wide-ranging digitalization in Pakistan. *Telecommunications Policy*, 45, 102206. <https://doi.org/10.1016/J.TELPOL.2021.102206>.
- Johan, Z., Hussain, M., Mohd, R., & Kamaruddin, B. (2020). Muslims and non-Muslims intention to hold Shariah-compliant credit cards: a SmartPLS approach. *Journal of Islamic Marketing*. <https://doi.org/10.1108/jima-12-2019-0270>.
- Johnstone, I. M., & Lu, A. Y. (2009). On consistency and sparsity for principal components analysis in high dimensions. *Journal of the American Statistical Association*, 104(486), 682-693.
- Jolliffe, I. T., & Cadima, J. (2016). Principal component analysis: a review and recent developments. *Philosophical transactions of the royal society A: Mathematical, Physical and Engineering Sciences*, 374(2065), 20150202.
- Jones, S., & Hensher, D. (2004). Predicting Firm Financial Distress: A Mixed Logit Model. *The Accounting Review*, 79, 1011-1038. <https://doi.org/10.2308/ACCR.2004.79.4.1011>.
- Jose, J., & Ghosh, N. (2025). Digital financial literacy and financial inclusion in the global south for a sustainable future: A scoping review. *Decision*, 1-20..
- Joudar, F., Msatfa, Z., Metwalli, O., Mouabid, M., & Dinar, B. (2023). Islamic financial stability factors: An econometric evidence. *Economies*, 11(3), 79.
- Kadoya, Y., & Khan, M. S. R. (2020). Financial literacy in Japan: New evidence using financial knowledge, behavior, and attitude. *Sustainability*, 12(9), 3683.
- Kaiser, H. F. (1974). An index of factorial simplicity. *psychometrika*, 39(1), 31-36.
- Kanungo, R. P., & Gupta, S. (2021). Financial inclusion through digitalisation of services for well-being. *Technological Forecasting and Social Change*, 167, 120721.
- Kanwal, A., Tayyab, M., & Idrees, S. (2023). Exploring the Nexus of Financial Technologies, Financial Inclusion, and Blockchain in Islamic Finance within Digital Transformation. *Pakistan Journal of Humanities and Social Sciences*. <https://doi.org/10.52131/pjhss.2023.1104.0675>.
- Kaplan, B., Franck, C., McKee, K., Gilroy, S., & Koffarnus, M. (2021). Applying Mixed-Effects Modeling to Behavioral Economic Demand: An Introduction. *Perspectives on Behavior Science*, 44, 333 - 358. <https://doi.org/10.1007/s40614-021-00299-7>.
- Kass-Hanna, J., Lyons, A. C., & Liu, F. (2022). Building financial resilience through financial and digital literacy in South Asia and Sub-Saharan Africa. *Emerging Markets Review*, 51, 100846.

6. REFERENCES

-
- Kassim, S. (2016). Islamic finance and economic growth: The Malaysian experience. *Global Finance Journal*, 30, 66-76. <https://doi.org/10.1016/J.GFJ.2015.11.007>.
- Kaur, I., & Kaur, A. (2021). A Novel Four-Way Approach Designed With Ensemble Feature Selection for Code Smell Detection. *IEEE Access*, 9, 8695-8707. <https://doi.org/10.1109/ACCESS.2021.3049823>.
- Ke, D. (2017). Who Wears the Pants? Gender Identity Norms and Intrahousehold Financial Decision-Making. *FEN: Behavioral Finance (Topic)*. <https://doi.org/10.2139/ssrn.2909720>.
- Kebede, D. A. (2020). Determinants of interest free financial products in Ethiopian banking industry. *Jurnal Perspektif Pembiayaan dan Pembangunan Daerah*, 8(3), 219-230.
- Kebede, K. M., Tadesse, A. H., & Bekele, B. B. (2020). A qualitative study of factors influencing the utilization of institutional delivery: Insights from pastoral communities, Southwest Ethiopia. *Journal of Midwifery & Reproductive Health*, 8(3).
- Kedir, A., & Kouame, E. (2022). FinTech and women's entrepreneurship in Africa: the case of Burkina Faso and Cameroon. *Journal of Cultural Economy*, 1-16.
- Khan, F., Siddiqui, M., & Imtiaz, S. (2022). Role of financial literacy in achieving financial inclusion: A review, synthesis and research agenda. *Cogent Business & Management*, 9. <https://doi.org/10.1080/23311975.2022.2034236>.
- Khan, M. S., Lakha, F., Tan, M. M. J., Singh, S. R., Quek, R. Y. C., Han, E., ... & Legido-Quigley, H. (2019). More talk than action: gender and ethnic diversity in leading public health universities. *The Lancet*, 393(10171), 594-600.
- Khera, P., Ng, M., Ogawa, S., & Sahay, R. (2021). Is Digital Financial Inclusion Unlocking Growth?. *IMF Working Papers*. <https://doi.org/10.5089/9781513584669.001>.
- Khmous, D., & Besim, M. (2020). Impact of Islamic banking share on financial inclusion: evidence from MENA. *International Journal of Islamic and Middle Eastern Finance and Management*, 13, 655-673. <https://doi.org/10.1108/imefm-07-2019-0279>.
- Kilian, P., Ye, S., & Kelava, A. (2023). Mixed effects in machine learning—A flexible mixedML framework to add random effects to supervised machine learning regression. *Transactions on Machine Learning Research*
- Kim, D. S. (2025). A Hybrid EM Algorithm for Linear Two-Way Interactions with Missing Data. *Journal of Educational and Behavioral Statistics*, 10769986241304015.

