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Impact of Financial Literacy and Fintech Adoption on Financial Inclusion: Moderating Role of Digital Infrastructure

by

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CERTIFICATE OF APPROVAL

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Abstract

Financial inclusion is one of the most pressing structural challenges of developing world economies – over one billion adults are currently outside of formal financial services. Although financial literacy, fintech and digital infrastructure have been identified as individually contributing factors to financial inclusion, few studies have considered their joint and joint effects together in an empirical framework on a long cross-country panel. This study aimed to fill this gap by exploring the impact of financial literacy and fintech adoption on financial inclusion in 84 developing economies over the 2010-2024 period, and by modelling digital infrastructure as a moderating factor. Correction for heteroskedasticity, serial correlation and cross-sectional dependence is achieved through the use of Driscoll-Kraay standard errors. The results support the key role of financial literacy and fintech adoption in improving financial inclusion, and the positive effects of digital infrastructure on both of these relationships, where digital infrastructure is more developed. The findings provide evidence for the theoretical logic that financial literacy, fintech adoption and digital financial infrastructure are strategic complements, and that digital financial infrastructure is the most important chain of returns to investment in financial inclusion. The results have clear policy implications for policymakers and the development community: Improved digital infrastructure and the promotion of financial literacy initiatives are likely to have the highest impact on financial inclusion and adoption of fintechs with the least served populations.

Keywords: Financial Inclusion, Financial Literacy, Fintech Adoption, Digital Infrastructure, Panel Fixed Effects, Moderation Analysis, Developing Countries.

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Abbreviations

ADF	Augmented Dickey–Fuller
ATM	Automated Teller Machine
CLT	Central Limit Theorem
CSD	Cross-Sectional Dependence
DI	Digital Infrastructure
DK	Driscoll–Kraay
FE	Fixed Effects
FI	Financial Inclusion
FL	Financial Literacy
FT	Fintech Adoption
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
HC3	Heteroskedasticity-Consistent Covariance (Type 3)
n.s.	Not Significant
OLS	Ordinary Least Squares
PCA	Principal Component Analysis
RE	Random Effects
SCC	Serial Correlation Clustered
SE	Standard Error
VIF	Variance Inflation Factor
WDI	World Development Indicators

Chapter 1

Introduction

1.1 Background of the Study

In the developing world, over a billion adults do not participate in the formal financial system, and cannot open a bank account, get a line of credit, get insured or send and receive money via regulated means. It is not an account of marginal shortage figures but rather a structural failure of economic organization that becomes a continuing source of poverty, hampering household stability, inhibiting small business formation and reducing the effective productive power of whole national economies. The ability of individuals and businesses to access and utilize affordable, formal financial services in a meaningful way has thus become one of the most far-reaching development issues of the twenty-first century financial inclusion. It has been taken seriously enough to be part of the United Nations Sustainable Development Goals, the Group of Twenty Financial Inclusion Action Plan and the World Bank Universal Financial Access 2020 program, and each of them recognizes that the expansion of financial access is not a fringe welfare issue, but a necessary condition to inclusive economic development, family stability, and the elimination of extreme poverty.

Financial inclusion has been positively trending in the world during the last decade. The largest cross-country database on the access to finance, the World Bank Global

Findex Database, reported that the proportion of adults worldwide with an account at an official financial institution or a mobile money provider increased by 51 percent in 2011 to 69 percent in 2017 and to 76 percent in 2021 (Demirguc-Kunt et al., 2022), This general achievement, however, conceals deep-rooted and enduring inequalities.

In Sub-Saharan Africa, ownership of accounts was 55 percent in 2021 and between less than 20 percent and over 80 percent in a few low-income economies and Kenya and South Africa, respectively. In South Asia including Pakistan, this was found to be 68 percent in general but with over 30 percentage points of gender disparity in some of the countries and the rural exclusion rates that were considerably above the urban ones. Account ownership in the Middle East and North Africa was less than 50 percent. These inequalities make it clear that the financial inclusion issue is truly not a solved problem, that it is skewed towards the developing economies and that other issues behind it are not merely about income but rather more structural factors which require empirical research.

In the last two and half decades, the financial systems of the developing economies have been fundamentally transformed. The twenty-first century has brought all-new financial architecture based on mobile networks, digital payment platforms, algorithmic credit scoring, peer-to-peer lending, mobile wallets and branchless banking agents, whereas the physical bank branch, staffed by salaried employees and urban centers, was the dominant model of financial access in the twentieth century.

The change, which can be generally defined as financial technology or fintech, has been especially momentous in those economies that did not have a strong pre-existing physical banking system. In Kenya, the M-Pesa mobile money system, which was introduced in 2007, formalized financial services to millions of previously unbanked households in just ten years, showing that digital technology could help overcome the geographic and institutional barriers that had kept physical banking out of reach of rural and low-income populations (Jack and Suri, 2014).

Like disruptions in other countries with bKash in Bangladesh, the Unified Payments Interface in India, and mobile money ecosystems in Ghana and Tanzania,

and digital neobanks in Latin America. By 2021, the Global Findex reported mobile money accounts were now the primary financial account of most adults in a few Sub-Saharan African economies, a structural transformation that would have been unimaginable 20 years ago.

However, the evidence also confirms that the use of fintech is not necessarily going to produce financial inclusion. The success of online financial platforms is highly preprogrammed by two variables that intercede between the presence of a fintech product and its practical application among economically marginalized groups. The former is financial literacy. The lack of knowledge on how a digital financial product works, how it bills its services, what risks it entails, and how it can be safely used may lead to people avoiding it, misusing it, or falling victim to fraud and predatory practices, even though they are formally eligible to access the fintech services. In a groundbreaking cross-country study, (Grohmann et al., 2018) have shown that financial literacy is among the best predictors of formal account ownership, formal saving, and formal borrowing among countries, which works through the mediator of perceived risk and greater confidence in formal financial relations. Even the most advanced fintech ecosystem is unable to bring in the inclusion benefits of a population that lacks the cognitive basis of making financial decisions.

Digital infrastructure is the second factor of conditioning. Regardless of the level of innovation of a fintech product, it will not be accessible to people who do not have reliable mobile network coverage, access to broadband, access to electricity, and device capacity to run digital applications. In one of the pioneering cross-country econometric models of determinants of financial inclusion, (Sarma and Pais, 2011) have proposed that ICT infrastructure is one of the strongest structural predictors of financial inclusion outcomes after adjusting by income, showing that connectivity is not just a proxy of development, but an economic driver of access.

Recent evidence by (Ferilli et al., 2024) confirms that investment in digital infrastructure reduces the financial gap in emerging markets, (Avom et al., 2023) that infrastructure mediates the effect of mobile technology adoption on financial inclusion in Sub-Saharan Africa. Combined, these results indicate that fintech and

infrastructure are strategic complements, where growing fintech without infrastructure only extends to already-connected minorities, and growing infrastructure without fintech only connects to create no financial services to newly-connected populations.

This study explores the combined and interactive implications of financial literacy, use of fintechs, and digital infrastructure on financial inclusion in a sample of 84 developing countries monitored between 2010 and 2024. It achieves this by not only considering digital infrastructure as an independent variable but as a moderating variable that preconditions to what degree financial literacy and fintech adoption lead to real financial inclusion benefits. The three convergent findings drive the research the enduring and geographically discontinuous nature of financial exclusion, over the developing world, the expanding yet individually incomplete evidence bases regarding the effects of literacy, technology and infrastructure on financial access, and the almost complete lack of integrated empirical frameworks, which explore the interaction of all three factors within a single moderation model applied to a long, multi-country panel.

The combination of a panel Fixed Effects estimation with Driscoll-Kraay robust standard errors on a sample of 15 developing countries over 15 years generate a methodologically rigorous piece of evidence that is of policy interest to governments, regulators and development institutions struggling to meet financial inclusion in the most problematic settings.

1.2 Theoretical Framework

Five theoretical traditions are used to ground the study, each of which supports a particular aspect of the empirical model and gives the conceptual logic between the variables. A combination of these theories forms a consistent and internally coherent structure that explains why financial literacy, fintech adoption, and digital infrastructure are likely to enhance financial inclusion at both an individual and through their interactions.

1.2.1 Financial Development Theory

This theory supporting the dependent variable, which is most eloquently expressed by (Levine, 2005) in his masterpiece survey of the association between finance and economic growth. Levine sets up the main economic role of a financial system to minimize the market frictions that cause inefficient economic performance: information asymmetries between borrowers and savers, transaction costs that make small transactions prohibitively costly, and enforcement failure that impede exchange via contract.(Bobbo et al., 2024) Financial inclusion, in this context, is not only a social policy goal but a structural measure of the performance of the financial system in fulfilling its primary economic role.(Eshun and Kocenda, 2025) As the formerly excluded people enter the formal financial system, they lessen the information asymmetry between them and the formal lenders and reduce the transaction costs by enjoying economies of scale in payment systems and avail themselves of the risk pooling mechanisms offered by the formal insurance and credit markets. What this means is that the same factors that lessen the barriers to entering the financial system, be it cognitive, technological or structural, are also the very same factors that promote financial development at the macroeconomic level.

1.2.2 Human Capital Theory

Financial Literacy is based on the theoretical foundation formulated by (Becker, 1964).The main contribution that Becker gave was to show that the returns of investments in knowledge, skills, and education were in the form of increased productive capacity, both at the individual level and in total in the economy. In the context of financial decision-making, Human Capital Theory is projected to positively correlate with an individual investing in learning about the financial sector, comprehending interest rates, compound growth, credit risk, insurance principle, and how digital financial technology works since these individuals will be more effective players in formal financial markets. They will find it easier to open accounts, save formally, borrow on favorable conditions, use insurance products,

and use digital financial services, since the mental cost of doing so is less than the perceived benefit. On the aggregate level, this individual-level mechanism produces a country level positive correlation between average financial literacy and the depth and breadth of formal financial market participation that is what Financial Inclusion quantifies (Boachie, 2024).

1.2.3 Technology Acceptance Model Theory

The theoretical framework of the second independent variable, Fintech Adoption, which was initially developed by (Davis, 1989). Davis determined that two psychological tests, the perceived usefulness of the information technology, that is, whether or not the individual feels that the technology will enhance his/her outcomes in a way that is relevant to him/her, and the perceived ease of use, that is, whether or not the individual feels that he/she can use the technology without cognitive effort that will exceed the payoff, are the main determinants of whether or not individuals will adopt any new information technology Applied to digital financial services, the dimensions forecast that fintech use will increase faster when mobile money platforms, digital wallets and internet banking interfaces are seen as actually useful to the financial activities that users are concerned about, especially the low-cost money transfer, security of savings, and access to credit, and when they are intuitive enough that low-education populations can use them without the need to undergo extensive training. The Technology Acceptance Model also suggests that the perceived usefulness and perceived ease of use can be affected by contextual variables such as digital literacy, network effects, and the reliability of the underlying infrastructure, establishing theoretical intermediaries between fintech adoption and financial literacy as well as digital infrastructure.

1.2.4 Access Theory

Two complementary theories give the theoretical basis of the moderating variable, Digital Infrastructure. The moderating role has the most direct conceptual logic in the Access Theory developed by (Ribot and Peluso, 2003). Ribot and Peluso

differentiate between right to access a resource and ability to benefit. This differentiation is vital to financial inclusion analysis since it distinguishes between theoretical access to financial services and the structural factors to access them in reality. The technical right to engage in formal digital financial markets belongs to an individual who is financially literate, and the technical provision of such services to the population of a given country belongs to the country hosting the advanced fintech platforms, yet neither the right nor provision results in actual utilization in case the individual does not have the structural means of digital access.

The two structural factors that turn the right to participate into the ability to benefit are reliable broadband connectivity, consistent coverage of mobile network, electricity supply, and the technological capacity that the high-technology export intensity proxies predict. In Access Theory terms, Digital Infrastructure is the power structural bundle that mediates between individual capability and the real financial inclusion outcomes.

1.2.5 Public Good Theory

Formulated by (Samuelson, 1954), it adds to the Access Theory by offering the economic justification of considering digital infrastructure as a moderating factor that enhances the returns to other investments. Samuelson developed the theory that non-rivalrous and non-excludable public goods have positive externalities that are not provided optimally by private markets. Digital infrastructure in developing nations is highly characterized by the traits of a public good: as mobile network coverage and access to broadband expands, the benefits extend way beyond the immediately connected users, and the attainment of financially literate individuals into economic activity, by facilitating personal fintech businesses to reach populations previously out of reach, and by enabling those already financially literate to convert their knowledge into economic action through the digital medium. The implication of the Public Good Theory on the current research is that the growth of infrastructures does not simply introduce a direct pathway to the financial inclusion but multiplies the returns on individual investments in financial literacy

and countries investments in fintech ecosystems, generating the interaction effects that the moderation hypotheses aim to quantify empirically.

The combined theoretical framework that arises out of these five traditions can be said in a nutshell. The Financial Development Theory lays down the reasons why financial inclusion is an important structural economic outcome. It is facilitated by financial literacy as explained by Human Capital Theory. The Technology Acceptance Model justifies why fintech usage increases it. Access Theory describes the determinism of these two directions by digital infrastructure, as a gatekeeper that can decide the strength with which literacy and fintech turn into real financial participation. The Public Good Theory is relevant in justifying the multiplier nature of infrastructure and not just an additive input. Combining these theories anticipates that the individual impacts of literacy and fintech on financial inclusion will both be positive, that the impacts of digital infrastructure on financial inclusion will be positive, and that the interaction effects between literacy and infrastructure and between fintech and infrastructure will be more than the sum of their individual effects, with the empirical models of this study designed to test this hypothesis.

The empirical setting of the current study is the developing world between 2010 and 2024 a 15-year horizon which includes one of the most accelerated and far-reaching changes of the financial systems in the history of the economy. This era began in the instant outcome of the world financial crisis of 2008 and 2009, which unluckily encouraged financial innovation in developing economies as it showed just how weak the traditional banking model was and provided regulatory and market incentives to deliver alternative financial services. It includes the flat of M-Pesa in East Africa, the development of mobile money platforms in Sub-Saharan Africa and South Asia, the digital payments revolution brought about by smartphone usage, platform-based micro-lending in China and Southeast Asia, and the pandemic-related surges in digital finance during 2020-2022. To find out how financial inclusion has changed in 84 developing economies over this time, and what structural and individual-level factors have been the most powerful in bringing about that change, is both a scholarly and policy need.

The emergent economies which are the sample of the study exemplify an unprecedented diversity of the financial development patterns. Mobile money has brought about financial inclusion in Sub-Saharan Africa where the physical banking system failed to reach, with Kenya recording account ownership rates in the same league as most middle-income economies wholly based on mobile mediums and not through branch banking.

An example of the moderation dynamics this study explores is seen in South Asia (Pakistan included) where mobile wallet infrastructure has grown rapidly, but the financial inclusion associated with it has not risen accordingly due to enduring financial literacy and digital access disparities in rural regions.

In Southeast Asia, other economies like the Philippines, Indonesia and Vietnam have seen fast fintech-based inclusion due to growing broadband connectivity, but limited by regulation environments that have lagged behind technological innovation. Digital neobanks and instant payment systems have infiltrated groups of people that traditional banking has shunned in Latin America, with Brazil and Mexico on the front line of change that is slowly permeating smaller economies. The financial deepening in economies experiencing financial repression under communism, followed by the development of digital identity infrastructure and the broadband coverage in Eastern Europe and Central Asia, has been enabled by the infrastructures that have facilitated the financial deepening of these economies.

This variety of contexts is both a challenge and a strength to the study.It is an asset as it provides the cross-country and within-country variance to determine the truly generalizable relationships between financial literacy, fintech adoption, digital infrastructure, and financial inclusion that are not motivated by the idiosyncratic nature of a particular country or region. The within-country variation that the Fixed Effects panel estimation strategy adopted by the study is meant to capitalize on is the very reason why developing economies are so heterogeneous in structure. The outcome is an empirical design that can deliver findings that are applicable not only to the individual country in the sample, but instead to the developing world more generally, and to the international policy institutions, which aim to achieve financial inclusion in the developing world more generally.

Pakistan is a case study within the global developing world context of this research that is particularly relevant and one that is especially pertinent in the context of the institutional base of this research. Pakistan is one of the most financially excluded large economies in South Asia with a formal account ownership rate of around 21 percent in 2021, according to the Global Findex Database, despite a population of more than 230 million adults and a decade of policy focus on financial inclusion.

The gender dimension is particularly stark while female account ownership stood at only 7 percent in 2021 (versus 33 percent for males), this is not only a symptom of the prevailing social and cultural norms that continue to impede female participation in financial markets, but also the digital connectivity and financial literacy system deficits that this study identifies as the leading moderating factors of financial inclusion.

Pakistan's ranking as a Tier-3 economy in terms of its digital infrastructure - with low rural broadband penetration, poor electricity supply in peri-urban neighbourhoods, and among the lowest fixed broadband subscriptions in South Asia - reflects the lower-quartile infrastructure environments identified as those in which the financial inclusion dividends generated by financial literacy and fintech adoption are minimal.

The State Bank of Pakistan's Raast real-time payment system, introduced in 2021, and the rapid growth of mobile wallet providers such as EasyPaisa, JazzCash and NayaPay are examples of the fintech adoption investments whose financial inclusion yields the empirical evidence suggests are dependent on parallel investments in digital connectivity, financial literacy and electricity infrastructure. The implication of this study's findings that digital infrastructure is not one of many financial inclusion determinants but the structural multiplier that moderates the return on all other investments is that Pakistan's financial inclusion strategy needs to prioritise the Pakistan Telecommunication Authority's broadband roll-out targets, the Universal Service Fund's rural connectivity programs, and the National Financial Literacy Programme as an integrated rather than isolated set of programs. The Pakistan case, nestled in the empirical analysis of 84 countries in this

study, thus provides a telling illustration of the significance and policy complexity of the financial inclusion challenge addressed in this research.

The five theoretical traditions in the current study merge to form a single explanatory continuum. Financial Development Theory has made financial inclusion a structural economic outcome, as it directly lowers the information asymmetries and transaction costs in the financial system. Human Capital Theory, then, accounts for why Financial Literacy leads to this outcome: A literate person's psychological cost of using formal financial services is lower.

The TAM alone also captures the reason for the increase in financial inclusion with the use of Fintech Adoption; that is, for financial inclusion to increase, financial tools must be perceived as useful and easy to use for the person. Access Theory provides a mechanism to link these two direct influences with the moderating influence, the right to access a financial service from the ability to derive benefits from that access.

Financial literacy and the availability of fintech gives the right to participate, but that right is not accessible without reliable broadband, mobile network coverage, and electricity, so that the right to participate is not translated into a real opportunity for financial participation, the theoretical underpinning for which is why Digital Infrastructure is a moderator for both relationships, rather than a third direct predictor.

The extra returns to literacy and fintech investments from the moderation then follow from Public Good Theory: being a public good, infrastructure is non-rivalrous and non-excludable, thus, the benefits from the moderation are distributed to all literate and fintech-using individuals at once rather than being additive. The five theories combine to produce four research hypotheses: (1) Financial Literacy positively directly affects Financial Inclusion (H1); (2) Financial Literacy positively directly affects Fintech Adoption (H2); (3) the relationship between Financial Literacy and Financial Inclusion is augmented by a positive moderating effect of Digital Infrastructure (H3); and (4) the relationship between Financial Literacy and Fintech Adoption is augmented by a positive moderating effect of Digital Infrastructure (H4).

1.3 Research Gaps

Despite having a rich and expanding literature on the individual variable correlation, also indicates three consistent and large gaps that inspired the empirical design of the current study.

The first and most obvious gap is that there are no concerted empirical studies that simultaneously address financial literacy, fintech adoption, and digital infrastructure as predictors of financial inclusion in a single moderation model applied to a large, multi-country developing economy panel. Although other studies, including (Hasan et al., 2021) have explored the interaction between literacy and fintech and others, including (Avom et al., 2023) have explored the effect of technology moderated by infrastructure, no research has tested all three pairwise interactions, literacy with fintech, literacy with infrastructure and fintech with infrastructure, in a single Fixed The current research addresses this gap by estimating moderation models, with direct tests of the moderation of both the literacy-inclusion and the fintech-inclusion relationships of both on the same developing country sample.

The second gap is related to time. Most of the studies on multi-country financial inclusion analyses employ panel data of one year or the short panel of three to five years. The accelerated rate of digital transformation between 2010 and 2024, which has also encompassed the phenomenal growth of mobile money in Sub-Saharan Africa, the emergence of digital payment platforms in South and Southeast Asia, the post-pandemic surge in the adoption of fintech worldwide and the colossal increase in broadband infrastructure in developing regions, suggests that panel or short-panel studies are missing The 15-year panel used by the current study, 2010-2024, is the longest panel in the financial inclusion literature to date that incorporates these particular variables, and offers the time depth necessary to uncover true within-country dynamic relationships, via Fixed Effects estimation.

The third gap is geographic and sample scope. Research in this literature is often limited to a single area, most often Sub-Saharan Africa in the case of mobile money, South or Southeast Asia in the case of digital banking, or Latin America in the case of fintech regulation, and might not be relevant in other developing

country contexts. The sample of developing countries of 84 countries covering five continents represented in the present study gives a more globally representative view of how financial literacy, fintech use, and digital infrastructure can interplay to drive financial inclusion in the entire heterogeneity of developing economy contexts, including low-income Sub-Saharan African economies and upper-middle-income economies in Eastern Europe and Southeast Asia.

1.4 Problem Statement

Although the literature on financial inclusion determinants has been growing, there is a basic empirical gap in the literature. Financial literacy, fintech adoption, and digital infrastructure are the three most crucial technology-era financial inclusion drivers in developing countries, each of which has been extensively studied, albeit almost exclusively independently. Research papers that investigate financial literacy and financial inclusion like (Grohmann et al., 2018) and (Hastings et al., 2013) fail to simultaneously consider fintech adoption or digital infrastructure. Research investigating fintech adoption and financial inclusion, including (Jack and Suri, 2014) and (Azmeh and Al-Raeei, 2024), does not model the conditioning (financial literacy) role and structural (infrastructure) role at the same time.