6. REFERENCES

-
- Kim, N. (2018). Comparison of indicators for identification of least developed countries and for measuring progress towards the sustainable development goals. *UN CDP Policy Review*, (7).
- Klapper, L., Lusardi, A., & Van Oudheusden, P. (2015). Financial literacy around the world. World Bank. Washington DC: *World Bank*, 2, 218-237.
- Klapper, Leora, and Annamaria Lusardi. 2019. "Financial Literacy and Financial Resilience: Evidence from around the World." *Financial Management* 49(3):589–614. doi: 10.1111/fima.12283.
- Koomson, I., Villano, R. A., & Hadley, D. (2020). Effect of financial inclusion on poverty and vulnerability to poverty: Evidence using a multidimensional measure of financial inclusion. *Social Indicators Research*, 149(2), 613-639.
- Kulkarni, L., & Ghosh, A. (2021). Gender disparity in the digitalization of financial services: challenges and promises for women's financial inclusion in India. *Gender, Technology and Development*, 25(2), 233-250.
- Kurunkatil, U. (2019). Islamic Finance and Financial Exclusion in Minority Muslim Countries: The Case of India. *Islamic Finance, Risk-Sharing and Macroeconomic Stability*. https://doi.org/10.1007/978-3-030-05225-6_11.
- Kwateng, K., Atiemo, K., & Appiah, C. (2019). Acceptance and use of mobile banking: an application of UTAUT2. *J. Enterp. Inf. Manag.*, 32, 118-151. <https://doi.org/10.1108/JEIM-03-2018-0055>.
- Lakew, T., & Azadi, H. (2020). Financial Inclusion in Ethiopia: Is It on the Right Track?. *International Journal of Financial Studies*. <https://doi.org/10.3390/ijfs8020028>.
- Lee, C., Lou, R., & Wang, F. (2022). Digital financial inclusion and poverty alleviation: Evidence from the sustainable development of China. *Economic Analysis and Policy*. <https://doi.org/10.1016/j.eap.2022.12.004>.
- Leszczensky, L., & Wolbring, T. (2022). How to deal with reverse causality using panel data? Recommendations for researchers based on a simulation study. *Sociological Methods & Research*, 51(2), 837-865.
- Lever, J., Krzywinski, M., & Altman, N. (2017). Points of Significance: Principal component analysis. *Nature Methods*, 14, 641-642. <https://doi.org/10.1038/nmeth.4346>.
- Liu, L., & Guo, L. (2023). Digital Financial Inclusion, Income Inequality, and Vulnerability to Relative Poverty. *Social Indicators Research*, 170, 1155 - 1181. <https://doi.org/10.1007/s11205-023-03245-z>.
- Llewellyn, D. T. (2024). Evidence. *International Review of Economics and Finance*, 61, 1–16. Retrieved from <https://www.elgaronline.com/> at 07/12/2024 01:46:31 PM

6. REFERENCES

- Lo Prete, A. (2021). Digital and financial literacy as determinants of digital payments and personal finance. *DecisionSciRN: Financial Decision-Making (Topic)*. <https://doi.org/10.2139/ssrn.3948927>.
- Lotto, J. (2018). Examination of the Status of Financial Inclusion and Its Determinants in Tanzania. *Sustainability*. <https://doi.org/10.3390/SU10082873>.
- Luo, C., Li, S., & Sicular, T. (2020). The long-term evolution of national income inequality and rural poverty in China. *China Economic Review*, 62, 101465. <https://doi.org/10.1016/j.chieco.2020.101465>.
- Luo, W., & Li, B. (2016). Combining eigenvalues and variation of eigenvectors for order determination. *Biometrika*, 103, 875-887. <https://doi.org/10.1093/BIOMET/ASW051>.
- Lusardi, A., & Messy, F. A. (2023). The importance of financial literacy and its impact on financial wellbeing. *Journal of Financial Literacy and Wellbeing*, 1(1), 1-11.
- Lusardi, A., & Mitchell, O. S. (2014). The economic importance of financial literacy: Theory and evidence. *Journal of Economic Literature*, 52(1), 5-44. <https://doi.org/10.1257/jel.52.1.5>
- Lusardi, Annamaria, and Flore-Anne Messy. 2023. "The Importance of Financial Literacy and Its Impact on Financial Wellbeing." *Journal of Financial Literacy and Wellbeing* 1(1):1-11. doi: 10.1017/flw.2023.8.
- Lyons, A., & Kass-Hanna, J. (2021). A multidimensional approach to defining and measuring financial literacy in the digital age. Available at SSRN 3873386.
- Lyons, A., Kass-Hanna, J., Liu, F., Greenlee, A., & Zeng, L. (2020). Building Financial Resilience Through Financial and Digital Literacy in South Asia and Sub-Saharan Africa. *Financial Literacy eJournal*. <https://doi.org/10.2139/ssrn.3496562>.
- Mandala, G. N., Ippili, T. R., Divya, D., & Nagesh, N. (2025). Digital financial literacy in rural households: A study of Manyam Parvathipuram District in Andhra Pradesh. *International journal of economic perspectives*, 19(2), 455-463.
- Mansoor Khan, M., & Ishaq Bhatti, M. (2008). Development in Islamic banking: a financial risk-allocation approach. *The Journal of Risk Finance*, 9(1), 40-51. <https://www.emerald.com/insight/content/doi/10.1108/15265940810853235/full/html>
- Mazziotta, M., & Pareto, A. (2019). Use and Misuse of PCA for Measuring Well-Being. *Social Indicators Research*, 142, 451-476. <https://doi.org/10.1007/S11205-018-1933-0>.
- McNeish, D. (2017). Challenging conventional wisdom for multivariate statistical models with small samples. *Review of Educational Research*, 87(6), 1117-1151. <https://doi.org/10.3102/0034654317727727>

6. REFERENCES

-
- McNeish, D., & Kelley, K. (2019). Fixed effects models versus mixed effects models for clustered data: Reviewing the approaches, disentangling the differences, and making recommendations. *Psychological Methods*, 24(1), 20–35.
<https://doi.org/10.1037/met0000182>
- McNeish, D., & Stapleton, L. M. (2016). Modeling clustered data with very few clusters. *Multivariate Behavioral Research*, 51(4), 495–518.
<https://doi.org/10.1080/00273171.2016.1167008>
- McNeish, D., Stapleton, L. M., & Silverman, R. D. (2017). On the unnecessary ubiquity of hierarchical linear modeling. *Psychological Methods*, 22(1), 114–140.
<https://doi.org/10.1037/met0000078>
- Mennawi, A. (2020). The Impact of Liquidity, Credit, and Financial Leverage Risks on Financial Performance of Islamic Banks: A Case of Sudanese Banking Sector. *Risk and Financial Management*. <https://doi.org/10.30560/rfm.v2n2p59>.
- Menza, Mesfin, Wondwossen Jerene, and Mubarek Oumer. 2024. “The Effect of Financial Technology on Financial Inclusion in Ethiopia during the Digital Economy Era.” *Cogent Social Sciences* 10(1). doi: 10.1080/23311886.2024.2309000.
- Meteyard, L., & Davies, R. A. (2020). Best practice guidance for linear mixed-effects models in psychological science. *Journal of Memory and Language*, 112, 104092.
- Meyer, R., & Höllerer, M. (2014). Does Institutional Theory Need Redirecting?. ORG: Other Strategy & Organizational Behavior (Topic). <https://doi.org/10.1111/joms.12089>.
- Mingione, G. (2011). Nonlinear measure data problems. *Milan Journal of Mathematics*, 79(2), 429-496.
- Mize, T., Doan, L., & Long, J. (2019). A General Framework for Comparing Predictions and Marginal Effects across Models. *Sociological Methodology*, 49, 152 - 189.
<https://doi.org/10.1177/0081175019852763>.
- Mndolwa, F. D., & Alhassan, A. L. (2020). Gender disparities in financial inclusion: Insights from Tanzania. *African Development Review*, 32(4), 578-590.
- Moahid, M., & Maharjan, K. (2020). Factors Affecting Farmers’ Access to Formal and Informal Credit: Evidence from Rural Afghanistan. *Sustainability*.
<https://doi.org/10.3390/su12031268>.
- Mohieldin & H. Ahmed (Eds.), Islamic Finance and the Role of Qard Hassan (pp. 125-142). *Palgrave Macmillan*.
- Mohieldin, M., Iqbal, Z., Rostom, A., & Fu, X. (2011). The role of Islamic finance in enhancing financial inclusion in Organization of Islamic Cooperation (OIC) countries (Policy Research Working Paper No. 5920). *The World Bank*.

6. REFERENCES

-
- Morgan, P. J. (2021). Fintech, financial literacy, and financial education. *The Routledge Handbook of Financial Literacy*, 239-258.
- Morgan, P. J., Huang, B., & Trinh, L. Q. (2019). The need to promote digital financial literacy for the digital age. IN THE DIGITAL AGE.
- Morgan, P., & Long, T. (2020). Financial literacy, financial inclusion, and savings behavior in Laos. *Journal of Asian Economics*. <https://doi.org/10.1016/j.asieco.2020.101197>.
- Morgan, Peter J., and Long Q. Trinh. 2019. "Fintech and Financial Literacy in the Lao PDR." *SSRN Electronic Journal*. doi: 10.2139/SSRN.3398235.
- Mossie, W. (2022). Understanding financial inclusion in Ethiopia. *Cogent Economics & Finance*, 10. <https://doi.org/10.1080/23322039.2022.2071385>.
- Mossie, W. (2023). Financial inclusion drivers, motivations, and barriers: Evidence from Ethiopia. *Cogent Business & Management*, 10. <https://doi.org/10.1080/23311975.2023.2167291>.
- Mukherjee, S., & Sood, K. (2020). Triggers and barriers of financial inclusion: A country-wise analysis. *Asian Economic and Financial Review*, 10(9), 970.
- Muryanto, Y. (2022). The urgency of sharia compliance regulations for Islamic Fintechs: a comparative study of Indonesia, Malaysia and the United Kingdom. *Journal of Financial Crime*. <https://doi.org/10.1108/jfc-05-2022-0099>.
- Musa, H., Ahmad, N., & Nor, A. (2024). Expanding financial inclusion participation in Muslim-dominated communities through Islamic finance products (IFP) adoption. *Journal of Islamic Accounting and Business Research*. <https://doi.org/10.1108/jiabr-09-2023-0308>.
- Muslichah, I., & Sanusi, S. (2019). The effect of religiosity and financial literacy on intention to use Islamic banking products. *Asian Journal of Islamic Management (AJIM)*. <https://doi.org/10.20885/ajim.vol1.iss2.art2>.
- Mustafa, J., Marie, A., Al-Amarneh, A., & Al-Abbadi, A. (2023). The Role of Fintech Payment Instruments in Improving Financial Inclusion. *Information Sciences Letters*. <https://doi.org/10.18576/isl/120637>.
- Mustonen, P., Karlsson, L., Kataja, E., Scheinin, N., Korttesluoma, S., Coimbra, B., Rodrigues, A., Sousa, N., & Karlsson, H. (2019). Maternal prenatal hair cortisol is associated with prenatal depressive symptom trajectories. *Psychoneuroendocrinology*, 109. <https://doi.org/10.1016/j.psyneuen.2019.104383>.
- Muthia, F., Novriansa, A., & Andaiyani, S. (2023). Do Demographic Factors Affect Digital Financial Literacy?. *SRIWIJAYA INTERNATIONAL JOURNAL OF DYNAMIC ECONOMICS AND BUSINESS*. <https://doi.org/10.29259/sijdeb.v7i1.41-50>.

6. REFERENCES

-
- Naceur, S. B., Barajas, A., & Massara, A. (2015). Can Islamic banking increase financial inclusion? (IMF Working Paper No. 15/31). *International Monetary Fund*.
- Naceur, S., & Zhang, R. (2016). Financial Development, Inequality and Poverty: Some International Evidence. ERN: *Equity*. <https://doi.org/10.1016/J.IREF.2018.12.015>.
- National Bank of Ethiopia. (2022). Annual financial inclusion report. Addis Ababa: *National Bank of Ethiopia Publications*.
- National bank of Ethiopian annual reports, 2020/2021
- Negera, M., Alemu, T., Hagos, F., & Hailelassie, A. (2024). Does financial inclusion enhance farmers' resilience to climate change? Evidence from rural Ethiopia. *Sustainable Development*. <https://doi.org/10.1002/sd.3277>.
- Nguyen, T. (2022). Does Financial Knowledge Matter in Using Fintech Services? Evidence from an Emerging Economy. *Sustainability*. <https://doi.org/10.3390/su14095083>.
- Nguyen, T. T. H. (2020). Measuring financial inclusion: a composite FI index for the developing countries. *Journal of Economics and Development*, 23(1), 77-99.
- Nguyen, T., & Kelley, C. (2018). Methods used for estimating mixed-effects models in EdSurvey. *American Institute for Research*.
- Nik Azman, N. H., Zulkafli, A. H., Masron, T. A., & Abdul Majid, A. R. (2023). The interconnectivity between Islamic financial literacy and financial sustainability: evidence from Muslim micro-entrepreneurs in Malaysia. *Journal of Islamic Accounting and Business Research*.
- Nkoa, B. E. O., & Song, J. S. (2020). Does institutional quality affect financial inclusion in Africa? A panel data analysis. *Economic Systems*, 44(4), 100836.
- Noor, M., Fourqoniah, F., & Aransyah, M. (2020). Investigation of financial inclusions, financial literation, and financial technology in Indonesia. , 8, 257-268. <https://doi.org/10.22437/PPD.V8I3.9942>.
- Nordjo, R., & Adjasi, C. (2019). The impact of credit on productivity of smallholder farmers in Ghana. *Agricultural Finance Review*, 80, 91-109. <https://doi.org/10.1108/afr-10-2018-0096>.
- North, D. C. (2007). Limited access orders in the developing world: A new approach to the problems of development (Vol. 4359). *World Bank Publications*.
- Nsiah, A. Y., & Tweneboah, G. (2023). Determinants of financial inclusion in Africa: is institutional quality relevant?. *Cogent Social Sciences*, 9(1), 2184305.
- Nurhayati, L., Mandey, S. L., Taroreh, R. N., Trang, I., & Djamali, R. (2021). Why Non-Muslims Become Customers of Islamic Banking?. *Studies of Applied Economics*, 39(12).