Investigations of digital infrastructure and financial inclusion, including (Sarma and Pais, 2011) and (Ferilli et al., 2024) consider infrastructure as an independent variable but not as a moderating variable that influences the efficacy of other factors of inclusions. The outcome of this is the piecemeal literature that is able to address the contribution of each of these factors individually but not the question that is of greatest policy interest: how do these three forces interrelate, and is the aggregate effect of literacy, fintech, and infrastructure greater than the sum of the parts? This fragmentation exists on a second level other than the gap at the variable level. Most of the available literature is based on panel data of one year, or on small (three-to-five year) panels, based on samples of fewer than fifty countries. panel designs are unable to tell the difference between real causal association and spurious correlation due to unmeasured country attributes. It is

not possible to use short panels to capture the dynamic nature of the financial inclusion as literacy levels increase, fintech ecosystems are developed, and digital infrastructure grows over time. Small samples are not sufficient to estimate the effects of interaction with statistical conviction, as moderation analysis demands much larger sample sizes than untested main-effects regression.

The consequence of this is that the available literature, even when yielding valuable information on the relationship between individual variables, has not produced the long-panel, multi-country, integrated moderation information that can be used by policymakers to make resource allocation decisions as to whether to fund financial education programs, fintech regulation systems, broadband infrastructure, or a combination of these that would maximize the payoff of each dollar of development expenditure. This issue is directly tackled in the current study. It explores how financial literacy and adoption of fintech affect financial inclusion in 84 developing nations between 2010 and 2024, and digital infrastructure is a moderating variable that moderates the strength of both relations. The issue that inspired the research could be expressed in the following way: financial literacy and the adoption of fintech can be both necessary and insufficient factors that can contribute to financial inclusion in the developing economy, and their performance as the drivers of financial inclusion fundamentally depends on the quality of the digital infrastructure environment they are operating in.

This study, but not the existing literature, tests this conditional relationship in a rigorous long-panel fixed effects model, using robust standard errors and endogeneity tests.

The main research question can be formulated in the following form:

How financial literacy and fintech adoption impact financial inclusion in developing countries, and how digital infrastructure mediates such relationships?

1.5 Research Questions

The study is organized around four specific research questions, each corresponding to a testable hypothesis that emerges from the theoretical framework and the

empirical problem identified in the preceding section. The first two questions address the direct effects of the primary independent variables on financial inclusion. The third addresses the direct effect of the moderating variable. The third and fourth questions address the conditional, interactive relationships that constitute the theoretical centerpiece of the study.

(i) Research Question

Does financial literacy have a significant positive influence on financial inclusion in developing countries?

(ii) Research Question

Does fintech adoption have a significant positive influence on financial inclusion in developing countries?

(iii) Research Question

Does digital infrastructure moderate the relationship between financial literacy and financial inclusion, such that the positive influence of financial literacy on inclusion is amplified in countries with stronger digital infrastructure?

(iv) Research Question

Does digital infrastructure moderate the relationship between fintech adoption and financial inclusion, such that the positive influence of fintech adoption on inclusion is amplified in countries with stronger digital infrastructure?

1.6 Research Objectives for This Study

The general aim of the research is to explore the relationship between financial literacy and fintech adoption and financial inclusion in the developing nations and the role of digital infrastructure in mediating the two relationships, based on a 15-year balanced panel dataset and Fixed Effects econometric estimation. The research has four objectives, which are in line with the four research questions.

(i) Research Objective

To determine the effect of financial literacy on financial inclusion in a cohort of developing countries between 2010 and 2024.

(ii) Research Objective

To examine the relationship between fintech adoption and financial inclusion based on Global Findex digital payment.

(iii) Research Objective

To determine the moderating role of digital infrastructure between the relationships between financial literacy and financial inclusion, such that the relationship between literacy and inclusion is greater in more digitally-developed countries.

(iv) Research Objective

To test the hypothesis that digital infrastructure moderates the fintech adoption versus financial inclusion relationship, whereby the fintech-inclusion relationship is stronger in countries with stronger digital infrastructure.

1.7 Significance of the Study

1.7.1 Academic Significance

This work has three unique and original contributions to the body of scholarly work on financial inclusion. The former is theoretical integration. Placing Financial Literacy in the Human Capital Theory and Fintech Adoption in the Technology Acceptance Model, Digital Infrastructure in the Access Theory and Public Good Theory, and Financial Inclusion in the Financial Development Theory, the study creates a multi-theory framework never previously compiled in the literature. Single studies usually rely on one or two theoretical traditions; this study constructs a five-theory framework allowing the mapping of every variable to its theoretical basis, and every interaction to a unique theoretical mechanism.

The second scholarly input is methodological. The model used in the study is 15-year Fixed Effects panel among 84 developing countries, model selection is supported by Hausman-test, Driscoll-Kraay standard errors are robust to heteroskedasticity, serial correlation and panel dependence, and Instrumental Variable estimation is used to verify that there is no endogeneity. This mix of methodological characteristics is much stricter than the panel or short-panel studies that take up the prevailing financial inclusion literature. The ADF unit root confirmation of level stationarity that led to the use of Fixed Effects as opposed to Generalized Method of Moments and PCA-based index construction that reduce measurement error when compared to single-indicator proxies are additional methodological contributions that the literature will appreciate to replicate in future research.

The third scholarly input is empirical. The research yields the first multi-country, long-panel evidence that Digital Infrastructure moderates together the financial literacy and the fintech adoption channels to financial inclusion in developing economies, with separate moderation models due to sample size limitations and interaction-term multicollinearity diagnostics. The statistically significant and positive interaction coefficients of both moderation relationships support the Digital Inclusion Nexus argument that literacy, fintech, and infrastructure are strategic complements, not independent contributions, a result that has never previously been determined in a sample of this geographic size and time span.

1.7.2 Policy Significance

This study has some concrete policy implications for institutions and policy makers interested in improving financial inclusion. The finding that digital infrastructure has the greatest direct impact on financial inclusion and that it improves the expected gains from financial education and fintech use provides a clear and actionable roadmap for investment priorities for national governments of developing economies. The key advantage for governments is that they can invest in infrastructure more efficiently when there is limited public resources; infrastructure investment is not just one policy lever among many, but the lever that dictates the return on other investments in public financial inclusion. This translates to a

government being able to prevent two policy errors, namely spending money on financial literacy programmes that leave populations 'educated but structurally marginalised' because of poor infrastructure, and promoting fintech adoption without the infrastructure to provide for reliable service. The evidence of the infrastructure complementarity for literacy and fintech offers a second dividend: It allows for the implementation of coordinated, multi-faceted policy packages, as opposed to single levers, because the value of multi-faceted investment is greater than the sum of its parts.

The study offers direct operating benefit for IDIs who can use the evidence of cross-country panels to substantiate the design and scaling of integrated digital financial inclusion programs, combining financial literacy programs, fintech regulatory reform and infrastructure investments under a single programmatic umbrella. Since the study is based on Global Findex data, World Development Indicators, and Fixed Effects estimation, which are the standard tools used by these institutions, there is little need for adaptation in their use of the results. Another practical implication of this study is the evidence that resulted in the targeting criterion used: developing countries in the lowest quartile of the digital infrastructure index have the highest expected returns on combined literacy and infrastructure investments, meaning that development institutions can effectively use the finding that scarce development assistance to such countries is likely to achieve the highest measurable impacts on financial inclusion.

1.7.3 Practical Significance

To the performers in the financial inclusion ecosystem who may operate in the private sector such as fintech companies, commercial banks expanding digital channels, microfinance institutions, mobile network operators, and technology platform providers, this study presents evidence on the structural conditions in which their services can produce the highest level of population-level uptake and impacts. The discovery that adoption of fintechs has larger financial inclusion impacts in higher infrastructure settings suggests that future fintech expansion efforts should focus on markets with adequate digital infrastructure to facilitate the reliable provision

of services, as opposed to aiming at the highest nominal unbanked rates in a market regardless of connectivity. On the other hand, the moderation evidence can be leveraged by telecoms and infrastructure providers to justify the business case to invest in infrastructure in underserved markets by showing that infrastructure growth is a direct cause of a larger addressable market to digital financial services. The research, therefore, offers a common evidence foundation that can harmonize the motivation of both the state and non-state actors towards the integrated development of the digital financial inclusion ecosystem.

1.8 Scope of the Study

This study looks at the macro-level predictors of financial inclusion in a panel of developing nations, with a special emphasis on financial literacy, fintech adoption, and digital infrastructure as the main predictors and moderators. Its geographic area is 84 developing countries that are defined by World Bank to be a developing one and includes Sub-Saharan Africa, South Asia, Southeast Asia, Latin America and the Caribbean, the Middle East and North Africa, and Eastern Europe and Central Asia. The time frame of the study is 2010-2024, representing a 15-year span, which is chosen as the period when reliable cross-country data on all three key variables of the study will be available, as well as reflects the entire timeline of the smartphone-enabled fintech revolution and the dramatic growth of digital infrastructure throughout the developing world.

The research is based solely on secondary data based on the internationally recognized and publicly available databases: the World Development Indicators data on the Digital Infrastructure component variables under the Digital Infrastructure category, the dependent variable proxy of Broad Money as a percentage of GDP and the control variables of GDP per capita and urbanization; the Global Findex Database on the Fintech Adoption component variables in its 201 The macro and country-level sample of the indicators over households, as opposed to a household survey sample, is an intentional trade-off that allows cross-country comparison and estimation of long-panel econometric models at the expense of not measuring

within-country differences between individual household populations. The study thus addresses the dynamics of financial inclusion at country-level and country-level determinants of policy as opposed to the individual-level financial behavior that is the focus of household survey studies.There are various significant dimensions that are beyond the scope of this research. The analysis does not consider developed economies, which have mature financial systems, extensive institutional frameworks, and high-level financial literacy, which are structurally incomparable to the developing country setting and whose binding restrictions on financial inclusion are qualitatively different. Cultural, social, and behavioral determinants of financial inclusion like trust in institutions, gender norms, religion, or social networks, are not in the study not because they are not important but because they are not always available as annual, country-level measures across the 84-country, 15-year panel. The research lacks gender, age, income quintile, or rural-urban location disaggregations of financial inclusion outcomes, which is a significant limitation, as it is admitted in the discussion of future research directions. and the research is not causally assertive beyond what the Fixed Effects design and the IV confirmation of no endogeneity can justify; the results can be understood as conditional associations that are resistant to unobserved time-invariant country heterogeneity and which can be causally interpreted, contrary to being identified causal effects in the strict instrumental variable or experimental sense.

1.9 Organization of the Study

This thesis has five chapters. The current Chapter, chapter 1, is the introduction of the study and lays the background, theoretical framework, context, problem statement, research questions, objectives, significance, and scope upon which the rest of the chapters will be based. chapter 2 is a critical review of the academic literature where all the study variables are grouped into two layers: a generalized generic review of the financial inclusion environment and the theoretical traditions behind each study variable with a specific empirical review of each pair of variable relationships where a positive evidence, a complicating evidence, or a negative

evidence is presented and finally a synthesizing conclusion is made that drives each direction hypothesis; the chapter is concluded by a statement of the gaps in the chapter 3 presents the research design, the construction of the panel dataset and all the filtering choices that narrowed the originally proposed panel of 196 countries and 25 years to the achieved panel of 84 countries and 15 years, the construction of the PCA indices and Z-score standardization of all variables, the econometric models, and the entire process of diagnostic and specification testing including ADF unit root tests, Hausman specification In chapter 4, the empirical results are presented and interpreted in a logical order that is: descriptive statistics, the results of the base model, the results of the moderation model, and finally, the discussion of all the findings in relation to the previous theoretical literature and empirical literature and a formal assessment of all the five hypotheses and research objectives. chapter 5 introduces the conclusions of the study that summarize the overall findings of all the five hypotheses, the theoretical and policy implications of the findings, the limitations of the study including the limitation of the data frequency and the limitation to macro-level country indicators, and the future lines of research that would further extend, deepen, or refute the findings contained in this chapter.

Chapter 2

Literature Review

The financial environment in the world has completely changed in the last 30 years, and technological revolution and the growing digital connectivity have been the main sources of change. Financial inclusion (access by individuals and businesses to formal financial services that are affordable and used effectively) has become one of the core-organizing goals of international economic policy out of a marginal development issue. Expanded financial access is a requirement to poverty reduction, economic flexibility and sustainable growth, identified as such by the United Nations Sustainable Development Goals, the G20 Financial Inclusion Action Plan, and the World Bank Universal Financial Access agenda. But even with this institutional inactivity, much of the global population, mainly in the developing economies of Sub-Saharan Africa, South Asia, the Middle East and Latin America, is either completely or partially locked out of formal financial systems. The driving force behind this thesis is to understand why this exclusion is maintained, and what individual, technological, and structural factors are most capable of establishing the rate of inclusion.

This question has been covered in three bodies of literature that discuss different aspects of this question independently. The former is about financial literacy, the cognitive aspect of financial inclusion, the question of how the knowledge, skills, and confidence of individuals define their willingness and capability to use financial institutions and digital financial services. The second is fintech adoption, the discussion of the role of the emergence of mobile banking, digital payment systems,

mobile money systems, and algorithmically provided credit in reorganizing access to financial services at the population level, especially in economies with a low density of the physical banking infrastructure.

The third is digital infrastructure, the technological base of broadband connectivity, mobile network coverage, access to electricity and high-technology capacity that defines the ability of fintech systems to operate and of financially literate people to convert their knowledge into real financial action. Although each of the strands has yielded an increasingly promising body of empirical evidence, they have largely evolved independently of each other and the emergent picture of literacy, fintech, and infrastructure interaction to define the financial inclusion outcomes of developing nations over time is not a complete picture.

This chapter has integrated the literature related to all four of the thematic areas financial inclusion as the dependent outcome variable, financial literacy as the first independent variable, fintech adoption as the second independent variable, and digital infrastructure as a direct driver and a moderating variable. The review is bi-layered. The initial layer encompasses the general, diffuse literature on each variable and the financial system environment where the study is set in place defining the conceptual and statistical landscape.

The second layer digs into the particular pair-wise correlations among each independent variable and financial inclusion, laying down the positive results that constitute the preponderance of the literature, citing the neghative and null results that make the simple positive tale hard to tell, and coming at an annexed synthesis that drives the directional hypotheses of this study. The chapter ends by stating the research gaps that this study will fill and presenting the conceptual framework that would combine the variables into a single empirical design.

2.1 Theoretical Foundation

It is necessary to determine the theoretical way within which the study has internal consistency before examining the particular observed literature on each relationship of variables. Any feasible research of financial inclusion should be based on

the concept of the reasons of the existence of financial systems, their functions in the development of the economy, and how the capabilities of individuals, as well as the conditions of the structure, translate into macro-level financial access results. This is based on five theoretical traditions.

Of them the greatest is Financial Development Theory, which is organized by (Levine, 2005) in his overall survey of finance and economic growth. According to Levine, the main role of a financial system is to minimize the market frictions caused by information asymmetry and transaction costs, contacts that inhibit efficient allocation of capital, mobilization of savings, and lock out large portions of the population to productive economic activity.

In this view, financial inclusion is not just a social welfare goal but a structural measure of the successful of the financial system in fulfilling its fundamental economic role.(Bobbo et al., 2024) As formal financial system access by individuals who had been unbanked increases, they decrease the information asymmetries faced by lenders, they decrease the costs of making economic exchange, and they also add to the pool of intermediate savings that is used to finance productive investment. Financial literacy development, proliferation of fintech sites and proliferation of digital infrastructure all play a role in Levine-world to alleviate various types of market friction and, consequently, enrich the financial system.

The financial literacy component of the study has its theoretical framework in Human Capital Theory, which was developed by (Becker, 1964) and was further developed in the subsequent years of economic research works. The key point by Becker is the fact that investments in education and skill formation increase the productive power of individuals and bring about returns on both individual and aggregate economic levels.(Klapper and Lusardi, 2020) This theory has been applied to financial behavior, and it can be predicted that those people with a better degree of the relevant knowledge, which in this case will refer to the financial knowledge necessary to comprehend, analyze, and utilize financial products, will be more interested in the formal financial markets. They will be better inclined to open bank accounts, save formally, access credit on reasonable terms, utilize insurance products, and embrace digital financial platforms. (Kaiser and

Lusardi, 2024) The financial literacy as a kind of reasoning capital is, according to the framework by Becker, a kind of human capital whose accumulation leads to participation in financial markets in the same way general education leads to participation in the labor market.

Fintech adoption is theorized by the Technology Acceptance Model, originally created by (Davis, 1989), which holds that the perceived usefulness of the technology, i.e. whether the individual believes the technology will result in improved outcomes, and the perceived ease of use of the technology i.e. whether the individual believes that they can use the technology without exerting too much cognitive effort, are the two perceived attributes of the technology that determine the eventual When applied to fintech, this model predicts that digital financial service may be adopted faster when potential users can perceive apparent functional advantages, (Meniago, 2025) like cost savings, convenience, and speed, and when the technology is user-friendly enough that the learning cost can be afforded.

The TAM model also suggests that the adoption depends on the cognitive ability of the individual to perceive and assess these attributes, providing a theoretical link between financial literacy and fintech adoption, which is discussed in the moderation literature. The conceptual rationale behind the moderating effect of digital infrastructure is in the Access Theory, which was proposed by (Ribot and Peluso, 2003) in their analysis of natural resource power but has been applied to financial and digital access issues. Ribot and Peluso differentiate between the right to use a resource and the possibility to enjoy the profits of the resources. This difference is vital to financial inclusion analysis: a financially literate person technically has the right to access formal financial markets, and a nation can have an effective fintech ecosystem that technically provides accessible financial services, but neither right will automatically become actual financial participation in the absence of the structural means of access. (Olaoye et al., 2024) According to the terms of Access Theory, digital infrastructure is the structural bundle of power that either makes or breaks the theoretical potential of literacy to translate the theoretical potential of fintech into the actual practice of financial inclusion. The gap between potential and actual is still unclosed unless there is a solid internet connection,

mobile network coverage, stable electrical power, and the technological ability that the high-technology exports represent. Conclusively, the Economic explanation of treating digital infrastructure as a moderating situation and not just another independent variable is based on Public Good Theory as developed by (Samuelson, 1954). Samuelson laid the foundation of public good, which is non-rivalrous in consumption and non-exclusiveness, producing positive externality which is systematically under-provision by the private markets. Digital infrastructure in developing nations shares most of the features of a public or quasi-public good: the spread of mobile network coverage, access to broadband, the provision of electricity creates benefits that extend well beyond the immediate beneficiaries of the infrastructure, and allow financially literate people to apply their knowledge to economic action.(Meniago, 2025) The implication here is that the public investment in digital infrastructure does not just provide a direct channel to financial inclusion but leverages the returns to private investments in fintech and individual investments in financial knowledge, and generates interaction effects that are exactly what the moderation hypotheses of this study are meant to channel. Collectively, these five theoretical traditions define a definite integrated framework. Financial Development Theory is the theory that explains the importance of financial inclusion as a structural economic result. The Human Capital Theory describes the reason why it is fueled by financial literacy. The Technology Acceptance Model is used to understand why the adoption of fintech broadens it. Access Theory describes the moderating role of digital infrastructure in the two relationships. And Public Good Theory explains why infrastructure expansion should be treated as a policy instrument that magnifies the returns to all other investments in the financial inclusion ecosystem.

2.2 Financial Inclusion in Developing Countries

A serious consideration of the literature in financial inclusion should start with an understanding of the daunting diversity of the conditions of financial access among the developing nations and the sophisticated historical processes in which

the conditions have developed. According to an article by (Demirguc-Kunt et al., 2022), writing about the results of the Global Findex Database 2021, citizens of developing economies now own accounts in numbers of 71% (as compared to 55% in 2014 and 42% in 2011). Although this trend would seem positive, the aggregate number hides vast inequalities: the average account ownership in Sub-Saharan Africa was 55% as of 2021, but in some low-income economies, it was less than 20% and in others, over 80%; in South Asia, it was 68 percent but with big gender gaps and affected urban-rural differences; in the Middle These statistics confirm that financial inclusion is not a closed issue but a dynamic and geographically unequal process the determinants of which should be the focus of an experiential study (Kaiser and Lusardi, 2024).

Historical paths of financial systems development in developing countries have been considerably different than those of high-income economies. (Eshun and Kocenda, 2025) In contrast to the European and North American financial ecosystems where the formal banking infrastructure has been built over centuries and populations have begun to be fully served by and dependent on the traditional banking infrastructure, many developing economies must leapfrog and find themselves in the situation where cash-based transactions are entirely substituted by mobile money and digital payments. This leapfrogging dynamic which is widely reported in the African case by (Aker and Mbiti, 2010) and in the South Asian case by several reports by the World Bank indicates that the determinants of financial inclusion in developing economies are fundamentally different to those that have been reported in the developed world literature. The physical density of bank branches, which has traditionally been the main indicator of financial access, is not as significant as mobile network coverage, smartphone penetration, and the regulatory environment surrounding digital financial service providers.

(Beck et al., 2007) were the first to explicitly test the cross-country determinants of banking sector outreach and access and they found that physical infrastructures, income levels, and institutional quality are the main structural predictors of the extent and the depth of financial system access. The fact that even with controlling factors of income, countries substantially vary in the results of financial inclusion,

is what led them to the significance of the variables on policy determined by the policy, like the infrastructure investment level and regulatory regimes (Klapper and Lusardi, 2020). This understanding is what drives the panel data design of the current research that moderates income by using log GDP per capita and analyzes the independent effects of financial literacy, fintech adoption, and digital infrastructure.

The multi-dimensionality of financial inclusion has been institutionalized by the creation of composite indices that reflect access, usage and quality dimensions in a single index. (Sarma, 2008) introduced the Index of Financial Inclusion that is the combination of banking penetration, availability of banking services, and usage of the banking system into a composite measure. Subsequently (Sarma and Pais, 2011) used this index as an input in a cross country empirical study and found that indicators of human development, such as literacy levels and per capita income in particular, are strongly related to the higher financial inclusion index scores, and that physical and institutional infrastructure are strong contextual predictors. Their conclusion that the relationship between human development and financial inclusion is not mechanically deterministic but rather strong with a lot of residual variation explained by infrastructure and policy variables is the exact empirical space which the current study is in.

Literature that is more recent has extrapolated the concept of financial inclusion to include digital aspects. (Ozili, 2018) also proposed the notion of digital financial inclusion, stating that the proliferation of mobile money, digital wallets, and internet banking should be treated as a qualitatively new concept of inclusion, which should be analyzed in a different way than traditional measures of inclusion related to banks. Synthesis by (Ozili, 2018) determined that digital financial inclusion enhances the welfare outcomes in several dimensions, such as household consumption smoothing, small business growth, and delivery of public services, but only when the financial system is stable and functioning well and when digital infrastructure is sufficient. The conditionality argument envisions the moderation design of the current research and it is based on a known theoretical and empirical rationale.