6. REFERENCES

-
- Nurkholik, A. (2024). R Approach in Digital Financial Literacy Influence Subjective Financial Well-Being. *Revista mexicana de economía y finanzas*, 19(1).
- Obaidullah, M. (2005, March). Islamic financial services.
- Oberrauch, L., Lusardi, A., Brugiavini, A., & Cavapozzi, D. (2025). Financial literacy in PISA 2012-2022: An overview and avenues for research. *Journal of Financial Literacy and Wellbeing*, 1-15. <https://doi.org/10.1017/flw.2024.17>
- OECD. (2013). PISA 2012 Financial Literacy Framework (pp. 139–166)
- OECD. (2020). OECD/INFE Toolkit for Measuring Financial Literacy
- OECD. (2022). Improving Financial Literacy: Analysis of Issues and Policies. *OECD Publishing*. https://www.oecd-ilibrary.org/finance-and-investment/improving-financial-literacy_9789264012578-en
- OECD. (2023). OECD/INFE 2023 International Survey of Adult Financial Literacy. OECD Business and Finance Policy Papers. https://www.oecd.org/en/publications/2023/12/oecd-infe-2023-international-survey-of-adult-financial-literacy_8ce94e2c.html
- Oh, S., Kim, K., Kim, M., Oh, J., Chu, S., & Choi, J. (2020). Measurement of Digital Literacy Among Older Adults: Systematic Review. *Journal of Medical Internet Research*, 23. <https://doi.org/10.2196/26145>.
- Ouma, S. (2020). Farming as financial asset: Global finance and the making of institutional landscapes (p. 220). *Agenda Publishing Limited*.
- Oxford Analytica. (2019). Ethiopia's homegrown economic reforms face challenges. *Emerald Expert Briefings*, (oxan-db).
- Ozdemir, M., Savasan, F., & Ulev, S. (2023). Leveraging Financial Inclusion Through Islamic Microfinance: A New Model Proposal for Participation Banks in Türkiye. *Borsa Istanbul Review*. <https://doi.org/10.1016/j.bir.2023.01.011>.
- Ozili, P. (2018). Impact of Digital Finance on Financial Inclusion and Stability. *Big Data & Innovative Financial Technologies Research Paper Series*. <https://doi.org/10.1016/J.BIR.2017.12.003>.
- Ozili, P. (2020a). Theories of Financial Inclusion. ERN: Other Monetary Economics: Financial System & Institutions (Topic). <https://doi.org/10.2139/ssrn.3526548>.
- Ozili, P. (2020c). Optimal Financial Inclusion. *ERN: Latin America & the Caribbean (Development) (Topic)*. <https://doi.org/10.2139/ssrn.3551463>.
- Ozili, P. (2021a). Financial Inclusion: A Strong Critique. FinPlanRN: Financial Well-Being (Topic). <https://doi.org/10.2139/ssrn.3584574>.)

6. REFERENCES

-
- Ozili, P. (2021b). Financial Inclusion-Exclusion Paradox: How Banked Adults become Unbanked Again. *Financial Internet Quarterly*, 17, 44 - 50. <https://doi.org/10.2478/fiqf-2021-0012>.
- Ozili, P. (2022). Financial inclusion and sustainable development: an empirical association. *Journal of Money and Business*. <https://doi.org/10.1108/jmb-03-2022-0019>.
- Ozili, P. (2025). Financial inclusion, religiosity and economic welfare in majority Christian, Hindu and Muslim countries. *foresight*. <https://doi.org/10.1108/fs-03-2024-0046>.
- Ozili, Peterson K. 2021c. "Financial Inclusion: Globally Important Determinants." *Financial Internet Quarterly* 17(4):1–11. doi: 10.2478/fiqf-2021-0023.
- Özşuca, E. A. (2019). Financial Inclusion in Turkey: Evidence from Individual Level Data. *Ankara Üniversitesi SBF Dergisi*, 74(4), 1377-1400.
- Panos, G., & Wilson, J. (2020). Financial literacy and responsible finance in the FinTech era: capabilities and challenges. *The European Journal of Finance*, 26, 297 - 301. <https://doi.org/10.1080/1351847X.2020.1717569>.
- Parvin, S., & Panakaje, N. (2022). A Study on the Prospects and Challenges of Digital Financial Inclusion. *International Journal of Case Studies in Business, IT, and Education*. <https://doi.org/10.47992/ijcsbe.2581.6942.0210>
- Perry, V. G., & Morris, M. D. (2005). Who is in control? The role of self-perception, knowledge, and income in explaining consumer financial behavior. *Journal of Consumer Affairs*, 39(2), 299-313. <https://doi.org/10.1111/j.1745-6606.2005.00016.x>
- Pesqué-Cela, V., Tian, L., Luo, D., Tobin, D., & Kling, G. (2021). Defining and measuring financial inclusion: A systematic review and confirmatory factor analysis. *Journal of International Development*. <https://doi.org/10.1002/JID.3524>.
- Possumah, B. T., Appiah, M. K., & Hilmiyah, N. (2018). Determinants of islamic banking adoption across different religious groups in Ghana: A panoptic perspective. *Journal of International Studies*, 11(4), 138-154.
- Prabhakaran, S., & L., M. (2023). Perception vs. reality: Analysing the nexus between financial literacy and fintech adoption. *Investment Management and Financial Innovations*. [https://doi.org/10.21511/imfi.20\(4\).2023.02](https://doi.org/10.21511/imfi.20(4).2023.02).
- Prasad, H., Meghwal, D., & Dayama, V. (2018). Digital Financial Literacy: A Study of Households of Udaipur. *Journal of Business and Management*. <https://doi.org/10.3126/jbm.v5i0.27385>.
- Prina, S. (2015). BANKING THE POOR VIA SAVINGS ACCOUNTS: EVIDENCE FROM A FIELD EXPERIMENT . *Journal of Development Economics*, 115, 16-31. <https://doi.org/10.1016/J.JDEVECO.2015.01.004>.

6. REFERENCES

-
- Prykaziuk, N., & Khodakivska, Y. (2023). DIGITAL FINANCIAL LITERACY: COMPONENTS AND METHODS OF ENHANCEMENT. *Innovation and Sustainability*. <https://doi.org/10.31649/ins.2023.2.31.37>.
- PSI newsletter. 2024. Ethiopia's Digital Finance Sector: Overcoming Challenges and Driving Financial Inclusion Digital Finance and Interbank Competition in Ethiopia PSI Newsletter.
- Quresh, M., Ismail, M., Khan, M., & Gill, M. A. (2023). THE IMPACT OF FINTECH ON FINANCIAL INCLUSION: OPPORTUNITIES, CHALLENGES, AND FUTURE PERSPECTIVES. *PalArch's Journal of Archaeology of Egypt/Egyptology*, 20(2), 1210-1229.
- Rahmanto, D., Muhammad, I., Nurwiyanti, F., Kamal, A., & Sani, A. (2023). Islamic Banks: Study of Financial Literacy, Digital Marketing, Accessibility, Age, and Education. *Journal of Islamic Economics and Finance Studies*. <https://doi.org/10.47700/jiefes.v4i1.5805>.
- Rai, K., Dua, S., & Yadav, M. (2019). Association of Financial Attitude, Financial Behaviour and Financial Knowledge Towards Financial Literacy: A Structural Equation Modeling Approach. *FIIIB Business Review*, 8, 51 - 60. <https://doi.org/10.1177/2319714519826651>.
- Raudenbush, S. W., & Bryk, A. S. (2002). Hierarchical linear models: Applications and data analysis methods (2nd ed.). *Sage Publications*.
- Raut, R. (2020). Past behaviour, financial literacy and investment decision-making process of individual investors. *International Journal of Emerging Markets*, 15, 1243-1263. <https://doi.org/10.1108/ijoem-07-2018-0379>.
- Ravikumar, T., Suresha, B., Prakash, N., Vazirani, K., & Krishna, T. A. (2022). Digital financial literacy among adults in India: measurement and validation. *Cogent Economics & Finance*, 10(1), 2132631.
- Rawat, R., Chakrawarti, R. K., Raj, A. S. A., Mani, G., Chidambarathanu, K., & Bhardwaj, R. (2023). Association rule learning for threat analysis using traffic analysis and packet filtering approach. *International Journal of Information Technology*, 15(6), 3245-3255.
- Refera, M. K., Dhaliwal, N. K., & Kaur, J. (2016). Financial literacy for developing countries in Africa: A review of concept, significance and research opportunities. *Journal of African Studies and development*, 8(1), 1-12.
- Robson, J., & Peetz, J. (2020). Gender differences in financial knowledge, attitudes, and behaviors: Accounting for socioeconomic disparities and psychological traits. *Journal of Consumer Affairs*, 54, 813-835. <https://doi.org/10.1111/joca.12304>.
- Roy, P., & Patro, B. (2022). Financial inclusion of women and gender gap in access to finance: A systematic literature review. *Vision*, 26(3), 282-299.

6. REFERENCES

- Saba, I., Khan, A., & Jawed, H. (2021). Islamic Finance and SDGs: Connecting Dots. In *Islamic Finance and Sustainable Development* (pp. 55-76). *Palgrave Macmillan*, Cham.
- Sachs, J., Kroll, C., Lafortune, G., Fuller, G., & Woelm, F. (2021). Sustainable development report 2021. *Cambridge University Press*.
- Saihi, A., Ben-Daya, M., & As' ad, R. (2023). Underpinning success factors of maintenance digital transformation: A hybrid reactive Delphi approach. *International Journal of Production Economics*, 255, 108701.
- Sakyi-Nyarko, C., Ahmad, A. H., & Green, C. J. (2022). The gender-differential effect of financial inclusion on household financial resilience. *The Journal of Development Studies*, 58(4), 692-712.
- Sarma, M., & Pais, J. (2011). Financial inclusion and development. *Journal of International Development*, 23(5), 613-628.
- Sawani, M., & Patterson, S. (2010). Informal saving practices in developing countries. *Journal of international business and cultural studies*, 2, 1.
- Sayinzoga, A., Bulte, E. H., & Lensink, R. (2016). Financial literacy and financial behaviour: Experimental evidence from rural Rwanda. *The economic journal*, 126(594), 1571-1599.
- Scholz, Trebor, and York Office. n.d. PLATFORM COOPERATIVISM Challenging the Corporate Sharing Economy.
- Schunck, R., & Perales, F. (2017). Within-and between-cluster effects in generalized linear mixed models: A discussion of approaches and the xthybrid command. *The Stata Journal*, 17(1), 89-115.
- Sekyi, S., Domanban, P., & Honya, G. (2019). The impact of informal credit on rural agricultural productivity in the savannah ecological zone of Ghana. *African Journal of Economic and Management Studies*, 11, 301-315. <https://doi.org/10.1108/ajems-03-2019-0121>.
- Seltman, H. J. (2009). Mixed models. A flexible approach to correlated data. *Experimental design and analysis*, 357-377.
- Sembiring, S., & Muhajir, A. (2024). The Role of Accounting And Auditing Organization For Islamic Financial Institutions (AAOIFI) in Sharia Statement Of Fiancial Accounting Standards (PSAK). *International Journal Of Humanities Education and Social Sciences*, 3(4).
- Şen, S., & Cohen, A. (2023). An Evaluation of Fit Indices Used in Model Selection of Dichotomous Mixture IRT Models. *Educational and Psychological Measurement*. <https://doi.org/10.1177/00131644231180529>.

6. REFERENCES

- Setiawan, D., Darwanto., & Gunanto, E. Y. A. (2021). Determinants of Behavioral Intentions to Use Sharia Financial Technology. *Signifikan: Jurnal Ilmu Ekonomi*, 10(2), 325-342. <https://doi.org/10.15408/sjie.v10i2.21451>.
- Setiawan, M., Effendi, N., Santoso, T., Dewi, V. I., & Sapulette, M. S. (2022). Digital financial literacy, current behavior of saving and spending and its future foresight. *Economics of Innovation and New Technology*, 31(4), 320-338.
- Shaikh, A. A., Glavee-Geo, R., Karjaluoto, H., & Hinson, R. E. (2023). Mobile money as a driver of digital financial inclusion. *Technological Forecasting and Social Change*, 186, 122158.
- Sharma, A., Sengupta, S., & Roy, C. (2023). FINANCIAL INCLUSION INDEX OF INDIA. *Journal of Southwest Jiaotong University*. <https://doi.org/10.35741/issn.0258-2724.58.3.58>.
- Shih, H., Chen, B., Chen, M., Wang, C., & Wang, L. (2022). A Study of the Financial Behavior Based on the Theory of Planned Behavior. *International Journal of Marketing Studies*. <https://doi.org/10.5539/ijms.v14n2p1>.
- Shinkafi, A., Yahaya, S., & Sani, T. (2019). Realising financial inclusion in Islamic finance. *Journal of Islamic Marketing*. <https://doi.org/10.1108/JIMA-02-2017-0020>.
- Shrestha, N. (2021). Factor Analysis as a Tool for Survey Analysis. *American Journal of Applied Mathematics and Statistics*, 9, 4-11. <https://doi.org/10.12691/AJAMS-9-1-2>.
- Siddik, M. N. A., & Kabiraj, S. (2020). Digital finance for financial inclusion and inclusive growth. Digital transformation in business and society: *Theory and cases*, 155-168.
- Siddiq, F., & Scherer, R. (2019). Is there a gender gap? A meta-analysis of the gender differences in students' ICT literacy. *Educational Research Review*. <https://doi.org/10.1016/J.EDUREV.2019.03.007>.
- Siddique, M. A., Haq, M., & Rahim, M. (2022). The contribution of Shariah-Compliant products to SDGs attending through the pace of economic growth: an empirical evidence from Pakistan. *International Journal of Islamic and Middle Eastern Finance and Management*, 15(4), 681-698.
- Snijders, T. A., & Bosker, R. (2011). Multilevel analysis: An introduction to basic and advanced multilevel modeling.
- StataCorp, L. P. (2017). *Stata statistical software*: release 15.
- Stella, G. P., Filotto, U., & Cervellati, E. M. (2020). A Proposal for a New Financial Literacy Questionnaire. *International Journal of Business and Management*, 15(2), 34-48.