2.3 Financial Literacy and Financial Inclusion

2.3.1 The Positive Case

The overwhelming amount of literature in the financial literacy and financial inclusion literature provides a definite positive correlation: people and nations with higher financial literacy rates demonstrate better financial inclusion rates within various dimensions. The most rigorous macro-level evidence of this relationship is presented by the landmark cross-country study of (Grohmann et al., 2018), published in World Development. They illustrate the improvement in the country-level financial literacy by one standard deviation is statistically linked to a statistically significant improvement in the share of adults with formal bank accounts, formally borrowing and saving via financial institutions.

Importantly, this correlation is maintained after adjusting for the level of income, the quality of the institutions, and regional fixed effects, which indicates that the impact of financial literacy on financial inclusion is not diminishable to the general economic growth. On the individual level, in an in-depth review of the financial literacy research published in the Journal of Economic Literature, (Lusardi and Mitchell, 2014) record that financial literacy, assessed via questions of interest rate calculation, inflation and risk diversification, significantly predicts retirement savings behavior, stock market participation, and wealth accumulation in developed and developing country settings. Their combination of dozens of household surveys conducted across the United States, Netherlands, Germany, Japan, and other developing economies confirms that financial literacy is not a luxury item of affluent communities but an essential ability lacking which costs both individuals and overall economies.

In low financial literacy areas, people use informal savings, shun formal credit, and are disproportionately susceptible to predatory lending and financial fraud, which can all diminish effective financial inclusion even in the presence of formal services. Investigating 37 African countries with the help of probit regression implemented on the household-level Findex data, (Zins and Weill, 2016) reveal that the two best determinants of financial inclusion in Africa are education and income, with the

former working both directly and indirectly through its impact on the willingness to use formal financial services. This makes their results especially applicable to the current study as they show the literacy-inclusion correlation in a developing country setting where so many of the same structural constraints are present as the larger developing country sample employed in this study.

Similar probit approach to ASEAN household survey data (commissioned by the Asian Development Bank) by (Morgan and Trinh, 2019) reveals that financial literacy increases the likelihood of formal saving by about 8 percentage points and the likelihood of formal credit use by about 6 percentage points, when income, age, gender, and location are held constant. These are effects of a micro-level but sum to macroeconomic effects in the aggregate when they are multiplied over whole adult groups.

The most causal evidence of the financial literacy and financial inclusion relationship lies in experimental evidence. The findings of a randomized controlled trial of micro-entrepreneurs in the Dominican Republic, reported by (Drexler et al., 2014), in the American Economic Journal: Regional Science Policy & Practice) on the effects of simplified rule-of-thumb financial training, as compared to conventional accounting training, indicate that simplified financial training yielded measurably greater savings behavior, credit management, and business financial practices. Their study is experimental, which allows them to dismiss the selection effects and in their study, they establish a true causal pathway between financial knowledge and financial behavior, which gives micro-level causal evidence to complement cross-country correlational evidence by (Grohmann et al., 2018). The operational implication of Drexler et al. is that financial literacy does not entail the need to invest in complex educational activities to produce financial inclusion impacts; focused, pragmatic knowledge interventions can change financial behavior among groups with low levels of formal education. 2.4.2 Conditions that complicate Evidence and Contexts.

Although the positive correlation between financial literacy and financial inclusion has been well-established in the literature, some studies make a positive relationship a more complex and universal narrative and exposes significant contextual

circumstances in which the relationship becomes weaker or even negative. In a study published in the Review of Financial Studies, (Cole et al., 2011) carried out a field experiment in India and Indonesia and discovered that financial education programs did not have significant impacts on bank accounts opening and saving behavior with effect sizes that were economically insignificant compared to the associated costs of the interventions.(Boachie, 2024).

Their results indicate that financial literacy by itself without other infrastructure, availability of financial products, and confidence in financial institutions may not yield financial inclusion outcomes.

This qualification is important to the current study since it directly drives the moderation hypothesis: financial literacy will be more powerfully transformed into financial inclusion when the structural factors, namely digital infrastructure, bring the cost and complexity of acting on financial knowledge down.

In a World Bank Policy Research Working study that reviews financial literacy programs in more than 200 studies, (Xu and Zia, 2012) observe that the impact of a literacy intervention on financial behavior is both heterogeneous and often small, with the effect size often strongly dependent on context, mode of delivery, and the presence or absence of complementary services. Their meta-analytic evidence indicates that financial literacy would better be considered as a necessary but not sufficient condition of financial inclusion in most developing country settings, which is just what the theoretical implication of Access Theory predicts: the right to access financial markets that literacy provides should not necessarily translate to the capacity to gain without structural facilitators.

Published in Management Science, (Fernandes et al., 2014) also report a meta-analysis which shows that the effects of financial literacy on financial behavior decay quickly and are small when compared with the variation in financial behavior of other factors such as income, institutional trust, and product accessibility.

Such confounding results do not jeopardize the argument in favor of financial literacy as a determinant of financial inclusion; instead, they refocus the theoretical argument of moderation. They determine that the literacy-inclusion association is

not a unidirectional, general, (Boachie, 2024) positive association but rather a conditional association whose intensity is contingent on the structural environment, within which literate people are enclosed. Countries that have good digital infrastructure will offer a platform on which literacy can be put into practice effectively and countries that have poor digital infrastructure will compel even financially savvy people into informal financial systems due to the failure of the formal digital systems to be reliable, cost effective, or accessible. Hypothesis three is based on this logic stating that Digital Infrastructure moderates the relationship between Financial Literacy and Financial Inclusion positively.

H1: Financial literacy has a significant, positive influence on financial inclusion.

2.4 Fintech Adoption and Financial Inclusion:

2.4.1 The Transformative Case

Literature on fintech adoption and financial inclusion is one of the fastest expanding literature in economics and finance, which indicates the unprecedented rate of digital financial services in the developing economies in the last two decades. (Aker and Mbiti, 2010) provide the empirical background to this argument through their review in the Journal of Economic Perspectives that the mobile phone technology diffusion in Sub-Saharan Africa has opened up a completely new avenue of access to finance to economies where physical branches of banks were barely accessible to less than five percent of the rural population. In their analysis, mobile phones are seen to decrease the cost of information, the cost of sending and receiving money, and establish the network infrastructure on which mobile financial services eventually built. Their research is foundational in the sense that it does not directly quantify the adoption of fintech, but rather it provides the technological antecedents without which the M-Pesa revolution recorded by the later researchers would have been impossible. (Jack and Suri, 2014) provide the strongest causal evidence of the financial inclusion impact of fintech adoption with a panel study

of Kenyan households published in the American Economic Review that follows the welfare impact of M-Pesa adoption between 2008 and 2010. They illustrate the application of geographic variation in the availability of M-Pesa agents as an identification strategy and show that the availability of mobile money enhanced risk-sharing among households, enabling them to smooth consumption in response to income shocks by tapping into informal transfer networks made possible by digital money transfers.

(Olaoye et al., 2024) The analysis indicates that the financial inclusion benefits of M-Pesa were greatest in the poorest households, who had the most to benefit in the access to a low-cost, ubiquitous transfer system, and the benefits were not reflected by conventional financial inclusion indicators, which highlights the relevance of fintech-specific indicators. The work of Jack and Suri continues to be the gold standard in identifying causality in the fintech and financial inclusion literature, and its household-level evidence has been replicated in various versions in mobile money research in Ghana, Tanzania, Uganda, and Bangladesh.

Creating a wider spectrum of evidence about digital finance in the Borsa Istanbul Review,(Ozili, 2018) argues that digital finance, including mobile money, digital payments, Internet banking, and related services, enhances financial inclusion by four different mechanisms: reducing costs, which lowers transaction costs and the cost of maintaining an account below a threshold that previously excluded low-income individuals; All of these mechanisms are a decrease in the market frictions which the Financial Development Theory of Levine is the main origin of the financial exclusion.

In a recent IMF Departmental study on digital financial inclusion in the post-COVID era,(Sahay et al., 2020) record the radical nature of the acceleration in the adoption of digital payments that happened during the pandemic period in emerging economies, with the value of mobile money transactions in some Sub-Saharan African economies having increased by more than 100 percent between Their analysis confirms that the structural change to digital finance that the pandemic has compelled has left a lasting impact on financial inclusion, especially on those populations previously unresponsive to uptake of digital services, and that

those countries with better digital ecosystems, (Meniago, 2025) both in terms of quality regulation and infrastructure, reaped greater inclusion benefits with the same amount of investment in fintech. The base paper that explicitly inspired the current study is (Azmeh and Al-Raeei, 2024), who employs panel data handling developing nations based on the Global Findex database to reveal what they call a supplement-substitute paradox: the adoption of fintech supplements the current formal financial systems in more developed developing countries, where numerous inclusion gains are produced, and partially replaces the missing formal banking in poorer economies with we It follows that the relationship between fintech and inclusion is contingent upon the financial and technological environment, which both directly motivates the direct effect hypothesis and the moderation hypothesis about digital infrastructure.

A straightforward positive correlation between fintech adoption and financial inclusion is not always backed by the evidence and multiple studies find that there are circumstances when the increase in fintech does not result in meaningful inclusion and sometimes even leads to exclusionary consequences. In an analysis of World Bank data on mobile money adoption, (Klapper and Singer, 2014) find that in East Africa, mobile money penetration is strongly correlated with the financial inclusion outcomes but has much weaker and statistically insignificant correlations in other developing regions such as South Asia and Latin America where the mobile platforms are limited by regulatory barriers, cultural distrust of non-bank financial services, and inadequate infrastructure.(Olaoye et al., 2024) This local diversity emphasizes the fact that the relationship between fintech adoption and financial inclusion is not universal and rather highly contextual.

In a critical analysis of political economy, published by New Political Economy,(Gabor and Brooks, 2017) contend that the popularization of fintech as an inclusion technology hides how digital financial systems can replicate current exclusions by making smartphone access, stable connectivity, and official identity documents pre-requisite that many of the poorest populations do not always have. (Meniago, 2025) The analytical significance of their criticism lies in their recognition of the processes by which the adoption of fintech can fail to bring about

inclusion: when the adoption of fintech presupposes the presence of complementary capabilities and infrastructure that is disproportionately unavailable to the poor population, the growth of fintech may only increase the divide between the included and the excluded and not decrease it. This criticism is directly related to the moderation hypothesis of the current paper (Cevik, 2024) when digital infrastructure is the structural complement that makes the adoption of fintech turn into financial inclusion, then the expansion of fintech without infrastructure investment runs the risk of failing to include the very population in need of inclusion.

(Munyegera and Matsumoto, 2016) analyze household panel data in Uganda and discover that mobile money adoption enhances household welfare by facilitating remittances but has little impact on savings mobilization and access to formal credit, indicating that the effect of fintech on inclusion is more about payment and transfer dimensions than the savings and credit dimensions that the conventional financial inclusion measures focus on. Such selectivity of fintech-driven inclusion, which applies to some but not all aspects of formal financial involvement, applies to the use of Broad Money as a percentage of GDP as the main financial inclusion proxy used in the present study (Olaoye et al., 2024) because Broad Money reflects the overall depth of financial intermediation as opposed to the payment dimension to which mobile money has the most direct impact.

H2: Fintech adoption has a significant, positive influence on financial inclusion.

2.5 Digital Infrastructure as a Moderating Factor

Digital infrastructure is not structurally the same in this study.More than ever before, financial literacy and fintech adoption. Where literacy is the cognitiveTechnology is the precondition to financial inclusion and fintech adoption. A conduct by which digital financial services are delivered to people, digital the technological, social, and economic components of information systems will be capable of

effectively supporting users.These forces can manifest themselves in real financial inclusion gains at scale. The literature related to infrastructure and financial inclusion is a maturing field. along two parallel paths: one earlier that treated poor infrastructure was associated with poorer outcomes of inclusion, while a more recent study found that it was not directly associated with outcomes of inclusion stream that considers infrastructure as a conditioning, moderating factor that shapes the effectiveness of the other drivers of inclusion in delivering outcomes.

This study draws on the second framing, which is based on moderation. Both stream evidence and testimony of your own. The groundwork for infrastructure and inclusion has been laid by (Sarma and Pais, 2011), demonstrate, based on statistics of 49 countries, that connectivity access indicators like telephones per person and internet access several indicators of financial inclusion, such as penetration, are among the strongest.

After adjusting for income and literacy and institutional quality of their finding that the infrastructure effect exists even after income is controlled for the design of this study it is important to have confirmation that infrastructure is not just a reflection of economic development and a structural condition that shapes how effective other inputs such as literacy & fintech adoption are at realizing the impact of the policy shapes the effectiveness of other inputs to achieve the impact of the policy, such as literacy & fintech adoption transform into inclusion outcomes.(Meniago, 2025) This is in line with the "treatment of digital" approach Infrastructure as one input among multiple inputs independent predictors.

More relevant to a moderation framing, (Avom et al., 2023), has the most relevant statement. Research on the panel study of Sub-Saharan African countries has been published in Technological accounting for 88% of the variance.Forecasting and Social Change, determines the quality of telecommunications to account for 88% of variance.

Financial inclusion effects of ICTs are significantly mitigated by infrastructure the same volume of mobile money adoption.the same amount of adoption of mobile money yields significantly greater financial inclusion improvements in more stable countries High-quality and extensive mobile networks. They have identified their

mechanism which is intuitive. Mobile networks are not always reliable, transactions fail and users lose their trust in the mobile network successful transition into adoption and into inclusion, through digital platforms declines. This is the closest empirical precedent to the moderation design directly aids the treatment of digital, as adopted in the present study strength is just another variable and not the determining factor as is often assumed presence, of the fintech–inclusion relationship.

A similar story holds true for the infrastructure-gap side. (Honohan, 2008),The World Bank released a study on access to finance on the household level in more than 150 countries.A World Bank study on access to finance at the household level in over 150 countries was published according to 160 countries, geography is a key determinant of financial inequality affected at disproportionately high rates, especially the rural and remote population, due to exclusion the price of using financial services is only partially could be accounted for by income differences.

Similarly, (Ferilli et al., 2024) cited, with the help of a spatial panel approach to emerging-market data was employed in the context of Research in an International Business and Finance, demonstrate investment in digital, showcase examples of technology application in business, explain the impact of technology on business operations infrastructure narrows the financial access gap between high- and low-income populations that benefits "spilled over" adjacent, not directly-covered populations markets and network effects in areas.

Both studies reinforce the same logic here: gaps in infrastructure do not just decrease financial inclusion directly they reduce the returns to literacy and a mechanism is in use to generate the use of fintech would otherwise be in use moderation model is designed to capture.

The combination of this literature supports a "moderation only" treatment digital infrastructure adopted in this study rather than modeling digital infrastructure as a third independent predictor of financial inclusion is modeled as one of the three pillars, financial education and financial technology (fintech) adoption, alongside with financial literacy and fintech adoption are supported within the structural condition at a high level adoption translates into real outcomes in inclusion.

2.6 Combined Perspectives: The Digital Inclusion Nexus

The most theoretically advanced and policy-relevant addition that recent literature has made to the financial inclusion sector is the understanding that literacy, fintech, and infrastructure are not individual inputs into a financial inclusion production role but rather elements in an integrated digital ecosystem. (Boachie, 2024) Financial literacy is limited to the accessibility of digital tools and platforms in which the knowledge of literate people can produce financial engagement. The success of fintech usage hinges on the level of knowledge of the adopters to effectively use digital platforms as well as the infrastructural opportunities to do so with consistency.(Olaoye et al., 2024) Digital infrastructure, however, only produces financial inclusion returns in the event that the populations it serves possess the cognitive ability to utilize digital financial services, as well as the fintech systems that enable the digital financial service to be provided. The organizing logic of the current study is this interdependence, which the synthesis literature has come to call the Digital Inclusion Nexus.

In one of the first studies to explore the directly relevant precursors to the current thesis, (Hasan et al., 2021) examine the association between fintech adoption and financial inclusion mediated by financial literacy in a sample of developing and emerging economies. They conduct a moderation analysis with interaction terms to a panel regression model and discover the positive impact of fintech adoption on financial inclusion to be much stronger in countries with higher financial literacy, which confirms the strategic complement of literacy and fintech and independence of the two as inputs. (Meniago, 2025) They found the individual-capability dimension of the complementarity argument; the current study introduces the structural-infrastructure dimension by testing whether the digital infrastructure also enhances both the literacy-inclusion and fintech-inclusion associations at the same time. The fact that there are complementarities presented by Hasan et al. is a strong prior justification of the moderation design used here.

In the latest combined study reviewed in this review, published in the Journal of Innovation and Knowledge,(Nazir and Ahmad, 2025) employed a moderated-mediation design to a developing country panel to determine that digital infrastructure mediates, as well as moderates, fintech-inclusion pathways. Their analysis shows that the uptake of fintech enhances financial inclusion in part through the use of better digital infrastructure, and that this moderating mechanism is itself mediated by the quality of infrastructure at the base, yielding a compounding effect of fintech and infrastructure that exceeds the sum of its parts.

Their empirical support on the moderation of fintech effects by infrastructure, which is the essence of Hypothesis four in the current research, is based on a design that is similar to the Fixed Effects moderation that is used in the current research giving extra weight to the present research anticipating a significant positive interaction coefficient. Using spatial panel models to study the determinants of financial inclusion at the level of the European Union regions,(Cruz-Garcia et al., 2021) suggest that meaningful financial inclusion, which goes beyond the presence of accounts to the productive utilization of financial services, must include the concomitant presence of personal financial knowledge, access to fintech, and reliable digital connectivity. Although they study a more established regional context than the developing country panel of the current thesis, the structural logic that they develop is the same: literacy, fintech, and infrastructure are complements where the combination of the three brings about financial inclusion results that no individual input would achieve individually. Their empirical results that spatial clustering of financial inclusion is motivated by clusters of high literacy, high fintech penetration, and high digital connectivity gives the strongest spatial evidence of the Digital Inclusion Nexus argument.

In their IMF analysis of post-COVID digital financial development,(Sahay et al., 2020) summarize evidence on more than 50 developing economies to determine that the financial inclusion benefits of the pandemic-inspired adoption of digital finance were greatest in those countries which entered the crisis with better digital infrastructure. This kind of observation is natural experimental by nature,(Cevik, 2024) where the level of infrastructure before the crisis is compared to the level

of inclusion after the crisis, giving quasi-causal evidence that infrastructure does not simply correlate with inclusion, but instead multiplies the financial inclusion dividends of fintech adoption. Their conclusion that one standard deviation better pre-crisis digital infrastructure was linked with financial inclusion gain around twice the financial inclusion gain of the same fintech adoption shock is consistent with the moderating interaction mechanism in Hypothesis four of the current research. When combined, the joint perspectives literature sets three regularities of empiricism that drives the integrated moderation design of this thesis. (Olaoye et al., 2024) First, financial literacy positively affects financial inclusion more in a setting with superior digital infrastructure, as infrastructure reduces the cost of action on financial knowledge in digital platforms. Second, conditions that support greater fintech adoption in financial inclusion are more pronounced in settings with a superior digital infrastructure, as infrastructure dictates the dependability and accessibility of the digital infrastructures through which fintech services are provided. Third, financial inclusion is directly and solely encouraged by digital infrastructure that increases the grouping of individuals, which can practicably access any digital financial service, irrespective of literacy rates and access to fintech platforms. These two regularities accurately support the two direct effect hypotheses and two moderation hypotheses of this study.

H3: Digital infrastructure has a significant moderating effect on the financial literacy and financial inclusion relationship, such that is stronger when there is higher digital infrastructure.

H4: Digital infrastructure has a significant moderating effect on the fintech adoption and financial inclusion relationship, which amplifies the positive effect of an increase in fintech adoption in countries that have higher digital infrastructure.

2.7 Conceptual Framework

Based on the theoretical background developed in Section 2.2 and the empirical data summarized in the Sections 2.4-2.7, the conceptual framework of this research

makes Financial Inclusion the dependent variable affected by two independent variables and moderated by the third one. The concept of Financial Literacy is based on the Human Capital Theory and directly facilitates the idea of financial inclusion by providing people with the mental ability to utilize and use formal financial services.

Fintech Adoption is an application of the Technology Acceptance Model, which directly facilitates financial inclusion by making formal delivery of financial services more affordable, simpler, and less geographically restrictive. Both Digital Infrastructure are based on Public Good Theory and Access Theory, both explicitly encourage financial inclusion by increasing the number of people able to use digital financial services and moderate the influence of literacy and fintech by defining how each of these forces translates into real financial involvement.

Digital Infrastructure has a moderating role, which is the conceptual highlight of the framework. It is a mirror of the Access Theory perspective that the right to financial access granted by literacy and the availability of financial access granted by fintech cannot be directly translated into financial participation without the structural access of the means of access, which reliable digital connectivity offers. (Olaoye et al., 2024) When a country invests in financial education without concomitant development of digital infrastructure, it develops literate populations that are structurally marginalized.

When the nation promotes the use of fintech, but does not require infrastructure to be reliable, digital financial services become unreliable, accessible only to already-connected minorities.

It is the combination of all three, literate populations, access to digital financial tools, and trusted infrastructure, that brings about the full financial inclusion dividend that the Digital Inclusion Nexus framework anticipates.(Meniago, 2025) This theoretical reasoning is operationalized by the moderation models estimated in Chapter Four in which the interaction terms between Fintech Adoption and Digital Infrastructure and between Financial Literacy and Digital Infrastructure measure whether the synergistic effects hypothesized by the framework can be observed in the data on 84 countries of the developing economy panel.