6. REFERENCES

-
- Suhrab, M., Chen, P., & Ullah, A. (2023). Digital financial inclusion and income inequality nexus: Can technology innovation and infrastructure development help in achieving sustainable development goals?. *Technology in Society*. <https://doi.org/10.1016/j.techsoc.2023.102411>.
- Sundararajan, A. (2018). Decolonial fintech: Rethinking financial inclusion through indigenous knowledge systems. *Journal of Financial Technology and Development*, 4(2), 45–63.
- Suri, Tavneet, and William Jack. 2016. "The Long-Run Poverty and Gender Impacts of Mobile Money." *Science* 354(6317):1288–92. doi: 10.1126/science.aah5309.
- Su'un, S. U. (2018). Determinants of Islamic banking adoption across different religious groups in Ghana: a panoptic perspective. *Journal of International Studies*, 11(4), 138-154.
- Tay, L., Tai, H., & Tan, G. (2022). Digital financial inclusion: A gateway to sustainable development. *Heliyon*, 8. <https://doi.org/10.1016/j.heliyon.2022.e09766>.
- Taylor, J., & Verbyla, A. (2018). *The University of Adelaide*. The Grants Register 2019. https://doi.org/10.1007/978-1-349-94186-5_1135.
- Taylor, Marcus. "The antinomies of 'financial inclusion': Debt, distress and the workings of Indian microfinance." *Journal of Agrarian Change* 12, no. 4 (2012): 601-610.
- Tchamyou, V. S., Erreygers, G., & Cassimon, D. (2019). Inequality, ICT and financial access in Africa. *Technological Forecasting and Social Change*, 139, 169-184.
- Thaler, R., & Sunstein, C. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. Yale University Press.
- Thambiah, S., Eze, U., Santhapparaj, A., & Arumugam, K. (2010). Customers' Perception on Islamic Retail Banking: A Comparative Analysis between the Urban and Rural Regions of Malaysia. *International Journal of Biometrics*, 6, 187. <https://doi.org/10.5539/IJBM.V6N1P187>.
- Tigist, B. (2019). the Effect of Financial Inclusion on Household Income in Ethiopia. (Issue August). *ADDIS ABABA UNIVERSITY*.
- Tina Dacin, M., Goodstein, J., & Richard Scott, W. (2002). Institutional theory and institutional change: Introduction to the special research forum. *Academy of management journal*, 45(1), 45-56.
- Tindi, S. (2025). Digital Transformation and Digital Inequality in Ghana, West Africa.
- Tony, N., & Desai, K. (2020). Impact Of Digital Financial Literacy On Digital Financial Inclusion. *International Journal of Scientific & Technology Research*, 9, 1911-1915.

6. REFERENCES

-
- TRENDS, G. (2017). Challenges and opportunities in the implementation of the Sustainable Development Goals. *United Nations Development Programme & United Nations Research Institute for Social Development*.
- Uddin, S., Abusloun, M., & Afroz, N. (2020). Islamic Financial Inclusion. Research Anthology on Personal Finance and Improving Financial Literacy. <https://doi.org/10.4018/978-1-7998-1611-9.ch009>.
- UNCDF. (2023). Digital and Financial Literacy in Ethiopia: UNCDF and Ministry of Innovation and Technology Convene Key Stakeholders to Deliberate on an Upcoming Nationwide Survey. *UNCDF*
- Union, A. (2020). The digital transformation strategy for Africa (2020-30).
- UNSGSA. (2018). Igniting SDG progress through digital financial inclusion 2023 edition.
- Usman, H. M., & Hussain, A. (2022). Facilitating Condition of Acceptance and Use of Islamic Financial Technology (Islamic Fintech): Technological Forecasting in Saudi Banks. *INKISHAF*, 2(5), 47-67.
- Usman, H., Mulia, D., Chairy, C., & Widowati, N. (2020). Integrating trust, religiosity and image into technology acceptance model: the case of the Islamic philanthropy in Indonesia. *Journal of Islamic Marketing*.
- Wagner, J., & Walstad, W. (2018). The Effects of Financial Education on Short-Term and Long-Term Financial Behaviors. *Journal of Consumer Affairs*. <https://doi.org/10.1111/JOCA.12210>.
- Wajdi Dusuki, A., & Irwani Abdullah, N. (2007). Why do Malaysian customers patronise Islamic banks?. *International journal of bank marketing*, 25(3), 142-160.
- Wang, Wenjing, Taiyi He, and Zhenhui Li. 2022. "Digital Inclusive Finance, Economic Growth and Innovative Development." *Kybernetes* 52(9):3064–84. doi: 10.1108/k-09-2021-0866.
- Wang, X., & Fu, Y. (2021). Digital financial inclusion and vulnerability to poverty: evidence from Chinese rural households. *China Agricultural Economic Review*. <https://doi.org/10.1108/caer-08-2020-0189>.
- Warde, I. (2010). Islamic Finance in the Global Economy. . <https://doi.org/10.1515/9780748631674>.
- Williams, R. (2018). Multilevel/Mixed Effects Models: A Brief Overview. *University of Notre Dame*.
- Williamson, C. (2009). Informal institutions rule: institutional arrangements and economic performance. *Public Choice*, 139, 371-387. <https://doi.org/10.1007/S11127-009-9399-X>.

6. REFERENCES

- Wolfolds, S. E., & Siegel, J. (2019). Misaccounting for endogeneity: The peril of relying on the Heckman two-step method without a valid instrument. *Strategic Management Journal*, 40(3), 432-462.
- Workineh Ayenew Mossie | (2022) Understanding financial inclusion in Ethiopia, *Cogent Economics & Finance*, 10:1, 2071385, DOI: 10.1080/23322039.2022.2071385.
- World Bank Group. (2017). Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution. *World Bank Group*.
- World Bank Group. (2024). Ethiopia economic update: Strengthening financial inclusion for inclusive growth. *World Bank Publications*.
- Xiao, G., Zhu, S., Xiao, X., Yan, L., Yang, J., & Wu, G. (2017). Comparison of laboratory tests, ultrasound, or magnetic resonance elastography to detect fibrosis in patients with nonalcoholic fatty liver disease: *A meta-analysis*. *Hepatology*, 66. <https://doi.org/10.1002/hep.29302>.
- Xu, X. (2020). Trust and financial inclusion: A cross-country study. *Finance Research Letters*, 35, 101310. <https://doi.org/10.1016/j.frl.2019.101310>.
- Yadav, M. (2024). A Comparative Study on Digital Financial Literacy and E-Banking Adoption. *International Journal for Research in Applied Science and Engineering Technology*. <https://doi.org/10.22214/ijraset.2024.63616>.
- Yakubi, Y. A. Y., Basuki, B., Purwono, R., & Usman, I. (2022). The Impact Of Digital Financial Inclusion On Socio-Economic Development In Low-Income Countries. *Applied Econometrics and International Development*, 22(2), 89-108.
- Yang, Junhong, Yu Wu, and Bihong Huang. 2020. "Digital Finance and Financial Literacy: An Empirical Investigation of Chinese Households." *SSRN Electronic Journal*. doi: 10.2139/ssrn.3806419.
- Yaqin, M., & Safuan, S. (2023). DIGITAL FINANCIAL INCLUSION AND IMPLICATIONS FOR DEVELOPING COUNTRIES ECONOMIC GROWTH. *Journal of Developing Economies (JDE)*, 8(1).
- Yeni, F., Mulyani, S. R., & Susriyanti, S. (2023). Islamic financial literacy, spiritual intelligence, public perception and behaviour on public interest in Islamic banking services. *Cogent Economics & Finance*, 11(1), 2
- Yıldırım, S., Yıldırım, D. C., & Diboglu, P. (2020). Does Sukuk market development promote economic growth?. *PSU Research Review*, 4(3), 209-218.
- Yusfiarto, R., Nugraha, S., Mutmainah, L., Berakon, I., Sunarsih, S., & Nurdany, A. (2022). Examining Islamic capital market adoption from a socio-psychological perspective and Islamic financial literacy. *Journal of Islamic Accounting and Business Research*. <https://doi.org/10.1108/jiabr-02-2022-0037>.

6. REFERENCES

- Yusha'u, M. J., & Servaes, J. (Eds.). (2021). The Palgrave handbook of international communication and sustainable development (Vol. 6). *Palgrave Macmillan*.
- Zauro, N. A., Zauro, N. A., Saad, R. A. J., & Sawandi, N. (2020). Enhancing socio-economic justice and financial inclusion in Nigeria: The role of zakat, Sadaqah and Qardhul Hassan. *Journal of Islamic Accounting and Business Research*, 11(3), 555-572.
- Zhou, J., & Xiao, T. (2018). Analyzing Determinants of Household Financial Decision-Making: Household Stock Investment in China. *Emerging Markets Finance and Trade*, 54, 3385 - 3400. <https://doi.org/10.1080/1540496X.2018.1474736>
- Zins, A., & Weill, L. (2016). The determinants of financial inclusion in Africa. *Review of development finance*, 6(1), 46-57.
- Ziyn Engdasew, Z. E. (2012). Functional adult literacy for the pastoralist community in Ethiopia-challenges and prospects.
- Zuboff, S. (2019, January). Surveillance capitalism and the challenge of collective action. In *New labor forum* (Vol. 28, No. 1, pp. 10-29). Sage CA: Los Angeles, CA: sage Publications.
- Zulhibri, M. (2016). Financial inclusion, financial inclusion policy and Islamic finance. *Macroeconomics and Finance in Emerging Market Economies*, 9, 303 - 320.

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APPENDIXES I APPENDIX A 7.1 THE DEFINITIONS OF VARIABLES, SYMBOLS, AND HYPOTHESES

Variables	Symbol /abbrev	Measurements	Hypotheses	Sourecs
Financial Inclusion	FI	Multidimensional Financial inclusion PCA score indicating access to and usage of Financial services by the <i>i</i> individual. It is the Outcome variable .	from DFL and FL (+)	ESS4 ,2018/19
IFB financial inclusion	IFB	Use of IFB Financial service, Binary (0=No, 1=Yes) , Outcome variable	from DFL and FL (+)	ESS4 ,2018/19
Digital Financial Service Adoption And Usage.	DFSU	Use of Digital Financial service, Binary (0=No, 1=Yes) ,Outcome variable	from DFL and FL (+)	ESS4 ,2018/19
Digital Financial Literacy Score	DFL	Key1 variable by the PCA score of the individual self-reported ability to use (Mobile banking ,Online banking , ATM .)	+	Lyons et al. (2020), Golden and Cordie (2022), and Ozili (2021c)
Financial Literacy Score	FL	Key2,Multidimensional measured by the PCA score of the individual aggregated FL scores. Indicators of FK , FA, and FB)	+	Lyons et al. (2020), Golden and Cordie (2022), and Ozili (2021c)
Knowledge(FK)	FK	It is a sub-dimension of the FL variable measured by the PCA score of the individual answers to financial knowledge questions.	+	OECD/INFE (2018) ,2023, Ozili (2021c)
Behavior (FB)	FB	It is a sub dimension of the FL variable measured by the PCA score of the individual answers to financial Behavior questions.	+	OECD/INFE (2018) ,2023, Ozili(2021c),
Attitude (FA)	FA	It is a sub dimension of the FL variable measured by the PCA score of the individual answers to financial attitude questions.	+	OECD/INFE (2018) ,2023, Ozili (2021c)
Gender	Female or Male	Binary 1=Female ;0=Male	-/+	Demirgüç-Kunt et al. ,(2018)
Age And Age ²	A & A ²	Continuous variables in number of years and its square	A(+),A ² (-)	Khmous, & Besim(2020), Zşuca (2019), and Ozili (2021)
Educational Attainment	Educ	Continuous variable:Years of schooling attended	+	World Bank (2022)