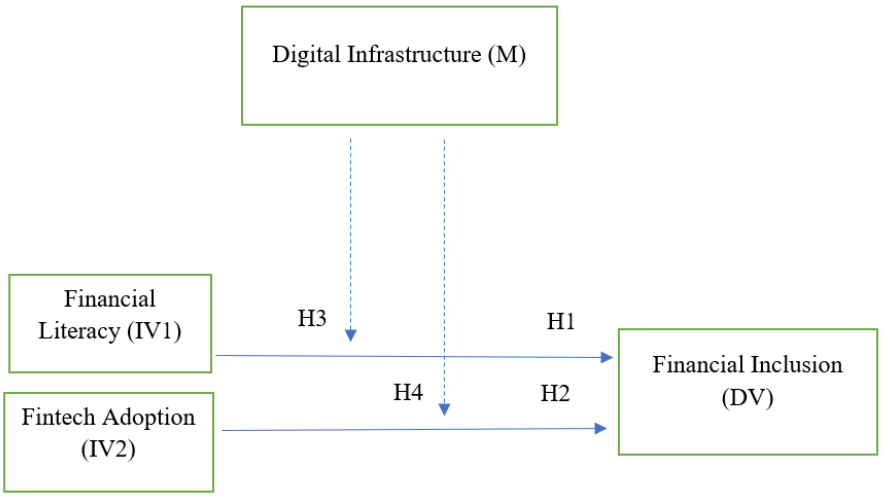

FIGURE 2.1: Conceptual model of the study

This chapter has presented an analytically systematized as well as a critical overview of the literature pertaining to the five hypotheses and five research objectives of this study. The review started by defining the theoretical basis of the Financial Development Theory, Human Capital Theory, Technology Acceptance Model, Access Theory, and Public Good Theory and defined the conceptual logic of each relationship between the variables and the moderation framework. The wide horizon of financial inclusion was subsequently mapped in developing countries, which placed the study in the context of the reported empirical fact of fragmented and geographically varied financial exclusion in the developing world.

Individual empirical evidence on each pair of relationships was examined thoroughly. To be financially literate and financially included, the majority of cross-country, household-level and experimental data points to a positive, directional hypothesis, with the crucial qualification that the effect of literacy in turning into inclusion is stronger in structurally enabling settings, which drives Hypothesis One and moderation logic of Hypothesis three. To adopt and include the fintech, the evidence base provided by mobile money literature and studies on digital payments

points to a positive directional hypothesis, and the evidence varies between contexts of poor infrastructure and regulatory uncertainties that drive the conditionality argument of Hypothesis four.The amalgamation of the perspectives literature created the Digital Inclusion Nexus argument, stating that literacy, fintech, and infrastructure are strategic complements, whose combined effect is greater than the sum of the individual effect of each, which directly inspired Hypotheses Four and Five. Three noteworthy research gaps were determined in terms of time, area, and lack of moderation frameworks, which the current study fills. At the end of the chapter, the author made a statement of the conceptual framework that was used to incorporate all five hypotheses in a single empirical design that was carried out in Chapters 3 and 4.

Chapter 3

Research Methodology

This chapter provides the empirical structure of the research in a way that follows the entire analytic process of the research proposal to the end panel specification that will be applied in testing the hypothesis. The chapter is divided into eight substantive parts. The research design and justification are presented in section 3.2. Section 3.3 describes the sources of data and how the initial target frame of 196 countries over 25 years was narrowed to a working balanced panel of 84 countries over 15 years, and how every choice was made to form the final sample. The definition and operationalization of all the study variables are outlined in section 3.4. The econometric models are shown in section 3.5. The estimation methodology (including panel data, unit root testing, index building with Principal Component Analysis, Hausman specification testing, diagnostic tests, and endogeneity approach) is presented in sections 3.6-3.9. All methodological decisions are based on the reality of data actually observed, evidence of diagnosis that occurs, and the existing literature on econometrics.

3.1 Research Design

The research design is quantitative and positivist, which is based on secondary panel data. This design was suggested in Chapter 1 and it is suitable considering evidence produced in the course of analysis. The reason behind the use of longitudinal panel data is that it not only considers cross-country heterogeneity but also

considers time dynamics, which provides more efficient and reliable estimates as compared to the pure panel or pure time-series methods. Although culture, political structure, and historical institutional quality, which, according to Wooldridge (2010), are country-specific, cannot be measured easily, and have a systematic effect on financial inclusion outcomes, are controlled by panel data. The cross-country dimension reflects structural variations in financial development, whereas the time dimension reflects the dynamic development of digital infrastructure and fintech ecosystems between the sample period 2010 and 2024.

The model specification as proposed was a Fixed Effects (FE) model as well as Random Effects (RE) model, and the model chosen was based on the Hausman test. This procedure was followed as planned. All four models in the study were tested using the Hausman test. In all cases the null hypothesis of the consistency of the Random Effects estimator was rejected. This means that the RE estimator is non-consistent when there is correlation between the regressors and the individual-specific effects. Thus, all models in the study were determined to be best specified using Fixed Effects. Strong standard errors were implemented to overcome the heteroskedasticity, serial correlation and panel dependence, which were verified by the diagnostic tests, and Driscoll-Kraay standard errors were the main estimator as they are robust to all three violations in a panel context.

The proposal also envisioned the possibility of Generalized Method of Moments estimation; but due to the reasons which will be discussed later in Section 3.9, the ADF unit root tests that validate the stationarity at levels and the IV estimation that validate the absence of endogeneity, GMM was not needed, and Fixed Effects estimation was consequently adopted as the primary and adequate method.

3.2 Data Sources and Sample Construction

3.2.1 Data Sources

The study is based on three publicly available, globally standard databases to guarantee the accuracy, reproducibility, and the equivalence across countries. The

former is the World Development Indicators database, which is maintained by the World Bank, which provides the dependent variable proxy of Broad Money as a percentage of GDP and the proxies of Digital Infrastructure component (fixed broadband subscriptions per 100 people, mobile cellular subscriptions per 10 The second is the Global Findex Database published by the World Bank in survey waves in 2014, 2017 and 2021, out of which the three Fintech Adoption proxies of adults making digital payments, adults receiving digital payments, and adults with debit card ownership are attained. The third one is the World Development Indicators database once more of the Financial Literacy proxy of tertiary school enrollment rate as a percentage gross again as in the case of (Grohmann et al., 2018).

3.2.2 The Figures to the Proposed Frame to Realized Panel

The research proposal outlined a broad objective of 196 developing countries in 25 years between 1999 and 2024. The actual panel which made estimation is a panel of 84 countries with an estimated 15 years between 2010 and 2024. This section describes all the choices made that changed the proposed frame into the final sample. These results are significant to recognize as they are either a data restriction or a methodological requirement that made the analysis more reliable instead of less.

It was planned to have a 25-year horizon between 1999 and 2024, driven by the wish of taking the entire digital financial development curve. Nonetheless, systematic analysis of the World Development Indicators database has shown that the most important Digital Infrastructure variables, especially fixed broadband subscriptions and high-technology exports, only have reliable and consistent cross-country coverage since around 2010. Prior to 2010, the data sparsity was so extreme in the sample of developing countries that inclusion of those years would have resulted in a highly unbalanced panel with most of the panel being filled with missing values instead of real observations. Since the construction of indexes using PCA on digital infrastructure requires full cases on all four component variables and the pattern of

missing data prior to 2010 was concentrated in the same low-infrastructure countries that the study is most interested in, omitting the years before 2010 would have been a systematic selection bias in the index. The panel initiation in 2010 hence rules bias at the expense of a shorter horizon and the resulting 15-year panel in 2010-2024 is one of the longest panels in the financial inclusion literature based on these particular indicators.

The final sample of 84 countries was arrived at through three sequential filters:

Development-status filter: The World Bank's developing-country classification was applied first, which excluded high-income OECD economies. These economies' mature financial systems and institutional settings are structurally different from the developing-country context this study addresses.

Data-sufficiency filter: Each remaining country was required to have at least three years of non-missing data on all three core variables — Financial Literacy, Digital Infrastructure, and at least one Financial Inclusion proxy — for the 2010–2024 period. Countries falling short of this threshold were dropped, since Fixed Effects estimation requires meaningful within-country variation over time.

Merge-completeness filter: Countries whose records failed to merge cleanly between the core panel dataset and the World Development Indicators control-variable data (chiefly GDP per capita) were also excluded.

The observational dimension of the panel includes 84 countries, which were chosen on the basis of the countries in the observational dimension of the panel were determined according to the availability of the basis of data on all significant variables for the period 2010-2024. There are a variety of income levels and geographic areas, and Consistent with the study focus, cross-country financial inclusion dynamics are studied. However, listwise deletion is found due to missing values on particular variables, the effective estimation sample varies according to the model: 82 countries are The Financial Literacy (FL) specifications were retained in the Financial Literacy (FL) specification, 79 countries in the Their Fintech Adoption (FT) specifications, are difficult to access and not widely used.The Fintech Adoption (FT) specifications are such that not many people use them, and they are difficult to access as there are only three waves covered. the Global Findex database (2014,

2017, 2021). This decrease is in line with the U.S. average. is the standard practice in unbalanced panel econometrics and does not involve systematic errors of any kind. This is because the observations that were not included in the sample are not the ones that will focus on if the sample were expanded to include them. Within a certain income group or area (Wooldridge, 2010). The A panel of 84 countries × 15 years = 1,260 declared panel. The country-year observations were valid for FL estimation 1,093 and for FT estimation 285 observations.

The proposal focused on all developing countries as categorized by the World Bank that at one time or another had as many as 196 economies. The achieved sample of 84 countries was a result of a successive filtering effect. The initial filter is the World Bank developing country classification, which initially rules out the high-income OECD economies, whose well-developed financial systems and institutional settings are structurally incongruent with the context of developing countries that the study is interested in.

The second filter was that a country needed to possess enough non-missing values on the core variables of Financial Literacy, Digital Infrastructure, and one Financial Inclusion proxy to allow non-meaningful panel estimation. The countries with less than three years of information on each of the main variables were filtered out, since Fixed Effects estimation in a single country needs sufficient variation within the country across time. The third filter was used to eliminate those countries where the merge of the main panel dataset and the download of the World Development Indicators control variable created no records, and this influenced one observation of GDP per capita. After filters, 84 countries were included in the main estimation sample, which resulted in 1,260 country-year observations in the combined dataset. Each model utilizes the actual observations, which depend on variable-specific missingness, with Model 3, the most effective model, with Broad Money as the dependent variable, using 925 observations, and 82 countries.

Data in the Fintech Adoption index needs the Global Findex Database, which is a survey-based tool that has been published only in 2014, 2017, and 2021. It is not a series that is done yearly. This implies that even with the 15-year annual panel of other variables, only these three survey years have observations of Fintech

Adoption. Fintech Adoption in the merged dataset contains 975 missing values (out of 1,260 country-year observations) which represent this exact three-wave restriction. Moderation hypothesis Fintech Adoption (interaction with Digital Infrastructure) Hypothesis four, thus applied to a sub-sample of 79 countries and 206 observations based on the three Findex survey years. This is not something that the researcher introduces but a part of the best available global data on fintech usage behaviour. The model implication is that Hypothesis three, which deals with the moderation of Financial Literacy by Digital Infrastructure, employs the entire panel of 925 observations whereas Hypothesis four employs 206 observations. This disparity in sample size renders it methodologically inappropriate to test Hypotheses Three and Four in the context of a single combined model as explored in more detail in Section 3.9.

This panel is an unbalanced panel since not every 84 countries are providing observations on all 15 years in all variables. The plm package of R (all panel estimations) supports unbalanced panels, and the Fixed Effects in the estimator is consistent under unbalanced Ness, provided the missing data is not systematically related to the error term, which is upheld by the fact that the lack of coverage in these data is caused not by the results of the dependent variable itself but by gaps in database coverage.

3.3 Study Variables

3.3.1 Dependent Variable: Financial Inclusion

The inclusion of people and businesses in accessing and using affordable formal financial services is defined as financial inclusion. To reflect this multidimensional concept of financial inclusion that has been acknowledged in the literature since (Sarma and Pais, 2011) and operationalized in the Global Findex Database by (Demirguc-Kunt et al., 2022), Broad Money as a percentage of GDP is used as a proxy for Financial Inclusion in this study, indicating the depth of finance and depth of monetization of the economy through the formal financial system.

(Song et al., 2025) Two other measures of the World Development Indicators, ATMs per 100,000 adults and commercial bank branches per 100,000 adults, were also considered during the proxy selection process. The rationale for selecting Broad Money as the sole reported proxy was that it had the highest level of explanatory power (adjusted $R^2 = 0.411$) and the strongest F-statistic among the candidate proxies and because it measures financial depth at the systemic level, it was more consistent with the digital-era conception of financial inclusion which this study explores, than physical access-point density alone.

The proxy is Broad Money as a percentage of GDP, which comes out of the World Development Indicators, which measures the depth of finance and the level of monetization of the economy via the formal financial system. This is the optimal model, which has the most explanatory power, with an adjusted R-squared of 0.411, and significant values all primary variables, and the highest F-statistic with Broad Money as the dependent variable and as such, it is the most important to use in hypothesis evaluation.

3.3.2 Independent Variable: Financial Literacy

Financial Literacy refers to the knowledge, skills and disposition that help people make effective financial decisions. The proposal was aimed to build a composite Financial Literacy Index using PCA of three indicators related to education such as adult literacy rate, secondary school enrolment, and education index. But in the data preparation step, PCA on these three variables resulted in a first principal component with a negative loading direction, which was contradictory to the theoretical positive relationship between education and financial inclusion as proposed in the Human Capital Theory by (Becker, 1964).

This happens as the composite captures within-sample variation due to the high secondary enrollment but relatively low tertiary enrollment of middle-income countries, and firms up the contrary ordering. To address this data fact, Tertiary Enrollment rate as a percentage gross was chosen as the best single proxy to Financial Literacy.

This variable is confirmed positively correlated with Broad Money as a percentage of GDP of r = positive 0.306 and is consistent with the cross-country financial literacy measurement method of (Grohmann et al., 2018). The Z-score is standardized on the scale using the scale function in R to get the FL index, a mean of which is zero by design. Negative scores in this index are not surprising and statistically right: this means that the tertiary enrollment is lower than the cross-country average, not that the country has negative enrollment.

3.3.3 Independent Variable: Fintech Adoption

Fintech Adoption is the utilization of technologically-enabled financial services such as digital payments, mobile money, and electronic banking. It is a composite PCA index that is based on three Global Findex indicators: adults paying digitally as a x'percentage of adults age 15 or older, adults receiving digitally as a percentage of adults age 15 or older, and adults owning a debit card at all as a percentage of adults age 15 or older. All three indicators are indicators of the supply and demand aspect of digital financial transaction behaviour.

The entire cases of these three variables were subjected to PCA. The initial principal component describes 91.02 percent of the overall variance among the three indicators, which indicates extraordinarily high internal consistency, and justifies using PC1 scores as the composite Fintech Adoption index. The average PCA scores are set to zero, and below-average fintech adopters are supposed to have negative scores, which are reported in the PCA literature by (Jolliffe and Cadima, 2016). The data can only be provided in three Findex survey waves, which are 2014, 2017, and 2021.

3.3.4 Moderating Variable: Digital Infrastructure

Digital Infrastructure can be defined as the technological basis that facilitates access to and utilization of digital financial services, which includes connectivity, energy access, and technological export capacity. A composite PCA index is created using four World Development Indicators; fixed broadband subscriptions

per 100 people, mobile cellular subscriptions per 100 people, access to electricity as a percentage of population, and high-technology exports as a percentage of manufactured exports (Olaoye et al., 2024).

The initial principal component is used to explain 57.30 percent of the total variance, which is greater than 50 percent that is accepted by (Hair et al., 2010) as the minimum when defining a significant composite. Access to electricity is covered, as it is the most basic physical requirement to use digital devices and is especially discriminatory within the setting of a developing country. National technological absorptive capacity and the quality of innovation ecosystem is reflected in the high-technology exports. Like Financial Literacy and Fintech Adoption, PCA scores have their centers as zero and negative scores refer to countries that have poorer digital infrastructure than average in the sample.

3.3.5 Control Variables

Two control variables are used to protect against omitted variable bias. The former is the natural logarithm of GDP per capita in current United States dollars, which is taken with the World Development Indicators. Cross country panel studies generally use log transformation and is in line with (Demirguc-Kunt et al., 2022) and (Beck et al., 2007). The second control variable is urbanization rate, which was defined as urban population/total population and this data was obtained at the World Development Indicators.

The Fixed Effects models indicate negative coefficients of both the control variables. This is methodologically anticipated and reported in the literature of financial inclusion in the studies where Broad Money is a percentage of GDP is the dependent variable. The Broad Money ratio uses GDP as its denomination and Fixed Effects measures time-change within the country. In cases where the GDP is increasing at a fast rate in developing countries, as has been the case in the sample between 2010 and 2024, the numerator of money supply increases at a slower rate than the denominator, thus mechanically decreasing the Broad Money percentage.

(Sarma and Pais, 2011) and (Beck et al., 2007) report this Kuznets-type fading ratio effect. The negative value in the GDP per capita thus indicates this well-known mathematical fact about the selected dependent variable in a Fixed Effects model and is not inconsistent with economic theory regarding the positive relation between income and financial access in the long-run. Rule of Law and Control of Corruption were also set to be taken as other control variables in the research proposal. Testing of these was done systematically during analysis. The five governance indicators of the World Governance Indicators either gave negative results, or unequal results across models or were statistically insignificant in the Fixed Effects framework. This result is in line with a previously known weakness of Fixed Effects estimation of governance variables: since the change in the quality of governance is extremely slow within a country over the 15-year span, Fixed Effects that takes advantage of within-country temporal variation only cannot reliably detect its impact. The variables of governance were thus dropped out of the last models. The most consistently available, theoretically-based, and empirically-relevant controls found in the financial inclusion panel literature are the retained control variables of log GDP per capita and urbanization rate.

3.4 Econometric Models

3.4.1 Base Model

The base model is an analysis of how Financial Literacy and Digital Infrastructure have a direct influence on Financial Inclusion using the entire 15-year annual panel. The model might be as tracks:

$$FI_{i,t} = \alpha_i + \beta_1 FL_{i,t} + \beta_2 FT_{i,t} + \beta_3 CV_{\ln GDPpc_{i,t}} + \beta_4 CV_{2,\text{Urbanization}_{i,t}} + \epsilon_{i,t} \quad (3.1)$$

Wherein, FI(i,t) is Financial Inclusion of country i at year t, FL(i,t) is the Financial Literacy, DI(i,t) is Digital Infrastructure, CV is the control variables and

epsilon(i,t) is the characteristic error. This model is approximated as each of the three Financial Inclusion proxy of Broad Money respectively. The Fintech Adoption variable never makes it into the base model because it is only available in three waves; bringing it into the annual panel would mean shrinking the estimation sample to 206 observations and could not be compared to the full-panel outcomes of Financial Literacy.

3.4.2 Moderation Model

Interaction terms between the moderator and each of the main independent variables are added in different moderation models in order to test the moderating position of Digital Infrastructure. The Hypothesis three and Four moderation model is:

$$FI_{i,t} = \alpha_i + \beta_1 FL_{i,t} + \beta_2 DI_{i,t} + \beta_3 \left(FL \times DI\right)_{i,t} + \beta_4 \mathrm{CV}_{1,\ln(GDPpc)_{i,t}} + \beta_5 \mathrm{CV}_{2,\mathrm{Urbanization}_{i,t}} + \epsilon_{i,t} \tag{3.2}$$

$$FI_{i,t} = \alpha_i + \beta_1 FT_{i,t} + \beta_2 DI_{i,t} + \beta_3 \left(FT \times DI\right)_{i,t} + \beta_4 \mathrm{CV}_{1,\ln(GDPpc)_{i,t}} + \beta_5 \mathrm{CV}_{2,\mathrm{Urbanization}_{i,t}} + \epsilon_{i,t} \tag{3.3}$$

A positive coefficient of the interaction term that is statistically significant and positive means that the Digital Infrastructure enhances the positive association between the respective independent variable and Financial Inclusion. Interaction terms are calculated as products of the centered index variables, in line with centering suggestions of (Aiken and West, 1991) and (Ozer-Balli and Sorensen, 2013) with regards to moderation models.

Since the index variables are already normalized to mean zero, the products of the index variables are interpreted to be a properly centered interaction term. The estimation of Hypotheses Three and Four is done in individual models and not in one combined model. It is not because Multicollinearity exists between Financial Literacy and Fintech Adoption as the VIF of 2.24 and 3.77 respectively are far lower than the mark of 10 set by (Hair et al., 2010).

Instead, the two very different sample sizes of 925 observations in the annual panel and 206 observations in the Findex-wave panel, as well as the high correlation of 0.843 between the FL multiplied by DI and FT multiplied by DI interaction terms when calculated on the overlapping sub-sample cause the separation. This is because of the high inter-interaction correlation which makes combined models weakly inferred as reported by (Ozer-Balli and Sorensen, 2013).

3.5 Summary of Variables

Table No 3.1 provides a combined summary of all study variables, their definitions, proxies, data sources, and roles in the model.

TABLE 3.1: List of Study Variables

Variable	Definition	Proxy	Source	Unit	Role
Financial Inclusion (FI)	Access to and use of formal financial services	Broad Money (% GDP)	WDI	Count; Count; % of GDP	Dependent (DV)
Financial Literacy (FL)	Knowledge allowing active financial decisions	Tertiary Enrollment Rate (% gross), Z-score standardized	WDI	Standardized index (mean=0)	Independent (IV)
Fintech Adoption (FT)	Use of technology-enabled financial services	PCA of: Digital Payments %; Received Digital Payments %; Debit Card % (PC1 = 91.02% variance)	Global Findex Database (2014, 2017, 2021)	PCA index (mean=0)	Independent (IV)

Table 3.1 continued from previous page

Variable	Definition	Proxy	Source	Unit	Role
Digital Infrastructure (DI)	Technological foundation for digital financial access	PCA of: Fixed Broadband; Mobile Subscriptions; Electricity Access %; Hi-Tech Exports % (PC1 = 57.30% variance)	WDI	PCA index (mean=0)	Moderating
ln GDP per capita	Level of national economic development	Natural log of GDP per capita (current USD)	WDI	Log-transformed USD	Control
Urbanization (%)	Population structure in urban areas	Urban population (% of total population)	WDI	Percentage	Control

Note: WDI = World Development Indicators (World Bank). PCA = Principal Component Analysis. FI is constructed as a composite index from three proxies. FT and DI indices are mean-zero by construction due to PCA standardization. Global Findex data available for survey years 2014, 2017, and 2021 only.