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Shock-resilience		1 if worries about being able to meet unforeseen bills; 0 otherwise.	+/_	Lyons et al. (2020),and Ozili (2021).
Income Frequency Of Saving ≥ 600 ETb Weekly ,Monthly ..		Categorical, a proxy of, on average income , the person's ability to save ≥ 600 ETB at least once ,weekly,monthly..	+	Lyons et al. (2020); and Demirgüç-Kunt et al. (2018)
Employment	Emp	Binary(1=employed;0=Unemployed)	+	Lyons, et al (2020)
Informal (<i>Equb</i>)		1 if an individual informally SAVE CASH for <i>EQUB</i> and 0 other	+/-	Coulibaly & Sirpé (2023), Lakew& Azadi (2020), and Abdesamed & Wahab (2015)
Mobile Phone Ownership	Mobile	Binary (1=owns mobile;0=does not own)	+	Demirgüç-Kunt,et al.,2022
Place Of Residence	Place(Rural Vs. Urban)	Binary (1 = Rural if person identify as Rural resident ,other 0= Urban	Rural(-) & Urban (+)	Yang, J., et al. (2020), Shinkafi, A. (2019)
Distance From Formal Financial Institution	DISTA NCE	The distance of the ith adult or HHs from the nearest Urban center in KM. It is a continuous variable variation in closeness to FFI .	(-)	Yang, J., et al. (2020),Shinkafi, A. (2019)
Geographic Region	Region	Category variable for geographic regions(Tigray, Afar, Amhara , Oromia Somali.,SNNP14	Varies by regions (+/-)	Yang, J., et al. (2020), World Bank (2022)
Household Id		Unique identifier (clustering).		

Source: Authors compiled based Ethiopia ESS 18/19 variables and Prior literature's ,2025

¹⁴ Since 2023, the SNNP region has been divided into four separate regions: Sidama, Southwest Ethiopia, South Ethiopia, and Central Ethiopia.

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APPENDIX B 1 THE KMO AND EIGENVALUES OF FINANCIAL LITERACY WITH ITS SUB-DIMENSION

FINANCIAL_ KNOWLEDGE				2 Financial_ Attitude			
Variable	CUM	Eigenvalue	KMO	Variable	CUM	Eigenvalue	KMO
Know_ Inflation	0.359	2.157	0.744	No_ Trust_ Bank	0.333	1.104	0.493
Know_ IFB service	0.527	1.006	0.735	Prefer informal	0.667	1.003	0.495
Know_ Interest	0.679	0.911	0.745	Saved in Cash	1.000	0.893	0.497
Financial Management	0.795	0.695	0.702				0.495
KNOW where to complain	0.900	0.633	0.759				
Know how to open Account	1.000	0.598	0.757				
			0.743				
3.Financial behavior				4 Financial_ Literacy score			
Variables	Cum	Eigenvalue	KMO	Variables	Cum	Eigenvalue	KMO
Credit gap	0.25	1.083	0.52	Knowledge	0.333	1.068	0.501
Saved for emergence	0.50	1.017	0.49	Attitude	0.667	0.977	0.503
Saved for medical	0.75	0.996	0.484	Behavior	1.000	0.935	0.501
SAVED_ Start Business	1.000	0.904	0.486				0.501
			0.490				
Digital Financial Literacy Scores (DFL-Score)							
Variable	Weight	Cum	Eigenvalue	KMO			
Online Banking skills	0.524	0.524	2.067	0.683			
Mobile Banking skills	0.218	0.742	0.870	0.678			
ATM skills	0.141	0.883	0.564	0.704			
Agent Banking	0.117	1.000	0.470	0.717			
				0.692			

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APPENDIX C 1 DIGITAL AND FINANCIAL LITERACY BY REGION

DFL BY Region	Mean1	Mean2	dif(M2-M1)	t value	*p value	*Cohen's d ,95%CI
AFAR	.062	.028	.035	3	0.001	0.145[0.010,0.281]
AHMARA	.063	.042	.021	2.2	0.03	0.087[-0.004,0.177]
OROMIA	.058	.1	-.043	-2.75	0.006	-0.178[-0.281,-0.075]
SOMALI	.06	.115	-.055	-1.95	0.052	-0.231[-0.406,-0.055]
BG	.061	.048	.013	.9	0.379	0.056[-0.082,0.194]
SNNP	.06	.066	-.005	-.4	0.687	-0.022[-0.126,0.082]
GAMBELA	.064	.023	.041	4.65	0.001	0.169[0.060,0.278]
HARAR	.06	.064	-.003	-.3	0.777	-0.014[-0.105,0.078]
TIGRAY	.061	.06	.001	.1	0.913	0.005[-0.085,,0.095]
DD	.06	.069	-.009	-.9	.373	-0.039[-0.121,0.043]
AA	.06	.062	-.002	-.25	0.799	-0.008[-0.068,0.052]
FL BY Region	Mean1	Mean2	dif(M2-M1)	T	*p value	*Cohen's d 95%CI
AFAR	.005	-.072	.077	4.55	0.001	0.136[0.070,0.202]
AHMARA	.002	-.017	.018	1.35	0.178	0.033[-0.021,0.087]
OROMIA	.011	-.088	.1	6.45	0.001	0.176[0.123,0.229]
SOMALI	.027	-.261	.288	19.65	0.001	0.514[0.455,0.573]
BG	-.001	.008	-.009	-.5	0.635	-0.015[-0.089,0.058]
SNNP	.005	-.042	.046	3.2	0.002	0.082[0.027,0.136]
GAMBELA	-.001	.011	-.011	-.6	0.538	-0.020[-0.084,0.043]
HARAR	-.002	.019	-.021	-1.1	0.279	-0.037[-0.098,0.025]
TIGRAY	.001	-.009	.01	.65	0.515	0.017[-0.038,0.072]
DD	-.01	.103	-.113	-7.3	0.001	-0.199[-0.258,-0.140]
AA	-.04	.252	-.29	-18.75	0.001	-0.522[-0.572,-0.472]

NB: The DFL (Digital Financial Literacy) and FL (Financial Literacy) gap is expressed as the percentage difference obtained by subtracting Mean1 from Mean2 (M2 - M1). "Mean1" and "Mean2" refer to the average DFL/FL scores categorized by region, which reflect adults' digital capabilities in accessing and using financial services. The "dif" column shows this difference, which may be positive or negative depending on regional comparisons. The "t value" and "*p value" indicate the statistical significance of the difference, derived from Welch's two-sample t-test using Satterthwaite's degrees of freedom for unequal variances. Cohen's d, along with the 95% confidence interval for effect size, is calculated using the formula $|M_1 - M_2| / \sqrt{[(SD_1^2 + SD_2^2)/2]}$. The interpretation of Cohen's d is as follows: The interpretation: $|d| < 0.2$: Trivial, $0.2 \leq |d| < 0.5$: Small, $0.5 \leq |d| < 0.8$: Medium, and $|d| \geq 0.8$: Large (Brydges, 2019)

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The end !