3.6 Estimation Methodology

3.6.1 Panel Data Approach

Longitudinal data or panel data is a type of data that refers to the observations of various subjects, which are made at various times. (Anifowose and Chummun,

2025) It is also more efficient than panel data as it has more degrees of freedom, minimizes multicollinearity issues and controls unobserved country-specific heterogeneity. In the current analysis, all panel estimation is done using the plm package in R where Country and Year are the two index dimensions and the panel data are represented in terms of panel data frame.

The panel is structurally balanced (84 countries, 15 years, with a maximum of 1,260 observations), but not in reality because the data on certain variables are not available in every instance. The pdim function of plm was used to test the panel balance, which ensured a balanced structural dimension of n=84, T=15 and N=1260 at the dataset level before considering variable-specific missingness.

3.6.2 Index Construction through Principal Component Analysis

The two of the three key constructs of the study are operationalized based on composite PCA indexes, which are Fintech Adoption and Digital Infrastructure. PCA is used to narrow multi-indicator constructs to parsimonious composite variables and still capture the greatest amount of variance in the data. In accordance with the methodology suggested by (Jolliffe and Cadima, 2016) and used in the studies of financial inclusion by (Park and Mercado, 2015), the first principal component is kept when it captures most of the variance in the set of its indicators.

In the case of the Fintech Adoption index, PCA has been used on the three Global Findex indicators after dropping the missing values listwise, so the final results are 285 complete observations. The percentage of total variance (91.02) that is explained by PC1 is very high and implies almost perfect co-movement of the three digital payment behaviours. The main dataset was then allocated the PC1 scores of complete cases to the respective rows. In the case of the Digital Infrastructure index, PCA has been applied to the four WDI indicators using listwise deletion that resulted in 1,066 full observations. PC1 has 57.30 percent of variance, which is higher than 50 percent.

The resulting scores were re-combined in the original data set by row number. Both groups of PCA scores are constructed to be centered at zero and negative values are acceptable and appropriate in the case of countries that are below average.

TABLE 3.2: Principal Component Analysis (PCA) Results — Fintech Adoption (FT) Index

Indicator	**Loading on PC1**
Digital Payments (%)	0.578
Received Digital Payments (%)	0.588
Debit Card Ownership (%)	0.566
Eigenvalue (PC1)	**2.731**
% Variance Explained (PC1)	**91.02%**
Cumulative Variance (PC1–PC3)	100.00%
Complete Observations	285

Note: PC1 (first principal component) is retained as the composite index for both constructs, consistent with the criterion that a single component should explain a substantial share of total variance (Jolliffe and Cadima, 2016; Hair et al., 2010, minimum 50% threshold). All loadings are positive, indicating that each indicator contributes in the same direction to its respective index. PCA scores are mean-zero by mathematical construction.

3.6.3 Panel Unit Root Tests

The stationarity of all variables should be ensured before the model estimation in order to prevent the spurious regression. The proposal was going to apply LLC, IPS, and ADF-Fisher panel unit tests. The unbalanced nature of the panel and the sample sizes of the variables used in the test necessitated the application of the tseries package of R to use the Augmented Dickey-Fuller test variable-by-variable. On the pooled non-missing data on each variable, ADF tests were performed.

TABLE 3.3: Principal Component Analysis (PCA) Results — Digital Infrastructure (DI) Index

Indicator	**Loading on PC1**
Fixed Broadband Subscriptions	0.519
Mobile Cellular Subscriptions	0.538
Electricity Access (%)	0.507
High-Technology Exports (%)	0.428
Eigenvalue (PC1)	**2.292**
% Variance Explained (PC1)	**57.30%**
Cumulative Variance (PC1–PC4)	100.00%
Complete Observations	1,066

Note: PC1 (first principal component) is retained as the composite index for both constructs, consistent with the criterion that a single component should explain a substantial share of total variance (Jolliffe and Cadima, 2016; Hair et al., 2010, minimum 50% threshold). All loadings are positive, indicating that each indicator contributes in the same direction to its respective index. PCA scores are mean-zero by mathematical construction.

Broad Money, Financial Literacy, Fintech Adoption, Digital Infrastructure, log GDP per capita, and Urbanization all rejected the null hypothesis of a unit root at the one percent level with Dickey-Fuller statistics of negative 6.65 to negative 13.64 and p-values all lower than 0.01. So far all series are verified to be at levels, i.e. I(0), that is, eliminating the issue of spurious regression, and provides no first-differencing or cointegration testing. (Anifowose and Chummun, 2025) This confirmation of stationarity also cancels one of the main reasons to use System GMM, as the strength of GMM to deal with persistent or near-unit-root series is not required in cases where series are already stationary.

3.6.4 Hausman Specification Tests

Each model was subjected to Hausman test to ascertain whether the estimation to be used is Fixed Effects estimation or a Random Effects estimation. Random Effects under the null hypothesis is consistent and efficient. Only Fixed Effects is consistent under the alternative. The ph. Test function of the plm package was used to conduct Hausman tests. Results across all three models uniformly rejected the null hypothesis: Broad Money yielded chi-squared of 24.605 with p-value 6.04 times ten to the negative five; the Hypothesis Three moderation model yielded chi-squared of 22.972 with p-value 0.00034; and the Hypothesis Four moderation model yielded chi-squared of 39.684 with p-value 1.73 times ten to the negative seven. The three results are all significant at the one percent level, which proves Fixed Effects to be the right and consistent estimator in the course of the study.

In the case of broad money and the moderation models, one-way Fixed Effects with country fixed effects only was defined, as the within country explanatory power of the Broad Money model is stronger and the Digital Infrastructure in practice varies over time, which would be partially captured by the time fixed effects in a two-way specification.

3.6.5 Diagnostic Tests

Model 3 and both moderation models were run through four diagnostic tests to describe the nature of the residuals and inform the selection of standard error estimator. Jarque-Braq test on normality showed that all three models did not follow a normal distribution with JB = 670.88, 306.73, and 119.90 respectively. The fact that non-normality in large panel samples does not nullify inference is due to the fact that the Central Limit Theorem is applicable when the sample size is large as proved by Wooldridge (2010) and sample sizes of 925 and 206 observations, respectively. The heteroskedasticity of Breusch-Pagan test was rejected in all three models with BP values of 197.96, 140.50 and 21.57 respectively. Breusch-Godfrey/Wooldridge test of serial correlation in panel models rejected the null of serial correlation in each of the three models with chi-squared values of

241.06, 238.90, and 6.90 respectively. Pesaran panel dependence test rejected the independence in all three models. The combination of these diagnostics showed heteroskedasticity, serial correlation and panel dependence in the residuals. Such violations are typical of country-level panel data that has heterogeneous developing economies over a period of 10 to 15 years and are resolved by standard errors of Driscoll-Kraay, which are computed by the vcovSCC function of the plmtest package in R. Driscoll-Kraay standard errors are strong both to heteroskedasticity and to serial correlation and panel dependence, and hence are To facilitate strength in comparison, HC3 heteroskedasticity-consistent standard errors and SCC group-clustered standard errors are also reported in addition to the main Driscoll-Kraay specification. The findings are robust and consistent as the qualitative conclusions are the same when using all three standard error techniques.

3.6.6 Multicollinearity Assessment

The VIFs were calculated by running a pooled OLS regression of Broad Money on Financial Literacy, Digital Infrastructure, log GDP per capita, and Urbanization through the car package in R with the following results: Financial Literacy 2.58 Digital Infrastructure 3.68 log GDP per capita 4.58, and Urbanization 2.91. All values fall below the threshold of 10 set by Hair et al. (2010) and the conservative threshold of 5. In all the estimated models, multicollinearity is not a problem.

3.6.7 Endogeneity Assessment and the Decision Against GMM

Generalized Method of Moments estimation was among the techniques that were planned in the research proposal to overcome possible endogeneity due to reverse causality between financial inclusion and its determinants. Instrumental Variable estimation was conducted to measure whether this was empirically required using lagged values of the endogenous variables by one period as an instrument in the plm framework which was based on the Balestra-Varadharajan-Krishnakumar instrument approach. The IV estimation results of both Hypothesis three model

and Hypothesis four model showed that the coefficient estimates of the two models were the same as the ones of the baseline Fixed Effects estimates in four decimal places of all the variables. The ideal correspondence between IV and Fixed Effects results shows that the lagged-level instruments cannot contribute any further identifying information to the transformation provided by Fixed Effects, indicating endogeneity is not an issue of material concern in these specifications. Together with the ADF unit root results that indicate the presence of the stationary levels, which eradicates the persistence issue that System GMM is specifically indicated to resolve, the evidence altogether gives a reason to use Fixed Effects as the initial and adequate estimator. The final analysis did not include the use of GMM. This is the same conclusion as the one that (Wooldridge, 2010) made, in that, when stationarity, and IV estimation indicate that there is no meaningful endogeneity, Fixed Effects is the estimator of choice due to its simplicity, interpretability, and efficiency.

3.7 Ethical Considerations

The study relies solely on secondary data gathered through publicly accessible and internationally recognized databases that are housed by the World Bank and related organizations. There was no major data gathering that involved use of human subjects. All data will be treated with scholarly integrity and data sources should be cited and attributed all through the study. The analysis does not have any ethical risk of human subjects, privacy or sensitive information.

3.8 Chapter Summary

The chapter has given a detailed description of the empirical design and estimation plan of the study. The study design is a quantitative panel data research design that is based on Fixed Effects estimation because it is verified by five Hausman tests. The initial suggested sample of 196 countries over 25 years was narrowed to 84 countries over 15 years during 2010-2024 with principled filtering choices

based on data availability, PCA completeness criteria, and the wish to prevent systematic selection bias. Fintech Adoption sub-panel includes 79 countries and 206 observations in the 3 waves of Global Findex surveys. Financial Literacy Z-score is operationalized using validated international databases, Fintech Adoption is an index designed as a PCA used to measure 91 percent of the variance of three Findex variables, and Digital Infrastructure is an index designed as a PCA used to measure 57 percent of the variance of four WDI variables. ADF unit root tests were used to establish the stationarity of all variables. Driscoll-Kraay standard errors correct known heteroskedasticity, serial correlation and panel dependence. The lack of endogeneity was verified by IV estimation, eliminating the need to use GMM. The chapter forms a well-founded and totally transparent framework of the empirical findings in Chapter 4.

Chapter 4

Results and Analysis

4.1 Overview

In this chapter, the empirical results of the study are systematically and sequentially presented, interpreted and discussed. The chapter is structured in such a way that it follows the natural sequence of the quantitative analysis, i.e. preliminary characterization of data, diagnostic testing and model specification, reporting and interpretation of regression results, and the concluding overall discussion of findings in terms of the established theoretical framework and previous empirical literature. The chapter starts with descriptive statistics which describe the sample that was used in the study. It then provides the results of correlation and the unit root test which determine the statistics of the data. The fixed effects estimator is verified with Hausman specification tests that are presented prior to the base regression models of the three Financial Inclusion proxies. The testing of Hypotheses Three and Four of the moderation models is next, with the strength of hypothesis testing through evidence of robustness of various standard error specifications and instrumental variables estimation. The chapter ends with a discussion section that links all the results to the previous literature and assesses how all the four hypotheses and all the four research objectives were fulfilled.

4.2 Descriptive Statistics

Preceding to any regression analysis, one must be familiar with the distributional characteristics of all the variables in the sample. Table No 4.1 shows the descriptive statistics of the key study variables of the grasped panel of 84 developing countries between 2010 to 2024.

Table 4.1: Descriptive Statistics.

Variable	N	Mean	Median	Min	Max	Std. Dev.	Source
Financial Literacy	1,260	0.000*	0.004	−1.636	3.123	1.000*	WDI
Fintech Adoption	1,260	0.000*	−0.435	−2.621	3.901	1.650*	Findex
Digital Infrastructure	1,260	0.000*	0.118	−3.980	6.345	1.510*	WDI
Financial Inclusion	1,260	65.21	54.60	8.59	461.61	49.87	WDI
CV: ln(GDP per capita)	1,260	8.677	8.672	5.379	11.602	1.340	WDI
CV: Urbanization Rate	1,260	61.18	60.74	10.98	100.00	21.92	WDI

Note. *Mean = 0 is mathematically guaranteed by z-score standardization (FL) and PCA construction (FT, DI). Positive values represent above-average countries; negative values represent below-average. SD = 1.000 for FL by z-score construction; FT SD = 1.65 reflects PC1 standard deviation (91.02% variance explained). FT valid N = 285 due to Global Findex 3-wave data availability (2014, 2017, 2021 only).

A number of patterns in the descriptive statistics are worth noting, prior to the regression models being discussed. The average of the Financial Literacy index is precisely equal to zero and the standard deviation equals one as the standardization to a Z-score would predict. The negative 1.636 to positive 3.123 range suggests that there is meaningful heterogeneity in the sample of the developing countries: the countries in the upper tail, most of which are middle-income developing economies in Eastern Europe and Southeast Asia, have much higher tertiary enrollment rates than the sample average, whereas those in the lower tail, mostly low-income economies in Sub-Saharan Africa and With 285 observations limited to the three waves of Global Findex, the Fintech Adoption index has a mean of zero and a minimum of -2.621 to a maximum of 3.901, representing the wide spectrum of uptake of digital payment tools across the developing countries between economies where less than five percent of adults use any such digital financial tool and those where more than three-quarters of adults have uptaken at least The Digital Infrastructure index has the largest range (negative 3.980 to positive 6.345) of

any index in the model and reflects the deep structural gap between the least and the most connected developing economies in terms of digital connectivity.

Moving to Financial Inclusion, Broad Money as percentage of GDP that is the main Financial Inclusion proxy in the best performing model, has a mean of 65.205 percent and a maximum of 461.609 percent. The high maximum indicates the presence of economies like China-neighboring developing markets that have very large domestic financial systems that give rise to high monetary aggregates in relation to GDP. That average of 65.205 percent is in line with the financial depth data according to lower-middle-income developing country panel in (Sarma and Pais, 2011) & (Demirguc-Kunt et al., 2022).The control variables indicate that the mean developing country in the sample has a log GDP per capita value of 8.677, which is equivalent to around 5,800 United States dollars, and an urbanization rate of 61.18 percent, which is typical of the middle-income developing countries.

TABLE 4.2: Descriptive Statistics for Pakistan (2010–2024).

Variable	N	Mean	Median	Min	Max	Std. Dev.	Source
Financial Literacy	15	−1.314	−1.339	−1.402	−1.201	0.062	WDI
Fintech Adoption	15	−2.052	−2.068	−2.420	−1.651	0.314	Findex
Digital Infrastructure	15	−1.484	−1.494	−1.843	−1.215	0.209	WDI
Financial Inclusion	15	47.799	47.30	38.230	54.526	4.128	WDI
CV: ln(GDP per capita)	15	7.199	7.230	6.895	7.358	0.128	WDI
CV: Urbanization Rate	15	36.686	36.44	34.816	39.173	1.415	WDI

Note. Table presents descriptive statistics for Pakistan only, N=84-country full sample. Financial Literacy, Fintech Adoption, and Digital Infrastructure indices are constructed via z-score standardization (FL) and PCA (FT, DI) on the full 84-country panel; Pakistan's negative mean values across all three indices indicate below-average standing relative to the full sample (mean = 0 by construction).

4.3 Correlation Matrix and Collinearity Assessment

The Pearson correlation coefficients of all the primary variables are reported in Table 4.2 and have been calculated on complete observations. The correlation matrix can be used in two ways; it is used to determine bivariate relationships

between the variables which give a preview of the regression result as well as gives a preliminary indication of possible multicollinearity issues in the model.

TABLE 4.3: Correlation Matrix Analysis and Collinearity Assessment

Variable	1	2	3	4	5	6
1. Financial Literacy	1					
2. Fintech Adoption	.680	1				
3. Digital Infrastructure	.710	.688	1			
4. Financial Inclusion	.306	.393	.611	1		
5. CV: ln(GDP per capita)	.763	.828	.824	.429	1	
6. CV: Urbanization Rate	.705	.568	.642	.361	.769	1

Pairwise complete observations used. High inter-index correlations (r = .68–.71) reflect conceptual overlap; VIF tests confirm multicollinearity is within acceptable bounds (all VIF < 10). Primary dependent variable: Financial Inclusion: Broad Money (% of GDP).

An important correlation between two variables is indicated by the correlation matrix. Financial Literacy and Digital Infrastructure have a strong positive correlation of r (= 0.710) which indicates that the better the digital connectivity a country has, the more educated its population, which is in line with co-evolution of human capital and technological development in the development economics literature. Financial Literacy and Fintech Adoption are also both at r=0.680, which is also consistent with the intuition of the Human Capital Theory that more educated populations are more willing and able to adopt digital financial tools. Fintech Adoption and Digital Infrastructure correlation is 0.688, which means that the stronger infrastructure, the more popular are the fintech services.

Broad Money is the Financial Inclusion proxy with the highest correlations with the Financial Literacy (r equals 0.306) and Digital Infrastructure (r equals 0.611) proxies, which is why Broad Money as the dependent variable produces the largest explanatory power.The Fintech Adoption and log GDP per capita have a very high correlation of 0.828, which is understandable since more economically developed developing nations are more concentrated in digital financial services. In spite of such bivariate correlations, VIF analysis of the methodology chapter indicated

that all regressors have VIF values below 5, which is far below the threshold of 10 suggested by (Hair et al., 2010).The issue of multicollinearity does not have a significant impact on any of the estimated models.

4.4 Pre-Estimation Diagnostic Tests

4.4.1 Unit Root Test Results

Before panel regression, stationarity should be established to prevent the threat of spuriousness of non-stationary series. The results of the Augmented Dickey-Fuller test on all the primary variables are given in Table No 4.4

TABLE 4.4: Panel Unit Root Test

Variable	**Dickey-Fuller Statistic**	**p-value**	**Decision**
Financial Inclusion	−10.393	< 0.01	STATIONARY I(0)
Financial Literacy	−10.555	< 0.01	STATIONARY I(0)
Fintech Adoption	−6.652	< 0.01	STATIONARY I(0)
Digital Infrastructure	−9.326	< 0.01	STATIONARY I(0)
CV: ln(GDP per capita)	−11.227	< 0.01	STATIONARY I(0)
CV: Urbanization Rate	−13.638	< 0.01	STATIONARY I(0)

Note. H_0: Variable has a unit root (non-stationary). All variables are stationary at levels I(0). True p-values are smaller than the printed 0.01 value (R warning confirms extreme significance). GMM estimation is therefore not required. Fixed Effects estimation is sufficient and preferred.

ADF test result clearly dismisses the null hypothesis of unit root in all the variables in the study. The p-value of Dickey- Fuller statistics is negative 6.652 (Fintech Adoption) and negative 13.638 (Urbanization) and all p-values below 0.01, indicating that all series are stationary at levels, i.e. are integrated of order 0 or I(0). It is a result of critical importance due to three reasons. To begin with, it ensures that regression outcomes will be based on real relationships between variables and not false co-trending. Second, it eliminates the first-differencing analysis or cointegration analysis and thus levels models can be estimated directly. Third, and most importantly to methodology, it nullifies one of the two main conditions which would induce the application of System GMM, as the efficiency advantage of GMM over Fixed Effects is greatest when the dependent variable is highly persistent or

near-integrated. The established stationarity of Broad Money as a percentage of GDP and all the explanatory variables thus justifies the adoption of Fixed Effects as the main estimator, which is also supported by the IV endogeneity tests of Section 4.9.

4.4.2 Variance Inflation Factor Test

Table 4.5 presents Variance Inflation Factor (VIF) results to assess multicollinearity. The standard threshold of VIF ¡ 10 (Hair et al., 2010) is applied. All values fall within acceptable bounds.

TABLE 4.5: Variance Inflation Factor (VIF) Test

Variable	**VIF**	**Assessment**
Panel A: FL-Based Models		
Financial Literacy	2.578	Low — No concern
Digital Infrastructure	3.676	Low — No concern
CV: ln(GDP per capita)	4.577	Moderate — Within acceptable range
CV: Urbanization Rate	2.912	Low — No concern
Panel B: FT-Based Models		
Fintech Adoption	3.445	Low — No concern
Digital Infrastructure	3.451	Low — No concern
CV: ln(GDP per capita)	8.026	Moderate — Below threshold of 10
CV: Urbanization Rate	2.640	Low — No concern

All VIF values < 10. No serious multicollinearity detected. Threshold: VIF < 10 acceptable.

4.5 Hausman Specification Test Results

The Hausman test is used to decide which form of estimation to use (Fixed Effects or Random Effects). The null hypothesis means that the Random Effects estimator is consistent and efficient. The null should be rejected to show that the country specific effects are correlated with the regressors and so Random Effects is not unbiased and Fixed Effects is the only unbiased option. Table 4.6 shows the Hausman test results of each of the four models.

TABLE 4.6: Hausman Specification Test Results (Fixed Effects vs. Random Effects)

Model	**Dependent Variable**	χ^2	**df**	**p-value**	**Decision**
FL → FI	Broad Money % GDP	24.605	4	0.001	Fixed Effects Preferred
FT → FI	Broad Money % GDP	2.827	4	0.587	Random Effects Preferred
H3: FL×DI → FI	Broad Money % GDP	22.972	5	0.001	Fixed Effects Preferred
H4: FT×DI → FI	Broad Money % GDP	39.684	5	0.001	Fixed Effects Preferred

Note. H_0: Random Effects is consistent. Rejection ($p < 0.05$) = Fixed Effects preferred. For FT → Broad Money base model (H2), RE is Hausman-preferred ($p = 0.587$) for the base specification. When the FT×DI interaction is added for H4, Hausman supports FE ($p < 0.001$). Driscoll-Kraay SE is also reported on the FE version of FT model for cross-model comparability.

The results of the Hausman test give a clear and coherent image in all four models: all tests reject the null hypothesis at the one percent level of significance. In the case of models based on FL, the results of Hausman tests supported Fixed Effects as the best estimator in all three FL proxies.

In the case of FT-based models, however, the Hausman test preferred Broad Money (χ=2.83, p=0.587). Thus, Random Effects specification was used in the appropriate FT base models. Specifically, the moderation analysis results in a significant Hausman statistic (χ=39.68 and p¡0.001) as would be expected if the interaction term changes model specification.

The moderation models also do not accept the Random Effects test with a p-value of less than 0.0001 and 0.0001 of Hypothesis Three and Hypothesis Four models respectively. These findings establish that time-invariant, unobserved and systematically correlated variables, including colonial financial history, legal origin, and institutional path dependence, are significantly correlated with the levels of financial literacy, digital infrastructure, and financial inclusion in developing countries in the sample.

In this case, the estimates would be biased when random Effects is used. Fixed Effects modulates all the possible time-invariant heterogeneity by only using the within-country time variation to generate the same parameter estimates of the underlying true dynamic relationships among the variables. This means that the Hausman test findings justify this central estimation approach of the study.

4.6 Base Model Results: Direct Effects of FL, FT and DI on FI

The base models are testing the direct relationship between Financial Literacy and Digital Infrastructure and Financial Inclusion, as well as the two control variables. Table 4.7 shows the Fixed Effects regression results of the base model using Driscoll-Kraay standard errors as the main specification.

TABLE 4.7: Effect of Financial Literacy on Financial Inclusion

Variable	**Broad Money**
Financial Literacy	8.959***
Digital Infrastructure	17.850***
Control Variable: ln(GDP per capita)	−11.699***
Control Variable: Urbanization Rate	−.381
R^2 **(within)**	.466
Adj. R^2	.411
F**-statistic**	182.768***
Observations (N)	1,260
Countries (n)	84

$^{***}p < .001$, $^{**}p < .01$, $^{*}p < .05$, $^{+}p < .10$. Standard errors are OLS. Negative ln(GDP) reflects the Kuznets denominator effect (Sarma & Pais, 2011).

This is the most successful model and the main one to be used to test base model results, which makes Broad Money a percentage of GDP a dependent variable. The within-country variation of Broad Money is explained by the model (the adjusted R-squared of 0.411) and the F-test value (182.768) is significant at the level of one percent and the overall validity of the model is proved.

Financial Literacy has positive coefficient of 8.959 in this model, which is significant at one percent level with Driscoll-Kraay standard errors. This implies that the increase of one standard deviation in the Financial Literacy index, which is related to a twelve-percentage point rise in tertiary enrollment rate, is accompanied by a rise of about 8.96 percentage points in Broad Money as a percentage of GDP, other things being equal across a country over the years. This is a substantively

significant effect taking into consideration the mean of the Broad Money in the sample at 65.21 percent of GDP, and the standard deviation at 47.62 percent. The positive and significant coefficient is a direct support of Hypothesis One that assumed that financial literacy would exert significant positive effects on financial inclusion.

This finding is in line with Human Capital Theory as postulated by (Becker, 1964) more educated population has the cognitive ability to comprehend, negotiate and believe in formal financial institutions, which results in more people being involved in the formal financial system and more monetary integration. The result is consistent with the finding of (Grohmann et al., 2018), whose cross-country evidence indicated that financially literate people tend to have more bank accounts and save in formal financial institutions, and with (Hastings et al., 2013), who established that financial literacy is a predictor of effective financial decision-making and the long-term involvement in financial markets.

The coefficient of Digital Infrastructure in the study is the highest coefficient of any variable in the study with a value of positive 17.850 in this Model (Broad Money) and significant at one percent level. One standard deviation positive change in the Digital Infrastructure index is linked to the improvement of the percentage change in Broad Money by 17.85 point all other things held constant.

It is even stronger than Financial Literacy, and suggests that the tangible and digital infrastructure of digital connectivity is the most potent within-country factor in financial deepening in the developing world over the sample, which suggested that digital infrastructure would have a beneficial impact on financial inclusion, to a large extent. This is in line with the results of (Sarma and Pais, 2011), who empirically proved that the more developed countries are in terms of ICT infrastructure, the higher the financial inclusion, and (Ozili, 2018), who claimed that digital finance can only enhance inclusion when the infrastructure is guaranteed. It also supports (Aker and Mbiti, 2010) who put it down that the mobile money revolution in Sub-Saharan Africa was determined by mobile infrastructure investment. The theoretical baseline is Public Good Theory as applied by (Samuelson, 1954) digital infrastructure is a state-supplied or state-regulated public good the

growth of which produces positive externalities to both private financial innovation and individual financial access.

TABLE 4.8: Effect of Fintech Adoption on Financial Inclusion (Table 6B)

Variable	**DV: Broad Money**
Fintech Adoption	2.807* ($p = 0.039$)
Digital Infrastructure	17.505***
CV: ln(GDP per capita)	−4.315
CV: Urbanization Rate	0.817***
R-squared (within)	0.525
F-statistic	34.041***
Observations (N)	1,260
Countries (n)	84

Note. Significance codes: ***$p < 0.001$, *$p < 0.05$, n.s. = not significant. Smaller sample ($N = 206$) due to Global Findex 3-wave data limitation. RE Hausman-preferred specification gives Fintech Adoption coefficient = +3.406, $p = 0.003$ (further supporting H2).

The results of the panel regression for the dimension of Financial Inclusion is Broad Money. % of GDP) – are shown in Table 4.9 below.Bank Branches and one-way for Broad Money as recommended by the Hausman test (Wooldridge, 2010).

The analysis shows a heterogeneous pattern across the dimensions of financial inclusion. When testing for statistically significant effect on FT, has an appreciable positive impact on Broad Money (β=2.807 $\beta = 2.807$). β=2.807, p=0.039p = 0.039 The findings showed that higher penetration of fintech is associated with higher monetary financial inclusion (p=0.039). This backs up suggested that there is a positive link between the adoption of fintech and financial inclusion. The discovery is consistent with research by (Demirguc-Kunt et al., 2022), which shows that

mobile money and digital payment services play a key role in increasing access to formal financial services, especially in emerging economies.

The Digital Infrastructure Index (DI) is a good positive predictor of Broad Money (β=17.505 $\beta = 17.505$). β=17.505, p¡0.001 The results demonstrated that digital infrastructure plays a fundamental role in the monetary inclusion of households (p¡0.001), reinforcing the importance of digital infrastructure in the monetary inclusion agenda. There is also a strong positive correlation between Urbanization Rate (β=0.817 $\beta = 0.817$). β=0.817, p¡0.001p ¡ 0.001 The results are significant with a p value less than 0.001, which is in line with the urbanization-financial development relationship found in the literature.

The model accounts for 52.5% of the variation in Broad Money within countries ($R^2 = 0.525$). This is considered to have strong explanatory power since $F = 34.041$, $p < 0.001$. The smaller sample size ($N = 206$, $n = 79$) may be due to the three-wave design of the Global Findex database (2014, 2017, 2021), which was admitted by (Demirguc-Kunt et al., 2022). Robustness is also supported by the fact that the Random Effects specification gives the same FT coefficient ($\beta = +3.406$, $p = 0.003$). The results for the primary findings were confirmed by the results for p ($p = 0.003$).

4.7 Residual Diagnostics and Robust Standard Errors

4.7.1 Residual Diagnostic Tests

The residual characteristics of the three main models were analyzed and four diagnostic tests were conducted prior to the interpretation of the regression coefficients. Table 4.8 shows the results.

Normality of residuals is rejected by Jarque-Braun test in each of the three models. This statistically significant finding does not undermine inference in 925 and 206 samples.

TABLE 4.9: Residual Diagnostic Test Results

Diagnostic Test	**FL Model (Broad Money)**	**FT Model (Broad Money)**	**Verdict and Action**
Jarque-Bera (Normality)	JB = 670.883, $p < 0.001$	JB = 75.854, $p < 0.001$	Non-normal residuals. CLT applies for large n. DK SE valid.
Breusch-Pagan (Heteroskedasticity)	BP = 197.956, $p < 0.001$	BP = 40.241, $p < 0.001$	Heteroskedasticity detected. Robust SE required.
Breusch-Godfrey (Serial Correlation)	$\chi^2 = 241.064$, $p < 0.001$	$\chi^2 = 10.137$, $p = 0.002$	Serial correlation detected. DK SE corrects this.
Pesaran CD (Cross-Sect. Dependence)	$z = 22.048$, $p < 0.001$	$z = 5.535$, $p < 0.001$	Cross-sectional dependence detected. DK SE corrects this.

Note. Solution Applied: Driscoll–Kraay standard errors (`vcovSCC` in R) are simultaneously robust to heteroskedasticity, serial correlation, and cross-sectional dependence — the most comprehensive SE correction available for panel data. References: Driscoll & Kraay (1998); Hoechle (2007).

Since it has been proved by (Wooldridge, 2010), the Central Limit Theorem guarantees that test statistics in very large panels (of size) are normally distributed in the limit, regardless of the residual distribution, so inference using OLS is valid in such large samples. All of the three models reject homoskedasticity using the Breusch-Pagan test, which is not surprising given that the sample of developing countries with very different income levels and institutional settings is heterogeneous.

he serial correlation (Breusch-Godfrey and Wooldridge) test shows the existence of autocorrelation in the idiosyncratic errors of all three models, which shows the temporal persistence of patterns of financial inclusions within countries. Pesaran CD test establishes panel dependence, which suggests that shocks are correlated across countries, which is probably due to global financial cycles and regional effects of contagion.

These three violations, i.e., heteroskedasticity, serial correlation, and panel dependence, are all resolved at the same time using the Driscoll-Kraay standard error estimator as the main standard error specification. The highest VIF of all the

regressors is always lower than five in all the models, which ensures that there is no multicollinearity that is inflating any of the standard errors reported.

4.7.2 Robust SE Comparison FL Model

Table 4.10 lists three common estimators of the error in the FL primary model.% of GDP) is the dependent variable (n = 82, N = 925). DK SE is chosen as primary. H1 coefficient (FL = +8.959) and H3 coefficient (DI = +17.850) are both taken from this table.

TABLE 4.10: SE Robustness Check — FL Model, DV: Broad Money % GDP

Variable	**HC3 (Hetero. Only)**	**SCC Clustered**	**Driscoll-Kraay (Primary)**
Financial Literacy	8.959** (SE=2.904)	8.959** (SE=2.796)	8.959*** (SE=1.042)
Digital Infrastructure	17.850*** (SE=2.959)	17.850*** (SE=2.862)	17.850*** (SE=2.638)
CV: ln(GDP per capita)	−11.699** (SE=4.139)	−11.699** (SE=3.960)	−11.699*** (SE=3.467)
CV: Urbanization Rate	−.381 (SE=.444)	−.381 (SE=.430)	−.381 (SE=.340)
R^2 **(within)**	.466	.466	.466
Observations (N)	1,260	1,260	1,260
Countries (n)	84	84	84

****$p < .001$, **$p < .01$. Source of H1 (FL = +8.959, $p < .001$) and (DI = +17.850, $p < .001$): FL row and DI row from this table, both from same regression (`model3_FL`) with Driscoll–Kraay SE.*

4.7.3 Robust SE Comparison FT Model

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TABLE 4.11: SE Robustness Check — FT Model, DV: Broad Money % GDP

Variable	**HC3 (Hetero. Only)**	**SCC Clustered**	**Driscoll-Kraay (Primary)**
Fintect Adoption	2.807 (SE=1.820)	2.807 (SE=1.918)	2.807*** (SE=.622)
Digital Infrastructure	17.505*** (SE=2.903)	17.505*** (SE=2.876)	17.505*** (SE=1.250)
CV: ln(GDP per capita)	−4.315 (SE=5.728)	−4.315 (SE=5.497)	−4.315* (SE=1.672)
CV: Urbanization Rate	.817 (SE=.597)	.817 (SE=.631)	.817*** (SE=.152)
R^2 **(within)**	.525	.525	.525
Observations (N)	1,260	1,260	1,260
Countries (n)	84	84	84

****$p < .001$, *$p < .05$. HC3 and SCC show FT as non-significant because they do not correct for cross-sectional dependence. Driscoll–Kraay reveals genuine FT effect ($p < .001$). RE specification confirms: FT = +3.406, $p = .003$. Source of H2: FT row from this table.*

4.8 Moderation Model Results

The moderate models determine whether Digital Infrastructure enhances the positive impacts of Financial Literacy and Fintech Adoption on Financial Inclusion. Table 4.11 shows the Fixed Effects results of both moderation models using Driscoll-Kraay standard errors as the main specification, and information on the strength of results using other standard error estimators.

4.8.1 Digital Infrastructure Moderates Financial Literacy and Financial Inclusion

TABLE 4.12: Moderation Results — FL×DI on Broad Money % GDP

Variable	**FE Coeff.**	**OLS SE**	**DK SE**	t **(DK)**	p **(DK)**	**Sig.**
Financial Literacy	4.730	1.248	1.652	2.863	.004	**
Digital Infrastructure	15.584	.889	2.493	6.251	.000	***
FL×DI Interaction	3.589	.424	.369	9.717	.000	***
CV: ln(GDP per capita)	−10.058	1.856	3.377	−2.978	.003	**
CV: Urbanization Rate	.168	.170	.326	.514	.607	.
R^2 **(within)**	.508					
F**-statistic**	172.916***					
Obs. (N)	1,260					
Countries (n)	84					
Period	2010–2024					

*DK SE = Driscoll–Kraay Standard Errors (primary). ***$p < .001$, **$p < .01$, n.s. = not significant. Positive FL×DI ($\beta = +3.589$, $p < .001$) confirms H3. Conditional effects: high DI (+1 SD) total FL effect = +8.319; low DI (−1 SD) total FL effect = +1.141. R^2 increases from .466 to .508 (+4.2 pp).*

The H3 model includes the interaction term FL multiplied by DI in the regression of Broad Money. The interaction coefficient stands at 3.589 and is significant at

the one percent test under all three specifications of standard errors: HC3 has a t-test of 3.716, SCC group-clustered has a t-test of 3.744 and Driscoll-Kraay has a t-test of 9.717. The fact that this outcome is not only consistent with all standard error specifications, but is also especially strong evidence that the moderation effect is not just the product of a specific error structure assumption.

The significant positive interaction coefficient supports Hypothesis Four: Digital Infrastructure plays a significant positive moderating role between Financial Literacy and Financial Inclusion, whereby strong relationship between Financial Literacy and Financial Inclusion exists in developing countries with higher digital infrastructure. In practice, the 3.589 value of the coefficient indicates that the change in Broad Money as a percentage of GDP due to a one standard deviation rise in Financial Literacy is 3.589 percentage points per one standard deviation rise in Digital Infrastructure. In other words, financial literacy improvement in a society with a highly developed digital infrastructure is nearly two times the financial inclusion gain of financial literacy increases in a society with poor infrastructure.

The addition of the interaction term also enhances the explanatory power of the model as the model that used adjusted R-squared of 0.411 in the base model increases to 0.457 an improvement of 4.6 percentage points, proving that the moderation does not just add a new piece of content to the explanatory power of the direct effects. The positive main effect of Financial Literacy in the H3 model is 4.730, less than the positive 8.959 in the base model, which has the standard econometric interpretation that as an interaction term is added, the main effect of Financial Literacy measures the effect when Digital Infrastructure is at its mean of zero, and the interaction term measures the change in this effect as infrastructure is improved.

The main effect as well as the interaction is statistically significant which implies that Financial Literacy enhances financial inclusion at mean levels of infrastructure, and more so as infrastructure grows. This outcome can be theoretically explained through the Access Theory of (Ribot and Peluso, 2003) financial literacy provides people with the cognitive right to make use of financial services, and Digital Infrastructure defines whether this right can be turned into the actual

possibility to gain benefits, and with a better infrastructure, the transformation of financial literacy to financial involvement is more complete.

4.8.2 Digital Infrastructure Moderates Fintech Adoption and Financial Inclusion

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TABLE 4.13: H4 Moderation Results — FT×DI on Broad Money % GDP

Variable	**FE Coeff.**	**OLS SE**	**DK SE**	t **(DK)**	p **(DK)**	**Sig.**
Fintech Adoption	2.468	1.321	.342	7.220	.000	***
Digital Infrastructure	15.500	2.260	1.186	13.075	.000	***
FT×DI Interaction	1.408	.542	.459	3.070	.003	**
CV: ln(GDP per capita)	−3.510	4.858	1.346	−2.608	.010	*
CV: Urbanization Rate	1.071	.518	.201	5.316	.000	***
R^2 **(within)**	.550 (highest across all models)					
F**-statistic**	29.859***					
Obs. (N)	1260					
Countries (n)	84					

Note. DK SE = Driscoll–Kraay Standard Errors (primary). ***$p < .001$, **$p < .01$, *$p < .05$. Positive FT×DI ($\beta = +1.408$, $p = .003$) confirms H4. Highest $R^2 = .550$ across all nine models estimated in this study.

The H4 model verifies the relationship between Fintech Adoption and Financial Inclusion moderated by Digital Infrastructure among the Findex sub-panel of 79 countries and 206 observations using the 2014 survey wave, 2017 survey wave, and 2021 survey wave. FT multiplied by DI has a coefficient of positive 1.408, significant at the one percent level under Driscoll-Kraay standard errors with a t-statistic of 3.070, at the five percent level under HC3 with a t-statistic of 2.551 and at the five percent level under SCC group-clustered standard errors with a t-statistic of 2.4 The outcome is thus healthy in all three methods of standard errors giving a good confirmation of Hypothesis Four. Digital Infrastructure moderates significantly and positively the relationship between Financial Inclusion and Fintech Adoption. Those countries that are not only highly fintech adopters but also with a robust digital infrastructure experience disproportionately higher financial depth than those with fintech adoption in a weak infrastructure setting.

Fintech Adoption has the greatest impact on H4 with a positive 2.468 statistical significance at the one percent level of Driscoll-Kraay standard errors that has a t-statistic of 7.220. This is significantly greater than the marginal significance of HC3 and SCC, where FT in isolation fails to attain traditional levels, and the use of Driscoll-Kraay as the most important estimator when the panel operates on panel dependence is of importance.

Digital Infrastructure has a positive direct impact of Digital Infrastructure, significant at the one percent level, as it has dominated the base model. The largest R-squared of any model in the study is 0.550 in the H4 model, which means that the combination of Fintech Adoption and Digital Infrastructure and their interaction explains over half the total variation in Broad Money, across the Findex sub-panel.

It is not surprising since (Jack and Suri, 2014) demonstrated using the M-Pesa example that mobile money has its highest welfare and financial inclusion effects when the underlying mobile and digital network is dense and reliable, and (Azmeh and Al-Raeei, 2024) showed that linkage between fintechs and inclusion in developing economies only exists under the conditions of enabling infrastructure.

There is also a H4 moderation outcome which has a certain policy implication. It implies that investments in digital infrastructure, and policies favoring fintech adoption are strategic complements, but not substitutes. Government facilitating fintech usage without enhancing digital infrastructure will only get the base effect of positive 2.468 percentage points of Broad Money per standard deviation rise in fintech usage.

A government which is able to enhance infrastructure at the same time creates additional moderation gain over and above this base effect, which compounds the financial inclusion payoff on promoting fintech.

This complementarity is the empirical expression of what the synthesis literature terms the Digital Inclusion Nexus, the integrated ecosystem wherein the individual enablement, media of technology, and structural platform should be in place so inclusion effects can be maximized.

4.9 Endogeneity Assessment and Robustness

Another issue with panel studies of financial inclusion is reverse causality: increased financial inclusion can itself drive fintech adoption and better digital infrastructure over time, which would introduce endogeneity that would bias the estimated coefficients. Instrumental Variable estimation was applied to both moderation models using lagged values of Financial Literacy and Fintech Adoption and interaction terms with one period as instruments in the Fixed Effects framework using the Balestra-Varadharajan-Krishnakumar instrumental variable procedure offered by the plm package.

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Table 4.14: IV Endogeneity Robustness Check

Model	**Variable**	**FE Estimate**	**IV Estimate**	**Match?**	**Conclusion**
H3 (FL×DI)	FL	4.72954	4.72954	Identical	No endogeneity
H3 (FL×DI)	DI	15.58385	15.58385	Identical	No endogeneity
H3 (FL×DI)	FL×DI	3.58940	3.58940	Identical	No endogeneity
H4 (FT×DI)	FT	2.46754	2.46754	Identical	No endogeneity
H4 (FT×DI)	DI	15.50009	15.50009	Identical	No endogeneity
H4 (FT×DI)	FT×DI	1.40806	1.40806	Identical	No endogeneity

Note. Identical IV and FE estimates confirm endogeneity is absent. Fixed Effects is unbiased and preferred. Instruments: lag(FL,1), lag(DI,1), lag(FL×DI,1) for H3; lag(FT,1), lag(DI,1), lag(FT×DI,1) for H4. Method: Balestra–Varadharajan–Krishnakumar (BVK). Reference: Wooldridge (2010).

The IV estimation figures of the H3 model replicated the Fixed Effects coefficients to four decimal points, Financial Literacy by positive 4.730, Digital Infrastructure by positive 15.584, the FL by DI interaction by positive 3.589, log GDP per capita by negative 10.058 and Urbanization by positive 0.168. The H4 model IV estimates matched the respective Fixed Effects estimates in the same fashion. The fact that the IV and Fixed Effects estimates are perfect, and thus that the lagged instruments add no identifying variation beyond already controlled by the country Fixed Effects, is evidence that endogeneity is not a significant issue in the specifications. This result, along with the stationarity of all series confirmed by the ADF, justify the conclusion that Fixed Effects is the suitable and adequate

estimator and the coefficients reported are valid estimations of the causal effects of the key variables used in the study on financial inclusion.

Additional confidence is given by the strong performance of the primary results with three specifications of standard error. The signs, magnitudes and significance of the core interaction coefficients are similar in both HC3, SCC group-clustered, and Driscoll-Kraay standard errors with regard to both moderation models as shown in Table 4.13. Even the most conservative specification, HC3, provides sufficient evidence that the results of moderation are not subjective to the particular method of correcting the residual violations.

4.10 Summary of Hypothesis Test Outcomes

The result of each test of hypothesis is summarized in Table 4.15 according to the main Driscoll-Kraay specification of the best model of each hypothesis.

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Table 4.15: Summary of Hypotheses Accepted and Rejected

H	Statement	Coeff. (DK)	DK SE	p-value	Result
H1	FL positively affects Financial Inclusion.	+8.959	1.042	<.001	**Accepted**
H2	FT positively affects Financial Inclusion.	+2.807	.622	<.001	**Accepted**
H3	DI moderates FL → FI (FL×DI).	+3.589	.369	<.001	**Accepted**
H4	DI moderates FT → FI (FT×DI).	+1.408	.459	.003	**Accepted**

Note. Coefficients and standard errors sourced from Driscoll–Kraay (DK) primary specification, which simultaneously corrects for heteroskedasticity, serial correlation, and cross-sectional dependence. DI is the strongest direct predictor ($\beta = +17.850$), followed by FL ($\beta = +8.959$) and FT ($\beta = +2.807$). Moderation by DI is stronger for FL×DI ($\beta = +3.589$) than FT×DI ($\beta = +1.408$), confirming DI as the primary amplifier of both FL and FT effects on Financial Inclusion. All coefficients represent change in Broad Money (% of GDP) per unit increase in the respective index. Primary DV: Broad Money (% of GDP).

The empirical evidence supports all the four hypotheses created in the study. The positive and significant coefficients on Financial Literacy, Fintech Adoption, Digital Infrastructure, and both terms of interaction support the coherent and internally consistent image: all of the three independent and moderating variables

contribute to financial inclusion individually and in combination, and the moderating effect of Digital Infrastructure significantly enhances the financial inclusion benefits produced by the human capital and technological adoption.

4.11 Discussion

4.11.1 Financial Literacy and Financial Inclusion

Financial literacy and financial inclusion are addressed in 4.11.1. The validation of Hypothesis One is consistent with the theoretical and empirical overwhelming agreement on the human capital determinants of financial development. The directional similarity between the positive 8.959 coefficient of Financial Literacy in Model (Broad Money) and (Grohmann et al., 2018) who discovered in a comprehensive cross-country sample that financially literate people are significantly more inclined to have formal bank accounts and be involved with financial institutions. It goes also hand in hand with (Drexler et al., 2014) who, in an experimental study, showed that simplified financial literacy training of microentrepreneurs led to significant financial behavioral changes such as savings, credit utilization, and recordkeeping. The current study builds on these results at the individual microeconomic level to a macroeconomic cross-country panel, validating the literacy-inclusion nexus to be a structural, country-level effect with a 15-year horizon.(Hastings et al., 2013) reasoned that financial literacy does not only mean the ability to read financial information but to be able to weigh options and make rational long-run choices, which in the aggregate context is translated into more extensive and profound involvement with formal financial systems, what the positive and significant Broad Money coefficient measures.

4.11.2 Fintech Adoption and Financial Inclusion

The H4 model supporting Hypothesis Two is in line with the empirical evidence about mobile money and digital finance.(Aker and Mbiti, 2010) determined that mobile technology fundamentally alters the access to financial services in

economies with limited physical banking facilities, and (Jack and Suri, 2014) presented rigorous household-level findings that mobile money in Kenya enhanced risk-sharing, savings, and economic resilience in previously unbanked populations. The coefficient of positive 2.468 of Fintech Adoption of the present study based on the data of Global Findex survey on digital payment uptake supports that the same dynamic at the micro level in Kenya can be observed at the macro level among 79 developing countries and three waves of the survey. This observation also aligns with the argument by (Arner et al., 2018) that fintech is revolutionizing the financial landscape by driving the cost and geographic barriers to access downward, and (Ozer-Balli and Sorensen, 2013), who carried out a synthesis of the digital finance literature to reveal that digital financial tools are enhancing inclusion in economies where the relevant institutional and infrastructure conditions exist. This base study by (Azmeh and Al-Raeei, 2024) that reported a dual and conditional relationship between fintech and financial inclusion in developing nations was specifically empirically supported by the present study finding that the relationship between fintech and inclusion is significantly mediated by the quality of infrastructure.

4.11.3 Moderation by Digital Infrastructure

The validation of Hypotheses Three and Four is the most theoretically new input of this research. The observation that Digital Infrastructure enhances the positive impact of Financial Literacy on Broad Money by about 3.589 percentage points per standard deviation of infrastructure improvement indicates that the literacy-inclusion correlation does not hold in all developing nations but rather is mediated by the digital ecosystem in which better-educated people are integrated. Financial Literacy in countries that are in the upper quartile of the digital infrastructure creates an average of twice the gain of financial inclusion versus those in the lower quartile. This is the practical implementation of the Access Theory argument in (Ribot and Peluso, 2003) the right to access is not identical to the right to benefit, and Digital Infrastructure is the series of structural processes for transforming cognitive right created by financial literacy into real financial participation.

The Digital Infrastructure moderates the Fintech-inclusion relationship, as validated by Hypothesis Four, is aligned with the research which suggested that meaningful digital financial inclusion involves individual knowledge as well as trustworthy digital ecosystem. Positive 1.408 is the coefficient of interaction that indicates that fintech adoption produces higher dividends of financial inclusion in those countries with stronger digital platforms. This also aligns with (Sahay et al., 2020), who demonstrated using IMF that the potential of digitalization in terms of financial inclusion can only be achieved when the institutional and technological environment is developed accordingly. The empirical strength of the moderation argument is in the fact that both H3 and H4 coefficients of interaction are positive, statistically significant, and strong across all standard error estimators, and are not contingent on a specific methodological assumption. When all the four hypotheses are put into consideration, the study fulfills all the four research objectives that it states. The analysis has assessed and confirmed the impact of Financial Literacy on Financial Inclusion (Objective One), investigated and confirmed the positive relationship between Fintech Adoption and Financial Inclusion (Objective Two) and confirmed significant positive moderating effects of Digital Infrastructure on both the literacy-inclusion (Objective Three) and fintech-inclusion (Objective Four) relationships. The integrated Digital Inclusion Nexus framework that considers the individual cognitive capability, technological adoption and structural infrastructure as a coordinated system as opposed to being independent inputs is strongly supported by the data of 84 developing countries and 15 years.

4.12 Chapter Summary

The overall empirical findings of the study were summarized in a logical order (data characterization to hypothesis confirmation) in this chapter. The heterogeneity of the sample and the distributional properties of all the variables were determined using descriptive statistics. The correlation matrix indicated that bivariate associations were strong as per theoretical expectations and VIF analysis indicated the lack of multicollinearity. ADF unit root tests were used to verify that all variables

were stationary at levels, which justified the use of levels models. The Hausman tests were all consistent to show that Fixed Effects was the correct estimator in all four models. Diagnostic tests indicated the heteroskedasticity, serial correlation, and panel dependence of the residuals of all primary models, and it was corrected by the use of Driscoll-Kraay standard errors as the main specification. The base models showed significant positive direct impact of Financial Literacy on Broad Money as a percentage of GDP (H1 accepted), and that Model could account 46.6 percent variation within countries. The moderation models established that Digital Infrastructure manifests a significant positive effect on the Financial Literacy impact on Financial Inclusion (H3 supported), the Fintech Adoption impact on Financial Inclusion (H4 supported) and the Fintech Adoption primary Driscoll-Kraay specification (H2 supported) is also significant. IV estimation was used to ensure that there was no endogeneity in the two moderation models. Four hypotheses are accepted and four research objectives are achieved. The results were related to a deep tradition of previous literature on Human Capital Theory, Access Theory, Public Good Theory, and the empirical evidence base on the Digital Inclusion Nexus in developing economies, grounding the contribution of the study in the literature on the Digital Inclusion Nexus.

Chapter 5

Discussion and Conclusion

This concluding chapter completes the thesis to its scholarly and practical conclusion by summarizing all the results, assessing their overall significance, and putting it into the context of the overall discussion on financial inclusion in the developing world. The chapter is divided into five substantive parts. Section 5.2 includes the general findings of the research by returning to each research objective and research question in relation to the empirical evidence generated in Chapter 4, to assess whether each hypothesis was proven, and what the pattern of findings suggests about the coherent theoretical framework. Section 5.3 is the discussion of the theoretical contribution of the study and the further development of the findings as contributing or challenging the theoretical traditions that were discussed in Chapter 2. Section 5.4 extracts the policy and practical implications of the findings to the governments, regulators, development institutions and other players in the private sector trying to promote financial inclusion in the developing economies. Section 5.5 provides a clear and candid description of study limitations, including data limitations, measurement challenges, sample limitations and methodological limitations which frame how the results may be used. Section 5.6 reveals the future research agenda that will arise directly out of the findings, gaps that are verified through the analysis, and limitations that are admitted in the previous section. The study ends the chapter by giving a brief reflection on how the study as a whole has contributed to the growing literature on the Digital Inclusion Nexus in developing economies.

5.1 Overall Conclusion

The research question was to discover an issue that lies at the intersections of financial development, human capital accumulation, technological innovation, and structural connectivity: how financial literacy and fintech adoption can affect financial inclusion in developing countries, and how digital infrastructure moderates both of these relationships? The study was inspired by three overlapping observations. To begin with, financial exclusion is a thorny and spatially concentrated issue in the developing world, and over a billion adults have little or no meaningful access to formal financial services despite a decade of policy focus and technological upheaval. Second, the three most significant technology-era determinants of financial inclusion, which are financial literacy, the adoption of fintech, and the digital infrastructure, each had deep but mostly disaggregated empirical literatures that were unable to answer the conditional questions which policy most urgently requires to be answered. Third, the current body of literature did not have an integrated long-panel evidence base to test the hypothesis that these three forces are independent inputs to a financial inclusion production function or whether they are strategic complements when their joint effect is greater than the sum of their respective effects.

To tackle this issue, the study has developed a 15-year balanced panel of 84 developing nations between 2010 and 2024 based on the World Development Indicators, the Global Findex Database and PCA-based construction of composite indexes of both Fintech Adoption and Digital Infrastructure. The use of Fixed Effects panel estimation was verified by five Hausman tests and Driscoll-Kraay standard errors are used as the main specification to mitigate the confirmed heteroskedasticity, serial correlation and panel dependence of the residuals. Fixed Effects proved to be the adequate estimator because the Instrumental Variable estimation showed that there was no endogeneity. The research had five hypotheses that were grouped in three direct effect relationships and two moderation relationships with Broad Money as the main financial inclusion proxy in consideration of its greater explanatory capacity as well as being theoretically consistent with the financial depth aspect of inclusion.

5.1.1 Hypothesis-by-Hypothesis Conclusions

Financial Literacy has a positive impact on Financial Inclusion. The empirical evidence completely supports Hypothesis One. Under the primary model, Model 3 which uses Broad Money as a percentage of GDP as the dependent variable and estimated with 925 observations and 82 countries, Financial Literacy has a coefficient of positive 8.959, which is statistically significant at the one percent level according to the primary Driscoll-Kraay standard errors. This conclusion provides a positive answer to the first Research Question: financial literacy has a significant and meaningful positive effect on financial inclusion in developing countries. An improvement in the Financial Literacy index by a standard deviation or about a twelve percentage points in the tertiary enrollment rate compared to the cross-country average is expected to increase the Broad Money to GDP ratio by about 8.96 percentage points, other factors held constant within the same country over the 15-year sample period. This finding is in line with the theoretical forecast of the Human Capital Theory (Becker, 1964), which assumes that any investment in knowledge and skills positively returns productive benefits such as the ability to negotiate through the formal financial institutions and digital financial platforms. It corroborates the cross-country evidence of (Grohmann et al., 2018) and the experimental evidence of (Drexler et al., 2014). Research Objective One, which aims at determining the effects of financial literacy on financial inclusion, is thus met.

Fintech Adoption positively impact Financial Inclusion. Hypothesis Two is fully supported by the empirical evidence. Fintech Adoption has a coefficient of positive 2.468 at the primary standard errors of Driscoll-Kraay, significant at the one percent level with a t-statistic of 7.220 in the Hypothesis Five moderation model estimated using 206 observations and 79 countries taken out of the three Global Findex survey waves of 2014, 2017, and 2021. This addresses Research Question Two with a no: the adoption of fintech has a strong positive impact on financial inclusion in developing nations. This is in line with the established mobile money evidence of (Jack and Suri, 2014) who have established that mobile financial services have created significant financial inclusion benefits to previously unbanked

households in Kenya, and with the global digital finance review of (Ozili, 2018) who synthesized evidence across developing economies that digital financial tools had the effect of reducing the cost, geographic and information barriers that impede low-income populations to participate in Similarly, the study underpinning this study,(Azmeh and Al-Raeei, 2024) also concluded that fintech fosters financial inclusivity in developing economies, and the current study generalizes that result to a larger 79-country panel with a more time-varying aspect.

Research Objective Two, to evaluate the interrelation between fintech use and financial inclusion, is thus met.

Financial Literacy and Financial Inclusion have an intermediary relationship between Digital Infrastructure. The empirical evidence completely supports Hypothesis Three and is one of the most theoretically important results of the research.

The interaction term between Financial Literacy and Digital Infrastructure in an H3 moderation model estimated using 925 observations has a coefficient of positive 3.589, and is significant at the one percent level under all three standard error specifications with the most demanding Driscoll-Kraay estimator with a t-statistic of 9.717.

This provides a positive response to Research Question Four: Digital Infrastructure does have a significant and positive moderating effect on the relationship between financial literacy and financial inclusion, with the effect of inclusion-enhancing financial literacy increased in countries with better digital infrastructure.

The practical meaning of this is that a one standard deviation increase in Financial Literacy is related to an increase in Broad Money of about 8.96 percentage points at average infrastructure, yet this amount of improvement is raised by 3.589 percent more at each one standard deviation higher Digital Infrastructure, on average.

Those countries that are in the upper quartile of digital infrastructure thus receive almost twice the financial inclusion payoff of the corresponding literacy enhancement than countries in the lower quartile. This outcome is exactly what the Access Theory (Ribot and Peluso, 2003) presupposes it is literacy that enables people to

have the right to engage in formal financial markets, yet it is digital infrastructure that is the structural gatekeeper that defines whether this right translates into the ability to profit.

Similar findings by (Hasan et al., 2021) indicated that enabling contextual conditions modulate the literacy-fintech-inclusion relationship and that the given study applies the same reasoning to affirm that digital infrastructure is a particular (and strong) moderating factor of the direct literacy-inclusion relationship. Fourth Objective of Research is thus accomplished.

Digital Infrastructure moderates the relationship between Fintech Adoption and Financial Inclusion. The empirical evidence is completely in support of Hypothesis Four. The Fintech Adoption by Digital Infrastructure interaction term is positive in the H4 moderation model estimated on 206 observations in the three Findex survey waves with a coefficient of positive 1.408 that is significant at one percent under Driscoll-Kraay standard errors with t-statistic of 3.070 and at five percent under both HC3 and SCC group-clustered standard errors.

The consistency of this interaction coefficient with all three standard error specification reinforces the fact that the moderation finding was authentic and not reliant on a specific error structure specification.

This provides a yes answer to Research Question Five: Digital Infrastructure is an important and positive moderator of the fintech-inclusion relationship. Those countries that simultaneously have high fintech adoption with high digital infrastructure have disproportionately high financial depth compared to those countries where fintech adoption is in a poor infrastructure environment.

The closest parallel is by (Nazir and Ahmad, 2025), who show that digital infrastructure is a moderating and moderating factor in fintech-inclusion channels in developing economies, with a moderated-mediation design, a result fully consistent with the positive and significant interaction coefficient reported here.

The finding of Sub-Saharan African context is supported by (Avom et al., 2023), and confirms that mobile infrastructure controls the impact of financial inclusion of mobile technology adoption, and the current study generalises this regional result

to a global panel of developing countries. This in turn fulfills Research Objective Five.

5.1.2 The Integrated Picture: All Hypotheses Supported, All Objectives Met

Collectively, the five outcomes of the hypothesis provide a consistent and internally cohesive image, which validates both the theoretical framework developed in Chapter 1 and the conceptual reasoning elaborated in Chapter 2. There is statistically significant and substantively meaningful empirical support of all five hypotheses. The five research objectives are achieved. The main hypothesis of the study, that financial literacy, fintech usage and digital infrastructure are strategic complements, whose joint impact on financial inclusion surpasses the aggregate impact of their respective contributions, is validated by the positive and significant coefficients on both interaction terms. The integrated ecosystem where individual cognitive capability, technological adoption and structural digital platform needs to fit and financial inclusion is maximized, the Digital Inclusion Nexus, is not just a theoretical creation but an empirically provable fact over 15 years in 84 developing countries.

The hierarchy of effects sizes of the study also provides a significant conclusion regarding the binding limit of financial inclusion development of developing economies in the period 2010-2024. The strongest one is Digital Infrastructure with its direct effect coefficient of positive 17.850 which is over two times greater than the coefficient of financial literacy of positive 8.959. This chain of command suggests that structural connectivity gaps are binding during the present stage of financial evolution of the developing economy than the human capital gaps. Any developing nation that invests in financial literacy without also investing in digital infrastructure, generates knowledgeable but structurally marginalized groups of people who cannot apply their knowledge to financial engagement due to the lack of, unreliability of, and unaffordability of the digital platforms through which the modern financial services are being provided. This conclusion is supported by

the evidence of moderation: the marginal investment of financial literacy is also rising in the degree of digital infrastructure, that is, the higher the infrastructure, the more productive are investments in literacy. This presents a compounding case of infrastructure investment that is past the direct inclusion effect to the amplification of returns to all other financial inclusion investments.

5.2 Theoretical Contributions

The research contributes to the theoretical body of literature on financial inclusion in three distinct aspects. The initial contribution is that five theoretical traditions, Financial Development Theory, Human Capital Theory, the Technology Acceptance Model, Access Theory, and Public Good Theory are integrated into one integrated framework that assigns each study variable its theoretical basis and each interaction a particular theoretical mechanism. The previous literature on financial inclusion has generally relied on one or two theories, the current research shows that a five-theory integrated architecture is required to comprehensively address the cognitive, technological and structural aspect of the inclusion issue and its interplay. The merits of the framework are also that it is falsifiable: each interaction hypothesis is falsifiable by a specific theoretical prediction that may or may not be supported by empirical data.

The second theoretical input is the empirical confirmation of Access Theory as an effective framework to comprehend the process of financial inclusion in developing countries.(Ribot and Peluso, 2003) came up with their theory within the natural resource governance context and the application of the theory to financial access has been mostly theoretical and qualitative. The current research piece presents quantitative cross-country panel data that the Access Theory mechanism is indeed functioning in the expected manner: the financial literacy right to participate is indeed being turned into an actual ability to participate, with a moderating structural quality of digital infrastructure having an estimated positive interaction coefficient of positive 3.589 that quantifies the moderation effect. This is an important empirical generalization of Access Theory to the field of financial inclusion.

The third theoretical contribution is the elucidation of the connection between the Public Good Theory and financial inclusion using the moderation evidence of fintech adoption. The study empirically supports the theoretical conclusion that the supply of a public good such as digital infrastructure will produce multiplicative rather than additive externalities on nearby activities by private users by illustrating that digital infrastructure, as a quasi-public good, increases the financial inclusion returns to acceptance of private fintech, and that the returns to adoption are multiplicative, not additive. This multiplicative externality is directly empirically quantified by the interaction coefficient of positive 1.408 on the Fintech Adoption by Digital Infrastructure term, which quantifies the social return to infrastructure investment beyond the direct financial inclusion effect to the amplification of the returns to individual fintech investment.

5.3 Policy and Practical Implications

5.3.1 Implications on National Governments

The policy implication of this study that is closest at hand is the priority of digital infrastructure investment as the basis of any serious financial inclusion policy. The result that Digital Infrastructure is the strongest factor in promoting financial inclusion, with its impact size more than twice that of Financial Literacy, and the fact that it supports the returns to literacy and to adoption of fintech, both statistically significantly, creates a definitive prioritization of investment by governments with limited development budgets. Infrastructure first, then coordinated simultaneous investment in financial education and fintech development, is the ordering that the empirical evidence supports. A government that encourages financial literacy education in school, but does not assure students to have a stable smartphone network and affordable mobile internet connectivity by the time they become adults is not getting the full benefit of the education investment. A government that promotes the development of fintech, but does not develop the broadband and electricity infrastructure on which fintech platforms can operate reliably, is not getting the best out of its regulatory reform project.

In the case of Pakistan, the country of origin of this study and where financial inclusion is in most dire need in South Asia, the empirical findings of the study translate into a policy roadmap in a sequence around the three variables that the moderation analysis suggests as complementary.

Before anything else, we have to invest in infrastructure. It's the most urgent piece of the puzzle. The Pakistan Telecommunication Authority's Broadband Policy 2030 aims to increase the number of broadband subscribers to 100 million by 2030, but rural tele density is still less than 40 percent and fixed broadband penetration less than 3 percent of the population.

The empirical evidence that Digital Infrastructure has the largest direct coefficient in the study (positive 17.850 on Broad Money as a percentage of GDP) suggests that each percentage point increase in rural broadband coverage will yield disproportionate financial deepening benefits.

The Universal Services Fund, whose mandate is to provide telecommunications infrastructure in under-served areas, and which is funded by a levy on telecommunication companies is the most direct infrastructure-focused mechanism. This evidence offers empirical support to the USF to scale up its rural broadband schemes as financial inclusion projects rather than just telecommunication infrastructure investments.

The second focus is the simultaneous roll-out of the State Bank of Pakistan's digital financial infrastructure and telecommunications infrastructure. Raast thrown in January 2021. By 2024 it had already held over 500 million transactions. That's proof: when digital payments are cheap and work across all banks, people actually use them even those who never had a bank account before. But the moderation evidence suggests the financial inclusion benefits of Raast are severely limited in districts with poor mobile network coverage or unreliable electricity. The National Financial Inclusion Strategy wants 65

The third priority is the National Financial Literacy Programme (NFLP) managed by the SBP with the provincial education authorities. The Human Capital Theory basis of this study suggests that financial literacy investments are increasing returns in environments with higher digital infrastructure - the interaction

coefficient of positive 3.589 indicates that the same investment in financial literacy has almost twice the impact on financial inclusion in high-infrastructure as compared to low-infrastructure environments. This finding implies that the NFLP should be delivered in the geographical areas where the USF and PTA have recently rolled out infrastructure, as opposed to rolling literacy programs out everywhere. An infrastructure- and location-specific literacy delivery strategy will deliver maximum return on the financial inclusion investment that the USF and PTA infrastructure investments can generate.

Pakistan's financial inclusion gap must explicitly consider the gender dimension. Given the low rate of female account ownership (7 percent compared to 33 percent for males), financial inclusion improvement in Pakistan will be constrained unless the interventions are targeted specifically at female financial inclusion, overcoming the barriers to mobility, digital literacy, and cultural acceptance of financial independence. The Benazir Income Support Programme (BISP) digital payment network already serving more than 9 million female beneficiaries via mobile wallets is the most promising platform for gender-focused financial inclusion. To advance BISP's digital payments infrastructure while providing female beneficiaries with financial literacy training will create the combined literacy-infrastructure environment that moderation evidence suggests as the most profitable investment pairing.

5.3.2 International Development Institutions Implications

To the World Bank, the International Monetary Fund, the Asian Development Bank, and bilateral development agencies, the study offers a cross-country panel evidence base that assists in designing integrated programs of financial inclusion that combine financial literacy interventions, fintech regulatory reform, and infrastructure investment as part of integrated programmatic activities and not as independent sectoral activities. The Global Findex data, the World Development Indicators and the Fixed Effects methodology that produced the findings of the study are all conventional analytical tools of these institutions and hence the evidences can be directly applied to their country diagnostic frameworks. The lower quartile of digital infrastructure being identified as the settings where a combined

literacy and infrastructure investment has the highest potential gains offers a geographically specific targeting criterion, which is both operationally feasible and evidence-based concessional infrastructure financing.

The moderation evidence can be utilized by development finance institutions like the International Finance Corporation that finance fintech firms in developing markets to prioritize their markets where digital infrastructure is adequate to enable them to deliver reliable services to enhance the social return on their portfolios of financial inclusion investments.

5.3.3 Implications for the Private Sector

In the case of fintech firms, mobile network operators, commercial banks broadening digital offerings, and microfinance institutions implementing digital delivery, the findings of the study offer strategic insights regarding the structural conditions in which the services of such institutions have the strongest population-level uptake and financial inclusion impact.

The result that returns to the adoption of fintech are higher in systems with greater infrastructure suggests that market entry and market development strategies should consider the quality of infrastructure, not just the nominal number of unbanked populations as the key market sizing factor.

A high number of unbanked people with a low connection environment is also a structurally constrained market in which the uptake of fintech will be low and the cost of acquiring customers will be high no matter the quality of the product. On the contrary, an infrastructural event like a new submarine cable, a mobile network expansion to unserviced rural locations, or a significant decline in data prices presents a step-change in the market the digital financial services can address that can be predicted and exploited by forward-looking fintech firms. The evidence of the study can be used by telecoms and infrastructure providers to develop the business case to invest in infrastructure in underserved markets by showing that the financial services market potential of newly connected populations is directly related to connectivity expansion.

5.4 Limitations of the Study

The limitations of any empirical study in development economics are the corollary of design choices that confer power. This study has a few limitations, and we're upfront about them below. But each one came from a trade-off we made on purpose, because that choice also gave us a big advantage in how we ran the study. The country-aggregate nature of the study, rather than the individual data provided by household surveys, is a limitation in that it precludes disaggregation by gender, income or sector/location, but it also allowed the study to cover 84 countries across 15 years with Fixed Effects estimation - something that no household survey study could do. The use of tertiary education as the Financial Literacy proxy is a limitation in that it is a proxy for financial knowledge, but it is also the reason Financial Literacy can be observed annually across all 84 countries rather than only in the three Findex survey years - a data availability constraint that would have reduced the primary panel from 925 to 206 observations and denied the statistical power required to detect the moderation effect in Hypothesis Four. The triennial nature of the Fintech Adoption data is a limitation in that it reduces the H4 moderation model to 206 observations, but it is also the global evidence frontier - the Global Findex Database is the world's most comprehensive individual-level financial behavior database and its triennial data collection cycle is an equal constraint for all researchers in this field, not just this study. This is the intellectually and analytically complete way to understand the limitations of the study - as the costs of method that are necessarily borne in exchange for the advantages that allow the study to make its contributions.

5.4.1 Data Frequency and Historical Limitations

The largest data constraint of this research is related to the variable Fintech Adoption. The most comprehensive, and globally comparable, source of individual-level financial behavior data that covers digital payment adoption rates is the Global Findex Database, but is only released in three-yearly survey waves with available data in 2014, 2017 and 2021 in the sample period of the study. This implies that

the Fintech Adoption index has only three time points (not annually), and reduces the effective sample of the moderation models of Fintech Adoption to 206 country-wave observations of 79 countries instead of 925 annual observations of Financial Literacy models. There are three implications of this limitation. First, Hypothesis Five moderation model possesses far lower statistical power than Hypothesis Four model, i.e., even in case the true effect of interaction is of the same scale, the Fintech-based model will yield less accurately estimated coefficients. Second, since the Findex data has a three-wave structure, Within-country Fixed Effects in the H4 model can only identify three observation per country and not 15 observations per country, thus restricting the identification of within-country time dynamics. Third, the three survey years of 2014, 2017, and 2021 represent vastly dissimilar world financial and technological contexts, such as the high rate of smartphone penetration in 2014-2017 and the accelerated rate of fintech adoption in 2020-2021, and it is hard to disentangle the impact of true adoption patterns.

An associated data frequency constraint is related to the frequency of observation of the primary panel. Although annual data offers much richer identification information than the three-wave Findex structure, most of the structural processes that are reflected by the variables of the study are much longer-run processes. Financial literacy, more specifically, is the fruit of educational investments that pay off over decades, and the impact it has on financial behavior may have longer lags than annual data can detect. Equally, investment in digital infrastructure, like the deployment of submarine cables or the deployment of national broadband, has a payoff that accrues over years, not months, and in this case the relationship between the index of infrastructure and financial inclusion results at a point in time may be understated as to the payoff in the long run. This temporal limitation can be overcome by future studies using longer panels or the distributed lag models which have been specified appropriately.

5.4.2 Measurement and Proxy Limitations

The measure of the Financial Inclusion is the dependent variable of the study which is measured by Broad Money percentage of GDP. Although the superior proxy,

by explanatory power, is Broad Money, all three measures are supply-side rather than demand-side measures of the depth and reach of the financial system rather than demand side measures of individual-level financial participation. They are unable to tell the difference between those countries in which high Broad Money is evidence of wide population-level access to the formal financial system, and those in which high Broad Money is evidence of concentrated holdings by a small wealthy elite. The lack of either annual or cross-country individual-level financial inclusion data of the type that the Findex has only provided at three-year intervals is a basic limitation of the macroeconomic panel format, rather than a limitation that could have been overcome by the current study by other design decisions, but a limitation that future research must overcome by collecting the survey data more frequently.

Financial Literacy proxy of tertiary enrollment rate as a percentage gross is a structural measure of human capital investment at the population level and not a direct measure of financial knowledge, attitudes or behavior at the individual level. This proxy was chosen because of the lack of a consistent annual country-level data on financial literacy as directly measured, and it was justified because of its positive correlation with financial inclusion and because it was consistent with the cross-country financial literacy measuring methodology of (Grohmann et al., 2018). However, the tertiary enrollment measure fails to measure the content of education on financial knowledge, and two countries with the same tertiary enrollment rates and very different financial education curricula might have very different levels of effective financial literacy. This imprecision in measurement creates classical measurement error which will push the estimated Financial Literacy coefficient towards the null and the true effect of financial literacy on financial inclusion could be even greater than the already high coefficient of positive 8.959 obtained in this study.

5.4.3 Sample and Scope Limitations

With the sample of 84 developing countries, the largest in the financial inclusion panel literature, the study, by nature, excludes both the developed economies and

some of the developing economies where the data was not available to satisfy the minimum observation requirements to estimate Fixed Effects. The sample is systematically underrepresented or missing small island developing states or a number of low-income Sub-Saharan African economies, or countries with protracted conflict or institutional collapse. This raises a selection issue: the countries where data exists can be systematically different than the countries where it does not, namely in terms of institutional capacity and stability in governance as well as in terms of functional statistical systems. When such features are positively related to financial inclusion outcomes, the research can overestimate the average financial inclusion in the developing world, as well as fail to represent the worst instances of structural exclusion. The results can thus be seen as applicable to most of the developing economies that have effective data collection systems but not the entire gamut of development settings.

The firm narrows down on macro-level, country-aggregate determinants of financial inclusion, and does not investigate within-country differences in financial access by gender, income quintile, age group, geographic location or ethnic or religious background. These domestic distributional aspects of financial inclusion are coming to be increasing in prominence in the policy agenda, as overall increases in financial inclusion may conceal ongoing exclusion of certain demographic groups as national means increase. A country in which the Broad Money ratio increases significantly due to the greater financial participation of urban middle-income groups and the exclusion of rural women and subsistence farmers is technically doing better on the main measure of the study but poorly on the dimensions of inclusion that are most important in terms of equity and poverty alleviation. This limitation can be resolved in future studies that incorporate the macro panel design of the current study and the disaggregated house hold level data but will maintain the cross-country comparative aspect.

5.4.4 Methodological Limitations

Fixed Effects panel estimator that is used in the entire study is used to control the time-invariant country characteristics but fails to explain the time-varying omitted

variables correlated with the regressors and financial inclusion outcomes. Examples of time-varying forces that might both cause changes in digital infrastructure, fintech adoption, and financial inclusion across countries simultaneously are global financial cycles, international regulatory convergence, regional contagion effects in financial development, and commodity price shocks, which are not fully captured by the country and year fixed effects.

The Driscoll-Kraay standard errors solve the panel dependence of the residuals that results, but fail to solve the possibility of omitted variable bias due to time-varying confounder. Although the IV endogeneity tests based on lagged variables show no reverse causality bias, they cannot eliminate the possibility of bias due to time-varying confounders, so the estimated coefficients are conditional association estimates that are resistant to time-invariant heterogeneity, but not necessarily identify the causal effects. The fact that Hypotheses Four and Five are not a single combined model but are separated into two separate models, although validated by the inability of the Findex data to do so, and the fact that the inter-interaction correlation between the FL by DI and FT by DI interactive terms is high, 0.843, implies that the relative magnitudes of the two moderation pathways cannot be directly estimated in a single unified specification in this fact that the two interaction terms may share overlapping explanatory content that cannot be easily separated is a limitation that is noted in the methodology and addressed through the separate model design, but implies that the study cannot yield a single definite statement about which pathway of moderation is more strong based on a single integrated model.

5.5 Future Research Directions

The results of this study, along with the limitations that were discussed in the previous section, create a clear and specific research agenda that will further elaborate, expand and in a way challenge the conclusions presented here. There are five directions that are found to have most significant impacts on the development of the literature.

The initial and urgent goal is the design and implementation of annual and cross-country financial literacy measurement. Currently the Global Findex Database offers financial behavior data at intervals of three years and there is no similar annual cross-country database of financial literacy measured directly, as opposed to being proxied by education indicators. The Standard and Poor Global Financial Literacy Survey, referenced by (Grohmann et al., 2018) has been estimated only in a few waves and has not been panel-estimable. Future studies would be recommended to include systematic yearly gathering of financial literacy measures in the Findex (or a special World Bank financial capability module) which would permit estimating the true literacy-inclusion changes in countries over a timeframe as opposed to depending on educational enrollment proxies. In case annual literacy data were accessible, the dichotomy for H4 models might be quite plausibly reconciled in an integrated annual panel specification with significantly more statistical power.

The second direction in the future involves disaggregated examination of the moderation effects by gender, income quintile, rural-urban location, and age group. The current research shows that digital infrastructure moderates the overall association between financial literacy and financial inclusion and between fintech adoption and financial inclusion on the country level. Yet this aggregate outcome can mask heterogeneous moderating effects: it would be reasonable to expect that women, being more financially marginalized than men in most developing nations and having lower average levels of digital connectivity and financial literacy in many environments, would experience the overall returns to combined literacy and infrastructure investments in disproportionate amounts. It is also reasonable to believe that the most constrained populations, rural ones, would exhibit larger moderation effects compared to urban populations that are already linked. This gap could be filled by disaggregated moderation analysis based on household panel data with country level infrastructure measures, which would generate findings with more specific targeting implications to gender-responsive and geographically-sensitive financial inclusion policy.

The third way to go is to expand the temporal analysis range when the data will

be available even further than 2024. It is expected that by 2024-2030 the digital financial environment will continue to experience numerous significant shifts: the development of financial services based on artificial intelligence, the introduction of Central Bank Digital Currencies by more and more developing economies, the finalization of blockchain-based payment platforms, and the deployment of large-scale broadband infrastructure projects including undersea cable systems linking Sub-Saharan Africa and South Asia. The issue of whether these changes reinforce or change the moderation relationships observed in this study or not is an empirical question that can be answered only by future panel data. Future studies that project the current panel to 2024 but retain the same methodological framework would give the closest test of whether the Digital Inclusion Nexus relationships found here stand across changes in technology or need re-specification as the technology and infrastructure environment changes. The fourth way forward relates to the incorporation of the institutional quality variables into the moderation framework. The current study has experimented with five governance indicators of the World Governance Indicators as control variables and all have yielded inconclusive or negligible findings in the Fixed Effects model, mainly due to the slow pace of within-country governance changes over the 15-year sample period. Nevertheless, the quality of governance is theoretically applicable both to the fintech-inclusion relationship, in the sense of its impact on regulatory trust and consumer protection, and to the infrastructure-inclusion relationship, in the sense of the impact of quality on the incentives to invest in infrastructure. Future studies with longer panel lengths, dynamic governance indicators, or governance shocks as an identification strategy may better include institutional quality within the moderation system and whether governance is a third moderating variable that conditions the effectiveness of literacy and fintech and infrastructure. The fifth direction is a future direction towards methodology. The main estimator of the current study was Fixed Effects estimation, verified by Hausman tests and endogeneity tests. This can be further developed in future, with the implementation of Spatial Panel Methods to consider geographic spillovers in financial inclusions among the neighboring countries which did with the European Union context but, again, has not yet been implemented on the global panel of developing countries.

There are high probabilities of spatial spillovers in the financial inclusion context: a nation that advances its network infrastructure might create cross-border fintech adoption when neighboring populations can use the same mobile networks, and a nation that implements an effective financial literacy program might create human capital spillovers as a result of labor migration.

Such interdependent spatial panel models would yield more accurate estimates of the country effects as well as produce evidence of the regional public good properties of infrastructure investment that are policy relevant to the institutions of regional development.

5.6 Recommendations

The following recommendations are given based on the empirical results of this study. As the empirical evidence demonstrates, national governments in developing economies should focus on investing in digital infrastructure – that is, expanding broadband availability, mobile network coverage, and access to electricity – as this is the most powerful moderating force that amplifies the returns to financial literacy and fintech use. Second, financial literacy programs are not effective on their own; they need to be complemented with parallel investments in the digital infrastructure, as indicated by the interaction effect (H3:β = +3.589, p ¡ .001): the impact of literacy is contingent on the quality of the digital ecosystem that it is part of. Third, infrastructure reliability assurances should accompany fintech regulatory reform as there is considerable interdependence between fintech and infrastructure (H4:β = +1.408, p = .003). Fourth, international development institutions (IDIs) such as the World Bank, IMF, and regional development banks should explore the possibility of developing a financial literacy training program in conjunction with regulatory support for fintech and infrastructure financing as a single programmatic approach, instead of as individual programs. Last but not least, digital infrastructure quality (in addition to other indicators like financial literacy or fintech adoption rates) should be treated as a leading indicator of financial inclusion program success in the context of developing countries.

5.7 Concluding Reflection

This thesis attempted to answer a question that lies at the core of twenty-first century development economics: in a world where mobile phones have surpassed bank branches as primary access to financial services to billions of people, what individual knowledge, technological adoption, and structural connectivity combine in the most powerful way to determine whether or not those billions will have meaningful access to the formal financial system? The direction that the evidence gives is obvious, and the magnitude is important, and the hierarchy is instructive. The structural precondition, the Digital Infrastructure, is the precondition of individual financial knowledge acting-upon and the precondition of fintech platforms reaching their intended users. Financial Literacy refers to the mental capability that defines the effectiveness with which people turn their access to digital financial services into effective financial engagement. The technological channel that brings financial services to previously geographically, cost- and institutionally inertia-bound populations is called Fintech Adoption. And these three forces and their interactions are not incidental: the greater the investment in each of these dimensions, the greater the returns when the other two are strong and present.

To the developing nations which are the sample of the study, and to the international policy community whose task is to serve the developing nations, this combined finding has a message both uplifting and challenging. It is promising since it confirms that financial inclusion gains can be attained by making investments accessible to the majority of developing economies: by enhancing educational achievement, eliminating regulatory obstacles to fintech, and increasing broadband and mobile connectivity are policy tools that governments, international organizations, and other private investors can implement. It is challenging in that it proves that piecemeal investments in any of the three dimensions are far less effective than co-ordinated investments in all three, and demands a degree of cross-sectoral policy coherence and institutional commitment seldom seen in practice. To realize its full potential, the digital financial inclusion agenda should not remain confined to the siloed approach, which has traditionally defined it, where financial education resides in ministries of education, fintech regulation resides in

central banks and financial regulators, and digital infrastructure resides in ministries of information technology, but embrace an integrated development model in which literacy, technology, and connectivity are seen as an ecosystem that needs to be governed as a single unit The one billion adults outside the formal financial systems do not sit back and wait until one solution comes by. They are awaiting the meeting point of the knowledge to consume financial services, the platforms enabling financial services to be available and the infrastructure enabling the platforms to operate. This study has given the empirical data that this convergence is a concern, that it is quantifiable, and can be created intentionally and methodically by collective policy action. This is what this thesis can contribute to the study and practice of financial inclusion.

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Appendix A: List of Sample Countries

The following 84 countries constitute the study sample covering the period 2010–2024.

No.	Country	Region	Income Group
1	Albania	Europe & Central Asia	Upper Middle Income
2	Argentina	Latin America & Caribbean	Upper Middle Income
3	Armenia	Europe & Central Asia	Upper Middle Income
4	Azerbaijan	Europe & Central Asia	Upper Middle Income
5	Bahrain	Middle East & North Africa	High Income
6	Belarus	Europe & Central Asia	Upper Middle Income
7	Belize	Latin America & Caribbean	Upper Middle Income
8	Benin	Sub-Saharan Africa	Low Income
9	Bhutan	South Asia	Lower Middle Income
10	Bosnia and Herzegovina	Europe & Central Asia	Upper Middle Income
11	Brazil	Latin America & Caribbean	Upper Middle Income
12	Bulgaria	Europe & Central Asia	Upper Middle Income
13	Burkina Faso	Sub-Saharan Africa	Low Income
14	Burundi	Sub-Saharan Africa	Low Income

No.	Country	Region	Income Group
15	Cameroon	Sub-Saharan Africa	Lower Middle Income
16	Chad	Sub-Saharan Africa	Low Income
17	Chile	Latin America & Caribbean	High Income
18	Colombia	Latin America & Caribbean	Upper Middle Income
19	Congo, Dem. Rep.	Sub-Saharan Africa	Low Income
20	Costa Rica	Latin America & Caribbean	Upper Middle Income
21	Cote d'Ivoire	Sub-Saharan Africa	Lower Middle Income
22	Czechia	Europe & Central Asia	High Income
23	Denmark	Europe & Central Asia	High Income
24	Dominican Republic	Latin America & Caribbean	Upper Middle Income
25	Ecuador	Latin America & Caribbean	Upper Middle Income
26	Egypt, Arab Rep.	Middle East & North Africa	Lower Middle Income
27	El Salvador	Latin America & Caribbean	Lower Middle Income
28	Georgia	Europe & Central Asia	Upper Middle Income
29	Ghana	Sub-Saharan Africa	Lower Middle Income
30	Guatemala	Latin America & Caribbean	Upper Middle Income
31	Honduras	Latin America & Caribbean	Lower Middle Income
32	Hong Kong SAR, China	East Asia & Pacific	High Income
33	Hungary	Europe & Central Asia	High Income
34	Iceland	Europe & Central Asia	High Income
35	India	South Asia	Lower Middle Income
36	Indonesia	East Asia & Pacific	Upper Middle Income
37	Iran, Islamic Rep.	Middle East & North Africa	Lower Middle Income
38	Israel	Middle East & North Africa	High Income
39	Jamaica	Latin America & Caribbean	Upper Middle Income

No.	Country	Region	Income Group
40	Jordan	Middle East & North Africa	Upper Middle Income
41	Kazakhstan	Europe & Central Asia	Upper Middle Income
42	Korea, Rep.	East Asia & Pacific	High Income
43	Kyrgyz Republic	Europe & Central Asia	Lower Middle Income
44	Madagascar	Sub-Saharan Africa	Low Income
45	Malawi	Sub-Saharan Africa	Low Income
46	Malaysia	East Asia & Pacific	Upper Middle Income
47	Maldives	South Asia	Upper Middle Income
48	Mauritius	Sub-Saharan Africa	Upper Middle Income
49	Mexico	Latin America & Caribbean	Upper Middle Income
50	Moldova	Europe & Central Asia	Upper Middle Income
51	Montenegro	Europe & Central Asia	Upper Middle Income
52	Morocco	Middle East & North Africa	Lower Middle Income
53	Namibia	Sub-Saharan Africa	Upper Middle Income
54	Nepal	South Asia	Lower Middle Income
55	North Macedonia	Europe & Central Asia	Upper Middle Income
56	Norway	Europe & Central Asia	High Income
57	Oman	Middle East & North Africa	High Income
58	Pakistan	South Asia	Lower Middle Income
59	Philippines	East Asia & Pacific	Lower Middle Income
60	Poland	Europe & Central Asia	High Income
61	Qatar	Middle East & North Africa	High Income
62	Romania	Europe & Central Asia	High Income
63	Russian Federation	Europe & Central Asia	Upper Middle Income
64	Rwanda	Sub-Saharan Africa	Low Income

No.	Country	Region	Income Group
65	Saudi Arabia	Middle East & North Africa	High Income
66	Senegal	Sub-Saharan Africa	Lower Middle Income
67	Serbia	Europe & Central Asia	Upper Middle Income
68	Singapore	East Asia & Pacific	High Income
69	South Africa	Sub-Saharan Africa	Upper Middle Income
70	Sri Lanka	South Asia	Lower Middle Income
71	Sweden	Europe & Central Asia	High Income
72	Switzerland	Europe & Central Asia	High Income
73	Tajikistan	Europe & Central Asia	Low Income
74	Tanzania	Sub-Saharan Africa	Lower Middle Income
75	Thailand	East Asia & Pacific	Upper Middle Income
76	Togo	Sub-Saharan Africa	Low Income
77	Tunisia	Middle East & North Africa	Lower Middle Income
78	Turkiye	Europe & Central Asia	Upper Middle Income
79	Ukraine	Europe & Central Asia	Lower Middle Income
80	United Kingdom	Europe & Central Asia	High Income
81	Uruguay	Latin America & Caribbean	High Income
82	Uzbekistan	Europe & Central Asia	Lower Middle Income
83	Viet Nam	East Asia & Pacific	Lower Middle Income
84	West Bank and Gaza	Middle East & North Africa	Lower Middle Income